Federal Democratic Republic of Ethiopia
Ministry of Health

Hygiene and Environmental Health, Part 1

Blended Learning Module for the Health Extension Programme

HEAT

Health Education and Training
HEAT in Africa

unicef
unite for children

The Open University

AMREF
Better Health for Africa

Federal Democratic Republic of Ethiopia
Ministry of Health

The Ethiopian Federal Ministry of Health (FMOH) and the Regional Health Bureaus (RHBs) have developed this innovative Blended Learning Programme in partnership with the HEAT Team from The Open University UK and a range of medical experts and health science specialists within Ethiopia. Together, we are producing 13 Modules to upgrade the theoretical knowledge of the country's 33,000 rural Health Extension Workers to that of Health Extension Practitioners and to train new entrants to the service. Every student learning from these Modules is supported by a Tutor and a series of Practical Training Mentors who deliver the parallel Practical Skills Training Programme. This blended approach to work-place learning ensures that students achieve all the required theoretical and practical competencies while they continue to provide health services for their communities.

These Blended Learning Modules cover the full range of health promotion, disease prevention, basic management and essential treatment protocols to improve and protect the health of rural communities in Ethiopia. A strong focus is on enabling Ethiopia to meet the Millennium Development Goals to reduce maternal mortality by three-quarters and under-5 child mortality by two-thirds by the year 2015. The Modules cover antenatal care, labour and delivery, postnatal care, the integrated management of newborn and childhood illness, communicable diseases (including HIV/AIDS, malaria, TB, leprosy and other common infectious diseases), family planning, adolescent and youth reproductive health, nutrition and food safety, hygiene and environmental health, non-communicable diseases, health education and community mobilisation, and health planning and professional ethics.

In time, all the Modules will be accessible from the Ethiopian Federal Ministry of Health website at **www.moh.gov.et**; online versions will also be available to download from the HEAT (Health Education and Training) website at **www.open.ac.uk/africa/heat** as open educational resources, free to other countries across Africa and anywhere in the world to download and adapt for their own training programmes.

Dr Kesetebirhan Admasu
State Minister of Health
Ethiopian Federal Ministry of Health

Acknowledgements

Hygiene and Environmental Health is one of the 13 Blended Learning Modules for the Ethiopian Health Extension Programme. Together with the practical skills training sessions that accompany each of the supported self-study texts, this programme will upgrade the Health Extension Workers who complete the curriculum to Health Extension Practitioners at Level-IV of the Ethiopian Occupational Standards. The upgrading programme is sponsored by the Ethiopian Federal Ministry of Health (FMOH) and the Regional Health Bureaus (RHBs). The FMOH gratefully acknowledges the receipt of funding for this programme from the Ethiopian Office of UNICEF (the United Nations Children's Emergency Fund), The Open University UK, the Alan and Nesta Ferguson Foundation Trust UK, and AMREF (the African Medical and Research Foundation).

Hygiene and Environmental Health is in two separate Parts and was produced by a team of Ethiopian experts, who were trained and supported by experts in blended learning pedagogy from the HEAT (Health Education and Training) Team for Africa at The Open University UK. The contributors of original material are:

Ato Kassahun Alemu, Gondar University, School of Public Health

Dr Zegeye Hailemariam, Ethiopian Health and Nutrition Research Institute

Dr Abera Kumie (Module Academic Coordinator), Addis Ababa University, School of Public Health

Ato Worku Tefera, Addis Ababa University, School of Public Health

The Academic Editors of *Hygiene and Environmental Health* are Pam Furniss, Senior Lecturer in Environmental Systems in the Faculty of Mathematics, Computing and Technology, and Dr Sarah-Jane Davies, Lecturer in Environmental Sciences in the Faculty of Science, with contributions from Dr Hilary MacQueen, Dr Basiro Davey, Dr Stephen Burnley and Dr Suresh Nesaratnam, all at The Open University UK. The other members of the HEAT Team are:

Lesley-Anne Long, HEAT Programme Director

Dr Basiro Davey, HEAT Deputy Director (Ethiopia)

Alison Robinson, HEAT Programme Coordinator

Dawn Partner, HEAT Senior Production Assistant

Jessica Aumann, HEAT Programme Assistant

Ali Wyllie, HEAT Lead eLearning Adviser

We acknowledge the vital contributions of the Programme Coordinators within Ethiopia:

Ato Mohammed Hussein Abeseko, UNICEF Ethiopia and the Federal Ministry of Health

Ato Tedla Mulatu, AMREF Ethiopia

The cover design for *Hygiene and Environmental Health* is by Chris Hough, Learning and Teaching Solutions, The Open University UK. The cover illustration (large circle) and some other illustrations in this Module were produced by Terefe Wondimagegnehu from the Federal Ministry of Health. The small cover photo is reproduced with the permission of UNICEF Ethiopia.

We particularly wish to acknowledge our use in this Module of photographs supplied by WaterAid in Ethiopia and adapted extracts and illustrations from the following sources:

Bassett W.H. (ed.) (2004) *Clay's Handbook of Environmental Health* 19th ed, London, Spon Press.

Eawag: Swiss Federal Institute of Aquatic Science and Technology http://www.eawag.ch/index_EN

International Federation of Red Cross and Red Crescent Societies (2008) *Household water treatment and safe storage in emergencies. A field manual for Red Cross/Red Crescent personnel and volunteers*. http://www.wsscc.org/sites/default/files/publications/ifrc_hwts_in_emergencies_2008.pdf

Stockholm Environment Institute (2007) *Toilets that make compost: Low-cost, sanitary toilets that produce valuable compost for crops in an African context*, by Peter Morgan, Stockholm Environment Institute, EcoDSanRes programme. http://www.ecosanres.org/pdf_files/ToiletsThatMakeCompost.pdf

Sustainable Sanitation Alliance (SuSanA) (2007) *Fura kebele declared open defecation free environment*. http://www.susana.org/docs_ccbk/susana_download/2-297-open-defecation-free-environment-ethiopia-en.pdf

UNICEF (2009) *Community Approaches to Total Sanitation, Field Notes*. http://www.unicef.org/evaluation/files/CATS_field_note.pdf

University of California Regents, Dermatology Glossary. http://missinglink.ucsf.edu/lm/DermatologyGlossary/index.html

USAID/HIP (2007) *Preparing for Community-led Total Behaviour Change in Hygiene and Sanitation*. http://www.aed.org/Publications/upload/Health-Extension-Worker-Handbook.pdf

WaterAid in Ethiopia (2007) *The colour of change*. http://www.wateraid.org/documents/plugin_documents/the_colour_of_changeweb.pdf

WHO (1994) *Health Laboratory Facilities in Emergency and Disaster Situations*. http://helid.digicollection.org/en/d/Jh0193e/16.7.html

WHO (1996) *Participatory hygiene and sanitation transformation: A new approach to working with communities*. http://www.who.int/water_sanitation_health/hygiene/envsan/phast/en/

WHO (1997) *Vector control: Methods for use by individuals and communities*. http://www.who.int/water_sanitation_health/resources/vectorcontrol/en/index.html

WHO (1997) *Guidelines for drinking water quality, Volume 3 Surveillance and control of community supplies*. http://www.who.int/water_sanitation_health/dwq/gdwq2v1/en/index2.html

WHO (1998) *Participatory Hygiene and Sanitation Transformation (PHAST) Step-by-step Guide: A Participatory Approach for the Control of Diarrhoeal Diseases*. http://www.who.int/water_sanitation_health/hygiene/envsan/phastep/en/

WHO (2003) *Malaria entomology and vector control*. http://whqlibdoc.who.int/hq/2003/WHO_CDS_CPE_SMT_2002.18_Rev.1_PartI.pdf

WHO and IRC Water and Sanitation Centre (2003) *Linking technology choice with operation and maintenance in the context of community water supply and sanitation: A reference document for planners and project staff*, by F.Brikke and M.Brodero. http://www.bvsde.paho.org/bvsacd/cd41/agua.pdf

Contents

Study Session

Continued in Part 2

Introduction to the *Hygiene and Environmental Health* Module

Drinking, eating, washing, excreting – these are things we do every day of our lives. But the way we do them can have a major impact on our health. Good hygiene practices are an essential part of daily life and we all need to understand what hygiene means, why it's important for our health and wellbeing, and how we can change our behaviour to safeguard our health. Promoting good hygiene in your community and educating people in ways to protect themselves and their families from ill health is one of the most important aspects of your work.

The significance of hygiene and environmental health is recognised in the United Nations' Millennium Development Goals (MDG). One of the MDG targets is to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. Recent reports suggest that good progress has been made towards reaching that target, but there is still a long way to go. The World Health Organization (2008 data) estimates that, worldwide, there are 884 million people without access to a safe water supply. These people are dependent on rivers, lakes and other unprotected sources for drinking, cooking, food preparation and all other daily needs. An even greater number, 1100 million people, do not have access to latrines, toilets or other forms of improved sanitation. This has a major impact on health. Globally, 4 billion cases of diarrhoea occur every year and 88% of these can be attributed to unsafe water, inadequate sanitation and poor hygiene.

In Ethiopia, the public health importance of hygiene and environmental health is indicated in the Constitution and the National Health policy. The Ethiopian Constitution states that 'All persons have the right to a clean and healthy environment' (Article 44/1). The Constitution further states that all Ethiopians should have 'access to clean water, housing and food' (Article 90/1). The Ethiopian National Health policy considers that hygiene and environmental health is one of the cornerstones of the strategy for the promotion of health and wellbeing. More than 80% of communicable diseases in Ethiopia are believed to be preventable using environmental health interventions, so targeting environmental health is vital for improving the health of the population at large.

The *Hygiene and Environmental Health* Module comprises 23 study sessions divided into two parts. Part 1 starts with two sessions about the basic concepts and principles of hygiene and environmental health, which serve as the introduction to the rest of the Module. The next section covers good hygiene practice at personal, household and communal levels. This is followed by food hygiene. People can become seriously ill from consuming unhygienic and unsafe food. These sessions will explain the dangers of foodborne disease and enable you to help people understand why food hygiene is important and that their health can depend on the quality of the food they eat.

Part 2 covers water and waste. The water sessions describe the importance of having water that is safe to drink, the sources and treatment of water, the protection of drinking water and how you can assess the status of water provision in your area. Finally, the waste management sessions give you an overview of the basic concepts and principles of waste management, followed by details on liquid waste and solid waste management, latrine construction and utilisation, and healthcare waste management.

Studying this Module will help you address hygiene and environmental health issues in your area in order to improve the health of people in your community. Each study session is designed in a way that you, as a health worker, can use in your own context. The Module provides first the theoretical basis, and then the practices that are applicable at village level. Each study session is completed by a set of exercises so that you can check your understanding.

Study Session 1 Introduction to the Principles and Concepts of Hygiene and Environmental Health

Introduction

This first study session in the Module serves to introduce you to the important concepts and key terms that are used in environmental health and hygiene. Starting with a brief description of the historical importance of hygiene and sanitation, we will explain the scope of environmental health and describe the links between hygiene, sanitation and human health. We will describe the steps in environmental health planning and give you an overview of your role in the management of hygiene and environmental health at community level. This session will help you better understand subsequent sessions in this Module.

Learning Outcomes for Study Session 1

When you have studied this session, you should be able to:

1.1 Define and use correctly each of the key words printed in **bold**. (SAQ 1.1)

1.2 Briefly describe the history of hygiene and environmental health and its development in Ethiopia. (SAQ 1.2)

1.3 Describe the significance of environmental health at community level. (SAQs 1.1 and 1.3)

1.4 List the environmental risk factors involved in the transmission of communicable diseases. (SAQ 1.4)

1.5 Describe the interactions between development and environment that affect human health. (SAQ 1.5)

1.6 Explain the basic components and purpose of environmental health planning. (SAQ 1.6)

1.1 Historical perspectives on hygiene and environmental health

Hygiene and sanitation have a long history at various levels of human civilisation. We can roughly divide the historical events into two periods: the ancient and the modern.

1.1.1 Prehistoric and ancient civilisation

Religious laws, such as Moses' Law, writings in the Old and New Testaments and laws in the Koran, played major roles in the lives of ancient peoples. These laws mainly concentrated on the provision of personal hygiene. Dead bodies and contaminated surfaces were known to be unclean or unhygienic to touch. The importance of burying human faeces was also strongly indicated. The importance of body cleanliness before praying was a motive for maintaining the integrity of hygiene with a religious practice.

The importance of hygiene and sanitation flourished at the times of Greek, Roman and Egyptian civilisation. The use of private and public baths and latrines, cleaning of the body, shaving the head for protection from lice infestation, and the construction of water pipelines and sewage ditches were widely observed. The transmission of schistosomiasis (bilharzia) was linked to bathing and swimming in the Nile River. In these civilisations, the focus was on personal hygiene (hygiene) and human waste management (sanitation).

1.1.2 Modern times

A number of discoveries in the 19th century were important events for the understanding of communicable diseases. For example, the link between contaminated water and cholera was discovered by John Snow in 1854; the importance of hygienic handwashing before attending delivery of a baby was noted by Dr. Semmelweis in 1845; and the discovery that **microorganisms** (very small organisms only visible under a microscope) cause disease was made by Louis Pasteur around this time.

The period following the industrial revolution in Europe in the 19th century showed that improvements in sanitation, water supply and housing significantly reduced the occurrence of communicable diseases. The term 'environmental health' is used to describe human health in relation to environmental factors such as these. **Environmental health** can be defined as the control of all the factors in a person's physical environment that have, or can have, a damaging effect on their physical, mental or social wellbeing. The issue of environmental health is now a global matter under the guidance of the United Nations (UN) through the World Health Organization.

Although hygiene and infection are vital factors in environmental health, it is also good to be aware of emerging issues such as global warming and the links between medical conditions such as cardio-vascular disease and our environment and lifestyles. Our **environment** is everything that surrounds us. It includes all the external influences and conditions that can affect our health, life and growth. These influences are constantly changing and the effects on our health may not be easily foreseen.

1.1.3 Hygiene and environmental health development in Ethiopia

Historical information about hygiene practice among the Ethiopian population is sparse. We will note only the organisational aspects, as follows.

(a) A formal health service was organised in the Ministry of the Interior in 1908. Hygiene and sanitation in public health was a single service.

(b) The Ministry of the Interior had a Proclamation and Legal Notices to exercise sanitation (urine handling, refuse and excreta management, street sweeping) in 1942–1943.

(c) The Ministry of Public Health was created in 1947. It organised Municipal and Provincial Public Health services to run both curative and public health. Hygiene and sanitation were the focus of these organisations.

(d) Late in the 1970s, safe water supply and sanitation became components of primary healthcare.

(e) In the 1990s, the new Constitution in 1995 and a new Health Policy in 1993 were designed to reflect the social and health needs of the Ethiopian population. Hygiene, sanitation and environmental matters are stated aims.

(f) In early 2000 the Health Extension Programme was designed and integrated into the Health Sector Development Programme as a tool to enhance hygiene and sanitation in rural and urban areas.

1.2 Definitions

1.2.1 Hygiene and sanitation

■ What do hygiene and sanitation mean to you from your brief reading of the historical perspectives?

□ Hygiene is related to personal cleanliness, such as personal hygiene (body, clothing). Sanitation refers to waste management, particularly management of human waste.

Hygiene generally refers to the set of practices associated with the preservation of health and healthy living. The focus is mainly on personal hygiene that looks at cleanliness of the hair, body, hands, fingers, feet and clothing, and menstrual hygiene.

Improvements in personal knowledge, skill and practice that modify an individual's behaviour towards healthy practice are the focus of hygiene promotion. Safe hygiene practice includes a broad range of healthy behaviours, such as handwashing before eating and after cleaning a child's bottom, and safe faeces disposal. When you carry out hygiene education and promotion the aim is to transfer knowledge and understanding of hygiene and associated health risks in order to help people change their behaviour to use better hygiene practices.

Sanitation means the prevention of human contact with wastes, for hygienic purposes. It also means promoting health through the prevention of human contact with the hazards associated with the lack of healthy food, clean water and healthful housing, the control of **vectors** (living organisms that transmit diseases), and a clean environment. It focuses on management of waste produced by human activities.

There are different types of sanitation relating to particular situations, such as:

- **Basic sanitation**: refers to the management of human faeces at the household level. It means access to a toilet or latrine.
- **Onsite sanitation**: the collection and treatment of waste at the place where it is deposited.
- **Food sanitation**: refers to the hygienic measures for ensuring food safety. Food hygiene is similar to food sanitation.
- **Housing sanitation**: refers to safeguarding the home environment (the dwelling and its immediate environment).
- **Environmental sanitation**: the control of environmental factors that form links in disease transmission. This category includes solid waste management, water and wastewater treatment, industrial waste treatment and noise and pollution control.
- **Ecological sanitation:** the concept of recycling the nutrients from human and animal wastes to the environment.

1.2.2 Environmental health

Environmental health is broader than hygiene and sanitation; it encompasses hygiene, sanitation and many other aspects of the environment that are not included in this Module such as global warming, climate change, radiation, gene technology, flooding and natural disasters. It also involves studying the environmental factors that affect health.

The World Health Organization's definition is as follows:

> Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health.

Key phrases in this definition are *environmental factors* and *potentially affect health*.

1.2.3 Components of environmental health

Table 1.1 describes the areas of environmental health and hygiene that will be of importance to you as a healthworker and that you will learn about in the rest of this Module.

Table 1.1 Components of hygiene and environmental health.

Description	**Concerns**
Personal hygiene	Hygiene of body and clothing
Water supply	Adequacy, safety (chemical, bacteriological, physical) of water for domestic, drinking and recreational use
Human waste disposal	Proper excreta disposal and liquid waste management
Solid waste management	Proper application of storage, collection, disposal of waste. Waste production and recycling
Vector control	Control of mammals (such as rats) and **arthropods** (insects such as flies and other creatures such as mites) that transmit disease
Food hygiene	Food safety and wholesomeness in its production, storage, preparation, distribution and sale, until consumption
Healthful housing	Physiological needs, protection against disease and accidents, psychological and social comforts in residential and recreational areas
Institutional hygiene	Communal hygiene in schools, prisons, health facilities, refugee camps, detention homes and settlement areas
Water pollution	Sources, characteristics, impact and mitigation
Occupational hygiene	Hygiene and safety in the workplace

Figure 1.1 Components of hygiene and environmental health.

- ■ Figure 1.1 illustrates the various aspects of hygiene and environmental health that are described in Table 1.1. Look at the separate drawings within the figure and match each of them to one of the descriptions.

- □ Starting at top right, the drawing there illustrates solid waste disposal in a pit. Below that is a woman cooking at a stove to show food hygiene in a cooking area. The handpump illustrates water supply. Personal hygiene is represented by the person washing themselves. The next drawing shows a storage cupboard, again illustrating food hygiene. The drawing at top left is a pit latrine to represent human waste disposal. The central drawing illustrates healthful housing. (Vector control, institutional hygiene, occupational hygiene and water pollution are not shown.)

1.3 Concepts and principles in hygiene and environmental health

We will consider diarrhoea, which is a symptom of many common diseases, as a means to understand the concept of disease transmission, the role of environmental health and the framework for hygienic improvements.

1.3.1 Environmental health and disease transmission

The description of diarrhoea transmission represents a good way to understand the pathways of disease through the environment and how environmental health and hygiene can help prevent disease transmission. Figure 1.2 (on the next page) shows the factors that are essential for diarrhoea transmission. (This diagram is widely used to represent these important links in disease transmission. We have included two versions of it here to help you identify it if you see it again. It is used in later sessions in this Module.)

Look first at Figure 1.2 (a). On the left is a person defecating, representing the source of diarrhoea. The infectious agent or disease agent is actively discharged by a patient or carrier of the disease. On the right is the **host**, who is the person that could be affected by the disease. Between the two, there is the part of the environment that links the two; in other words, the pathway that the disease travels between the source and the host. Now compare Figure 1.2(a) with Figure 1.2(b); you will see they represent the same thing.

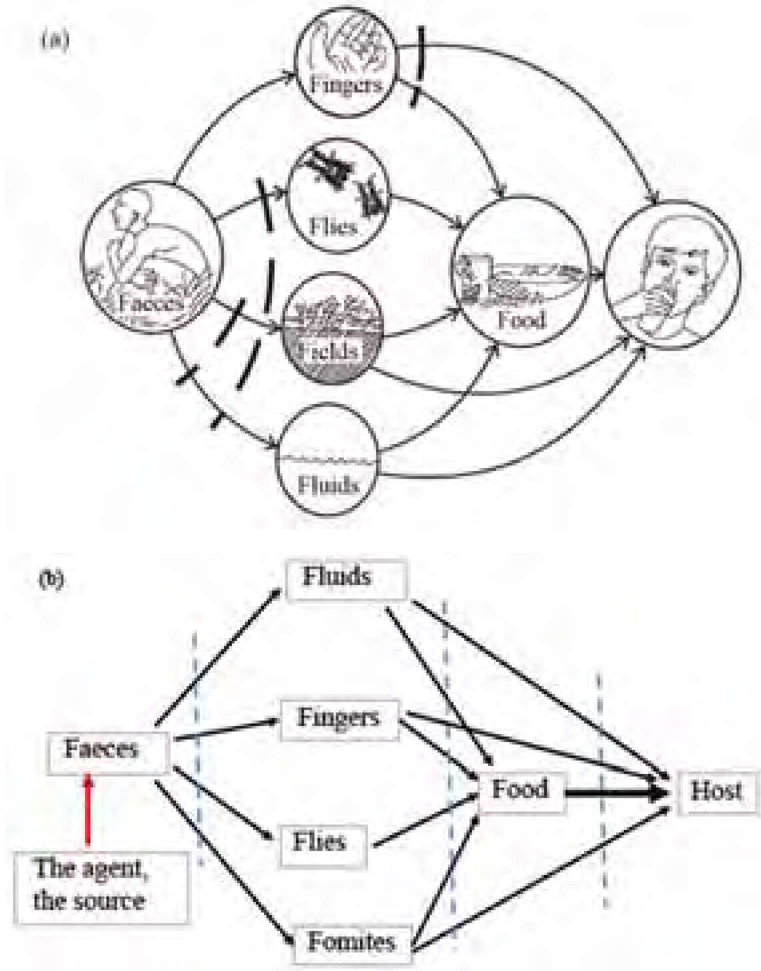


Figure 1.2(a) and (b) Pathways of diarrhoea transmission. (Source of 1.2(a): adapted from WHO, 1998, *PHAST step-by-step guide*)

Figure 1.2(b) similarly shows the different pathways of transmission through the environment. The *source* of diarrhoea is the *agent* or carrier who discharges infected faeces to the environment. To remember the possible pathways we can use the six 'F's:

1 Faeces: resulting from defecation.
2 Fluids: through contaminated water and other contaminated liquids.
3 Fingers: contaminated fingers transmit diseases.
4 Flies: all sorts of animals such as flies can carry and transmit diseases.
5 **Fomites** or fields: fomites are inanimate objects that carry the infectious agent (e.g. dishes, cups and other contaminated surfaces in contact with food or water).
6 Food: infected by fluids, flies, fingers or fomites and then eaten.

■ A mother had diarrhoea. She was making a meal for her child but did not wash her hands before preparing the food and her child became sick with diarrhoea. Can you identify the source, pathway of disease transmission and the host?

□ The source is the mother who had diarrhoea; the pathway in the environment is excreta → fingers → food → mouth; and the host is the child.

If you understand the pathway of the disease, then you can design an **intervention** for the disease that targets the source, environment or the host. An intervention is a way of stopping the disease from being transmitted. The broken lines, in Figure 1.2, indicate the possible interventions for the prevention and control of diarrhoea. Some of these interventions are described in Table 1.2.

Table 1.2 Possible environmental health interventions for diarrhoea.

Intervention strategies	Activities
Intervention at the source (where the diarrhoea infection comes from)	• Avoid open defecation • Install a latrine • Always use a latrine to bury faeces and urine
Intervention in the environment (how the diarrhoea infection is transmitted)	• Use safe drinking water • Handwashing • Vector control and management • Proper refuse and liquid waste management • Provision of food safety • Healthful housing
Intervention at the host (the person who might become infected)	• Hygiene promotion through hygiene education and community mobilisation • Vaccination (if available) • Healthy living

1.3.2 The place of environmental health in your community

Our living environment is composed of home, work and recreational centres where people spend their time. Water, air and food are our concern. The provision of environmental health services extends to all these aspects of our lives.

■ List the locations in your *kebele* where environmental health is important.

□ You may have thought of a list that includes the following, but the detail will depend on your own *kebele*:

- workplaces: health facilities, local workplaces, public offices, shops, mill house, metal and wood works
- schools
- social places: church, mosque
- homes: different types of home in your area.

It is important to know the different parts of your *kebele* so that you can promote better hygiene in all areas. The interaction of the environment and possible environmental hazards are indicated in Figure 1.3. These different types of hazard will be discussed in Study Session 2.

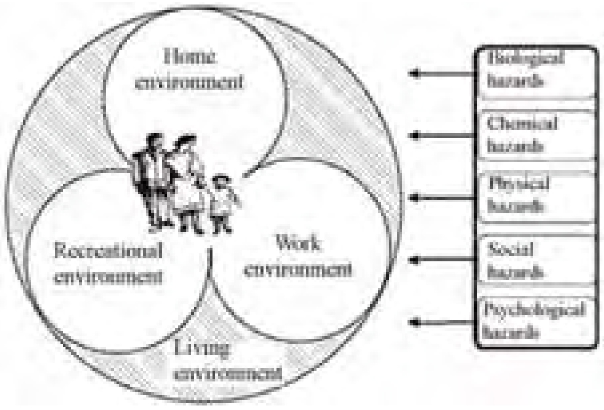


Figure 1.3 The system of environmental health. The human living environment consists of home, work and recreational environments. The interaction between these environments and human activities results in various types of hazards that may adversely affect human health. (Source: adapted from Bassett, 2004)

1.3.3 Environmental intervention models

According to the Federal Ministry of Health, more than 80% of communicable diseases in Ethiopia are believed to be preventable using environmental health interventions. Generally, there are two intervention models: the clinical intervention model, which looks at treating the sick person, and the public health model, including environmental health, which looks at how to stop people getting sick in the first place by providing a healthy environment. This is indicated in Figure 1.4.

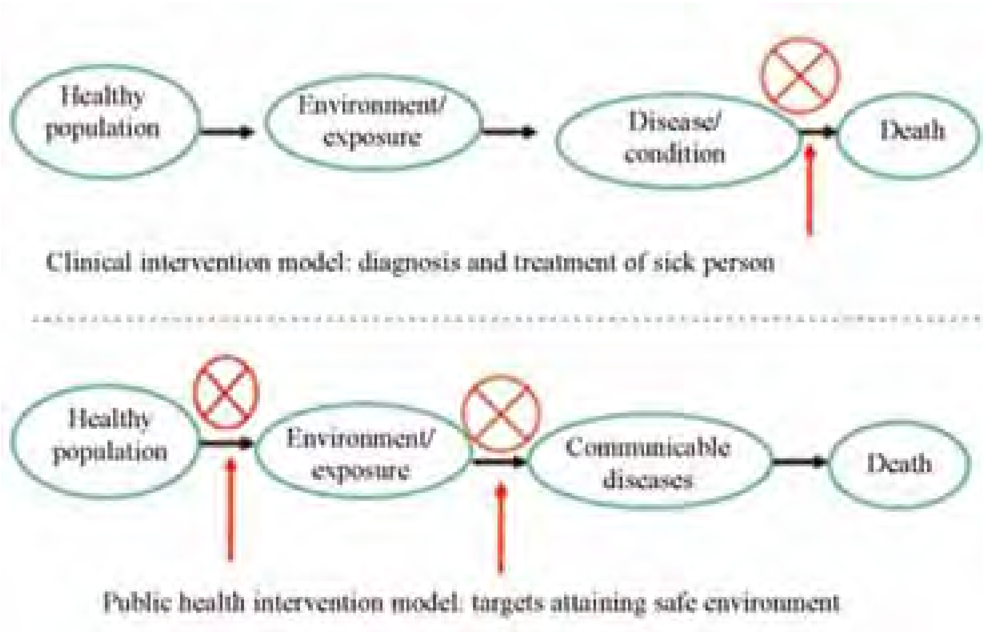


Figure 1.4 Health intervention models for the prevention and control of communicable diseases. The clinical intervention model focuses on the treatment of patients, while the public health intervention model concentrates on the maintenance of health through education and keeping the environment safe. The red arrows indicate the points of intervention.

If we look at these two models in a wider context, then there are additional factors that must be considered. These include having helpful local policies, appropriate community (*kebele*) level organisations, sanitation legislation, developing sanitation technology options and poverty alleviation efforts. Political will in policy development in health and environmental health, designing the hygiene and sanitation legal frameworks and long-term socio-economic developments, are aspects of the government's responsibilities. As a Health Extension Practitioner you have an important role in the prevention of environmental hazards that affect the health of the public.

1.3.4 Environmental risk factors

You have learned in previous Modules that infectious agents play a part in the transmission of disease. **Infectious agents** are pathogenic (disease-causing) bacteria, viruses, fungi, protozoa and parasites. To cause a disease, they must be introduced into our bodies in sufficient quantities. The environmental conditions and practices that facilitate the carrying of such infectious agents into our bodies are termed **environmental risk factors**. A good example is drinking water, which can be contaminated by human faecal matter that contains these infectious agents. When this water is consumed, we are likely to get diarrhoeal diseases.

There are other ways that infectious agents can get into our bodies; for example, the air we breathe can be contaminated by droplets that come out of a patient's lungs when they breathe or cough. TB and pneumonia are droplet-related infections that are transmitted in this way. There are also diseases and conditions that are not caused by pathogenic organisms, but are caused by other environmental risk factors, which may be due to chemicals or physical hazards such as noise. Major environmental risks and examples of the diseases and conditions that are related to these risks are indicated in Table 1.3. Further descriptions of these diseases can be found in the *Communicable Diseases* and *Non-Communicable Diseases, Emergency Care and Mental Health* Modules.

Table 1.3 Major environmental risk factors with related diseases and conditions.

Environmental risk factors	Related diseases and conditions
Contaminated water, lack of latrines, poor hand washing, inappropriate solid waste management, open defecation, vector infestation	Diarrhoeal diseases, trachoma, schistosomiasis, ascariasis, trichuriasis, hookworm, typhoid fever, relapsing fever
Indoor air pollution	Chronic obstructive pulmonary disease, lower respiratory infections, lung cancer
Outdoor/ambient air pollution	Respiratory infections, cardiovascular diseases, lung cancer
General environmental hazards (climate, mosquitoes, nutrition)	Diarrhoeal diseases, malnutrition, malaria and other vector-borne diseases; heat exhaustion
Environmental hazards in workplaces (excess noise, heat, dust, chemicals)	Injuries, hearing loss, cancer, asthma, back pain, chronic obstructive pulmonary disease

1.4 Human interaction with the environment

1.4.1 Urbanisation and industrialisation

Urbanisation and industrialisation bring rural people into urban centres that may not be ready to handle the additional sanitary needs. Ethiopia is at the stage of rapid development with priorities in agriculture and industry. Currently small-scale industries that bridge agriculture and industrialisation are booming. Large-scale industries, such as textiles, food and cement, are growing. The need to improve and expand social infrastructures such as water supply, waste management and health services is obvious in order to handle the needs of the growing urban centres. As a healthworker you need to understand that these developments have environmental health risks due to overcrowding, inappropriate waste management and a shortage of safe drinking water.

1.4.2 Development as a means of interaction

■ Assume for a minute that a textile factory is planned to operate in your *woreda*. Now, think what benefits and disadvantages may arise from the introduction of this factory.

□ Any development requires an interaction with the environment. The obvious advantages are in terms of providing cloth, creating job opportunities and contributing to the growth of the national economy. The disadvantage is when the factory produces environmental risks. The factory uses energy, raw materials and human labour for its process of producing cloth. It generates pollutants in the form of solid waste, liquid waste, air polluting substances and noise. Such wastes can pollute the air we breathe, our food, water and soil. The poor management of these wastes results in human exposure that may subsequently affect human health as well as the environment.

Figure 1.5 shows diagrammatically the relationship between development and the environment.

In this diagram, the two arrows lying between 'human activities' and 'ambient environment' indicate the relationship between them, i.e. that development requires resources from the environment (forward arrow) and, as a result, waste could be generated as a by-product (backward arrow). In fact, there are three possible types of interaction: humans can affect the environment, the environment can affect humans, and humans and the environment can co-exist (where they sustain each other). The red arrows in Figure 1.5 indicate the negative effect if the generated waste is not properly handled. This affects the environment in the form of pollution of air, water, etc., and can have a negative influence on development.

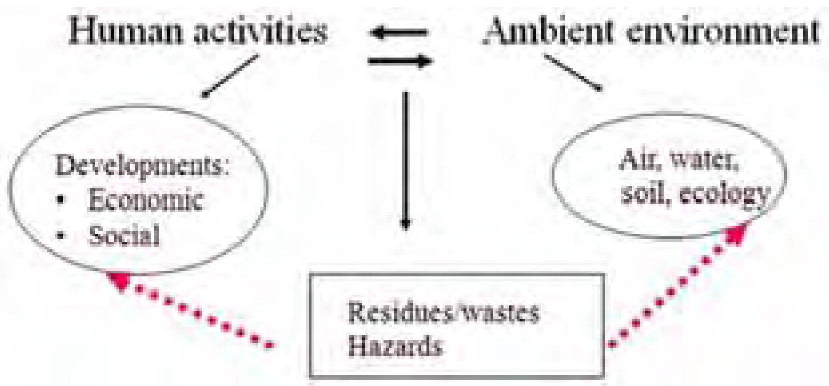


Figure 1.5 Human–environment interaction model.

Matters of development and health have been on the agenda in UN international conferences and meetings. The issue of sustainable development is a key message for the friendly coexistence between development and the environment. The World Commission on Environment and Development defined **sustainable development** as:

> development which meets the needs of the present without compromising the ability of future generations to meet their own needs.

■ Referring to Figure 1.5, think of different examples of the three types of interaction between human activities and the environment.

□ You may think of different examples; here are some that we thought of:

(a) Humans affecting the environment: deforestation, polluting surface water, loss of wildlife.
(b) The environment affecting humans: soil erosion, flooding.
(c) Friendly coexistence (sustainable development): operating a factory so that it provides goods and jobs that are needed now, without polluting the environment so that our children will have safe water in the future.

1.5 The role of environmental health in public health

Environmental health is a part of public health where the primary goal is preventing disease and promoting people's health. Environmental health is associated with recognising, assessing, understanding and controlling the impacts of people on their environment and the impacts of the environment on the public. The role of the environmental healthworker, therefore, includes the following functions of public health:

(a) Improving human health and protecting it from environmental hazards.
(b) Developing liaison between the community and the local authority, and between the local and higher levels of administration.
(c) Acting independently to provide advice on environmental health matters; designing and developing plans of action for environmental health.
(d) Initiating and implementing health/hygiene, sanitation and environmental programmes to promote understanding of environmental health principles.
(e) Enforcing environmental legislation.

(f) Monitoring and evaluating environmental health activities, programmes and projects.

You, as a healthworker, are very much involved in all of the above except (e) and (f), which are mainly carried out by the *woreda* environmental healthworker. However, the *kebele* administrator may ask you to help with the enforcement of environmental legislation, if deemed apprioriate.

1.6 Environmental health planning

Environmental health planning refers to a systematic process by which goals are established, facts are gathered and analysed, alternative proposals and programmes are considered and compared, resources are measured, priorities are established, and strategies and activities are designed to meet the established goals or objectives within a specified period of time. You, as part of *kebele* cabinet, will be requested to prepare an environmental health plan. The approach to planning is similar to that described in the *Health Management, Ethics and Research* Module. However, the primary focus is what makes it different. The following planning steps are suggested.

1 Identifying the needs and gaps

This is essentially an inventory (or list) of problems related to environmental health in your local context. You can use various tools in order to identify these problems.

- *Environmental health survey*: This is a systematic survey using a questionnaire. The questionnaire contains basic indicators of environmental health such as latrine availability, source of drinking water, waste disposal systems, cleanliness of the community, etc. You will need to do some statistical analysis (proportions and averages) to refine basic indicators of environmental health for your local context. You must be careful when designing a survey as it requires time, expertise and resources. You can plan it in coordination with the *woreda* environmental healthworker.
- *Rapid/quick assessment*: This is the usual method that helps you gain a quick overview of the range of problems. The usual data collection tools that you can use for this are focused or group discussion, physical observation with checklists and interviewing people.

2 Priority setting

It is difficult to handle all identified problems due to resource limitations. You need to know in advance the available resources in the *kebele*. Resources can be mobilised from government, community, private organisations and NGOs. Do not rely too much on governmental resources as there are always limitations. Mobilising community resources is the best option that could be sustained. Priorities are then made on the basis of the depth and severity of the problem, the feasibility and the degree of community concern and willingness to be involved in the resource mobilisation.

3 Writing a planning report

This is a systematic description of the planning functions. The recommended sub-titles are:

1. Title of the plan
2. Introduction or background
3. Objectives
4. Strategies and activities
5. Indicators
6. Resources (i.e. budget, human resource and materials)
7. Plan of action (i.e. activities by time and responsible person)

You should prepare and present an annual plan of action for improvement of hygiene and environmental health to the *kebele* head. The plan of action needs careful consideration of your work in the *kebele*. The activities in the plan should include identifying problems, inspection services (households, food establishments, public utilities such as water sources, health facilities), hygiene promotion, monitoring selected indicators, sanitation promotion, training of local partners, sanitation campaigns and commemorating sanitation and water days.

4 Implementing the plan

Once the plan has been approved by the *kebele* cabinet it can be implemented. Environmental health activities are put into practice on the ground at this stage.

5 Monitoring and evaluating the planned performance

Daily, weekly or monthly monitoring will help you check the progress of the implementation, while evaluating performance at the end of the year is useful to help you see the overall progress.

6 Learning by doing

You will be able to learn lessons from the experience of the previous year's implementation and the achievements and failures.

Summary of Study Session 1

In Study Session 1, you have learned that:

1. The historical perspectives show us that hygiene and sanitation have a deep-rooted origin. The practice of hygiene and sanitation is part of our daily life.
2. There are differences between hygiene, sanitation and environmental health. While hygiene focuses on individual personal hygiene/cleanliness, sanitation often refers to waste management, and environmental health has a broader meaning beyond hygiene and sanitation, referring to where we live, work and play. The focus of environmental health is on how environmental risk factors affect human health.
3. Environmental health plays a major role in the prevention and control of communicable diseases caused by pathogens, such as diarrhoea, and other diseases and conditions, such as chronic obstructive pulmonary disease caused through inhalation of air pollution.

4 There are various environmental health risks that affect our health. These include water and air pollution, food contamination and the disposal of wastes into our environment.

5 The interaction between humans and the environment has various forms. Urbanisation, industrialisation and development are the major forms of interaction. We should remember and try to control the disadvantages of development and not focus only on the benefits.

6 Environmental health planning requires you to gain knowledge of problems in your area and to identify needs and gaps, to set priorities and find resources to solve the problems.

Self-Assessment Questions (SAQs) for Study Session 1

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 1.1 (tests Learning Outcomes 1.1 and 1.3)

Emebet is a healthworker. Her weekly environmental health activities in her *kebele* include inspecting ten households and checking the proper storage of drinking water, food preparation and the presence of open windows. She also visits a first cycle school. In the same week, she inspects the local mill house and advises the workers how not to get hurt by machines.

Match Emebet's different activities with different areas of environmental health by drawing arrows between them.

Activity	**Environmental health area**
Inspecting ten households and checking the proper storage of drinking water	Food hygiene/sanitation
Inspecting food preparation	Housing sanitation or healthful housing
Inspecting for the presence of open windows	Occupational hygiene
Visiting a first cycle school	Water supply
Inspecting the local mill house and advising the workers how not to get hurt by machines	School sanitation/ hygiene

SAQ 1.2 (tests Learning Outcome 1.2)

Outline the differences and similarities in hygiene theory and practices in ancient and modern times.

SAQ 1.3 (tests Learning Outcome 1.3)

Make a quick visit in your village or town and make a list for yourself of the hygiene and sanitation problems that you can see.

SAQ 1.4 (tests Learning Outcome 1.4)

Diarrhoea among children under 5 is common in many rural villages. What environmental factors or practices may cause diarrhoea in young children?

SAQ 1.5 (tests Learning Outcome 1.5)

Development in your locality may bring job opportunities. List the specific kinds of development that are found in your locality and identify the types of environmental hazard they might cause.

SAQ 1.6 (tests Learning Outcome 1.6)

Why do we need environmental health planning? What documents will you need to use or to produce when designing environmental health planning?

Study Session 2 Environmental Health Hazards

Introduction

There are a range of environmental health hazards that affect our wellbeing. Hazards can be grouped together to improve understanding and action planning. The actions that you need to carry out to protect the health of your community depend on knowing how these hazards can affect us all. In this study session, you will learn about the types and categories of environmental health hazards, the routes of exposure and the ways of preventing and controlling these hazards.

Learning Outcomes for Study Session 2

When you have studied this session, you should be able to:

2.1 Define and use correctly all of the key words printed in **bold**. (SAQ 2.1)

2.2 Describe the main categories of environmental health hazards. (SAQ 2.2)

2.3 Explain the principles of hazard management. (SAQ 2.3)

2.4 List and describe the main types of environmental pollution. (SAQ 2.4)

2.5 Explain the basic principles of pollution management. (SAQ 2.4)

2.1 What is an environmental health hazard?

In Study Session 1, you learned that environmental health addresses the assessment and control of environmental factors that can potentially affect health. It is targeted towards preventing disease, creating health-supporting environments and encouraging positive human behaviours. You have also learned about the general issues of environmental health risks. Our environment generally consists of physical, chemical and biological factors and our relationship with our environment is always interactive. This means that we affect our environment and our environment affects us. These interactions may expose us to **environmental health hazards**; that is any environmental factors or situations that can cause injury, disease or death.

It is worth pausing here to clarify the difference between hazard and risk. A **hazard** is something which is known to cause harm, that is, a source of danger to health. **Risk** is the likelihood or probability of the hazard occurring and the magnitude of the resulting effects. For example, if you climb a ladder you know there is a chance you could fall off and be injured, although it is unlikely. The ladder is the hazard and the chance of injury is the risk you take by climbing the ladder.

We will illustrate an environmental health hazard with an example. The production of cow dung cake to be used for fuel is a common practice in Ethiopia. Fresh dung supports the breeding of flies. Dung cake is usually prepared near to the house (Figure 2.1 on the next page). Young flies need food and move from the dung to the food that is found in the house.

The flies pick up pathogenic organisms from the dung and transfer them to fresh food that is ready for consumption. A child eats the contaminated food and gets diarrhoea in a few days.

Figure 2.1 Dung cake for fuel is drying on boulders near the house. (Photo: Nicholas Watson)

The conditions or the situation of producing dung cake close to the house is hazardous (or dangerous) because it facilitates the breeding of flies near to fresh food in the house. The infected food is the hazard that damages the child's health. In this example, the hazard arises because of the infectious agent (the pathogenic organisms) and the process or condition (the preparation of cow dung cake close to the house). The risk of getting an infection is very high if someone consumes food that is contaminated with an infectious agent.

■ What causes environmental hazards? List some different types of natural and human-produced hazards.

□ You may have listed a number of factors. Natural hazards include earthquakes, volcanic eruptions and flooding. Human-produced hazards are mainly related to pollution of the air, water and soil, and contamination of food.

2.2 Categories of environmental health hazards

Hazards are generally categorised as follows:

2.2.1 Physical hazards

Physical hazards are those substances or conditions that threaten our physical safety. Fires, explosive materials, temperature (hot or cold), noise, radiation, spills on floors and unguarded machines are some examples of physical hazards.

Physical hazards also include **ergonomic hazards** which occur when the type of work, body position and working conditions put strain on your body. This happens when your capacity for work is restricted by the type of work. These instances are hard to spot since you don't always immediately notice the strain on your body or the harm these hazards cause. Short-term exposure in badly designed work may result in muscle fatigue or tiredness, but long-term exposure can result in serious long-term injuries of the musculo-skeletal system. *Injera* baking is one of the hardest tasks a woman faces routinely.

She spends one to two hours in a forced sitting and bending position which can be damaging to her body. Ergonomic hazards also exist among farmers, for example while manually ploughing and cleaning the weeds in farmland (Figure 2.2).

Figure 2.2 A farmer ploughing his land needs lots of physical effort. (Source: Pam Furniss)

2.2.2 Biological hazards

Biological hazards are organisms, or by-products from an organism, that are harmful or potentially harmful to human beings. They include pathogenic bacteria, viruses and parasites, and also toxins (poisons) that are produced by organisms. Biological hazards are the cause of the majority of human diseases. For example, bacteria cause cholera, tuberculosis, leprosy, relapsing fever and many diarrhoeal diseases; viruses are responsible for hepatitis B and C, HIV, measles and polio; and there are many diseases caused by parasites. A *parasite* is any organism that lives on or in another organism, called the host, and causes damage, ill health or even death to the host. Some human parasites are external and live on the skin and hair; for example, mites that cause scabies. Internal parasites, living inside the body, include protozoa and helminths.

Protozoan parasites are single-celled organisms that enter the body either by ingestion or via the bite of an infected insect. Malaria, sleeping sickness and leishmaniasis are examples of diseases caused by protozoan parasites introduced by insect bites; amoebic dysentery and giardiasis result from drinking or eating contaminated water or food.

Helminths are parasitic worms that live inside the body. Several helminths have complicated life cycles involving humans and other animals as secondary hosts. They have different routes of entry into the human body depending on the type of worm including ingestion with food or water, the faeco-oral route, insect bites and penetration through the skin. 'Helminth' is the general term used to describe several different types of parasitic worm. There are three main groups: tapeworms, roundworms and flukes. *Tapeworms* may be ingested with food, especially under-cooked meat, or with water or soil contaminated with faeces. *Roundworms*, also called nematodes, are responsible for many different diseases including ascariasis, dracunculiasis (guinea worm), filariasis, hookworm, onchocerciasis (river blindness), trichinosis and trichuriasis (whipworm). A type of *fluke* is the cause of schistosomiasis, also known as bilharzia. People become infected with schistosomiasis, not through food, but by standing or swimming in water that contains the immature form of the fluke; these are released into the water from the snail secondary host. The fluke gets into the water and the snail from the excreta of infected people.

Biological hazards arise from working with infected people animals, or handling infectious waste and body fluids, as well as contact with unsafe water, food and waste. The hazards may occur in the home, at school or at work. In particular, work in hospitals, hotel and hospital laundries, laboratories, veterinary offices and nursing homes may expose someone to biological hazards.

2.2.3 Chemical hazards

Chemical hazards are present when a person is exposed to a harmful chemical at home or at work. The chemicals can be in the form of gases, solids or liquids. Exposure to chemicals could cause **acute health effects** (an immediate or rapid onset) if taken in large quantities in a single dose; and **chronic health effects** (long-term effects on health) if taken in small doses over an extended time. Detergents (powdered soap, bleaching powder), drugs (veterinary and human) and pesticides (DDT, malathion, diazinon, zinc phosphide, warfarin) are chemical hazards that are commonly found in rural households (Figure 2.3). Farmers, young children (under 5 years) and household animals are vulnerable to chemical exposure, but it is always possible that anyone might come into contact with the chemical during preparation, spraying, use or storage. A person is exposed to chemicals through various ways: through inhaling the vapours, gases or dusts; through skin contact with solvents, acids and alkalis; and through ingestion of unknown chemicals with food and water.

Figure 2.3 Household chemical hazard – insecticide. (Photo: Abera Kumie)

Incomplete burning of fuel releases carbon monoxide (CO) which is a chemical hazard. When breathed in, CO binds to the haemoglobin in our blood, reducing the uptake of oxygen; the cells of the body then suffer because they are not getting enough oxygen. This can result in severe sickness and even death.

2.2.4 Cultural/practice-related hazards

Culture is the knowledge, belief, art, law, morals, customs and habits that are acquired by people as members of society. It is also the common ways of life and set of thoughts and feelings shared by the members of a society. Just as there are cultural practices that are good for health, such as breastfeeding a child, there are also cultural practices that adversely affect health and these can be considered to be **cultural hazards**. There are practices that are widely accepted and found in different areas of Ethiopia that can be hazards for health; for example, the belief that evil spirits are the source of diseases, practices of storing drinking water uncovered, open defecation and not handwashing before meals and after latrine use.

Hygiene and health promotion and community mobilisation are critical interventions that help improve practices that are not useful to the community. To change human behaviour away from undesired practices, you need to change knowledge and attitudes.

■ Let us assume you have observed that one of the households in your area has a clean latrine but it has not been used for the last few months. What could be the explanation for not using the latrine?

□ You may have thought of some different reasons, but here are some we have thought of:

  - The head of the household might not have taken the lead and guided others in using the latrine.
  - Children may be afraid of falling into the latrine hole.
  - They may be afraid the bad odour will cause a disease.
  - They have plenty of space for open defecation and don't understand why this is not a good practice.

2.2.5 Social hazards

Poverty and illiteracy are examples of **social hazards**. We know that poor and uneducated people get sick more frequently, compared to wealthier and more educated people. Alcoholism, obesity, smoking and drug abuse are also social hazards that affect our health. A person with such habits is, over time, degraded, not respected by society, physically and mentally dissatisfied, and ultimately is likely to suffer with chronic illnesses such as lung and cardio-vascular diseases.

2.3 Describing environmental exposure to hazards

To reduce the adverse impacts of environmental hazards on human health you need to understand where the hazard comes from, identify it and the pathway it can take to affect people.

The *source of the hazard* is the place of origin from proposed and existing activities. Patients and carriers discharge infectious agents (biological hazards) that could infect healthy people. Industrial processes in a factory release chemical hazards that may be found in sewage; the sewage could reach drinking water, thereby creating the possibility of ingesting these chemicals. Household activities could also be sources of hazards, for example, cooking with fuels such as animal dung and charcoal produces toxic smoke that can cause lung diseases.

The *type* of hazard is the particular chemical, infectious agent or other agent involved. The *pathway* is the route by which the hazard gets from the source to the person.

The *response* or the effect is the health outcome (changes in body function or health) after the hazard has affected the person. The amount and type of change (or response) depends on the type of hazard and the effect it can have on different people. This would depend on the person's individual health and factors such as their age; for example, young children or people who are already sick are often more harmed by diseases such as diarrhoea than healthy adults.

If you want to prevent a hazard, you need to understand the source of the hazard (where it comes from), the type of hazard (for example the type and concentration of a chemical), the pathway (the affected environment and how the exposure could take place), and the response (the effect the hazard could have on people).

We will demonstrate this with an example. Sewage containing cadmium (a toxic chemical) is produced by a hide-processing factory and flows into a river. People downstream of the point of discharge drink the contaminated water and become sick. The hazard exposure is described as follows:

- The source is sewage from a factory.
- The type of hazard is chemical, in this case cadmium.
- The pathway or affected environment is the river that is used by the public as a source of drinking water and the exposure took place by swallowing/ingesting the chemical with drinking water. In addition, any fish contaminated with cadmium may have been eaten.
- The response is that people who consumed the contaminated water and fish had symptoms of cadmium poisoning (i.e. joint and spinal pains, pains in the abdomen) and they complained to a health centre.

2.4 Principles of hazard management

You may be asked to plan how to manage environmental hazards, say in a Health Post or mill house that exists in your locality. Involvement in hazard management requires you to follow certain steps, which are outlined below.

- *Establish the context and identify the hazard*: These are the first steps. You have learned that a hazard is something that is harmful to our health. A description of the categories of hazards is given in Section 2.2 above. You should identify the type of the hazard in as much detail as you can. You should also describe the exposure conditions and try to answer the following questions: What is the source of the hazard? Who is exposed? What are the pathways or activities that expose a person? What part of the environment is involved in the transfer of the hazard to humans?
- *Hazard/risk analysis and evaluation*: Here you would analyse the risk and evaluate the potential of the hazard to cause damage to health. This step needs a deeper appraisal in collaboration with the *woreda* environmental health worker. The evaluation may require appropriate design, sampling and laboratory investigation.
- *Communicate and consult*: When the hazards and risks have been determined, advice can be communicated on the interventions or control measures that are needed to control the hazard. There can also be consultations with relevant people and organisations.
- *Treat the hazard/risk*: The interventions or control measures are carried out by the person or people responsible for the hazard or risk.
- *Monitoring and reviewing*: The implementation of interventions or control measures for the hazard must be followed up in order to determine whether they are successful. Correction measures can be applied if there is any failure. Identifying appropriate indicators for monitoring is critical and must be done formally.
- *Record keeping*: Keeping records and reports on hazard management is always important. These records must contain the type of hazard, exposures and what control measures were taken.

The process of hazard management is shown in Figure 2.4.

Figure 2.4 The hazard management process.

2.5 Environmental pollution

2.5.1 What is pollution?

We have seen that hazards are things that endanger human health or life, but hazards can also be harmful to our environment. **Pollution** is the introduction of contaminants into an environment causing harm, instability or disorder to the ecosystem. (An **ecosystem** includes all the living organisms (plants, animals, microorganisms) and their physical environment and the interactions between them.) Pollution can be also defined as the presence of a substance in a medium or environment that results in a change to its 'natural' state, potentially causing an adverse effect. Pollution, however, is not simply the introduction of contaminants. There is always a response in the form of modification or change in the environment. From this standpoint, pollution is the harm that results because substances are present where they would not normally be found, or because they are present in larger than normal quantities.

Contaminants are not necessarily pollutants. A **contaminant** is a minor substance, material or agent that is unwanted in the environment and may or may not be harmful. A **pollutant** is a contaminant which, due to its properties or amount or concentration, causes harm. Gases (carbon monoxide, ozone, nitrogen dioxides), chemical vapours, dust particles, fumes and liquid chemicals (pesticides, solvents, drugs, acids, etc.) are examples of potential pollutants of air and water ecosystems.

In nature, the environment has an inherent capacity to clean itself through self-cleaning processes. Natural environmental processes have the ability to deal with many pollutants and correct most imbalances if given enough time. For example, self-cleaning processes in a river could involve:

- Dilution: this takes place when a small amount of a chemical in sewage enters a large flowing river and the pollutant is diluted in the water.
- Oxygenation: this process occurs through mixing of air with water which introduces oxygen that can then be used by aquatic (water-living) plants and animals. Microorganisms consume oxygen when they break down organic matter.
- Sedimentation: this takes place when larger particles settle out at the bottom of the river.
- Biodegradation: this takes place when organic matter is broken down by microorganisms. **Organic matter** means everything that is derived from living organisms. In a river this could be human and animal waste, decaying plant material, etc.

You will learn more about these processes in Study Session 17.

2.5.2 Pollution sources and categories

Pollutants can come from natural or man-made sources. Examples of natural sources of pollution are volcanoes which give out ash and dust into the atmosphere and metals such as arsenic which are naturally present in some rocks and soils. Man-made pollutants can come from industrial, domestic (home), transport and agricultural sources.

■ Think of one example of a pollutant from industrial, domestic (home), transport and agricultural sources.

□ There are lots of different examples that you could think of. Here are some that we came up with:

  - Industrial sources: sewage discharged into water bodies; air emission of smoke released to the atmosphere (see Figure 2.5).
  - Domestic sources: cooking and heating that releases smoke to the atmosphere. Solid waste and liquid waste are other forms of pollutants that can be released to water bodies and soil.
  - Transport: discharge of air pollutants from various types of vehicles. Heavy trucks and diesel engine vehicles are much more polluting than a petrol engine.
  - Agricultural sources: organic wastes such as agriculture residues, animal dung and wastes from agriculture-based plants.

Figure 2.5 Air pollution from an industrial source. (Photo: Abera Kumie)

Pollution can take many forms. The air we breathe, the water we drink, the soil where we grow our food, and even the increasing noise we hear every day all contribute to health problems and a lower quality of life. Pollution can be classified as:

- Air pollution: the release of chemicals and particulates into the atmosphere.
- Water pollution: the release of wastes, chemicals and other contaminants into surface and groundwater.
- Soil pollution: the release of wastes, chemicals and other contaminants into soil.
- Radioactive pollution: presence of radioactive substances in the environment.
- Noise pollution: unacceptable levels of noise in work, residential and recreational places.
- Thermal pollution: the release of heat into the environment; for example heated water into a river.

Air pollution

This occurs with the release of chemicals in gaseous or dust form into the atmosphere. Household cooking, industries, vehicles and incinerators are common sources of air pollution.

Water pollution

Water can be polluted by the release of liquid waste (human, animal or industrial) into rivers, streams and lakes. A common type of water pollution is organic material such as human and animal wastes and in waste water from food processing. These wastes can be removed from rivers and lakes by the self-cleaning processes described above but, if present in large quantities, the biodegradation process can reduce the level of dissolved oxygen in the water so much that fish and other aquatic life cannot survive. As well as these environmental impacts, water contaminated with human waste is a significant cause of many diseases that will be described in more detail elsewhere in this Module. Some pollutants can be extremely harmful even if they are taken in small quantities and may cause cancer, reproductive health effects (abortion, embryo malformation, birth defects) or nerve damage when the contaminated water is consumed.

Land/soil pollution

This occurs when land is used as a site for accumulating wastes that are generated from various sources (industry, agriculture, health facilities, villages, private and public organisations). These wastes may be biologically, chemically or physically hazardous to plants and animals. The pollution by chemicals such as pesticides may have long-term consequences, such as groundwater pollution.

2.6 Principles of pollution management

■ Explain the differences between a hazard, a contaminant and a pollutant.

□ A hazard is anything that harms our health. A contaminant is something introduced to the environment (air and water) that may or may not pose a significant health risk. A pollutant is a contaminant introduced into the environment that adversely affects animal and human life.

There are two main approaches to pollution management:

- **Pollution prevention**: focuses on stopping pollution being produced in the first place, or reducing any waste generation at the source.
- **Pollution control**: those measures taken to control pollution and wastes after they have been generated or produced.

2.6.1 Principles of pollution prevention

There are a number of principles of pollution prevention; we will briefly discuss some of them.

Principle of **waste optimisation**: The motto in this principle is 'Do not produce any waste; if this is not possible, reduce or minimise waste generation as much as possible'.

Figure 2.6 The waste hierarchy. Waste management options are listed in order of desirability from most desirable at the top to least desirable at the bottom.

There are three 'Rs' that are applied in waste optimisation: Reduce, Reuse and Recover. Figure 2.6 shows the hierarchy or the order in which the waste optimisation options should be used. Reduction refers to changing the process so that waste is not produced in the first place. Reuse involves using an item more than once (for example you can reuse plastic bottles for collecting water). Recovery involves recovery of materials or energy through recycling, composting and incineration. An example of recycling is taking used aluminium cans (tin cans) and recycle the metal to make it into something else. In composting we can take waste organic matter and make it into useful compost for fertiliser. Through incineration (burning) we can recover the energy contained in waste materials. There is more information on these processes in Study Session 22 on solid waste management.

The concept of waste optimisation is applied in industries through cleaner production. Cleaner production implies appropriate environmental management, waste minimisation, replacement of toxic chemicals, process and product modification, and the application of the three 'Rs'.

Polluter pays principle: This principle identifies the people or organisations who generate or produce waste or pollution as those who are accountable for any human or ecological damage. They are responsible for paying the costs of any damage. The principle is an economic tool to enforce accountability and responsibility. Strict standards for pollutant discharge permissions and enforcing heavy taxation on products or waste handling are ways of making the polluter pay.

Principle of **'Cradle to Grave'**: This principle applies to the production of any object or to any activity by an individual or institution and all the pollution that object or activity might cause throughout its lifecycle; that is, from its 'cradle' to its 'grave'. For example, if you make a plastic bottle, pollution might be caused in the manufacturing process; pollution is also caused by the lorries that transport the bottles around the country; and pollution is caused when the bottle is thrown away. All these aspects should be taken into account.

Precautionary principle: For any activity, there is an obligation not to cause harm even when someone is uncertain about the effect of the activity on humans and the environment. Under this principle, you take precautions to avoid environmental damage, even if you are not certain that damage will result. The application of waste minimisation is an example.

Principle of **duty of care**: Any person or organisation that produces waste, i.e. a waste generator, has a citizenship and ethical obligation to handle their waste properly. They have a duty to ensure that it does not harm other people or the environment.

Principle of discharge/emission permit: A waste generator has an obligation to obtain permission from the regulatory authority in order to discharge waste to surface water and to the atmosphere.

Principle of sustainable development:

■ What do you remember about the term ‘sustainable development’?

□ Sustainable development is ‘development which meets the needs of the present without compromising the ability of future generations to meet their own needs’. You could think of this as friendly coexistence where people and the environment sustain each other.

Sustainable development requires people to carry out environmental mitigation (lessening the damaging effects) for newly developed factories, dams, irrigation schemes and other undertakings as prescribed by law.

Principle of the right to know: The public has the right to information about pollution from a particular process. Public participation at various stages of project development avoids mistrust and the consequences of conflicts of interest.

2.6.2 Pollution control

Pollution prevention through various applicable principles and methods is not always possible and the consequence is that some pollution is produced. If pollution is produced, there should be some measures to control it and minimise the effects on people and the environment. The application of waste treatment before disposal, restricting contact between the waste and the public, and monitoring and evaluating the effect of the waste on the immediate environment are some of the intervention options in waste control. Pollution control options will be explored later in this Module.

Summary of Study Session 2

In Study Session 2, you have learned that:

1 An environmental health hazard is anything in the environment that endangers human health and life; there are various types of environmental health hazard.

2 Managing environmental health hazards requires knowledge of environmental health hazard identification, exposure conditions including the pathways of the hazards and hazard controls or interventions.

3 The principle of hazard management involves hazard recognition, deeper analysis of the risk of the hazard and the control or treatment and monitoring of the hazard.

4 Contamination and pollution are different; uncertainty of damage is a characteristic of contamination, while there is certainty of harm in the case of pollution.

5 The environment has a natural self-cleaning process. Pollution occurs when the self-cleaning process is defeated. The consequence of water, air and soil pollution is damage to the environment and to humans.

6 Pollution management is an extension of hazard management with the focus on pollution prevention and control. Pollution prevention and control principles address various concepts including accountability, responsibility, and economic and environmental liability.

Self-Assessment Questions (SAQS) for Study Session 2

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 2.1 (tests Learning Outcome 2.1)

Match the descriptions with the following key terms: hazard, pollution and contamination. Explain the reasons for your answer.

Description	Key term
A mill house is releasing its liquid waste into a nearby river. The community drinks the water below the discharge point. There was no complaint when people drank the water. There were no observations of fish dying. The amount of the chemical was not significant.	
Later a new industry releases its liquid waste into the same river. The mill house also continued to release its waste. Fishes in the river began to die. Fishing became difficult. The community downstream did not like the taste of the water.	
The amount of the chemical released by the new industry was not known. No one knows if the chemical in the waste is harmful or not.	

SAQ 2.2 (tests Learning Outcome 2.2)

Have a walk-through visit at the Health Post in your locality and think about any environmental hazards you might find there. List the types and sources of possible hazards and their health effects.

SAQ 2.3 (tests Learning Outcome 2.3)

Describe the key steps in hazard management planning. Using your answer to SAQ 2.2, what are the appropriate interventions for the hazards you have identified?

SAQ 2.4 (tests Learning Outcomes 2.4 and 2.5)

Think about the possible types of pollution that could be produced from a health centre.

(a) List the types of pollution that could be produced, giving one example of each type.

(b) Describe the two main approaches to pollution management. Outline the pollution management methods that could be used for the pollutants you have listed.

Study Session 3 Personal Hygiene

Introduction

The exercise of proper personal hygiene is one of the essential parts of our daily life. Many people in rural areas may not understand what good or bad personal hygiene is. The prevention of communicable diseases, like diarrhoea, trachoma and many others is highly possible through the application of proper personal hygiene. You need to learn the proper practice of personal hygiene and use this for the prevention and control of important public health diseases that are prevalent in your locality. This study session will also help you to understand the links between personal hygiene and one's dignity, confidence and comfort.

Learning Outcomes for Study Session 3

When you have studied this session, you should be able to:

3.1 Define and use correctly each of the key words printed in **bold**. (SAQ 3.1)

3.2 Describe the public health importance of personal hygiene. (SAQ 3.3)

3.3 List and describe the components of personal hygiene. (SAQs 3.1 and 3.2)

3.4 Describe what are acceptable and poor personal hygiene practices. (SAQ 3.4)

3.5 Prioritise the components of personal hygiene that are critical for public health concerns. (SAQ 3.3)

3.6 Explain hygienic handwashing using standard procedures, and list the critical situations for effective handwashing. (SAQs 3.4 and 3.5)

3.7 Explain the elements and activities that are needed for planning personal hygiene promotion. (SAQ 3.6)

3.8 Describe the criteria that are used for evaluating the effectiveness of personal hygiene application. (SAQ 3.7)

3.1 What is personal hygiene?

Personal hygiene is a concept that is commonly used in medical and public health practices. It is also widely practised at the individual level and at home. It involves maintaining the cleanliness of our body and clothes. Personal hygiene is personal, as its name implies. In this regard, personal hygiene is defined as a condition promoting sanitary practices to the self. Everybody has their own habits and standards that they have been taught or that they have learned from others. Generally, the practice of personal hygiene is employed to prevent or minimise the incidence and spread of communicable diseases.

3.2 Difference between cleanliness and hygiene

The term **cleanliness** should not be used in place of hygiene. Cleaning in many cases is removing dirt, wastes or unwanted things from the surface of objects using detergents and necessary equipment. Hygiene practice focuses on the prevention of diseases through the use of cleaning as one of several inputs. For example, a janitor cleans the floor of a health centre using detergent, mop and broom.

They might also use chlorine solution to disinfect the floor. The cleaning process in this example is the removal of visible dirt, while the use of chlorine solution removes the invisible microorganisms. Hygienic practice encompasses both cleaning for the removal of physically observable matters *and* the use of chlorine for the removal of microorganisms. The hygiene practice in this example aims at preventing the spread of disease-causing organisms. Cleaning is a means to achieve this task.

3.3 Public health importance of personal hygiene

The knowledge and practice of personal hygiene are vital in all our everyday activities. The purposes are:

3.3.1 Preventing faeco-orally transmitted diseases

The fingers may get contaminated with one's own faeces, either directly or indirectly. Activities during defecation and child bottom-washing are additional opportunities for the contamination of the fingers that facilitate the transmission of infections.

3.3.2 Aesthetic values of personal hygiene

A person with clean hands is proud while eating because they feel confident of preventing diseases. A teacher in a school is always happy to see their students with clean faces and eyes, and dressed in clean clothes. A mother is mentally satisfied to feed her infant with clean hands because she ensures the preservation of her child's health. Generally, cleaning oneself produces pride, comfort and dignity at home and in public places. Caring about the way you look is important to your self-esteem.

3.3.3 Social impact

A person with poor personal hygiene might be isolated from friendship because telling the person about the situation might be sensitive and culturally difficult. The success of a job application or the chance of promotion could be affected by poor personal hygiene; no company wants to be represented by someone who does not appear to be able to look after themselves.

Figure 3.1 Scalp *Tinea capitis* (scalp ringworm). (Source: University of California, Dermatology Glossary)

3.4 Components of personal hygiene

3.4.1 Body hygiene (skin care)

The body has nearly two million sweat glands. Moistened and dried sweat and dead skin cells all together make dirt that sticks on to the skin and the surface of underclothes. The action of bacteria decomposes the sweat, thereby generating bad odour and irritating the skin. This is especially observed in the groin, underarms and feet, and in clothing that has absorbed sweat. Skin infections such as scabies, pimples and ringworm are results of poor body hygiene. Figure 3.1 shows ringworm of the scalp (*Tinea capitis*).

The first task in body hygiene is to find water, soap and other cleansing materials. Taking a bath or a shower using body soap at least weekly is very important to ensuring our body stays clean (Figure 3.2). Bathing can be every day or after periods of sweating or getting dirty. The genitals and the anal region need to be cleaned well because of the natural secretions of these areas. Dry the body with a clean towel after thorough rinsing. Change into clean underwear after a bath. Changing sweat-soaked clothes after each bath is advised. Cleaning the ears after every bath is also necessary. Avoid sharing soaps and towels because of the danger of cross-infection.

Figure 3.2 Body washing.

3.4.2 Oral hygiene (oral care)

The mouth is the area of the body most prone to collecting harmful bacteria and generating infections. Our mouth mechanically breaks food into pieces. This process leaves food particles (food debris) that stick to the surface of our gums and teeth. Our mouth cavity is full of bacteria and is a good environment for bacterial growth.

■ Why is the mouth a good environment for bacterial growth?

□ It is at the optimum temperature (37°C) and is often rich in food particles that support bacterial growth.

The decaying process that takes place on the surface of the teeth eventually produces a build-up called *plaque* (a sticky deposit on which bacteria grow) that is then converted into *tartar* (a hard, yellowish, calcified deposit on the teeth, consisting of organic secretions and food particles). The result is tooth decay. In addition, unpleasant smelling breath (*halitosis* or *stinking odour*), teeth and gum infections could be a result of poor oral hygiene.

Figure 3.3 Mouth cleaning.

Advice for keeping the mouth clean (Figure 3.3) is:

- Rinse the mouth after each meal.
- Brush your teeth with a fluoride-containing toothpaste twice a day – before breakfast and before you go to bed. Cleaning the mouth with twigs is possible if done carefully.
- During the day, fill your mouth with water and swish it around to get rid of anything sticking to your teeth.
- In addition to regular brushing, it is advisable to floss your teeth at least once a day, usually before you go to bed.

3.4.3 Handwashing (hand care)

The cleanliness of our hands is very important in all our daily activities. In our normal activities our hands frequently get dirty. There are many situations in which microorganisms are likely to attach to our hands along with the dirt. There are many communicable diseases that follow the route of faeco-oral transmission. Hand hygiene plays a critically important role in preventing this transmission.

Hygienic handwashing involves the mechanical removal of microorganisms from contaminated hand surfaces using soap or detergent. Handwashing should involve more than a quick rinse under a tap (faucet) or in running water.

The following handwashing technique (also shown in Figure 3.4) ensures that the hands are properly washed and it doesn't take long to complete:

- First wet your hands with clean water and lather with a bar of soap.
- Next rub your hands together vigorously and scrub all surfaces up to your wrists.
- Clean under your fingernails.
- Continue for 15–30 seconds or about the length of a little tune (for example, the 'Happy Birthday' song). It is the soap combined with the scrubbing action that helps dislodge and remove germs.
- Rinse your hands well with clean running water (pour from a jug or tap).
- Dry your hands in the air to avoid recontamination on a dirty towel – do not touch anything until your hands are dry.
- Wood ash will also rub off any dirt and smells. The slight irritation you feel when you wash your hands with ash shows the cleansing power of ash.
- Local seeds such as *indod* (Lemma's plant), which are known to be good cleaning agents, can also be used for regular handwashing.
- Clean sand with water can be used for handwashing to help to rub off dirt.

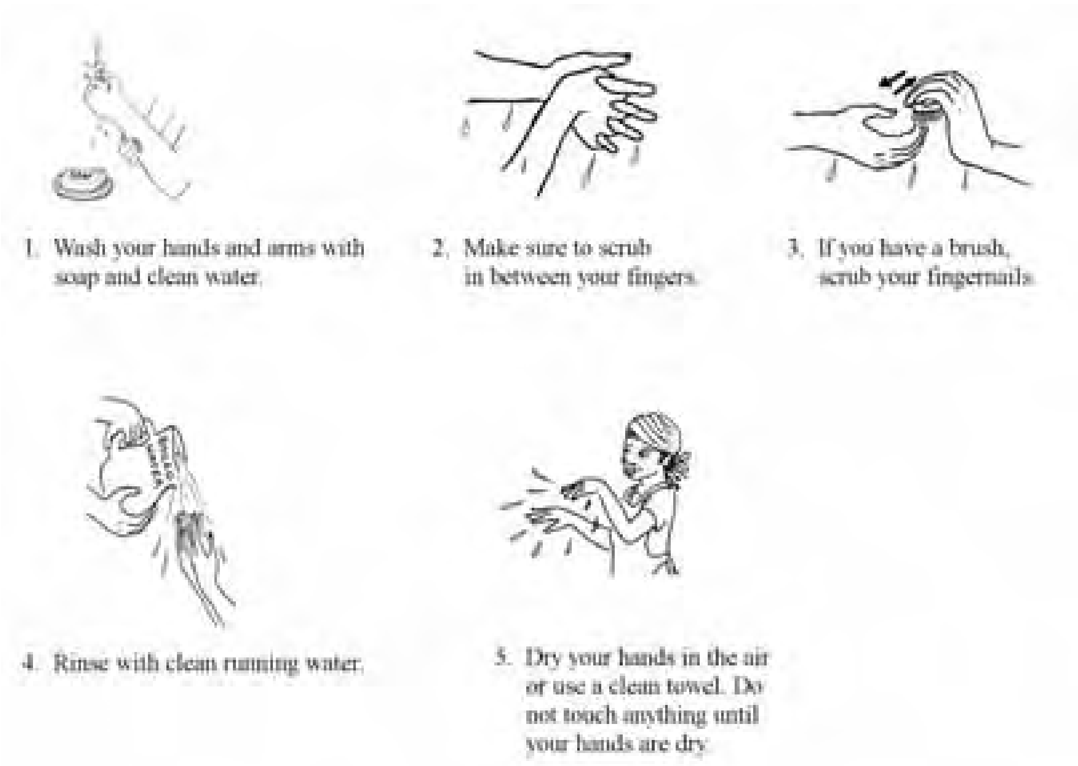


Figure 3.4 Handwashing technique.

If you don't have soap, you can use alternatives. These serve the same purpose as the soap, to help 'scrub' what is stuck on your hands, so the running water can brush it off. To get clean hands, you must POUR the water over your hands (no dipping in a bowl!). The soap or ash 'lifts' the dirt, and the water then washes off the visible dirt and the invisible germs. Various options for handwashing are indicated in Figure 3.5.

Figure 3.5 Handwashing (cleaning). (Photos: Abera Kumie, Basiro Davey, USAID/HIP, WaterAid in Ethiopia)

As well as routine personal hygiene that applies to everyone, your daily work will include many situations when you may ask yourself when you need to wash your hands. To know when to wash your hands at home and at work, you must first identify **critical situations**; that is, situations, activities or incidents that indicate the possibility that pathogenic microorganisms are present on hands, fingers and nail surfaces.

Critical situations in everyday activity include:

- After using the toilet (or disposing of human or animal faeces)
- After changing a baby’s diaper (nappy) and disposing of the faeces
- Immediately after touching raw food when preparing meals (e.g. chicken or other meat)
- Before preparing and handling cooked/ready-to-eat food
- Before eating food or feeding children
- After contact with contaminated surfaces (e.g. rubbish bins, cleaning cloths, food-contaminated surfaces)
- After handling pets and domestic animals
- After wiping or blowing the nose or sneezing into the hands (respiratory hygiene)
- After handling soiled tissues (your own or others’, e.g. children).

Critical situations in healthcare activity include:

- Before and after contact with an infected wound
- After contact with blood or body fluids (e.g. vomit)
- Before and after dressing wounds
- Before giving care to an ‘at risk’ person (e.g. attending delivery, attending a baby)
- After giving care to an infected person.

3.4.4 Face hygiene

Our face reveals our daily practice of personal hygiene. Face hygiene includes all parts of the face. The most important area to keep clean is the eyes. The eye discharges protective fluids that could dry and accumulate around the eye. They are visible when a person gets up in the morning. The organic substance of the eye discharge can attract flies and this is dangerous because the fly is a carrier (vector) of trachoma and conjunctivitis.

A person should wash their face every morning in order to remove all dirt that they have come in contact with during the course of the day. This will keep your face clean all day. Children are advised to wash their face frequently. Never share your face towel with others.

■ Why is it inadvisable to share a face towel?

□ Because some diseases, such as conjunctivitis and trachoma, can be transmitted easily from person to person in this way.

3.4.5 Fingernail and toenail hygiene (nail care)

A nail is hard tissue that constantly grows. Long fingernails tend to accumulate or trap dirt on the underside. The dirt could be as a result of defecation or touching infected and contaminated surfaces. Keeping nails trimmed and in good shape weekly is important in maintaining good health. Clip nails short along their shape but do not cut them so close that it damages the skin. Razor blades and fingernail cutters or scissors are used to cut nails. Nail cutters should not be shared with others.

■ Why is it inadvisable to share nail cutters?

□ Because some diseases, such as fungal infections, can be transmitted easily from person to person in this way.

3.4.6 Ear hygiene

Ear wax accumulates in the ear canal that leads from the outer ear to the ear drum. As the secretion comes out of the ear it collects dust particles from the air. Daily washing with soap and water is enough to keep the outer ear clean. Do not reach farther than you can with your little finger into your ear. Putting in hairpins, safety pins or blunt-edged things for cleaning purposes might harm the ear. If you feel wax has accumulated and is plugging your ears and interfering with hearing, consult your doctor.

3.4.7 Hair hygiene (hair care)

The hair follicles from which the hair grows produce oil from the sebaceous glands that keeps the hair smooth. The scalp (the skin covering the head) also has numerous sweat glands and is a surface for the accumulation of dead skin cells. The oil, sweat and dead cells all add together and can make the hair greasy and look dirty unless you wash it regularly.

Poor hair hygiene could cause dandruff and skin infections such as *Tinea capitis* (see Figure 3.1). Dandruff is dead skin on the scalp that comes off in tiny flakes when sebaceous glands produce too much oil and accumulates on the scalp.

Head hair is a good harbour for head lice (*Pediculus humanus capitis)* and nits (eggs of head lice). The head louse is a tiny insect that lives by sucking blood. Children are especially prone to lice infestation. Lice spread from one head to another when there is close contact as in school environments. They make the scalp itchy and are a cause of annoyance, irritation and embarrassment. Shaving of the head hair is possible in cases of heavy lice infestation. Sharing blades with others, however, should be discouraged.

Figure 3.6 Hair cleaning.

Hair cleaning (Figure 3.6) is important to ensure it stays clean, healthy and strong.

The recommended procedures for cleaning the hair are:

- Use clean water to wash your hair regularly (at least twice weekly, preferably once every other day) with body soap or shampoo, whichever is available.
- Massage your scalp well. This will remove dead skin cells, excess oil and dirt.
- Rinse well with clear water.
- Conditioner is helpful if you have longer hair as it makes the hair smoother and easier to comb, but hair doesn't need to have conditioner.
- Use a wide toothed comb for wet hair as it is easier to pull through.
- Dry the hair and the head with a clean towel. Never share a towel with someone else.
- Comb the hair to look beautiful for the day.

3.4.8 Foot hygiene (foot care)

We spend a lot of time on our feet. Our feet sweat as we walk day and night and the sweat accumulates on all foot surfaces and between the toes. The sweat may stain the shoes and can produce an awful odour.

■ What causes sweat on the skin to produce an unpleasant odour?

□ The action of bacteria as they decompose the sweat.

As well as bacteria, sweat also encourages fungal growth between the toes. This is called athlete's foot. The symptoms of athlete's foot are scaly skin and sores or blisters, which start between the toes but can often spread to the soles of the feet. This is a minor irritation and often disappears by itself but sometimes these cracks and sores become the site for other infections. The feet should be washed daily, or at least twice weekly.

Foot hygiene is also important in the treatment of *podoconiosis*, sometimes known as mossy foot. This disease causes swelling in the feet and lower legs and is common in certain parts of Ethiopia. It is a reaction in the body to very small soil particles that have passed through the skin of the feet. Podoconiosis can easily be prevented by wearing shoes at all times but, if someone is affected, careful washing and drying of the feet is an important part of the treatment.

Toenails do not have much role in the transmission of diseases. However, they can accumulate dirt and this can increase the potential for bacterial and fungal breeding e.g. athlete's foot.

3.4.9 Armpit and bottom hygiene

These are body parts that easily get sweaty and where ventilation is very poor. After puberty, our sweat gains a specific and unpleasant odour which may be offensive to others. The armpits and the bottom should be washed daily.

Anal cleansing is the hygienic practice of cleaning the anus after defecation. The anus and buttocks may be cleansed with clean toilet paper or similar paper products. Water may be used. Hands must be washed with soap afterwards. The use of rags, leaves, stones, corn cobs, or sticks must be discouraged as these materials can damage the skin.

3.4.10 Clothes hygiene

We usually have two layers of clothing. The internal layer is underwear (or underclothes) such as pants, vest and T-shirt. These are right next to our skin and collect sweat and dead skin cells, which can stain the cloth. Bacteria love to grow on this dirt and produce a bad smell in addition to the specific odour of the sweat. Underwear must be washed more frequently than the outer layer of clothing.

Clothes hygiene is an important aspect of one's dignity. Changing used clothes for clean ones every day is recommended. Washing dirty clothes requires adequate clean water, detergents (solid or powdered soap) and washing facilities (Figure 3.7). If possible, the washed clothes should be ironed to help the destruction of body lice and nits. Boiling water or insecticides can be used to destroy clothes infestation.

Figure 3.7 Washing clothes in rural areas (a) by a river and (b) at a communal washbasin. (Photos: (a) Nancy Platt, (b) WaterAid/Caroline Irby)

Frequent changing into clean clothes might not always be possible in poor households. However, the frequency of changing is advised to be twice a week for internal wear and once or twice per week for outerwear. The frequency mainly depends on the intensity of dirt on the clothes, and that depends on the climate and type of activity.

3.4.11 Menstrual hygiene (Personal hygiene for women)

The vagina is able to clean itself; no special care is needed other than washing the external genitals. Washing the outer genital area with clean water must be a daily practice. Change tampons and sanitary napkins or pads regularly. Always wash your hands before and after handling a tampon or pad. Clean and soft cloths can be used in place of sanitary pads. The use of dirty cloths must be discouraged. Menstrual blood-absorbing items must be properly disposed of in a burial pit or other appropriate method.

3.5 Planning for the improvement of personal hygiene

As a Health Extension Practitioner, educating the community members on personal hygiene is one of your main duties. You may ask yourself: what educating, educating whom, where, and how? You may further ask yourself: how do I monitor or evaluate my success in the promotion of personal hygiene? The following section will answer these questions.

You will find further details of hygiene promotion activities in the *Health Education, Advocacy and Community Mobilisation* Module.

3.5.1 Preparing a plan of action for personal hygiene promotion

You need to make a baseline survey of your community to help you understand the extent of personal hygiene problems. Villages and schools can be surveyed for this purpose. Designing a health survey will need collaboration with others but your input is valuable for structuring the questions so they relate to local knowledge, attitude and practice (abbreviated as KAP). Interviews with the respondents, group discussion and observations are all useful for exploring the practice of personal hygiene. From the results of the survey you should be able to identify the priorities and interventions for improving personal hygiene in your community. You can then design a plan of action knowing the key themes that need to be covered. The plan should include the themes, objectives, type of audience, key messages, etc. This is illustrated in Table 3.1 (on the next page). The first few rows of the table have been completed to demonstrate how you could use a plan of this type.

Table 3.1 Plan of action for personal hygiene education.

Themes of personal hygiene	Objectives*	Type of audience	Teaching aid	Place	Date	Responsible person
Body hygiene	To understand the importance for health	Students in elementary school	Poster and oral communication	School X	Date X	Mr X
Face hygiene	To prevent trachoma	Mothers with children	Poster and oral communication	Village X	Date X	Mr X
Hand hygiene	To prevent diarrhoea	Mothers with children	Poster, oral communication, demonstration	Women's Association Office X		
Oral hygiene	To keep teeth healthy	School children	Poster, oral communication, demonstration	School X		
Hair hygiene						
Women's hygiene						
Clothes hygiene						

*The objectives of a health promotion activity should target changing or modifying knowledge, attitude, practice and then behaviour.

3.5.2 Identifying the audience

There must be a good reason why you want to educate the community on personal hygiene. You should identify which group of people you want to target so that you can prepare appropriate health messages and teaching materials (Figure 3.8). School children, women, elders, adults, teenagers and patients seeking medical help are some groups that you might decide are priorities.

Figure 3.8 Children with hygiene education cards.
(Photo: WaterAid/Caroline Irby)

3.5.3 Sites for personal hygiene promotion

Whenever you have an outreach visit you can take the opportunity to promote personal hygiene to individual household members. Group meetings and mass gatherings (market, church, holiday) are also good opportunities, as are schools and patients in health facilities. Remember that the type and number of your audience will differ from site to site.

3.5.4 How to promote personal hygiene

This is a basic question that you need to address carefully. The most important point is that you must be prepared for the theme you want to cover. The preparation must focus on gaining detailed knowledge and adequate information on that theme. This requires reading materials, collecting appropriate teaching aids and knowing the audience (educational background, their needs, behaviour, habits, etc.). Fixing the site, date and time is also important. You should identify the key messages you want to get across to your audience.

3.5.5 Evaluating the status of personal hygiene

You will need to measure the success of your effort in the promotion of personal hygiene. It is not always a simple task to identify the absence of proper hygienic practice. Some of the methods that could be used widely are described as follows.

The presence of hygienic handwashing procedures

You should look for an instruction manual for handwashing procedures that should be available in public facilities (Health Post, health centre, hospitals). It's a good idea for the procedure to be posted on a wall where everyone can see it as an easy reminder.

Observation

This is the easiest and most reliable method. In order to say if the surface of an object (body surface, eye, table top, floor, etc.) is clean or not, you should first understand what 'clean' means for those objects because the degree of cleanliness is judged in different ways. It may be clean or not clean; acceptable or not; or it may be categorised using a five-point scale: not clean, somewhat clean, clean, very clean, and super clean. You have to understand that the degree of cleanliness may vary between your own and someone else's observations of the same object. Such judgement, however, is only applicable to visible dirt. It is important to realise that a surface that looks clean is not necessarily free of microorganisms.

Indirect way of assessing

You need to ask yourself why some infections are more prevalent in one village than another.

- ■ What could be the reason if you get reports that diarrhoea is a *frequent* problem in one out of ten villages?
- □ You must suspect that poor personal hygiene practice might be one of the factors for the sustained transmission of the disease. Lack of adequate water for handwashing or open defecation could be other factors.

Post-baseline surveying

The behaviour of your community can be surveyed again to find out if your efforts in personal hygiene education have been successful. The design of any follow-up survey should be based on the original baseline survey so you can compare your survey findings with the baseline. The timing of a post-baseline survey will depend on the local circumstances. It should be long enough to allow time for behaviour to change but not later than one year after the initial survey.

Summary of Study Session 3

In Study Session 3, you have learned that:

1. Personal hygiene is a necessity for our daily activities. It is very important for the protection of our health and helps to prevent the spread of communicable diseases.
2. Personal hygiene has social and aesthetic values. An individual who follows the practice of proper personal hygiene gains confidence, pride and dignity.
3. Personal hygiene applies to all parts of the body, but hand hygiene is probably the most important for public health.
4. The procedures that apply in personal hygiene (such as handwashing and oral hygiene) need to be followed strictly to gain the best results.
5. The promotion of personal hygiene should aim to change human behaviour. The provision of hygiene information first impacts on knowledge and then practice.
6. The promotion of personal hygiene must be well planned in order to bring positive changes.

Self-Assessment Questions (SAQs) for Study Session 3

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 3.1 (tests Learning Outcomes 3.1 and 3.3)

Identify the components of personal hygiene that are numbered in Figure 3.9.

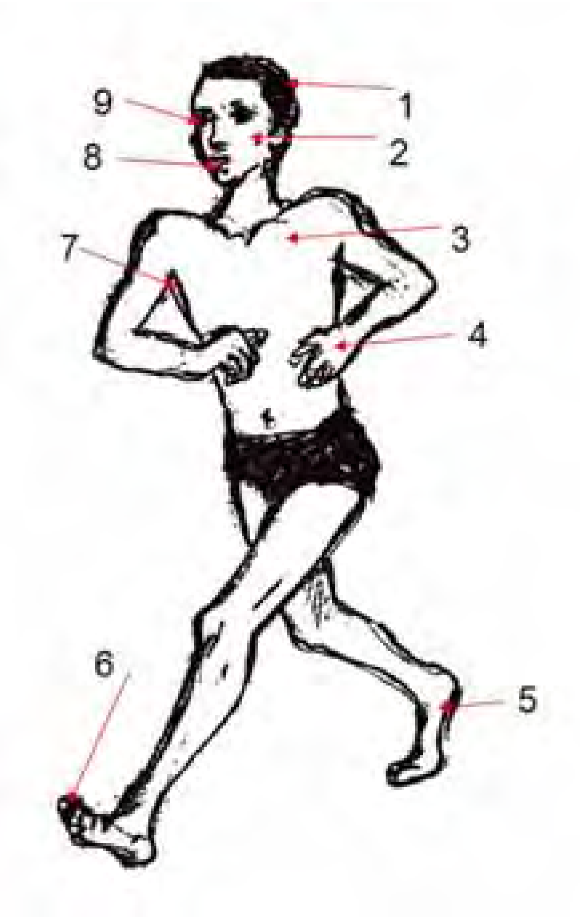


Figure 3.9 Body parts for personal hygiene

SAQ 3.2 (tests Learning Outcome 3.3)

Write the names of one or two communicable diseases or conditions and the recommended frequency of washing or cleaning for the following respective components of personal hygiene.

Components	Diseases/conditions	Recommended frequency of cleaning
Eye hygiene		
Hair hygiene		
Body hygiene		
Oral hygiene		
Feet hygiene		
Hand hygiene		
Clothes hygiene		

SAQs 3.3–3.7 are on the next page.

SAQ 3.3 (tests Learning Outcomes 3.2 and 3.5)

Given your answer for SAQ 3.2, which components are most important for your locality?

SAQ 3.4 (tests Learning Outcomes 3.4 and 3.6)

One day at a wedding, you observe some guests lining up for handwashing, while other people have started to eat the feast without handwashing. Among those who washed hands, some used soap, while others just used running water without soap. Are these acceptable or poor handwashing practices?

SAQ 3.5 (tests Learning Outcome 3.6)

The purpose of handwashing is to get rid of microorganisms from our hands. Suppose you want to educate family members on proper handwashing and demonstrate the correct procedure to follow. What will you tell them to do? What are the critical situations for proper handwashing they should be aware of?

SAQ 3.6 (tests Learning Outcome 3.7)

SAQ 3.5 addressed educating household members. What activities would you consider for the planning of personal hygiene promotion at community level?

SAQ 3.7 (tests Learning Outcome 3.8)

Go back to SAQ 3.5 and your answer. Imagine that you have given this handwashing promotion to a group of households. How will you evaluate whether the promotion was effective?

Study Session 4 Healthful Housing

Introduction

Our health depends not only on personal hygiene but also on the hygiene of our homes and housing. We spend much of our daily time in our home and our physical and mental development takes place there. This study session describes the basic hygiene requirements of housing to ensure that it is appropriate for our health. Factors affecting housing sanitation and possible interventions will be discussed. We will also closely examine the status and effect of indoor air pollution. You will learn the link between our health and environmental needs with respect to housing.

Learning Outcomes for Study Session 4

When you have studied this session, you should be able to:

4.1 Define and use correctly each of the key words printed in **bold**. (SAQ 4.1)

4.2 Describe the link between healthful housing and health. (SAQs 4.2 and 4.3)

4.3 Describe the main features of model rural housing and how it supports the health of its inhabitants. (SAQ 4.4)

4.4 Describe factors involved in indoor air pollution and its prevention. (SAQ 4.5)

4.5 Explain the elements/activities that are needed for planning healthful housing promotion. (SAQ 4.6)

4.6 Describe the criteria that are used for evaluating the effectiveness of healthful housing practice. (SAQ 4.6)

4.1 What is healthful housing?

Every family and individual has a basic right to a decent home and a suitable living environment. Housing is a basic prerequisite for health. This right is noted in the constitutions of many countries, including Ethiopia. However, a significant proportion of the population in rural and urban areas in Ethiopia does not possess suitable healthful housing.

Housing is a term that we use for a physical structure in which we live.

■ Just stop reading for a moment and ask yourself what is housing?

□ You may say housing is a shelter where we sleep and live, or a place in which we cook our food, or a place where a child grows, or a place where we get clean water for drinking.

You will probably have a long list like this. The question is, then, how will you provide a complete understanding of housing so that members of your community understand you?

If you look for definitions of housing in books, you may find different answers. The *Oxford Essential Dictionary* defines housing as ‘flats and houses for people to live in’. Housing is also considered as a **dwelling** or physical shelter that is used for living purposes. Many of these definitions focus on the nature of housing as a physical structure or shelter.

The public health understanding of housing goes beyond this. The World Health Organization uses the term 'residential environment', rather than 'housing', which they define as:

> the physical structure that man uses for shelter and the environs of that structure including all necessary services, facilities, equipment, and devices needed or desired for the physical, mental, and social wellbeing of the family and individual.

Note the key words in this definition. It combines the idea of shelter with the complete development of health and is equivalent to a definition of **healthful housing**. The definition has three elements:

- The physical structure or building that provides the shelter.
- The necessary services, facilities, equipment and devices that are used by an individual, for example, a bedroom for sleeping or a latrine for human waste excretion.
- The goal of housing is preserving one's health. This is the purpose of a physical building and its immediate environment.

Do not get confused with different terms such as housing sanitation, housing hygiene, hygiene of housing, residential environment and healthful housing. They mean almost the same thing.

Your role in the provision of healthful housing must be clear. You are an advocator and communicator of appropriate information and advice. You will need partners to help you in the work towards healthful housing; these are members of your local community, elders and local government staff.

4.2 Basic requirements of healthful housing

In order to understand further what housing is, WHO has adopted four basic requirements:

- satisfaction of physiological needs
- protection against infection
- protection against accidents
- protection against psychological and social stresses.

4.2.1 Satisfaction of physiological needs

Human **physiology** (the functioning of our bodies) is highly dependent on the immediate environment. Our environment should supply the necessary services and facilities for our physiological needs. For example:

Breathing

Breathing is a physiological process that utilises oxygen for energy production and expels the waste as carbon dioxide (CO_2). Housing must allow adequate fresh air to get into the house and used air to get out. This ventilation of air is facilitated by a window. The area of the window surface through which air can pass must be proportional to the floor area of the room in order to get adequate air supply per given time. A guide of 10% (light and air admitting window area divided by floor area) is assumed to be adequate for residential housing.

- ■ The floor dimensions of a room are 3 m wide and 4 m long. Calculate the size of the window that could supply adequate ventilation.
- □ Floor area = 3 × 4 m = 12 m^2

  The window should be 10% of the floor area. 10% of 12 m^2 is 1.2 m^2. The size of the window needed is therefore 1m wide by 1.2 m height if you had one window, or 0.8 m by 0.8 m each if you had two windows.

Getting clean and fresh air through the window could be compromised by household activities. Interference with breathing due to smoke and gases from the use of fuels such as wood or dung is common. Inefficient combustion releases many toxic chemicals that can affect our skin, eyes and lungs.

Seeing

This is the ability to observe the immediate environment using our eyes. Naturally, visual physiology requires adequate light in order to effectively see or look at an object. Adequate light is also important for reading, watching TV and attending class lectures in a school. The physical structure of housing provides the required light through two sources: artificial light from electric sources and natural light through the windows from the sun. The minimum recommended light-admitting window area is similar to that for breathing.

Sleeping

Sleep is a time when our body must get complete rest in order to be refreshed for the next day. Sleeping requires a separate room and should be free from any disturbance such as noise and indoor air pollution. The housing structure should provide adequate space in the form of a bedroom that is reasonably free from any environmental hazard that could disrupt sleeping. Separate bedrooms for children and adults are, in many families, a necessity.

Body heat regulation

Housing helps us to regulate our body heat, which means it helps us to keep warm or to keep cool.

- ■ How does housing help us regulate our body heat?
- □ It protects us from the weather, helping us to keep cool by shading us from the heat of the sun, or to keep warm by protecting us from cold, wind and rain.

The exchange of heat between our body and the immediate environment is dependent on the difference of temperature between the two. Relatively cold air is useful to take away excess heat through the process of convection. Convection is involved when there is a heat exchange between our body and relatively cold air moving across the body. Heat loss by conduction is involved when body heat is transferred to a colder surface by direct touch. The third mechanism for heat transfer is radiation, when body heat is lost directly to the immediate environment because of a temperature difference between two objects. Our housing should be suitable to help us regulate our body heat.

Eating

Eating food is linked with the digestive system of our physiology. A kitchen for food preparation and a separate space/room where a family gets together for meals are necessary to satisfy our housing needs for eating.

4.2.2 Protection against infection

Healthful housing is essential for the prevention of a number of diseases that you have learned about in the *Communicable Diseases* Module. Poor housing is associated with a wide range of diseases. Categories of communicable diseases due to poor housing include:

- Diarrhoeal diseases (acute watery diarrhoea, dysentery, shigellosis, typhoid fever and other faeco-orally transmitted diseases) because of poor personal hygiene, absence or poor utilisation of latrines and poor waste management.
- Tuberculosis, measles and other droplet infections due to poor ventilation and crowding.
- Acute and chronic lung diseases due to indoor/cooking smoke. Indoor smoke causes eye infection and irritation.
- Skin infections such as scabies and ringworm due to crowding as a result of limited housing space.
- Typhus fever and relapsing fever are possible due to crowding. Lice can easily travel from an infected person to the next nearby one.
- Disturbance of human comfort as a result of the bites of insects such as bedbugs and fleas.
- Breeding sites of rats in poor housing.

We want to make sure that our housing provides the necessary service and facilities to ensure the prevention of communicable diseases and protection of our health. These are summarised in Table 4.1. Household hygiene, personal hygiene, food hygiene and safe water supply are critical interventions for the prevention of infections in rural areas.

Table 4.1 Housing facilities and services needed for protection against infections.

Needs	**Facilities/services needed in the residential environment**
Drinking water supply and its safe handling	Access to protected water source; safe household water storage and utilisation
Safe human waste management	Presence and proper utilisation of latrines
Safe solid waste management	Presence of solid waste storage and disposal
Safe liquid waste management	Presence of liquid waste removal facilities (seepage pit, drainage pit)
Maintenance of personal hygiene practice	Presence of handwashing facilities
Food safety	Presence of hygienic kitchen; proper storage and handling of kitchenware
Vector control (flies, bedbugs, fleas)	Application of environmental controls; periodic cleaning of floors and walls; separate animal shed; proper dung management

You will learn more about these facilities and services in later sessions of this Module.

4.2.3 Protection against accidents

■ What accidents could be possible because of poor housing?

□ Poor housing can contribute to several types of accident including burns and electric shocks (if there is an electricity supply).

Table 4.2 shows several types of accident in the home and indicates the housing conditions that may cause them.

Table 4.2 Possible home injuries and their contributory causes.

Injury	**Conditions that may cause the injury**
Person falling over causing broken bones, bruising etc.	Slippery floor; steps that are too high or too low
Building materials falling on people	Poor structure of roof and walls
Burn	Improper use of fuel; damage to electrical wires
Carbon monoxide poisoning (see Box 4.1)	Not extinguishing fire sources while sleeping
Chemical poisoning (a child drinking pesticide, handling drugs, etc.)	Improper handling and storage of chemicals
Lack of air, breathing problems	No separate kitchen; keeping children close by while cooking with wood or dung fuel
Electric shock	Electrical wire is damaged by a rat; incorrect installation; overloading a circuit, etc.

Box 4.1 Carbon monoxide (CO) poisoning

Carbon monoxide (CO) is a toxic gas that is given off in incomplete combustion, when fuels don't burn properly. You can't see, smell or taste carbon monoxide, so it is very difficult for people to detect; this makes it very dangerous.

When we breathe in, oxygen is taken in through the lungs and carbon dioxide is breathed out. Haemoglobin in the red blood cells is used to carry oxygen to various parts of the body.

O_2 + haemoglobin = oxyhaemoglobin

If there is carbon monoxide in the breathed-in air, it combines with haemoglobin more easily than oxygen does.

CO + haemoglobin = carboxyhaemoglobin

CO reduces the oxygen-carrying capacity of the blood and poisons the body. It can lead to illness and even death.

4.2.4 Protection against psychological and social stresses

Remember that housing was defined as more than just a shelter. Poor housing can contribute to psychological and social stresses. These stresses cannot be physically observed but they may be revealed in the words people use to describe how they feel. We know that stress is not good for a healthy person. For example, the absence of a school in a village can be a stressful condition for a family with school-age children. Poorly built housing or the absence of water in a household could be a source of stress. On the other hand, the presence of a church or mosque pleases those who want to have access to them. The presence of playgrounds for children, markets, *kebele* and police offices, and recreational sites are some of the facilities that could alleviate human stresses. The satisfaction of psychological and social requirements through the presence of these facilities is very important to any organised village or community. These facilities are important for any existing as well as new settlements that include individual housing.

The objective of a healthful housing programme is to satisfy all or most of the above basic requirements. Improvements can be suggested based on priorities. Poor housing sanitation, overcrowding, insufficient daylight and poor ventilation are characteristics of *tukuls* in rural areas of Ethiopia.

4.3 Protecting people at special risk

Handling the housing conditions of people who have been displaced because of war, flooding, earthquakes, ethnic conflicts and epidemics requires special consideration. This group of people is vulnerable to communicable diseases, physical and sexual abuse, hunger, thirst, and various types of injury. They are likely to be socially and mentally stressed. The provision of shelter (tents and other types of shelter), food, plenty of water and accident prevention is most important. The representatives of displaced populations can be organised into a committee to assist the facilitation of relief assistance. The government needs to have similar organisation to work effectively.

4.4 Factors affecting healthful housing

Poverty, education, climate, culture and population mobility are the main factors that affect the structure of housing, i.e. the size, shape and design.

Figure 4.1 shows various types of *tukuls* (rural housing) that reflect different climatic and cultural variations. Big *tukuls* have tight-plastered walls and roofs, are more spacious and are usually found in cold areas. *Tukuls* in pastoralist areas are smaller in size, easily constructed and relatively inexpensive. Mobile populations require housing that can be reconstituted easily whenever needed. Some cultural values may hinder specific requirements such as the use of wider windows. Lack of education is also a problem. Even in high-income households, poor knowledge of the links between housing and health may be a barrier to the construction of healthful housing.

You should note that these factors affecting housing conditions are broad issues and not something that anyone can tackle alone but you should be aware of these factors because they may be relevant in your villages.

Figure 4.1 Structure of housing in different areas of Ethiopia. (Photos: Abera Kumie)

4.5 Guidelines for model housing

Here are suggested operational guidelines for the basic structural needs of a model *tukul* or other rural house.

4.5.1 Location of housing

The location of a *tukul* must be free from flooding and any potential natural disaster.

4.5.2 Size of housing

Based on the requirement to satisfy physiological needs, a minimum of 9–10 m^2 per individual is advised. This square unit is adequate for all purposes and services that our body needs. For a family of five, the total area required therefore is about 50 m^2. The wall height should not be less than 2 m depending on the length of the central axis of the *tukul*.

4.5.3 Type and size of rooms

Rooms for sleeping (bedroom), eating meals (dining room or salon) and storage (store room) are important (Figures 4.2 and 4.3). Sleeping rooms for children and adults should be separate if possible. Animal sheds and kitchen must not be part of the main rooms (sleeping and salon), but should be placed outside. Partitions should be used to create separate areas within the house although in a traditional *tukul*, it is not possible to have partitions that reach up to the ceiling. Based on the available literature, the space requirements are as follows:

- a living room (dining room or salon) 3–5 m^2 per person
- bedroom(s) at 5–6 m^2 per person, with a minimum room area of 8–12 m^2
- a kitchen (greater than or equal to 7 m^2)
- a store (5 m^2).

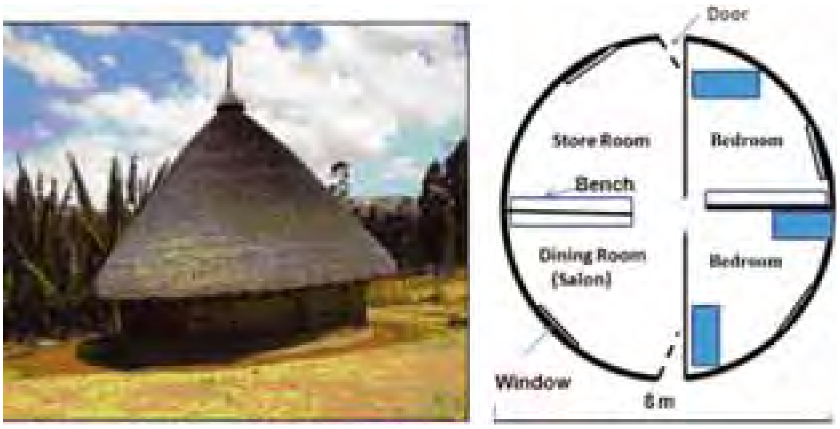


Figure 4.2 Traditional *tukul*: front view and floor plan.

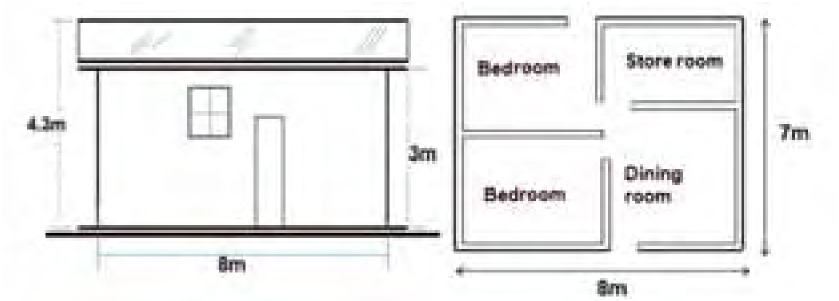


Figure 4.3 A housing unit with corrugated iron sheet roof and its floor plan.

4.5.4 Windows

As has been noted above (Section 4.2.1), the proportion of window surface area to floor area must be 10% at minimum. It is good to locate the window facing south, south-east or south-west so that adequate sunlight can be possible throughout the day. The presence of two windows is advisable for effective ventilation.

4.5.5 Structure of the walls

Walls must be well plastered with local materials both on the interior and exterior. Smooth interior walls are less likely to harbour insects such as bedbugs and cockroaches.

4.5.6 Kitchen

The kitchen must be totally separate from the main house. It must have an improved stove with a chimney for cooking *injera* and other foods.

4.5.7 Latrines and handwashing facilities

Latrines and handwashing facilities are explained in more detail in later sessions of this Module.

Good housing has a latrine and handwashing facilities to maintain personal hygiene and the prevention of infections.

4.5.8 Cleanliness

The interior of the dwelling and the immediate environment must be clean. Any type of solid waste and faecal matter must not be seen within and around the house.

4.6 Indoor air pollution

Cooking activities inside the main *tukul*, where family members spend most of their time, generates smoke that is hazardous to health. Mothers, children and elders are the ones who are most exposed to the effects of smoke. The usual type of fuel that is used for cooking and heating in the rural areas is **biomass**, i.e. animal dung (*kubet*) (Figure 4.4), crop residues and wood. Biomass fuel is understood to be inferior to, say, kerosene, because it is not energy-rich when burned. An inadequate supply of oxygen to the fire and wetness of the fuel increases indoor smoke. Biomass fuel generates visible smoke which is composed of a number of chemicals that are hazardous when breathed in. Carbon monoxide and tiny carbon particles (*tilashet*) are dangerous if inhaled.

Figure 4.4 Dung for fuel drying in the sun. (Photo: Pam Furniss)

Indoor air pollution occurs when the air inside a *tukul* is predominantly smoke instead of clean air (Figure 4.5). The presence of indoor air pollution is associated with acute respiratory infections, bronchitis and chronic lung diseases among children and mothers. You can help to prevent indoor air pollution by:

Figure 4.5 Indoor air pollution. (Photo: Abera Kumie)

- Advising the family to use an efficient stove that minimises fuel consumption and therefore smoke emission. The improved stove must be equipped with a chimney.
- Promoting the separation of the kitchen from the main house.
- Promoting the separation of animal sheds from the main house because fresh animal dung and urine produce bad odours when decaying.
- Advising mothers to cook without involving children in the kitchen.
- Recommending that a window be installed and left open until cooking is finished.

4.7 Planning for the improvement of healthful housing

How can you help to promote healthful housing? This is a question you should ask yourself once you have read this session. So far this session on healthful housing has focused on helping you to gain a scientific understanding of housing in terms of its definition, public health importance and basic housing requirements. Using this knowledge, you can consider how you can contribute to the improvement of housing conditions in your operating area.

4.7.1 Defining problems associated with healthful housing

The first step is to identify any housing problems in your area of interest using the above descriptions. Design a checklist and then make a quick survey to collect data on housing. A randomly selected sample of *tukuls* (say 30) is adequate for this exercise. At the end of the survey you should be able to list and prioritise the problems. Cultural and economic factors need to be identified. The findings will support your discussion with the community. The possible solutions must be indicated for each problem in concrete terms. The feasibility of using local materials should be studied as well. You should also indicate possible solutions in the form of proposed interventions that could be tackled without much additional investment.

4.7.2 Working with the local government

You cannot improve all the housing alone. You will need to discuss the survey findings with the members of the local government (*kebele* officials). They will be willing to provide you with additional advice and enrich your intervention.

4.7.3 Working with the community

You must be smart on how to implement the housing improvement programme you have designed. You should involve willing household heads in housing improvement and use these people to start your intervention. You can use these *model households* as examples for the rest of the community to follow. Once you have gained experience in handling this challenge, you can evaluate what can be done to expand these interventions.

4.7.4 Strategies for housing improvements

Designing a plan of action for housing improvement

Assuming that you have done a housing survey and identified related housing problems, you need to prepare a plan of action that contains the list of activities with the objectives and time for implementation. Focus on those that you can do in partnership with the community and local leaders.

Monitoring and evaluation must be a part of your plan of action. *Monitoring* reflects the routine checking of your planned housing activities, while *evaluation* focuses on the effect that you have brought about as a result of your activities. You have to ask yourself what achievements you have made and what it was not possible to do. Revisiting and modifying the plan of action in such cases will be important. Some indicators that can help you evaluate the housing conditions are the proportion of households with improved housing space, separated animal sheds, proper windows and improved stoves.

Public education

The understanding of housing problems by the people who will benefit from the improvements is very important. You can discuss the housing problems with a targeted audience. You can gain additional information based on the community members' reaction. This is useful to support your implementation plan.

Training of local craftsmen

You need to transfer your knowledge to local housing constructors in order to make them your partners. They are helpful in bridging the gaps between you and the community. The training needs to focus on the hygienic requirements of *tukuls* and the reasons for the poor housing in the locality. The options of housing improvements need to be sorted out with the assistance of local housing technicians.

New construction

This is the most appropriate means to implement housing improvement activities. The size of *tukul*, its location, the good use of partitions, and the inclusion of other facilities such as a latrine could be advised right at the beginning of the construction.

Improving deficiencies (taking remedial actions)

Many *tukuls* might lack one or more elements of healthful housing. These are usually the absence of windows, a separate kitchen, latrine, improved stoves and a chimney in the kitchen. You should carefully plan to fill the gaps with the advice of influential community members and consideration of local policies.

Summary of Study Session 4

In Study Session 4, you have learned that:

1 Healthful housing can be defined as the physical structure that people use for shelter and the environs of that structure, including all necessary services, facilities, equipment and devices needed or desired for the physical, mental and social wellbeing of the family and individual. This definition makes a good link between the physical nature of the housing and the goal of health.

2 There are four basic requirements for housing: satisfying physiological needs, protection against infections, protection against accidents, and satisfying psychological and social needs.

3 The implementation of all housing requirements is challenging. Listing all housing problems, testing them for their feasibility and discussing the priorities with the community and local community are important in order to design housing improvement strategies in your locality.

4 The dimension and size of a housing unit depends on satisfying the four basic requirements of housing. In addition, the local situation (economy, culture, willingness) should be considered for the implementation of housing improvements. However, there are some facilities that should not be compromised: latrine, separate kitchen, separate animal sheds, facilities for waste management and personal hygiene, and the presence of windows.

5 Model houses are a starting point for the implementation of new housing and improving existing housing. You need to evaluate the benefits of model houses and use the evidence to mobilise other residents who are not involved in model housing.

6 The kitchen should not be a source of indoor air pollution. The use of an improved stove with a chimney should be encouraged.

7 Your role in the provision of healthful housing must be clear. You are the advocator and communicator of appropriate information and advice. The model house owners, elders and local government staff are your partners in the work towards a healthful housing programme.

Self-Assessment Questions (SAQs) for Study Session 4

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 4.1 (tests Learning Outcome 4.1)

Briefly describe the main factors that contribute to indoor air pollution from smoke. What effect can it have on human physiology?

SAQ 4.2 (tests Learning Outcomes 4.1 and 4.2)

Match the four basic requirements of healthful housing with the following problems linked to housing.

Problem linked to housing	The basic requirements of healthful housing
Diarrhoea	
Lack of windows	
No school in the village	
Injury from falling	

SAQ 4.3 (tests Learning Outcome 4.2)

The *Communicable Diseases* Module describes four categories of disease transmission mechanism. These are:

(a) faeco-orally transmitted diseases
(b) droplet infections
(c) skin (contact) infections
(d) vector-borne disease.

Name at least one disease from each category that can be related to poor housing, and describe how poor housing aids the spread of these diseases.

SAQ 4.4 (tests Learning Outcome 4.3)

What are the requirements for a model house in terms of size, rooms (separation of rooms), ventilation, facilities and cleanliness?

SAQ 4.5 (tests Learning Outcome 4.4)

Read the following case study carefully and then answer the question.

Emebet cooks on an open fire in her small kitchen; she uses mostly dung and maize husks as fuel. She leaves the door open when cooking but there is no window or chimney. She has two children aged 3 and 1 and they are usually close by her when she is cooking. The cooking place is not separated from the main house.

If you were advising her how to reduce the dangers of indoor air pollution in her home, what steps would you recommend to her?

SAQ 4.6 (tests Learning Outcomes 4.5 and 4.6)

Suppose you are assessing the housing in the village where you are working to see if there are any problems.

(a) What will you do in order to identify the problems?
(b) What are the most important criteria you would use when judging the healthfulness of a *tukul*?

Study Session 5 Institutional Hygiene and Sanitation

Introduction

In this study session you will be introduced to the public health importance of various local institutions, such as schools, prisons, offices, clinics, Health Posts, churches and mosques. We will consider the essential hygiene requirements for these establishments and enable you to relate this to your own locality. In addition, this session introduces you to planning and making follow-up assessments of the hygiene status of these institutions.

Learning Outcomes for Study Session 5

When you have studied this session, you should be able to:

5.1 Define and use correctly each of the key words printed in **bold**. (SAQ 5.1)

5.2 Identify the local institutions that require attention for hygiene. (SAQ 5.2)

5.3 Describe the public health importance of public institutions. (SAQ 5.3)

5.4 Explain the basic hygiene requirements of institutions in your locality. (SAQ 5.4)

5.5 Describe the activities needed for planning the promotion of hygiene and sanitation in local institutions. (SAQ 5.5)

5.6 Identify the tools that are needed for institutional inspection. (SAQ 5.6)

5.1 Scope of institutional hygiene

Public institutions are those that provide social, educational and religious public services to the general population. They include schools, nursery homes, clinics, Health Posts, prisons, jails, churches and mosques. You may have some or all of these in your locality. These are the focus of **institutional hygiene**. However, there are other sectors of service such as shopping centres, mill houses, slaughterhouses and traditional markets that may also require your attention.

Children attending school, patients attending Health Posts and other people seeking services are vulnerable to various diseases, accidents and stresses. Protecting the health of all these people is essential from a public health point of view. The promotion of basic hygiene is very important in these local institutions.

5.2 Public health importance of institutional hygiene

The public health importance of local institutions is considered to be an extension of healthful housing. These institutions are places where people spend much of their time outside their home. The satisfaction of their physiological and psychological needs, and protection against infections and accidents, depend on the way hygiene is promoted in these local institutions.

It is possible for these institutions to be the focal point for epidemic diseases such as diarrhoea and measles due to poor hygiene.

5.3 School hygiene and sanitation

When we say schools, we mean kindergartens, primary schools (first and second cycle), and high schools, all of which could be present in your locality (Figure 5.1).

Figure 5.1 An elementary school in one of the rural areas of Ethiopia. (Photo: Abera Kumie)

5.3.1 Public health importance of school hygiene and sanitation

School children spend about one third of their time either in schools or doing school assignments, during which time they may be exposed to a variety of physical, social and psychological harm. Schools provide an ideal opportunity to detect poor hygiene practice by children.

The water supply and sanitation conditions of schools have become a public health concern in recent years. A Ministry of Health report in 2007 about school hygiene in Ethiopia indicated that the majority of surveyed primary schools did not have access to drinking water sources or adequate sanitation facilities for handwashing and excreta disposal. School dropouts are observed among female students due to a lack of latrines with facilities for menstrual hygiene. The report also found that the hygiene knowledge of the prevention of communicable diseases was poorly understood by students.

Other studies in Ethiopia among school children indicate that upper respiratory infections, skin infections, abdominal discomfort, eye infections, gastro-enteritis (diarrhoea) and tonsillitis are the commonest ailments for school clinic visits. Helminthic infections such as ascariasis and hookworm are prevalent because of the prevailing poor personal hygiene and waste management in the school and home environment.

The provision of school hygiene and sanitation ensures the rights of students to acceptable hygiene practices, safe water supply, latrines and a healthy school environment in general. The impact could have further beneficial effects, for example:

- Healthy environments facilitate more effective learning.
- Opportunities for students to gain life-long positive hygiene behaviours.
- Opportunities for increased school enrolment, retention and attendance for girls.

5.3.2 Components of school hygiene and sanitation

■ You have been a school student at some time in the past. What were the components of school health services in your time?

□ You might have various memories of events. Your classroom teacher might have checked your personal hygiene. You might have learned about trachoma and face washing in science class. Someone might have reminded you to use the latrine and wash your hands afterwards.

Your concern as a healthworker is the need to check systematically:

- health-related policies in schools
- hygiene
- safe water supply
- sanitation.

We will discuss these and other aspects of the school environment in turn.

Health-related policies in schools

All schools should be aware of the importance of school hygiene and sanitation for their students. Promotion of hygiene, organising hygiene/health clubs, having a clean school compound and supervising classrooms for their cleanliness are some of the items that require the attention of the *woreda* and *kebele* school authorities. The implementation of policy statements must take into account the availability of human resources and materials.

Promoting hygiene

Teaching students about health focuses mainly on the dissemination of hygiene information aimed at changing or modifying their behaviour. Health information is usually incorporated within various school subjects such as science, biology, home economics and physical education. However, teaching aimed at changing the behaviour of students is not part of the traditional education system. There are ways to fill this gap. Setting up and supporting health or hygiene clubs in schools, and the effective involvement of the Health Post, are important. You can take an active role in this by regular inspection and advising the school community in your area. You can take an active lead in coordinating and involving existing local health facilities in the promotion of school hygiene and sanitation. Detailed information on how to plan, organise and deliver health messages for school health promotion is found in the *Health Education, Advocacy and Community Mobilisation* Module.

The benefits of personal hygiene practice have been discussed in Study Session 3.

■ Which components of personal hygiene are most important to students?

□ Keeping the body clean, face and handwashing, wearing clean clothes, foot hygiene, and nail care are all important to students.

Healthy school environment

The physical and aesthetic values of the school environment and physical buildings need to satisfy the physical, physiological and psychological development of students. The important aspects of a safe and healthful school environment are:

- Adequate classroom space to avoid crowding. The Ministry of Health recommends: 2 m^2 per student at kindergartens; 1.11 m^2 per student at primary school; 1.26 m^2 per student at secondary schools.
- Classrooms with adequate daylight and ventilation; the proportion of window to floor area should be 25%.
- Classrooms that protect students' vision through the appropriate distance between the blackboard and the first line of seats.
- Dimensions of desks and chairs that match the students' physical development.
- The location of the school should be free from any potential physical and chemical hazards (e.g. free from noise and air pollution).
- Playing areas for physical exercise.

You should work in collaboration with the appropriate experts of the *woreda* education office for the satisfaction of the above needs. This can be discussed at the *kebele* cabinet meetings.

Provision of drinking water

Many students may walk hours to get to school. The provision of safe water for drinking and personal hygiene is important and there needs to be adequate facilities in proportion to the number of students. The Ministry of Health advises one water tap per fifty students. Low-cost water fountains and water taps arranged in a water trough design are acceptable for schools. They should be mounted at the appropriate height from the ground surface to match the height of the students (Figure 5.2). Water availability should be about five litres per day per student and water must be available throughout the school day. A water storage tank may be necessary to provide water reserves and satisfy the demand at peak hours. The sullage (wastewater) that results because of handwashing must be drained to a seepage or soak pit, or ditch.

Figure 5.2 Drinking taps and handwashing basin arrangements in a school. (Photo: Wasse Shiferaw)

Provision of latrines

The provision of latrines is also extremely important. In addition, separate latrines for girls and boys need to be provided to encourage girls to continue their education. The usual type of latrine at schools is a communal dry pit latrine equipped with a vent.

School latrines should meet the following requirements:

- They must be located away from the classroom in order to avoid interfering with the students' learning process. They must be reasonably accessible.
- They must be well-maintained and agreeable to use. They should provide privacy and security.
- The dimensions of the latrine must be adequate to accommodate the storage needs for three to five years. You will learn more about this in the waste management sessions later in this Module.
- There must be handwashing facilities near the latrine (Figure 5.3). Handwashing with soap after using the latrine and before lunch must be encouraged.
- There should be separate latrines for male and female students. Latrines for teachers must be separated as well.
- There must be a bucket with water and a jug inside female latrines. This is essential for cleaning the bottom for female students during menstruation.
- In primary and secondary schools, there should be one latrine for every thirty students and one urinal for every fifty male students.
- Latrines should be hygienic to use and easy to clean. Students themselves should participate in daily cleaning of the latrine. The hygiene/health club should take the leading role in the maintenance of latrine cleanliness.

Figure 5.3 School latrines with water container and handwashing facilities. (Photo: Abera Kumie)

Provision of solid waste management facilities

Discarded paper and cartons are the usual type of waste at schools. There could also be chemical wastes from school laboratories. Schools should have the following facilities:

- Waste bins/buckets in each classroom and teacher's office. Waste bins may be placed in the school compound where deemed necessary (around corridors, playgrounds).
- Waste disposal pit at an appropriate location; a local incinerator can be used if the amount of school solid waste is significant.

Classroom sanitation

The cleanliness of the classroom is vital for a good learning process. Students should be involved in the maintenance of classroom cleanliness on a daily basis. The floor of the classroom should be smooth to reduce dust (Figure 5.4). Dust and cracks in the floor must be avoided because these are good hiding sites for biting animals such as the chigger (also known as the chigger red bug or harvest mite).

Figure 5.4 Classroom sanitation: smooth floor, physical suitability of seats and desks, and adequate light and ventilation. (Photo: Abera Kumie)

5.4 Prison hygiene and sanitation

Detention homes such as prisons and jails, including temporary arrest facilities, must be hygienic. The transmission of communicable diseases such as diarrhoea, relapsing fever, scabies and typhus fever could be possible due to crowding and poor sanitation in prisons. The following provisions are important to check:

- Sanitation promotion: the strict nature of the prison requires some form of local organisation that could be actively involved in cleaning the interior rooms and compound. A sanitation committee can organise this with the guidance of the authorities of the prison. Its duty is to plan and execute a sanitation day at least once a week. Room and compound cleaning, clothes washing and personal hygiene are some of the priorities to maintain the health of detainees.
- The presence of any possible epidemics in a prison must be checked through regular prison inspection.
- Access to safe water, showers, clothes washing stands, latrines and solid waste disposal facilities are essential in a prison.
- An insanitary interior of the prison is attractive for insects such as cockroaches, fleas, lice and bedbugs. Inspection of new prisoners' clothing and bodies for the presence of these insects must be done when they arrive. High standards of personal hygiene through frequent body washing, maintenance of clean premises and clean clothes should be enforced.
- The rooms for detention should have an adequate supply of indoor light and fresh air. The surface area of windows should be a minimum of 10% of the floor area in order to admit daylight and adequate air.
- Overcrowding must be controlled as much as possible. Overcrowding leads to the transmission of many communicable diseases.
- Periodical hygiene education on selected relevant topics is important in order to maintain the healthy behaviour of prisoners.

5.5 Health facilities

There may be different types of local health facilities in your area, such as Health Posts, private and public clinics and health centres. The benefit of health facilities is well understood. However, the risks associated with health facilities are not always well understood by patients and the general population. Health facilities generate infectious wastes, needles and other sharps that are potentially harmful. The possibility of acquiring infections is another concern. The sanitation provision that you have learned about healthful housing in Study Session 4 is also applicable in these institutions. In particular, you should be aware of the following requirements for the Health Post you are working in:

1. Healthcare waste must be properly segregated, collected and disposed of. Needles, other sharps, contaminated linen, gauze, cotton and similar items must be disposed of by burning. The ash and unburned items must be properly handled and buried in a designated pit.
2. Liquid and semi-liquid wastes (placenta, blood, vomit, secretions) must be disposed of in a placenta pit.
3. Wastehandling facilities such as latrines, an incinerator and a placenta pit must be available, depending on the type of health services provided. Latrines should be clean, comfortable and pleasant to use.
4. Water supply and plumbing (water tank, handwashing facilities) are very important for good personal hygiene practice among healthworkers and patients.

You will learn more about healthcare waste management in Study Session 23.

5.6 Public offices

Various offices are organised to serve the population, such as the *kebele* administrative office. It's important to maintain a healthy office environment for the benefit of the health of the civil servants. Particular requirements include well-lit and ventilated offices/rooms, latrines, and proper solid waste management. The supply of safe water and handwashing facilities are important for the provision of personal hygiene.

5.7 Religious institutions

Churches and mosques may be present in your *kebele*. The need for environmental health service to the church servants on one hand, and to the attending people on the other hand, is the point of concern. The provision of a safe water supply with its auxiliaries, and the development of latrines in agreed sites should have priority. Proper liquid and solid waste management are also important areas of intervention.

5.8 Mill house hygiene and sanitation

You can find a mill house in almost every *kebele*. The basic principles of healthful housing are also applicable in mill house sanitation. The location of the mill house should not be a source of nuisance to the community such as from noise, flour dust and wastes. There must be adequate light and natural ventilation at the workplace. The provision of latrines, drinking water and waste management (solid and liquid waste) is important. The presence of handwashing and shower facilities is important for personal hygiene of the workers. Floor and walls should be easy to clean. The installation of an exhaust pipe for waste flour is necessary.

The safety of workers must be maintained through the proper guarding of machines, provision of personal protective devices (head cover, goggles, boots, ear plugs or muffs, working clothes).

5.9 Planning for the improvement of institutional hygiene and sanitation

There are certain planning activities that you must do in a stepwise way. The approach is the same as that used in Study Session 4 in Section 4.7 'Planning for the improvement of healthful housing'. The activities are briefly described below.

5.9.1 Knowing the scope of your activity

This requires the identification of institutions by type and number: schools (both elementary and high schools), prisons (both temporary and permanent prisons), health facilities (public and private clinics; you should leave the health centres and hospitals for the *woreda* environmental health worker), public offices (e.g. farmers' training centres, government offices), religious institutions (both Christian and Islamic), mill houses, and other workplaces. You should only consider those that are present at *kebele* level.

5.9.2 Identifying the problems related to hygiene and sanitation

Problems can be identified by carrying out a sanitary inspection of each institution. Before your inspection visit you need to prepare a checklist of basic hygiene requirements that is relevant to the institutions and your local context. An example of a checklist for a school is shown in Table 5.1.

The checklist and your physical observations should provide good baseline data that is useful for analysing any problems and setting priorities. You could also use interviews and questionnaires as additional tasks for identifying problems. However, you should note that you cannot address all problems at once because they could be deep-rooted and require resources. Setting priorities based on the local situation is helpful to select the problems that can be resolved more easily.

Table 5.1 School health survey form.

No.	Question	Response
1.0	**General information**	
1.1	Date of inspection	
1.2	Name of the institution	
1.3	Number of students by sex	Male:___ Female:___
1.4	Address	
1.5	Ownership	Private or public
1.6	Level of school	1st cycle/2nd cycle/high school
2.0	**School compound**	
2.1	Location of school: hazards such as noise, proximity to road	
2.2	Compound sanitation: free from solid wastes, flowing liquid waste	Yes/No, indicate the subject
3.0	**Classrooms**	
3.1	Windows	Adequate/inadequate
3.2	Ventilation	Adequate/inadequate
3.3	Lighting	Adequate/inadequate
3.4	Condition of classroom floor	Earth/concrete/other

4.0	**Water supply**	
4.1 4.2 4.3 4.4 4.5	Is water available in the school compound? Source Supply of drinking water and handwashing facilities Number of water taps Cleanliness around wash basins	Yes/No Piped/well/spring/river/pond/ other Yes/No Yes/No
5.0	**Latrine provision**	
5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9 5.10	Is a latrine available in the school compound? Type of latrine Floor of latrine Latrine available for: Separate latrines for male and female students Latrine superstructure Excreta seen around the latrine Excreta inside the latrine Can a student use the latrine in its current condition? Number of latrine holes	Yes/No Pit latrine/VIP/other Concrete slab/earth Students/teachers Yes/No Yes/No Yes/No Yes/No Yes/No
6.0	**Solid waste management**	
6.1 6.2 6.3 6.4	Is there a refuse container in the compound? Is there a refuse container in each classroom? Is there a burial pit for refuse? Is there an incinerator?	Yes/No Yes/No Yes/No Yes/No
7.0	**Students' personal hygiene (observe a few students)**	
7.1 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 7.10	Clothing Hair Face Nits Feet Fingernails Eyes Lice Teeth Scabies	Intact/torn/clean/unclean Clean/unclean Clean/unclean Yes/No Clean/unclean Clean/unclean Clean/unclean Yes/No Clean/unclean Yes/No
8.0	**Summary of main findings**	
9.0	**Suggestions**	

5.9.3 Identifying partners that you can work with

It is useful to identify partners in order to work together and bring improvements from mutual effort. Your role is to guide the hygiene and sanitation practice in your locality. The implementation of your recommendations will be the responsibility of one of your partner organisations. These are likely to be government offices such as the *kebele* health office, education office or water office, school staff, school parents' committees, traditional leaders, or police and court desks. It is also important to include authorities of religious institutions. The presence of a locally operating non-governmental organisation (NGO) could be a source of resources and expert advice.

5.9.4 Strategies for assessing and improving institutional hygiene

You need to understand the methods and tools for improving the hygiene conditions in public and private institutions. Here are some of them.

Designing the plan of action

You should have a plan of action that covers at least one year. The plan should indicate the list of activities in one column and the time in the second column (see Table 5.2). Note that the activities and time intervals in Table 5.2 are suggestions. You will need to devise your own schedule. The plan of action should be approved by the local authority or your supervisor so that they are aware of it. The local authority can provide you with better assistance if you involve them.

Table 5.2 Annual plan of action for assessing and improving institutional hygiene

Year:	______	
No.	**Activity**	**Time frame (suggested)**
1	Identify categories and number of public institutions	At the beginning of the year (specify the time)
2	Prepare survey tools	(specify the time)
3	Visit/inspect public institutions	Monthly
4	Provide a feedback report to visited institutions	Immediately after the visit
5	Discuss the findings with local authorities	Monthly
6	Hygiene education to students	Monthly
7	Discuss the main findings with the local government officials	Monthly
8	Check personal hygiene of students	Every week on Mondays
9	Discuss the hygiene status of religious institutions with the church and mosque leaders	At the beginning of the year (specify the time)
10	Call and address a general meeting in order to discuss the annual performance and get feedback from the stakeholders	Towards the end of the year
12	Mobilise resources	Whenever needed
13	Write reports	Monthly

Advocacy and public education

The enforcement of hygiene requirements is challenging. If a school has no latrine and you advise the school head to install latrines for students, they cannot do it immediately. They need time and a budget. In this case, you should emphasise the importance of latrines and encourage them to make the necessary budget allocation. You can also discuss the issue in the formal meetings which involve the local authorities. There are activities that do not require many resources. These are, for example, the establishment of hygiene/health clubs, hygiene education for students, and conducting personal hygiene inspections periodically.

Improving hygiene and sanitation services

Hygiene education and creating awareness are useful for the provision of information, but improvement of hygiene also needs facilities. The construction of latrines and safe water sources must be highlighted even if there are resource constraints. Just be aware that the provision of hardware, such as latrines, requires time and resources.

Inspection of public institutions

Inspection is a tool to identify problems, as described in Section 5.9.2, but it is also a means to design strategies for improvement. You need to make regular visits to each local public institution, at least once a year, using a checklist or a questionnaire that enables you to collect data, similar to the checklist for schools in Table 5.1. You should inform the owners or people responsible for the institution that you want to visit them at a specified date and time. Be transparent and genuine when inspecting to show that you want to help the institution to attain proper hygiene and not to criticise or fine them. You should give advice to the owners for improvement. You need to report to the *kebele* administrator for any sanitary violations that require enforcement.

Summary of Study Session 5

In Study Session 5, you have learned that:

1 Institutional hygiene is important for a range of institutions in your operational area, including schools, health facilities, prisons or jails, public and private offices, and local religious institutions.

2 It is important for public and environmental health that public institutions meet basic sanitation requirements, including: water supply, personal hygiene, provision of latrines and proper waste management.

3 School hygiene and sanitation are especially important because children spend a great deal of time at school and they need a healthy environment to learn and grow, physically, mentally and socially.

4 Sanitary inspection of public institutions is a method for identifying hygiene and sanitation problems. It can also be used to inform the design of strategies for improvement.

5 In order to address the institutional hygiene needs in your area, there should be an operational plan that can be applied locally.

Self-Assessment Questions (SAQs) for Study Session 5

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 5.1 (tests Learning Outcome 5.1)

You have visited one of the schools in your locality and drawn the diagram of the front view of the main building shown in Figure 5.5. You also inspected the facilities and took the photographs below. What parts of this building and its surroundings can you see that satisfy the criteria for physiological satisfaction, disease prevention and accident prevention? List the parts of the building and its surroundings using the numbers shown, and state why they are important.

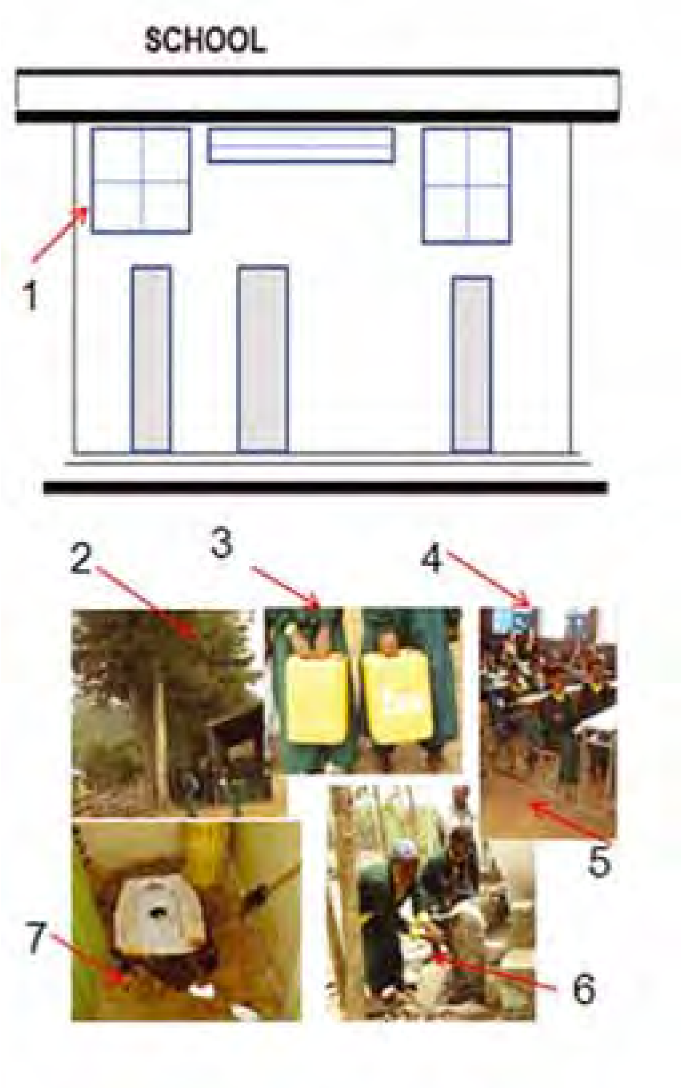


Figure 5.5 Diagram and photographs from school inspection. (Photos: Abera Kumie)

SAQ 5.2 (tests Learning Outcome 5.2)

Go around your *kebele* and list the categories and number of public institutions that require your service.

SAQ 5.3 (tests Learning Outcome 5.3)

You have learned about healthful housing in Study Session 4. What basic hygiene requirements are shared between healthful housing and institutional hygiene?

SAQ 5.4 (tests Learning Outcome 5.4)

The local *kebele* leader on the behalf of the *woreda* administrative office was asked to provide a licence for a private primary school. The *kebele* leader asks you to assist him to describe the basic hygiene requirements of an elementary school. What would you tell him?

SAQ 5.5 (tests Learning Outcome 5.5)

You have to make a plan of action for the forthcoming year for the promotion of institutional hygiene. Briefly describe the activities that need to be included in your plan.

SAQ 5.6 (tests Learning Outcome 5.6)

There is a school in your *kebele* that is due for an inspection of its hygiene and sanitation status. What tools of inspection will you consider using?

Study Session 6 Important Vectors in Public Health

Introduction

There are a number of vectors that transmit communicable diseases. Lice, fleas, various types of flies, snails, rats and mosquitoes are widely found in Ethiopia. You learned about some vector-related diseases in the Module on *Communicable Diseases*. Vectors are found within or close to human habitation; some breed in open water that may be found around homes and others breed inside the home. Certain vectors participate in the destruction of grains and household materials as well. In this study session, you will learn about the types of vectors that are of public health importance, their contribution to disease transmission and measures that can be used to control them.

Learning Outcomes for Study Session 6

When you have studied this session, you should be able to:

6.1 Define and use correctly each of the key words printed in **bold**. (SAQ 6.1)

6.2 List the vectors that are important for public health in your locality. (SAQs 6.2 and 6.3)

6.3 Describe various environments that support vector breeding. (SAQs 6.3, 6.4, 6.5 and 6.6)

6.4 Name some communicable diseases transmitted by vectors. (SAQs 6.2, 6.5 and 6.6)

6.5 Explain the main methods of vector control that are applicable in a local context. (SAQs 6.7 and 6.8)

6.1 Definition of vector

In ancient times, insects were very important in the transmission of communicable diseases. The definition of **vector** was then related mostly to insects. Later on the term vector has been used more widely to include other non-human animals including snails, dogs and rats. Alternative definitions are found. For example, vectors can be defined as:

> arthropods and other invertebrates which transmit infection by inoculation into or through the skin or mucous membrane by biting or by deposit of infective materials on the skin or on food or other objects.
>
> Ehlers, 1965*, Municipal and Rural Sanitation.*

This classical definition considers mainly the **arthropods** (which include insects and other organisms such as mites). It shows the mechanisms of transmission as inoculation (biting) and depositing infective materials (pathogenic organisms such as bacteria) on skin and food.

Vectors can also be defined as any non-human carriers of pathogenic organisms that can transmit these organisms directly to humans. Vertebrates, such as dogs and rodents, and invertebrates, such as insects, can all be vectors of disease.

This second definition focuses on the range of living things involved. Knowing this definition is helpful in the design of preventive measures for controlling living organisms such as insects and rats which carry the disease agent (bacteria, virus) from an infected person to a healthy person.

6.2 Public health importance of vectors

Malaria, yellow fever, typhus fever, epidemic typhus, malaria, onchocerciasis, leishmaniasis, rabies and schistosomiasis are all communicable diseases that are prevalent in Ethiopia. All of these are transmitted by vectors.

Three-quarters of the country is an area of malaria transmission and two-thirds of the Ethiopian population is at risk from malaria. Malaria is the number one illness and cause of human deaths in *kolla* areas of Ethiopia. A number of diarrhoeal diseases (acute watery diarrhoea, dysentery, typhoid fever) can also be transmitted by vectors and are commonly observed among children in areas where sanitation is very poor. Diarrhoea alone kills many children before they get to their fifth year.

Vector-borne diseases not only cause illness, they also act as a barrier to development. Irrigation and dam workers will not be productive if they get malaria or schistosomiasis (bilharzia or snail fever). A person with malaria will need healthcare and will lose productive days at work. Some diseases like onchocerciasis (river blindness) have a devastating health impact. If onchocerciasis is left untreated the person could go blind. Additionally, vectors like rats destroy food and household materials and weevils damage cereals.

The public health importance of vectors can be summarised as follows:

- They cause illness that could be fatal or restrict working capacity.
- They damage food and household goods.
- They are a barrier to development.

6.3 Vector-borne disease transmission mechanisms

There are two ways that vector-borne diseases are transmitted:

(a) **Mechanical transmission** takes place when a vector simply carries pathogenic microorganisms on their body and transfers them to food, which we then consume. Flies and cockroaches are in this category. Flies like to rest on faecal matter and then may move on to fresh food. They can carry infectious agents through their mouth and on their legs and other body parts. They deposit these agents on ready-to-eat foods and the recipient gets infected if they consume the contaminated food.

(b) **Biological transmission** involves the multiplication and growth of a disease-causing agent inside the vector's body.

Malaria is a good example of biological transmission. The female mosquitoes take the malaria infectious agent (*Plasmodium*) from an infected person with a blood meal. After sexual reproduction in the gut of the mosquito, the infectious agent migrates into the salivary gland of the insect, where it grows in size, matures and becomes ready to infect humans. When the mosquito next bites a human the saliva is injected into the skin and transfers the infection in doing so. An infectious agent may be passed from generation to generation of vector – this happens mostly in ticks and mites.

The methods of transmission for some known vectors are shown in Table 6.1.

Table 6.1 Important vectors and disease transmission mechanisms.

Vector	Diseases	Mechanism
Housefly	Diarrhoeal diseases, TB, polio, worms, food poisoning, infective hepatitis	Mechanical
Mosquito	Malaria, yellow fever, filariasis, dengue fever	Biological
Louse	Typhus fever, relapsing fever, dermatitis	Biological
Mite	Scabies, chigger	Biological
Flea	Plague, murine typhus/endemic typhus	Biological
Sandfly	Leishmaniasis	Biological
Blackfly	Onchocerciasis	Biological
Bedbug	Dermatitis, Chagas disease	Biological
Cyclops	Guinea worm, fish tapeworm	Biological
Tsetse fly	Sleeping sickness (trypanosomiasis)	Biological
Freshwater snail	Schistosomiasis	Biological
Dog	Rabies	Biological

6.4 Classification of vectors and their life cycles

6.4.1 Arthropods

The large group of animals called arthropods includes three main types of organism that are important for the transmission of diseases: insects, arachnids and crustaceans (see Figure 6.1). This section will focus on **insects**, because they cause major public health problems.

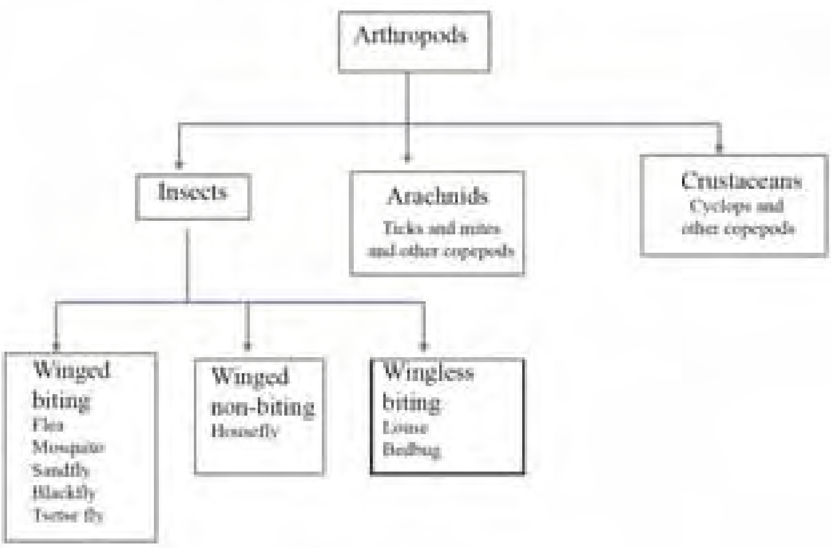


Figure 6.1 Classification of arthropods. (This diagram only shows types of arthropod that are disease vectors. There are many others not involved in disease transmission.)

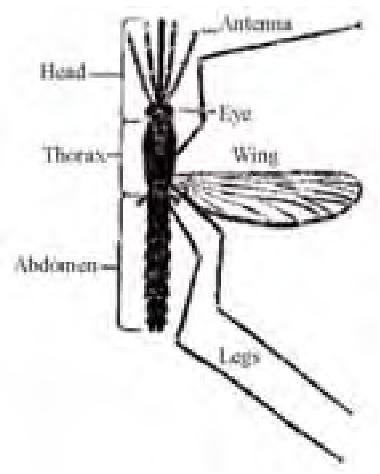


Figure 6.2 Main parts of the adult mosquito. (Source: WHO, 2003, *Malaria entomology and vector control*)

Morphology/structure of insects

The insect body is divided into head, thorax and abdomen. The mosquito, a typical example, is shown in Figure 6.2. The head has a pair of eyes, antennae, and mouth equipped with sucking or biting parts. The thorax has three joined segments, three pairs of legs, and one or two pairs of wings, although some insects are wingless.

Reproduction/life cycle of insects

Most insects follow one of two main modes of reproduction. Winged insects, such as the housefly, undergo four stages of development: egg, larva, pupa and adult. There may be several larval stages. Wingless insects, such as lice, undergo three stages: egg, larva and adult.

6.4.2 Common insect vectors

■ Take a look around your household environment: the kitchen, wastes, walls and clothes. What insect vectors might you find? You may want to ask someone else as well.

□ You may have seen houseflies and mosquitoes. Fleas and lice may also be present, although less easy to see.

Housefly

We are all familiar with this small creature that disturbs us in and around the household and in workplaces. The female lays 200–250 eggs at a time on organic matter. The organic matter could be human faeces, decaying animal and vegetable matter, fresh food or dung. Eggs are white and about 1 mm long. Within 8 to 48 hours the eggs hatch into tiny larvae. These maggots feed voraciously and pass through the three larval stages rapidly; then after four to eight days they pupate. The pupa gradually hardens and changes colour from yellow through red to brown and finally to black. This pupal stage takes three to five days under optimum conditions. The adult fly is attracted to breeding sites that will provide food and warmth for larvae.

You need to know that there are many different types of fly. Flies that are usually seen around a latrine are different from the common housefly in size and colour. However, they share similar breeding and eating behaviour.

Mosquitoes

There are three main mosquito groups: *Anopheles*, *Culex* and *Aedes*. *Anopheles* mosquitoes breed in stagnant, relatively clean water bodies; *Culex* breed in polluted water; and *Aedes* like relatively clean water. Eggs are laid in a group (150–200 for *Anopheles*, 200–500 for *Culex*) on the water surface and hatch into larvae within a few hours. The larvae breathe oxygen from the air and stay at the surface of the water. They feed on organic matter and microorganisms in the water or on the surface. The larva changes into a pupa which can propel itself using paddles at the bottom of the abdomen. The adult mosquito emerges from the pupa on to the surface of the water and then flies away. The duration of the cycle is about 10–14 days depending on the water temperature. The mosquito life cycle is shown in Figure 6.3.

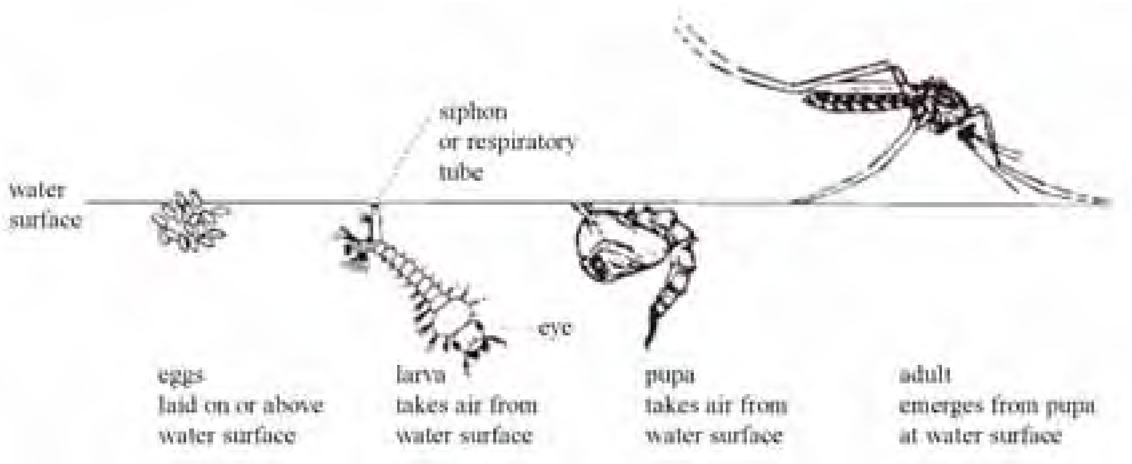


Figure 6.3 Life cycle of the mosquito. (Source: WHO, 1997, *Vector control: Methods for use by individuals and communities*)

Only female mosquitoes bite and suck blood; the males feed on the nectar of flowering plants. Females are attracted to a host by heat and exhaled carbon dioxide. A blood meal is required before viable eggs can be laid. During feeding on humans, a small amount of anticoagulant saliva will be injected into the host to prevent the blood from clotting. The malaria infectious agent is introduced into the bite site while feeding on blood.

Different species of mosquito carry different diseases. Malaria is transmitted by *Anopheles* mosquitoes; yellow fever and dengue fever mostly by *Aedes*. Identification of mosquitoes is difficult without training but breeding behaviour and physical markers can be used to identify the main groups (Figure 6.4).

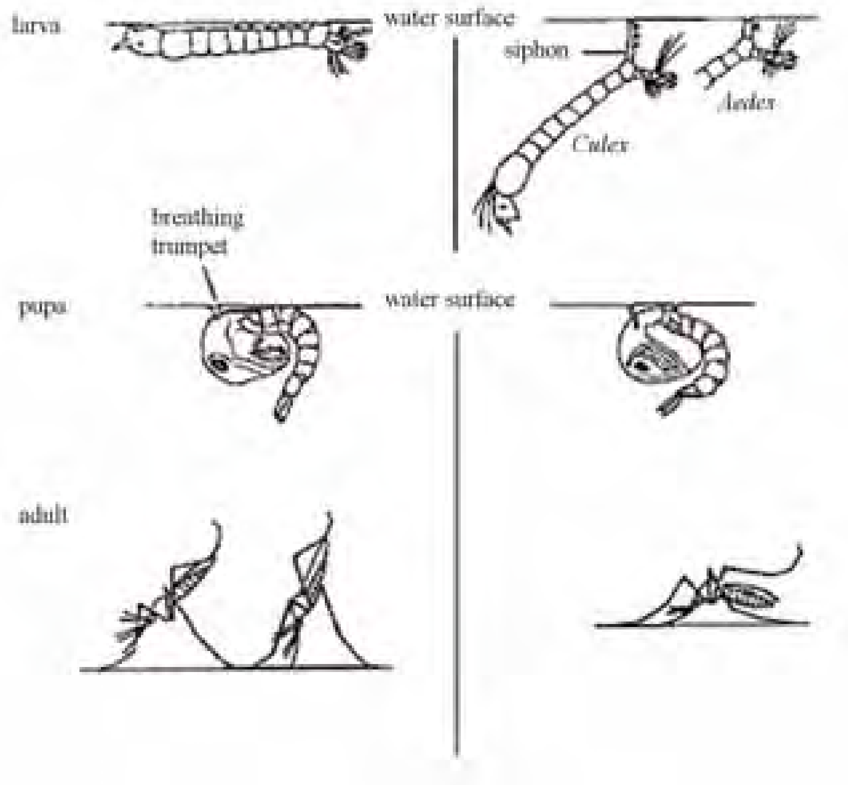


Figure 6.4 Comparison between different types of mosquito: *Anopheles* (on the left) and *Aedes* and *Culex* (on the right). (Source: as Figure 6.2)

- What do you notice are the differences between the two types of mosquito shown in Figure 6.4?

- *Anopheles* adults rest at an angle of about 45 degrees to the surface they are standing on, while adult *Aedes* and *Culex* rest with the body parallel to the surface. The opposite is true for the larval resting position in relation to the water level. *Anopheles* larvae lie horizontally at the water surface but *Culex* and *Aedes* hang at an angle below the surface.

Lice

There are three types of human louse: the head louse, body louse and pubic louse (see Figure 6.5). All of them are wingless biting insects and live by sucking human blood. They differ in colour and, as their names suggest, in the places on the human body where they are typically found. Head lice are particularly common in children. Being bitten by lice is painful, disturbing and embarrassing, and may cause an allergic reaction.

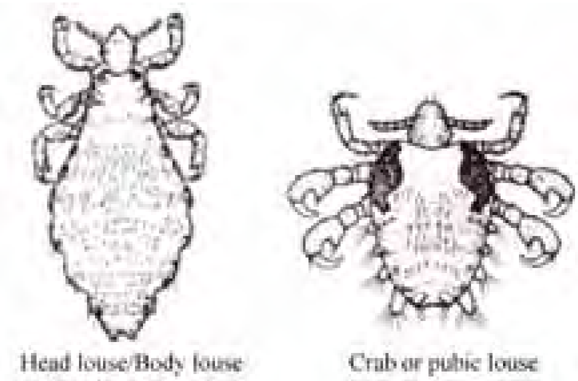


Figure 6.5 Adult lice. (Source: as Figure 6.3)

Head lice eggs are laid at the base of the hair and then hatch, leaving the pale-coloured egg casing, known as a 'nit', on the hair (Figure 6.6). The larvae feed on blood until they reach sexual maturity. The life cycle takes about 15 days with laying of about 300–350 eggs at a time. Body lice live in the clothing of the host, especially hiding in the seams. They move towards to the skin of the host to feed. Pubic lice favour the coarser body hair found in the pubic area and armpits.

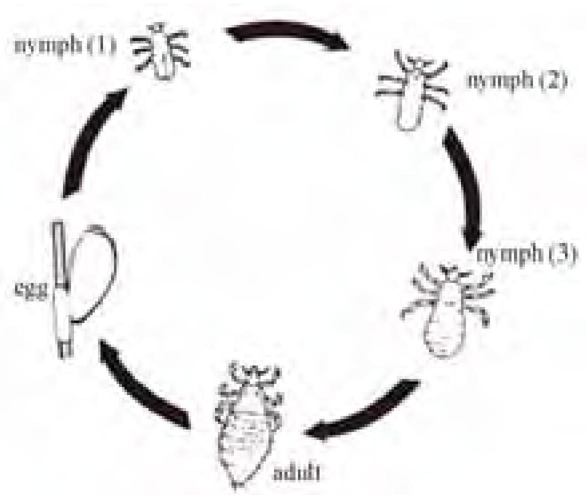


Figure 6.6 Life cycle of the louse. (Source: as Figure 6.3)

Bedbugs

Bedbugs are notorious night-biting insects. They are typically found in houses with poor housing sanitation and are abundant in poor urban and rural areas. They irritate the person while sleeping and disturb the sleep of children. Bedbugs love to hide around the bed and inside crevices of the wall during the daytime, and then become active at night.

Female bedbugs deposit three to eight eggs at a time. A total of 300–500 eggs can be produced by a single bug in a lifetime. They are often deposited in clusters and in cracks, crevices or attached to rough surfaces with a sticky glue-like substance. Eggs typically hatch in a week to 12 days (Figure 6.7). There are five larval stages for bedbugs to reach maturity, which usually takes about 32–48 days. Adult bedbugs can survive for up to seven months without blood and have been known to live in empty buildings for up to one year.

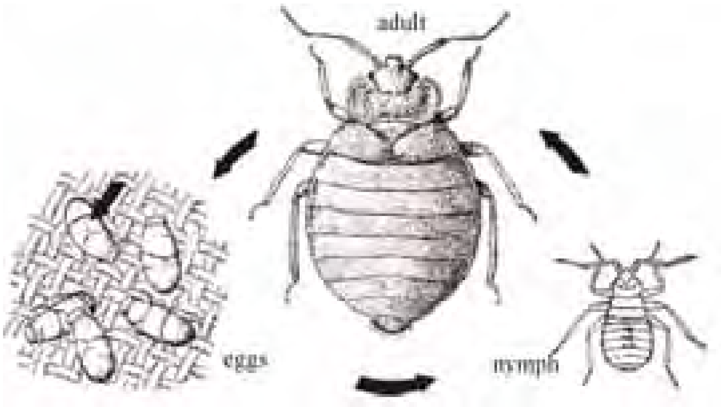


Figure 6.7 Life cycle of the bedbug. (Source: as Figure 6.3)

Fleas

The prefix ecto- means 'on the outside', as opposed to endo- which means 'on the inside'.

Adult fleas are ectoparasites of warm-blooded animals. There are human, rat, cat, bird and dog fleas, but they can all readily feed on other species in the absence of their primary host.

The human flea infests houses with poor sanitation, especially those with a warm, earth floor and dark places. The adults live by biting and sucking blood. The bite is painful, disturbing and irritating. The fleas may be seen on the host animal or on bedding or clothing. More commonly, humans will be alerted to the presence of fleas from the itching that results from being bitten. The bites of cat fleas tend to be confined to the lower legs and ankles, whereas the bites of human fleas tend to be concentrated around the waist and abdomen.

Females require a fresh blood meal in order to produce eggs. Females lay eight to ten eggs in dark places. The eggs hatch within two days into larvae which feed on organic matter and develop into pupae. The life cycle takes three to four weeks; it is shown in Figure 6.8.

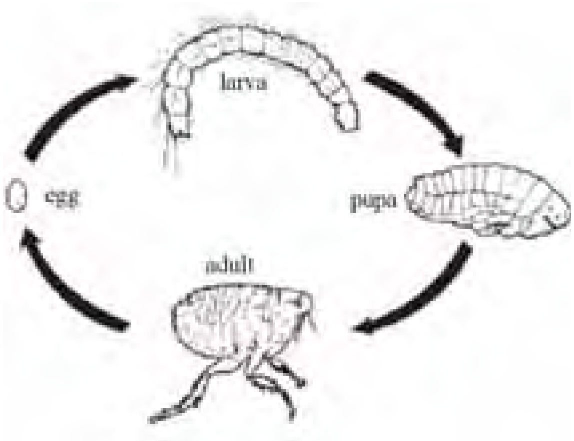


Figure 6.8 Life cycle of the flea. (Source: as Figure 6.3)

6.5 Rodents

Rodents are relatively small mammals with a single pair of constantly growing incisor teeth specialised for gnawing. The group includes rats and mice. Rodents are abundant in both rural and urban areas. They are found inside houses, in fields and around heaps of waste.

6.5.1 Types of rodent

Three types of rodent are commonly associated with public health problems.

Norway rats (*Rattus norvegicus*)

Also known as the brown rat or sewer rat, Norway rats are most numerous in urban areas. They burrow and live in the ground, and in woodpiles, debris, sewers and rubbish. Norway rats are omnivorous, which means they eat a wide variety of foods, but they mostly prefer cereal grains, meat, fish, nuts and some fruits. They do not travel more than 100 metres in search of water and food. When Norway rats invade buildings, they usually remain in the basement or ground floor. They reproduce rapidly (four to seven times a year producing eight to twelve young per litter with a gestation period of 22 days). The adult is relatively large in size, with a short tail and small ears. Their lifespan is 9–12 months.

Roof rats (*Rattus rattus)*

Also know as the black or grey rat, roof rats are more numerous in rural areas. They live in roofs, and eat mainly grains. They are smaller than Norway rats with longer tails and ears. They are excellent climbers and usually live and nest above ground in shrubs, trees and dense vegetation. In buildings, they are most often found in enclosed or elevated spaces in attics, walls, false ceilings, roofs and cabinets. They usually nest in buildings and have a range of 30–45 metres. They can often be seen at night running along overhead utility lines or fence tops using their long tails for balance. The average number of litters a female roof rat has per year depends on many factors but generally is between three and five, with five to eight young in each litter.

Mice

Mice are smaller in size than rats and generally prefer cereals to eat. They are excellent climbers and can run up any rough vertical surface. They will run horizontally along wire cables or ropes and can jump up to 30 cm from the floor on to a flat surface. Mice can squeeze through openings slightly larger than 1 cm across. In a single year, a female may have vie to ten litters of about five to six young. Young are born 19–21 days after mating, and they reach reproductive maturity in 6–10 weeks. The life span of a mouse is about 9–12 months.

6.5.2 Behaviour of rats

Rats are active at night. Although the vision of rats is poor, they have keen senses of smell and hearing, and a well-developed sense of touch via their nose, whiskers and hair. They like the same food as people and prefer it fresh, although they will eat almost anything. Rats constantly explore and learn about their environment, memorising the locations of pathways, obstacles, food and water, shelter, and other elements in their domain. They quickly detect, and tend to avoid, new objects placed in a familiar environment. Thus, objects such as traps and baits are often avoided for several days or more following their initial placement. While both species exhibit this avoidance of new objects, it is usually more pronounced in roof rats than in Norway rats.

6.5.3 Public health importance of rodents

Rodents cause a number of problems:

- Disease transmission: rats are the natural hosts of fleas that may carry bubonic plague and murine typhus or endemic typhus from an infected rat to a human.
- Food damage: mice and rats will eat stored food, mainly grains, and will spoil food by leaving their droppings. One rat can consume 15 kilograms of food per year. Rats are estimated to destroy 20% of the world’s crop production.
- Material damage: gnawing by front teeth to doors, windows, wood, boxes, bags, clothes, etc.

6.6 Vector management and control

Vectors can be controlled using various methods. Here we describe the basic methods.

6.6.1 Basic sanitation

This approach targets the elimination or reduction of that part of the environment that facilitates breeding and **harbourage** (places where vectors find refuge or shelter). It includes the elimination of all possible breeding places for insects, the prevention of stagnation of water to limit the breeding of mosquitoes, and proper solid waste management and use of a latrine to control the breeding of houseflies. The use of clean water from protected sources for drinking prevents the transmission of guinea worm. Rats are controlled by starving them and eliminating their breeding places. Personal hygiene contributes to the control of lice. Generally, a clean home and environment will prevent the breeding of insects. The use of ventilation, latrines and adequate water supply play a significant role in the control of insects.

6.6.2 Physical measures

Figure 6.9 Rat trapping (urban roof rat). (Photo: Abera Kumie)

These include methods that stop vectors from getting into close contact with humans, and methods that are used to kill vectors. They include bed nets for mosquitoes and wire mesh for flies and mosquitoes Mosquito larvae can be controlled in some water containers by putting a thin layer of used oil on the surface of the water. This acts as a barrier between the water and the air so the larvae cannot access oxygen, and suffocate. Physical methods also include traps such as adhesives to control flies and traps for rats and mice (Figure 6.9). Delousing by boiling or steaming infested clothes are physical methods for controlling lice.

6.6.3 Use of chemicals

Figure 6.10 Insect killer chemical insecticide and fly swat. (Photo: Abera Kumie)

Chemical insecticides can be used for the destruction of adults and larvae of insects. Commonly used chemicals are DDT, malathion and pyrethrums. Pyrethrum-containing aerosols are used for the destruction of cockroaches and flies in our homes (Figure 6.10). Rodenticides can be used to kill rats and mice. The indiscriminate use of these chemicals, however, could have undesired health effects on users and domestic animals. Extreme care should be taken during the application and storage of chemicals. It is always important to look at the instructions for using the chemical. Environmental health workers and veterinary technicians may be able to assist in the use of chemicals against vectors.

6.6.4 Biological methods

These include several very advanced methods that prevent the successful reproduction of pest species. They include the sterilisation of males (tsetse fly, mosquito), sex distortion or replacement of genes. All of these methods are expensive and often complex to monitor. Other biological methods involve introducing or encouraging predators of the vector species. For example, small fish can be used to feed on larvae of mosquitoes. Reptiles, birds and frogs feed on adult insects and cats will prey on rats.

6.6.5 Integrated approach

Integrated vector management includes a combination of two or more of the above methods. This is often more effective than using a single method of control. For example, the rat population may be significantly reduced by combining starving with trapping. Sanitation can be combined with other cheap methods in order to be both sustainable and effective.

6.7 Planning for the improvement of vector control

The community may seek your advice on vector management. There are situations where epidemics could be possible because of vectors such as lice and fleas. The following activities are required in order to have good planning in vector management.

6.7.1 Knowing the scope of vectors

You cannot tackle all types of vectors. However, you can be involved in the control of flies, lice, fleas, bedbugs and rats, which are the most important public health vectors. You will probably also be involved in mosquito control.

6.7.2 Identifying the extent of the problem

Knowing the depth of the problem is important in order to mobilise the necessary resources to deal with it. This will also help you in setting priorities for vector control. You need to visit a few dwellings and ask which vectors disturb the family. You should find out how common each vector is in the community.

6.7.3 Identifying control methods

Vector control methods vary depending on the species and you will need to use appropriate methods of intervention according to the above descriptions. Pay attention to breeding site control through the provision of basic sanitation. The use of sanitation, with one or more other methods, is the preferred tool of intervention.

6.7.4 Identifying partners in vector management

You will probably need to liaise with other people and offices to tackle vector problems. These may include local government institutions (for example, the police office for prison lice management; the school office for nits and lice management among students), local NGOs, and community institutions (*idir*, traditional leaders). They could provide resources and advice, and help mobilise the people.

6.7.5 Designing the plan of action

This requires the preparation of activities under a specified timeframe based on the identified problems. Such activities include: visiting houses, advocacy, public and individual education, and conferences. Your approach to preparing a plan of action for vector management should be similar to other action plans you have learned about in previous study sessions of this Module.

Summary of Study Session 6

In Study Session 6, you have learned that:

1 A vector is a non-human carrier of communicable diseases. Arthropods such as insects, and mammals such as rats, play major roles.

2 The public health importance of vectors is related to disease transmission, damage to food and property, and acting as a barrier to development.

3 There are mechanical and biological methods of disease transmission by vectors.

4 Insects are identified by their body structure and the presence of three pairs of legs. Insects go through three or four stages to complete their life cycles.

5 Rats are vectors that inhabit and breed inside a house. They are involved in the transmission of diseases, destroying materials and damaging food. There are different methods to control them.

6 Vectors can be managed using simple control methods such as sanitation and also physical, biological and chemical methods of control. An integrated approach using sanitation in combination with others is the best option in order to effectively reduce the vector population.

7 Planning activities for vector management on an annual basis is one major task of the health practitioner.

Self-Assessment Questions (SAQs) for Study Session 6

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 6.1 (tests Learning Outcome 6.1)

Which of these statements is *false*? In each case, explain why it is incorrect.

A All arthropods have six legs and a body divided into three parts, namely the head, thorax and abdomen.
B Diarrhoeal diseases can be transmitted to humans by houseflies.
C Transmission of a disease to a human by a biting insect is called mechanical transmission.
D Rats can transmit bubonic plague to humans by eating and contaminating stored food, especially grains.

SAQ 6.2 (tests Learning Outcomes 6.2 and 6.4)

Match the diseases with the respective vector, by drawing an arrow between them.

Vector	**Disease**
Flea	Malaria
Fly	Relapsing fever
Anopheles	Endemic typhus
Louse	Diarrhoea
Dog	Typhus fever
	Rabies

SAQ 6.3 (tests Learning Outcomes 6.2 and 6.3)

Visit five to ten households in your area. Observe and ask what environment and behaviour supports the breeding of vectors. List the commonly found vectors that the members of the household complain of. Prepare a checklist for vector assessment that can be used for field investigation.

SAQ 6.4 (tests Learning Outcome 6.3)

Visit a place in your locality where there is standing water such as a pond, stagnant water or slowly moving wastewater. Look closely at the water for at least ten minutes and identify the vectors you observe. Use the pictures that are given in this study session to help with identification.

SAQ 6.5 (tests Learning Outcomes 6.3 and 6.4)

What specific vector-borne diseases are likely to be found in jails, prisons or army camps? Explain your answer.

SAQ 6.6 (tests Learning Outcomes 6.3 and 6.4)

Houseflies are commonly found in all domestic situations. Describe the breeding environment of the housefly and name the diseases that are transmitted by flies in your area.

SAQ 6.7 (tests Learning Outcome 6.5)

Imagine that a local householder has a problem with rats and has consulted you for advice. What methods of vector control would you consider recommending?

SAQ 6.8 (tests Learning Outcome 6.5)

The *woreda* administrator asks you to prepare a plan of action for vector management. Describe how you would go about it.

Study Session 7 Introduction to the Principles of Food Hygiene and Safety

Introduction

All over the world people are seriously affected every day by diseases that are caused by consuming unhygienic and unsafe food. We have to give due emphasis to good hygienic practices to prevent and control **foodborne diseases**. Foodborne diseases result from eating foods that contain infectious or toxic substances. The food we eat should be free from contaminants such as microorganisms and chemicals. This session will introduce the principles of food hygiene and safety. You will also learn about food control, food inspection and supportive enforcement measures that can contribute to food hygiene and safety.

Food hygiene and safety usually refer to contamination with 'microorganisms' or 'microbes'; whereas in communicable diseases, the term 'infectious agents' is preferred.

Learning Outcomes for Study Session 7

When you have studied this session, you should be able to:

7.1 Define and use correctly all of the key words printed in **bold**. (SAQs 7.1 and 7.4)

7.2 Describe the public health importance and objectives of food hygiene. (SAQ 7.2)

7.3 Describe the essential functions of food. (SAQ 7.3)

7.4 Outline the principle aspects of a food control system and explain why food control is important. (SAQ 7.4)

7.1 Important principles in food hygiene and safety

In previous sessions of this Module, you have been introduced to the concept of hygiene, which was defined as the set of practices associated with the preservation of health. One important aspect of this is **food hygiene**, which refers to the many practices needed to safeguard the quality of food from production to consumption. This is sometimes referred to as 'from farm to fork' or 'from farm to table', because it includes every stage in the process from growing on the farm, through storage and distribution, to finally eating the food. It also includes the collection and disposal of food wastes. Throughout this chain of events there are many points where, directly or indirectly, knowingly or unknowingly, unwanted chemicals and microorganisms may contaminate the food.

The term 'food hygiene' refers particularly to the practices that prevent microbial contamination of food at all points along the chain from farm to table. **Food safety** is a closely related but broader concept that means food is free from all possible contaminants and hazards. In practice both terms may be used interchangeably.

Food hygiene is vital for creating and maintaining hygienic and healthy conditions for the production and consumption of the food that we eat.

A traditional way of eating food at the household level in Ethiopia, *injera* with *wot* (sauce), is shown in Figure 7.1. Usually this type of meal is safe because it is food that is prepared to eat immediately.

Figure 7.1 Traditional way of eating at home.

The overall purpose of food hygiene is to prepare and provide safe food and consequently contribute to a healthy and productive society.

Within this overall aim, the specific objectives for food hygiene are to:

- Prevent **food spoilage**, i.e. changes that make food unfit for consumption due to microbial or chemical contamination.
- Inform and educate people about simple and practical methods of keeping food safe to protect themselves against foodborne diseases.
- Protect food from adulteration (intentional contamination).
- Ensure proper practice in the food trade to prevent the sale of food that is offensive or defective in value and quality.

7.2 The use and function of food

7.2.1 What is food?

Food consists of edible materials such as meat, bread and vegetables; it may be raw (like fresh fruit, Figure 7.2) or cooked, processed or semi-processed. Food is a nutritious substance eaten by us to maintain our vital life processes. It is a fundamental need, a basic right and a prerequisite to good health.

Figure 7.2 Fresh fruit. (Photo: Basiro Davey)

Food can be described in a number of different ways. Here are some terms you will find useful:

- **Perishable food**: food items that have a short storage life and will become spoiled or contaminated if not preserved and handled properly, e.g. meat, eggs, milk, fruits, vegetables and the like.

- **Non-perishable food**: foods which are not easily spoiled or contaminated, e.g. sugar and cereals.
- **Wholesome food**: food which is sound, clean and free from harmful ingredients – it is suitable for human consumption.
- **Food hazard**: food that is contaminated with biological, chemical or physical agents and, if eaten, will cause ill health.

Food is essential for the existence of all living things. Our bodies need food for energy production, to survive and to remain strong. For good health you need a balanced diet; this means that you don't just eat one foodstuff, but you eat a range of foods so that you can get everything your body needs. The health of children will be improved and they will grow taller if they are given a healthy, balanced diet rich in protein, energy and vitamins.

The *Nutrition* Module covers all the food groups in detail and how they are used by the body.

Foodstuffs are of two main kinds: **organic** (carbohydrate, proteins, fats) and **inorganic** (water, various mineral elements and vitamins). The organic components are sources of energy for growth, cell multiplication, tissue repair, work and maintaining the vital processes of life. The inorganic components are believed to facilitate the physiological functions of the body, such as the regulation of blood circulation and the nervous system.

Figure 7.3 Vegetables are nutritious and healthy foods.

As well as being nutritious and balanced (Figure 7.3), to fulfil our needs food should also be **palatable** (which means tasty and good to eat) and culturally and psychologically acceptable. We should want to eat the food and have no cultural and social difficulties in eating it. Importantly, food should not contain harmful substances which are a risk to the health and wellbeing of the consumer.

Food for energy, growth and development

Food is needed to provide energy for movement, work and maintaining vital functions of the body, e.g. the heart needs energy to circulate blood in our body. Food is needed to repair and replace our body cells.

Social function of food

Food has always served an important function in the social interactions between people. In Ethiopia many social occasions are centred around food. During the many holidays, families prepare particular foods and drinks to celebrate the occasion. Food is also served at social events such as weddings and funerals. On all of these occasions, food indirectly serves as an instrument to develop social bonds and relationships.

Psychological function of food

In addition to nourishing the body and filling a need in our social life, food satisfies certain emotional needs. People who travel to or live in a new land often find adjusting to the unfamiliar food and food customs a serious problem; they feel anguish and a longing for their customary food. Food can also be used to express feelings for example, the giving of food is a sign of friendship. Serving favourite foods is an expression of special attention and recognition, and the withholding of wanted foods can be a means of punishment.

Whatever the occasion or purpose for serving and eating food, special attention must be paid to its handling at all stages to attain a good sanitary quality, otherwise it could turn out to be a source of illness and dissatisfaction.

7.2.2 Food that is not safe to eat

Although food is essential for life and good health, there are some foods that are not safe to eat.

Food must be labelled correctly. When any label, writing or other printed or graphic matter on a food container is false or misleading this is known as **misbranding**. Misbranding violates food safety regulations and is unlawful. Food labelling should include the following facts about the food:

- character (type of food)
- origin (country)
- constituents (what is in the food)
- amount in the container
- date of production and expiry date (this is the date when the food is no longer safe to eat).

Food labelling is very important and a sensitive area for the food trade. The quality and safety of imported, as well as exported, food depends on honest labelling. For example, if the food item has a mislabelled (false) expiry and production date, this can be dangerous for the consumer. In this way misbranding of canned meat products and other perishable food items can cause serious foodborne diseases.

Adulteration is when the normal content of the food has been intentionally changed by adding something to it that is not essential for example, diluting milk with water and selling it as whole milk. Adulterated food could be unsafe for a number of reasons. These include poor nutrition; watered-down milk is not as nutritious as whole milk. Unsafe ingredients may have been used, for example unclean water or other harmful ingredients might have been added.

Contamination is the undesired presence of harmful microorganisms or substances in food. Food can be contaminated by unhygienic practices in storage, handling and preparation, and may compromise food safety and palatability. (Food contamination is discussed in more detail in Study Session 8.)

The term **potentially hazardous food** is sometimes used to describe perishable foods because they are capable of supporting the rapid growth of microorganisms. If microorganisms are allowed to multiply, this will have the potential to cause disease if the food is eaten.

7.3 Principles of safe food preparation

Figure 7.4 Meat is a healthy and nutritious food but it can become unsafe if it is not handled properly. (Photo: Zegeye Hailemariam)

■ Why is it important to eat safe food?

□ If we eat safe food our health will be protected, we are less likely to get sick and we are more likely to stay healthy and productive.

You need to be able to advise people in your community about the correct methods of food handling and preparation to ensure that food is safe to eat. The key principles for safe food preparation are outlined below.

- Choose foods that are not easily damaged by transportation, accidents or by storage.
- Cook foods thoroughly, especially meat (Figure 7.4) because this can help to kill any microorganisms that might be present in the food.

- Eat cooked foods immediately after they are cooked, rather than leave them out and eat later. Delays in eating cooked food can lead to the growth and reproduction of microorganisms in the cooked foodstuff.
- Store cooked food carefully at an appropriate temperature. It should either be kept cold, ideally in a refrigerator, or it should be kept hot.
- If food must be reheated, be sure to reheat it thoroughly.
- Avoid contact between raw and cooked food.
- Wash hands properly before handling food and before eating.
- Keep all kitchen surfaces and utensils meticulously clean.
- Protect food from animals including insects, rodents and other animals.
- Use safe water in food preparation and for washing fruits and vegetables to be eaten raw (Figure 7.5).

Figure 7.5 Leafy vegetables must be washed thoroughly with clean water before being eaten. (Photo: Pam Furniss)

These principles will be described in more detail in Study Session 10.

7.4 Food control

Food control is the regulation of the food supply industry and enforcement of food laws by national or local authorities. Its purpose is to provide consumer protection and ensure that all foods during production, handling, storage, processing and distribution are safe, wholesome and fit for human consumption. A food control system ensures that foods conform to safety and quality requirements and are honestly and accurately labelled, as required by law.

The scope of food control includes:

(a) Food safety, which refers to all those hazards that may make food unhealthy for the consumer.

(b) Food quality standards, which includes all other attributes that influence a product's value to the consumer, e.g. composition, labelling, etc.

Food control covers all stages of production, processing and distribution of food. It covers controls on food that is produced or imported for consumption within the region and food that is exported outside the country.

The principal objective of the national food control system is the protection of public health by protecting consumers from unsafe, unwholesome, mislabelled or adulterated food. It also contributes to economic development by maintaining consumer confidence and providing sound regulatory controls for domestic and international trade in food.

7.4.1 Important principles in food control

There are several important principles for any food control system. We will consider four key aspects: the integrated farm-to-table concept, preventive approaches, risk analysis and transparency.

Integrated farm-to-table concept

The *integrated farm-to-table concept* refers to safety and quality built into food products from production through to consumption. Food control systems should address all stages of the food supply chain, including imported food. Consumers should expect protection from all hazards at all stages of the chain, i.e. 'the farm-to-table' continuum. This calls for a comprehensive and integrated approach in which the producer, processor, transporter, distributor, vendor, regulator and consumer all play a vital role in ensuring food safety and quality.

Preventive measures

It is much better to prevent food hazards arising than it is to simply monitor food at the point of sale or consumption. Sampling and analysing the final product will not provide adequate protection to the consumer. The introduction of *preventive measures* at all stages of the food production and distribution chain, rather than only inspection and rejection at the final stage, also makes better economic sense, because unsuitable products can be identified earlier along the chain.

An important assessment tool used in the food industry is the Hazard Analysis Critical Control Point system (HACCP). **HACCP** can be applied at all stages in the production, processing and handling of food products. It is a preventive measure designed to provide a systematic structure to the identification and control of foodborne hazards. Governments should recognise the application of a HACCP approach by the food industry as a fundamental tool for improving the safety of food.

Risk analysis

Food control requires the analysis of risks associated with unsafe food. There are three main components of *risk analysis* in food safety, namely risk assessment, risk management and risk communication. At the risk assessment stage, food hazards and risks are identified and described. Risk management means weighing up the alternatives and selecting appropriate options for prevention and control of food hazards. Risk communication is the stage in which information about the risks and hazards is shared among all people involved.

Transparency

Consumers need to have confidence in the safety and quality of their food and this depends, in part, on their perception of the integrity and effectiveness of food control activities. All decision making processes within the food control system should be *transparent*. This means that all stakeholders (that is all people who have an interest in food and food control) should be able to find out how and why decisions were taken. They should also be able to make effective contributions to the process themselves. Decisions must be explained, i.e. risk communication, so that people understand why a decision is important. In this way, consumer confidence can be kept high.

7.4.2 Components of a food control system

The main components of a national food control system are:

- Food law and regulations
- Food control management
- Inspection services
- Laboratory services for food monitoring and epidemiological data
- Information, education, communication and training.

To be effective, food law and regulations should be relevant, enforceable and ‘proactive’ (that is, have a preventive component) so that they can provide a high level of health protection. They must also include clear definitions to increase consistency and legal security.

There needs to be monitoring of compliance with food laws. Quantitative monitoring includes counting the number of food premises inspected, the number of food samples taken, the number of food complaints dealt with and the number of food poisoning cases dealt with.

Government regulators are responsible for auditing the performance of the food system through monitoring, surveillance and enforcing legal and regulatory requirements. The more economic and effective strategy is to entrust food producers and operators with primary responsibility for food safety and quality. An important aspect of education is to promote voluntary compliance with food regulations. Voluntary compliance means that food producers and providers adhere to the food laws voluntarily, because they understand the benefits of good practice, rather than be prosecuted or penalised for breaching the regulations.

7.4.3 Responsibility for food control

In Ethiopia, national food control is shared between different agencies and ministries including the Ministry of Health, Ministry of Agriculture, and the Quality and Standards Authority. Their roles and responsibilities are quite different and there may possibly be duplication of regulatory activity, fragmented surveillance and lack of coordination.

There is also considerable variation in expertise and resource between the different agencies, and a conflict between the need to protect public health and obligations to facilitate trade or develop an industry or business sector. You need to be aware of these potential difficulties with the food control system.

7.5 Communication and education

Your principal role in food control is to communicate with your community and educate people about food hygiene. You may also have responsibility for inspection of food and drink service establishments – this is described in Study Session 11.

■ Why are food control and food inspection important for your community?

□ Because maintaining food safety will protect the people from harmful and dangerous foods that could make them ill.

Effective food control must combine training, education and community outreach programmes with the effective enforcement of legal requirements.

Summary of Study Session 7

In Study Session 7, you have learned that:

1. Food is any nutritious substance eaten to maintain vital life processes. Food is important for human beings and affects human physiological activity, growth, repair and energy, and psychological and social relations.
2. Food hygiene and safety issues are not separate from human health concerns or from community health issues. Good food hygiene practices can protect the community from foodborne illness.
3. Different food safety terminologies like food hygiene, wholesomeness of food, food contamination and misbranding are important for understanding food safety issues.

4 Categories of unsafe food include misbranded food, adulterated food, unwholesome food and contaminated food.
5 Important principles for safe food preparation include having clean hands, clean surfaces, adequate cooking time and the correct conditions for food storage, among others.
6 Producing safe food must be considered as a continuum and attention needs to be given to the safety of food from 'farm to fork' or 'farm to table'.
7 Food laws and regulations are designed to provide a high level of protection against food contamination.
8 The objective of a food control system is to regulate the food supply industry and enforce food laws.

Self-Assessment Questions (SAQs) for Study Session 7

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 7.1 (tests Learning Outcome 7.1)

What category of unsafe food is applicable to each of the following?

- Pineapple juice that has been diluted with water from an unprotected source.
- A packet of tea that contains grains of sand as well as tea leaves.
- A packet of tea labelled 100g but actually only contains 70g of tea.
- Tilapia that were caught the day before yesterday and not kept cool or covered.
- Cooking oil that is sold in a plastic bottle that previously contained engine oil.

SAQ 7.2 (tests Learning Outcome 7.2)

What is the principal objective of food hygiene and why is it important for public health?

SAQ 7.3 (tests Learning Outcome 7.3)

Outline three reasons why food is important to people. Which do you think is the most important reason and why?

SAQ 7.4 (tests Learning Outcomes 7.1 and 7.4)

Why is it important to adopt a 'farm to table' approach to food control?

Study Session 8 Food Contamination and Spoilage

Introduction

All food should be safe and free from contamination and spoilage at all points in its journey from its source until it reaches the consumers. However, food contamination is a serious public health problem in Ethiopia, resulting in foodborne diseases that affect many people every year. Hence, awareness of potential sources of food contamination is an important component of good nutrition and good health. In this study session we are going to concentrate on food contamination by microorganisms, chemicals and physical factors.

Food may be contaminated by different microorganisms or by chemicals that can cause health problems for anyone who eats it. In Study Session 9 you will learn in detail about foodborne diseases. But first you will be introduced to the basic principles of food microbiology in this study session, and about the ways in which food becomes contaminated by different microorganisms, chemicals and physical objects. You will also learn about the causes of food spoilage and its consequences for health.

Learning Outcomes for Study Session 8

When you have studied this session, you should be able to:

8.1 Define and use correctly all of the key words printed in **bold**. (SAQ 8.1)

8.2 Describe the factors that contribute to bacterial growth and multiplication. (SAQ 8.2)

8.3 Explain the sources and types of food contamination. (SAQ 8.2)

8.4 Describe the main routes of food contamination. (SAQ 8.3)

8.5 List the types of food spoilage and describe the characteristics of food spoilage in different food items. (SAQ 8.4)

8.1 Infectious agents and foodborne diseases

8.1.1 An overview

Infectious agents are organisms that can be passed to, and between, people in the process of **infection** transmission. Those that cause diseases are often referred to as **pathogens** (‘pathogenic’ means disease-causing). Many infectious agents (bacteria, viruses, fungi and protozoa) are microorganisms that are too small to be seen except with a microscope; the adult stages of disease-causing parasites (e.g. worms) may be seen with the naked eye, but their eggs and immature stages are microscopic. **Microbiology** is the science that deals with the study of microorganisms.

Although infections often result in disease, it is possible to be infected with a pathogen and still appear healthy. This is either because the disease has not yet had time to develop, or because the person’s immune system is keeping it under control. However, the infectious agent can still be passed on to others, for example by spreading into food handled by the infected person.

The majority of foodborne diseases (those caused by infectious agents transmitted to people in the food we eat) are due to bacteria, but as you will see in Study Session 9, viruses, parasites and toxins can also cause foodborne diseases.

8.1.2 Bacteria

1.0 micrometre (μm) = 0.001 millimetres (mm); 1000 micrometres (μm) = 1mm. The symbol for the micrometre is μm. μ is a Greek letter pronounced 'mu'.

Bacteria are the most abundant of all organisms. Bacteria are unicellular organisms (made of one cell) and are very small in size, ranging from 0.5 to 5.0 micrometres (μm).

Bacteria reproduce *asexually*. This means that they don't need a partner to reproduce, but simply divide into two, producing two new bacteria. There are pathogenic bacteria capable of causing human illness and food spoilage, but there are also beneficial species of bacteria that are essential to good health and a healthy environment. For example, beneficial bacteria live in our gut and help us digest our food; some bacteria are used to produce foods such as yoghurt and cheese; and others break down wastes in the environment.

Some bacteria are capable of forming highly resistant and endurable structures called *spores*. Bacterial spores are resistant to heat, freezing, drying, chemicals and other adverse environments. This means the spores can survive the normal processes of food storage and preparation. Two examples of spore-forming bacteria important in food contamination are *Bacillus* and *Clostridium.*

Temperature, humidity, oxygen and water are important for bacteria to grow and multiply. Under favourable conditions a growing bacterial population can double at regular intervals ranging from about 15 minutes to several hours. This means that the numbers of bacteria in food can increase rapidly and soon become hazardous to health, particularly if the food has a favourable temperature and water content. In the next section, we look in detail at factors that can promote or delay bacterial growth in our food.

8.2 Factors affecting the growth of microorganisms in foods

You will learn more about food preservation methods in Study Session 10.

The growth of microorganisms in food products can be affected by *extrinsic factors* and *intrinsic factors*, as you will see below. By understanding the factors affecting the growth of microorganisms in food we can know how to keep food safe to eat. This knowledge can also help us to work out how to preserve food for longer.

8.2.1 Extrinsic factors

Extrinsic factors are factors in the environment *external* to the food, which affect both the microorganisms and the food itself during processing and storage. Extrinsic factors include temperature, humidity and oxygen.

Temperature

Different microorganisms grow over a wide range of temperatures. Some microorganisms like to grow in the cold, some like to grow at room temperature and others like to grow at high temperatures. This is of paramount importance in food safety, because if you know the temperature growth ranges for dangerous microorganisms it helps you to select the proper temperature for food storage to make them less able to grow and reproduce.

Humidity

The humidity of the storage environment is an important factor for the growth of microorganisms at the food surfaces. If you store food in a dry atmosphere, microorganisms are less able to grow than if the food is stored in a humid (moist) environment. Therefore, dry conditions are better for food storage than moist conditions.

Oxygen

Many microorganisms need oxygen in order to develop and reproduce: these are called **aerobic** microorganisms. A good example is *Escherichia coli*, a faecal bacterium which grows readily on many foods. If you keep food in a low oxygen environment, aerobic bacteria cannot grow and multiply. Conversely, there are some microorganisms that grow without oxygen, called **anaerobic** microorganisms. An example of this is *Clostridium botulinum*, the bacterium causing botulism, which can survive in very low oxygen environments such as tinned foods.

8.2.2 Intrinsic factors

Intrinsic factors exist as part of the food product itself. For example, meat has certain characteristics that may promote the growth of certain microorganisms. The following common intrinsic factors affect the growth and multiplication of microorganisms in foods.

pH

The scientific term **pH** is a measure of how acidic or alkaline an environment is, on a scale that has 'neutral' (neither acid nor alkaline) at pH7. Environments that are acidic have pH values below 7; those that are alkaline have pH values above 7. Most microorganisms grow best at close to the neutral pH value (pH 6.6 to 7.5). Only a few microorganisms grow in very acid conditions below a pH of 4.0. Bacteria grow at a fairly specific pH for each species, but fungi grow over a wider range of pH values. For example, most meats naturally have a pH of about 5.6 or above. At this pH meat is susceptible to spoilage by bacteria, moulds and yeasts; however the pH of meat can be lowered by pickling, which makes it less favourable as an environment for microorganisms to grow in.

pH is pronounced 'pee-aitch'.

Moisture content (water activity, a_w)

Microorganisms need a moist environment to grow in. The water requirements of microorganisms are described in terms of **water activity** (represented by the symbol a_W), a measure of how much water is present. The water activity of pure water is $a_W = 1.00$. Most foodborne pathogenic bacteria require a_W to be greater than 0.9 for growth and multiplication; however, *Staphylococcus aureus* may grow with a_W as low as 0.86. But even *Staphylococcus aureus* cannot grow and multiply in drier food like bread, which has $a_W = 0.7$, although fungi can (Figure 8.1).

Figure 8.1 Bread is too dry for bacterial growth, but fungi can grow in it very quickly. (Photo: Basiro Davey)

- ■ Think of some foods that store well when they are dry but become contaminated quickly when they are wet.

- □ You may have thought of different examples: the one that we thought of is rice. When rice is dry it will store for a long time, but when it is cooked and wet it will go bad quite quickly and cause food poisoning.

Nutrient content

In order to grow, multiply and function normally, microorganisms require a range of nutrients such as nitrogen, vitamins and minerals. Microorganisms therefore grow well on nutrient-rich foods.

Structure of food items

Figure 8.2 Many fruits are protected against spoilage by microorganisms, but only if their skin is intact. (Photo: Basiro Davey)

The natural covering of some foods provides excellent protection against the entry and subsequent damage by spoilage organisms. Examples of such protective structures are the skin of fruits and vegetables such as tomatoes and bananas (Figure 8.2).

8.3 Routes of microbial contamination of food

Bacteria are a major source of microbial contamination of food, i.e. the undesired presence in food of harmful microorganisms or the harmful substances they produce. Viruses, parasites and fungi are also able to contaminate food and cause foodborne illnesses in humans. Microorganisms can enter food through different routes.

Look at Figure 8.3, which was introduced in Study Session 1, and notice that eating contaminated food is a component of many transmission routes. The most common routes of entry are discussed below.

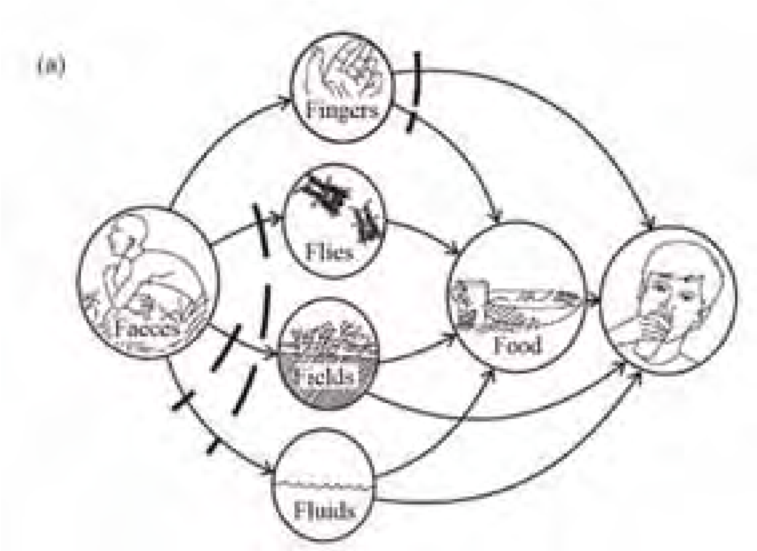


Figure 8.3 Routes of disease transmission. (Source: as Figure 1.2(a))

8.3.1 Air and dust

Microorganisms are found everywhere in our environment. Many types can be found in air and dust, and can contaminate food at any time during food preparation or when food is left uncovered (Figure 8.4). Imagine a kitchen where food is prepared and stored in rural communities, and think how easily microorganisms in the air and dust could contaminate the food.

Figure 8.4 Butter for sale in uncovered containers open to the air. (Photo: Janet Haresnape)

8.3.2 Soil, water and plants

Many microorganisms present in soil and water may contaminate foods. Microorganisms also grow on plants and can contaminate food if care is not taken to remove them by washing or inactivate them by cooking. Soil is a particularly rich source of *Clostridium* bacteria. Water may be contaminated by faeces. Plants may also be contaminated by faeces if untreated sewage has been used as a fertiliser.

8.3.3 Gastrointestinal tract

The intestines of all humans and animals are full of microorganisms, some of which are beneficial but others are pathogenic. Bacterial pathogens such as *Salmonella, Campylobacter* and *Escherichia coli* (strain O157:H7) are common examples. Contamination of foods by faecal material is the major cause of food poisoning events. This includes indirect contamination, for example from people's hands if they prepare food without washing their hands after visiting the latrine/toilet (see below).

Escherichia coli (abbreviated to *E.coli*) exists in many harmless varieties or 'strains', but some strains are pathogenic. The strain called *E.coli* O157:H7 causes a potentially fatal foodborne disease in humans.

8.3.4 Animals

Many foodborne microorganisms are present in healthy animals raised for food, usually in their intestines, hides, feathers, etc. Meat and poultry carcasses can be contaminated during slaughter by contact with small amounts of intestinal contents. For example, in animals slaughtered in rural communities without any safety measures, microorganisms present in the animals' intestines can easily contaminate the meat.

Animal hides are an important source of contamination of the general environment, the hands of meat workers, and skinned meat carcasses. Hides are a primary source of *E.coli* O157:H7 and *Salmonella* species, both of which cause sickness and diarrhoea. Hides become contaminated either because the outside of the hide is dirty, or because once removed from the animal, the inside of the hide is a good breeding place for microorganisms.

8.3.5 Animal feeds

Animal feeds are a source of microorganisms, especially *Salmonella*, which can contaminate poultry and other farm animals. The organisms in dry animal feed spread throughout the local environment and may get on to animal hides, hair and feathers, as well as on people who handle the feeds.

8.3.6 Food handlers

The term **food handler** can be applied to anyone who touches or handles food, and this includes people who process, transport, prepare, cook and serve food. The presence of microorganisms on the hands and outer garments of food handlers reflects the standard of hygiene in the environment and the individuals' personal hygiene (as you learned in earlier study sessions). The microorganisms transmitted to foods by food handlers may come from the hides of animals, soil, water, dust, gastrointestinal tracts and other environmental sources. In food preparation at home, foodborne microorganisms can be introduced from the unwashed hands of people who are infected by bacteria and viruses, and who cook and serve the food to family members.

8.3.7 Food utensils

Food utensils are cutting boards, knives, spoons, bowls and other equipment used in food preparation, which may become contaminated during food processing and preparation. For example, in families where there is no access to running water, the food utensils may not be properly cleaned, stored and handled, and may become a major route of food contamination.

8.3.8 Cross-contamination

Cross-contamination of food is the transfer of harmful microorganisms between food items and food contact surfaces. Prepared food, utensils and surfaces may become contaminated by raw food products and microorganisms. These can be transferred from one food to another by using the same knife, cutting board or other utensil without washing it between uses. A food that is fully cooked can become re-contaminated if it touches raw foods or contaminated surfaces or utensils that contain pathogens. For example, you should never:

- allow raw meat to touch cooked meat
- put cooked meat on a cutting board that has just been used for raw meat without cleaning it first (Figure 8.5)
- store raw meat on a shelf above cooked meat so that it could leak blood and raw juices on to the cooked meat below.

Figure 8.5 Never put cooked meat on an unclean cutting board that has been used to prepare raw meat. (Photo: Basiro Davey)

8.3.9 Unsafe temperature

An unsafe temperature for food storage is a major factor in food contamination. Many microorganisms need to multiply to a very large number before enough are present in food to cause disease in someone who eats it. However, if bacteria can have warm, moist conditions and an ample supply of nutrients, one bacterium can reproduce by dividing (on average) every half an hour and can produce 17 million bacteria in 12 hours! So, if you leave lightly contaminated food out overnight, it will be highly contaminated and infectious by the next day.

8.3.10 Poor personal hygiene

Poor personal hygiene of food handlers is another major factor in food contamination. The most important contaminants of food are the microorganisms excreted with faeces from the intestinal tract of humans. These pathogens are transferred to the food from faecal matter present on the hands.

- ■ We have already mentioned failure to wash hands after visiting a toilet as a source of food contamination. Can you suggest other times when food handlers should wash their hands?

- □ Hands should be washed before starting work on preparing food, and after touching any food, surface or equipment that may be contaminated (e.g. after handling raw meat).

Bad personal habits like scratching your hair and nose with your fingers also contributes to food contamination. Sneezing and coughing spreads contaminants and microorganisms through the air and onto uncovered food, and onto surfaces and hands that can transfer the infectious agents into food.

8.3.11 Pests

Foods can be damaged and also contaminated by pests. Many stored grains are lost through the damage done by pests, including termites (*mist*), beetles, locusts, cockroaches, flies and rodents such as rats and mice. Pests can damage and contaminate foods in various ways, such as boring into and feeding on the insides of grains, or tunnelling into stems and roots of food plants. For example, weevils cause large losses of stored grains, especially in warm and humid conditions such as in lowland areas of Ethiopia.

Pests also damage the protective skin of foods allowing microorganisms to get inside the food and causing it to rot more quickly. Pests can pollute food with their excreta, and with bodies and body fragments when they die. They also transfer microorganisms on to food while walking on it (Figure 8.6). Flies and cockroaches readily move between wastes and foods, transporting microorganisms with them as they go.

Figure 8.6 Insects can leave dirt, excreta and possibly pathogenic microorganisms if they are allowed to crawl on food. (Photo: Basiro Davey)

8.4 Avoiding food contamination

You now know that food can be contaminated from sources in the natural environment, people, food preparation surfaces and utensils, raw and uncooked food, animals, pests, and waste material. To prevent contamination, food production and preparation operations need to be carefully controlled.

8.4.1 Microbial food contamination

Prevention of microbiological (often abbreviated to 'microbial') contamination is an important function in food preparation, as summarised in Box 8.1.

Box 8.1 Avoiding microbial food contamination

Food handlers should follow these strategies:

- Thorough handwashing before and during food preparation, especially after using the toilet, and handling raw food or waste.
- Soap/ash sanitiser and clean water should be available for handwashing at convenient locations.
- Sick food handlers should not prepare food! One sick person can cause a foodborne disease outbreak, particularly where people are in crowded or unsanitary living conditions.
- Raw and cooked foods should be separated, because raw foods are a source of microorganisms and can recontaminate prepared foods.

8.4.2 Chemical contamination of food

Attention also needs to be given to possible chemical contamination of food. Food can be contaminated through the misuse or mistaken handling of chemicals, including pesticides, bleach and other cleaning materials. All chemicals (detergent, disinfectant, sanitiser) used in the food preparation area should be removed before food preparation begins, to prevent any chemical contamination of the food.

Other possible sources of chemical contamination are:

- reusing containers which have been used for chemicals (Figure 8.7)
- using chemical sprays (e.g. to kill cockroaches) in areas where food is exposed
- accidentally adding chemicals which have a texture similar to table salt or sugar during food preparation; they should always be stored separately.

Figure 8.7 The can that is being used to scoop salt from this sack has previously been used for insecticide. (Photo: Pam Furniss)

8.4.3 Physical contamination of food

Physical contaminants include stones, pieces of glass, and metal. Physical contamination can occur at any stage of the food chain: for example, stones, bones, twigs, pieces of shell or foreign objects can enter food during handling and preparation. These materials should be removed, if possible, for example by sieving or picking out the items with clean fingers.

8.5 Food spoilage

Food spoilage is the process of change in the physical and chemical properties of the food so that it becomes unfit for consumption. Food spoilage is any undesirable change in food. Most natural foods have a limited life: for example, fish, meat, milk and bread are perishable foods, which means they have a short storage life and they easily spoil. Other foods also decompose eventually, even though they keep for a considerably longer time. The main cause of food spoilage is invasion by microorganisms such as fungi and bacteria.

8.5.1 Microbial spoilage

Microbial spoilage is caused by microorganisms like fungi (moulds, yeasts) and bacteria. They spoil food by growing in it and producing substances that change the colour, texture and odour of the food. Eventually the food will be unfit for human consumption.

When food is covered with a furry growth and becomes soft and smells bad, the spoilage is caused by the growth of moulds and yeasts (look back at Figure 8.1). Microbial spoilage by moulds and yeasts includes souring of milk, growth of mould on bread and rotting of fruit and vegetables. These organisms are rarely harmful to humans, but bacterial contamination is often more dangerous because the food does not always look bad, even if it is severely infected. When microorganisms get access to food, they utilise the nutrients found in it and their numbers rapidly increase. They change the food's flavour and synthesise new compounds that can be harmful to humans. Food spoilage directly affects the colour, taste, odour and consistency or texture of food, and it may become dangerous to eat. The presence of a bad odour or smell coming from food is an indication that it may be unsafe. But remember that not all unsafe food smells bad.

- What is the difference between food contamination and food spoilage?
- Food contamination is when food is contaminated with microorganisms or substances and eating it could result in foodborne disease. Food spoilage is any undesired change in the natural colour, taste or texture of food items that makes it unfit for consumption because it has lost its quality and nutritional value.

The term **contact spoilage** is used when microbial spoilage is the result of direct contact or touching between the food and any contaminated or unclean surface such as shelves, food preparation boards or unwashed hands. It also includes food-to-food contact, for example between cooked meat and raw meat or between rotting fruit and sound fruit.

8.5.2 Physical spoilage

Physical spoilage is due to physical damage to food during harvesting, processing or distribution. The damage increases the chance of chemical or microbial spoilage and contamination because the protective outer layer of the food is bruised or broken and microorganisms can enter the foodstuff more easily. For example you may have noticed that when an apple skin is damaged, the apple rots more quickly.

8.5.3 Chemical spoilage

Chemical reactions in food are responsible for changes in the colour and flavour of foods during processing and storage. Foods are of best quality when they are fresh, but after fruits and vegetables are harvested, or animals are slaughtered, chemical changes begin automatically within the foods and lead to deterioration in quality. Fats break down and become rancid (smell bad), and naturally-occurring enzymes promote major chemical changes in foods as they age.

Enzymic spoilage (autolysis)

Every living organism uses specialised proteins called **enzymes** to drive the chemical reactions in its cells. After death, enzymes play a role in the decomposition of once-living tissue, in a process called **autolysis** (self-destruction) or **enzymic spoilage**. For example, some enzymes in a tomato help it to ripen, but other enzymes cause it to decay (Figure 8.8). Once enzymic spoilage is under way, it produces damage to the tomato skin, so moulds can begin to can attack it as well, speeding the process of decay.

Figure 8.8 Role of enzymes in tomato spoilage: the tomato on the right has also been attacked by fungi (moulds), speeding its decay.

Enzymic browning

When the cells of fruits and vegetables such as apples, potatoes, bananas and avocado are cut and exposed to the air, enzymes present in the cells bring about a chemical reaction in which colourless compounds are converted into brown-coloured compounds. This is called **enzymic browning**. If the food is cooked very soon after cutting, the enzymes are destroyed by heat and the browning does not occur. For example, apples are prone to discolouration if cut open when raw, but when cooked they do not go brown.

8.5.4 Appearance of spoiled food

Spoiled food is generally more a problem of appearance than a problem of disease causing. In food spoilage, the changes in appearance or texture of the food, such as rottenness, softness and change in colour, taste or odour are usually obvious, whereas in contaminated food such characteristics may not be noticed. A large majority of the microorganisms responsible for food spoilage are not pathogenic to humans. However, you should advise people in your community that they should not eat food that is spoiled because it is not nutritious and may make them sick (cause vomiting).

8.6 Factors affecting food spoilage

Finally, we turn to the factors that can increase or delay the process of food spoilage. They include its water content, environmental conditions, packaging and storage.

8.6.1 Water content

The amount of water available in a food can be described in terms of the water activity (a_w).

■ Can you recall the a_W of pure water?

□ Pure water has $a_W = 1.0$.

The water activity of most fresh foods is 0.99. This means that they have a very high water content and can support a lot of microbial growth.

■ Meat is traditionally dried by adding table salt to it. Can you suggest why salting enables the meat to be stored for a long time?

□ The salt draws out water from the meat so the a_W is reduced. This makes the conditions too dry for harmful microorganisms to multiply in the salted meat.

You will learn more about salting, smoking, refrigeration and other food preservation methods in Study Session 10.

8.6.2 Environmental conditions

No matter whether food is fresh or processed, the rate of its deterioration or spoilage is influenced by the environment to which it is exposed. The exposure of food to oxygen, light, warmth or even small amounts of moisture can often trigger a series of damaging chemical and/or microbial reactions. Changing the environment can help to delay spoilage. For example, storing foods at low temperatures reduces spoilage because both microbial and enzymic decay is faster at higher temperatures.

8.6.3 Packaging and storage

Packaging is a means of safeguarding food when it is raw, or after it has been processed or prepared. It helps to protect food against harmful contaminants in the environment or conditions that promote food spoilage, including light, oxygen and moisture. The type of packaging is a key factor in ensuring that the food is protected. Packaging of foods in cans, jars, cartons, plastics or paper also serves to ensure food safety if it is intact, because it provides protection against the entry of microorganisms, dust, dirt, insects, chemicals and foreign material.

Summary of Study Session 8

In Study Session 8, you have learned that:

1. One of the main, and most effective, ways of protecting food consumers is to prevent food from becoming contaminated by pathogenic microorganisms.
2. Cross-contamination is a process whereby pathogens are transferred from one food source to another, e.g. when pathogens in raw food are transferred to cooked foods which will not be cooked again, so any pathogens they contain will survive to infect the consumer.
3. Food may become contaminated by food handlers, contaminated surfaces and utensils, pests, and contaminated water used in food preparation.
4. Separate storage and preparation areas, and separate utensils, should always be used for raw foods.
5. Foods can be contaminated through the mishandling of chemicals such as pesticides, bleach and other cleaning materials.
6. Food can be contaminated by physical contaminants such as stones, glass, bones and feathers at any stage of the food chain.
7. Food spoilage is the process of changing the physical and chemical properties of the food, making it unfit for consumption.
8. Food spoilage is caused by living microorganisms and also by enzymic action (autolysis). Spoilage can also be brought about by physical or chemical factors.

Self-Assessment Questions (SAQs) for Study Session 8

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 8.1 (tests Learning Outcome 8.1)

Match each term in List A with the correct definition in List B by drawing an arrow between them.

A	B
Cross-contamination	Organisms that can be transmitted to susceptible hosts and cause disease
Foodborne disease	The entry and development or multiplication of infectious agents in the body of humans or other animals
Infection	Disease caused by pathogenic organisms or toxins transmitted to humans by food
Infectious agent	Lives and reproduces only in the presence of oxygen
Aerobic	Lives and reproduces only in the absence of oxygen
Anaerobic	Transfer of harmful microorganisms or their microscopic stages (eggs, larvae) from one source to another

SAQ 8.2 (tests Learning Outcomes 8.2 and 8.3)

You are asked by a school head teacher to explain to some students about food contamination by microorganisms. Write a plan of what you will tell them, including explaining why microorganisms are dangerous and under what conditions they grow and multiply.

SAQ 8.3 (tests Learning Outcome 8.4)

Suppose you went to a village for a house visit and found complaints of foodborne illness among the villagers. What possible ways of food contamination do you suspect and how will you teach the villagers about them?

SAQ 8.4 (tests Learning Outcome 8.5)

Study Figure 8.9 and explain why the two peppers look different.

Figure 8.9 For use with SAQ 8.4. (Photo: Basiro Davey)

Study Session 9 Foodborne Diseases and the Investigation of Disease Outbreaks

Introduction

Foodborne diseases are a major public health problem. They result from eating foods that contain substances which are either infectious or toxic in nature. In the previous session you have learned about microbial and chemical food contamination. In this session you will learn more about the foodborne diseases that are important for public health, their type and classification, their characteristics and their common symptoms. You will also learn how outbreaks of foodborne diseases should be investigated.

Learning Outcomes for Study Session 9

When you have studied this session, you should be able to:

9.1 Define and use correctly all of the key words printed in **bold**. (SAQ 9.1)

9.2 Describe the main types and classification of foodborne diseases. (SAQs 9.1 and 9.2)

9.3 Describe and give examples of the most common bacterial, viral and parasitic foodborne diseases. (SAQ 9.3)

9.4 Describe how you can conduct investigations of foodborne disease outbreaks. (SAQ 9.4)

9.1 Overview of foodborne diseases

Since as far back as the time when the documentation of human history began, consumption of contaminated food and foodborne diseases have been a major global health problem. Contamination can be with microorganisms, chemicals and physical objects in food (as you learned in Study Session 8), which can lead to a variety of foodborne diseases or ill effects such as poisoning.

Foodborne diseases are still a major public health concern all over the world today. They are responsible for many cases of adult illnesses and some deaths, but more importantly, contaminated food is a source of the acute diarrhoeal diseases that claim the lives of enormous numbers of children every day. Worldwide, about 2 million children under the age of five years die from diarrhoeal diseases every year.

In developing countries like Ethiopia, the problem reaches great proportions for many reasons. Most basic among these are poverty and a lack of public health awareness. The problem of foodborne disease is more serious among rural communities where there tends to be a lower level of awareness about the causes and prevention of foodborne infection.

Well-documented information is lacking regarding the extent of foodborne diseases in Ethiopia because many cases are not properly diagnosed or not reported, and many people who are sick with foodborne diseases do not visit health facilities. This makes it difficult to collect statistical data or even make an estimation of the level of the problem – except that it is certainly huge.

9.2 Transmission of foodborne diseases

In the two previous study sessions you have learned about microorganisms and food contamination. The single method of transmission of foodborne diseases to human beings is through ingestion (eating) of food in the following categories:

- Raw or undercooked meat and meat products
- Raw milk (that is, milk that has not been pasteurised or sterilised)
- Food items contaminated with human faeces (directly or indirectly)
- Raw vegetables contaminated with soil
- Food contaminated by chemicals, e.g. pesticides such as malathion
- Food prepared using contaminated water, e.g. for washing vegetables
- Food kept in an unsuitable condition for a long time after preparation
- Poisonous plants.

■ Why is it unwise to eat food that has been kept for a long time after it was prepared?

□ It may have been kept in conditions that created a favourable environment for the growth and multiplication of microorganisms in the food, especially if it was exposed to flies, cockroaches, etc., or kept at a warm temperature.

9.3 Classification of foodborne diseases

Foodborne diseases are usually classified on the basis of whatever causes them. Accordingly they are divided into two broad categories: food poisoning and food infections**.** Each of these categories is further subdivided on the basis of different types of causative agent (see Figure 9.1). We will discuss each of them in turn.

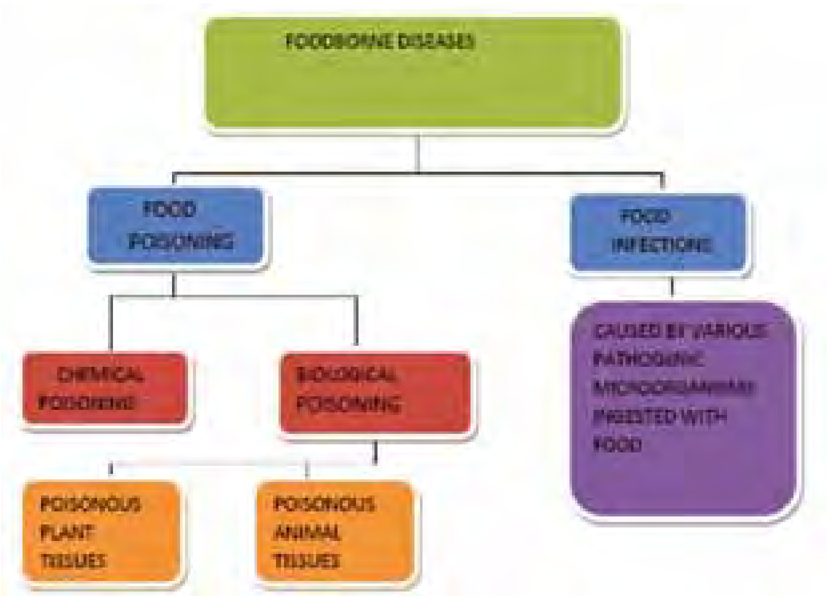


Figure 9.1 Classification of foodborne diseases.

9.3.1 Food poisoning

Food poisoning can be from chemical or biological sources. If we eat food that contains harmful chemicals, or biological toxins (poisons) from plants, animals or microorganisms, that food can make us sick. Some common sources of food poisoning are caused by contaminants already in the food when the raw materials are harvested, for example:

- Bacterial toxins produced by bacteria such as *Clostridium botulinum* and *Clostridium perfringens*, which are commonly found in the natural environment, e.g. in soil.
- Chemical toxins, e.g. insecticides sprayed onto growing crops.
- Heavy metals, e.g. lead and mercury, particularly in fish caught near chemical processing facilities.
- Certain toxic plant tissues, e.g. poisonous mushrooms.
- Toxic animal tissues, e.g. the poison glands of certain fish, crabs, etc.

Chemical food poisoning can also occur if foodstuffs have been in contact with toxic chemicals during food production, processing, storage and handling.

The symptoms of food poisoning can range from mild headache to severe flu-like symptoms. The most common signs and symptoms are nausea, stomach cramps, diarrhoea, fever, chills and vomiting. A person with food poisoning may have any combination of these symptoms depending on the cause or the agent involved. The illness may begin from 1 to 72 hours after eating the food.

9.3.2 Food infection

Food infection occurs as a result of ingestion of pathogenic microorganisms with food. The ingested microorganisms multiply in the gut and can cause diseases like diarrhoea, typhoid fever and cholera; intestinal parasites can cause diseases such as amoebiasis and taeniasis (tapeworm disease); and **zoonotic** foodborne diseases (i.e. those that are transmitted to humans from other animals), e.g. anthrax and bovine tuberculosis.

The diagnosis, treatment and prevention of all these diseases are covered in more detail in the Module on *Communicable Diseases.*

There are many different kinds of foodborne diseases and they may require different treatments, depending on the symptoms they cause. Illnesses that cause acute watery diarrhoea or persistent vomiting lead to dehydration if the person loses more body fluids and salts (electrolytes) than they are able to replace. It is therefore important to rehydrate the person, ideally with oral rehydration salts (ORS), or if this is not available, a simple mixture of clean water with some sugar and salt is advised.

Electrolytes are salts in the body that conduct electricity; they are found in all cells, blood and other body fluids, and are essential for normal functioning.

9.3.3 A catalogue of foodborne diseases

Tables 9.1 and 9.2 in Appendix 9.1 (at the end of this study session) summarise the types of organism which cause food infections and food poisoning (respectively). The tables also show the types of food items that are the main risk factors for the associated foodborne diseases. You are not expected to memorise the details of these tables; use them as references that you can consult for information when you need it.

- Look at Table 9.1. What do anthrax and tapeworm infection have in common?

- Raw meat consumption from sick and dying animals (like ox, cow, sheep, goat, camel) is responsible for transmitting anthrax, and raw beef and pork are the source of tapeworm infection.

- Which foodborne infections in Table 9.1 are commonly associated with consumption of contaminated milk and dairy products?

- Brucellosis, typhoid fever, non-typhoid salmonellosis, bovine tuberculosis, *E.coli* infection and listeriosis.

9.4 Selected examples of common foodborne diseases in Ethiopia

In Tables 9.1 and 9.2 we summarised the most widespread foodborne diseases and the different causative agents and types of foods involved. Now you will learn about a few of the most common foodborne diseases in Ethiopia, together with some advice that you can use to inform people in your community on how to avoid these diseases.

9.4.1 Bacterial infections

Many common diarrhoeal diseases are caused by bacterial infections transmitted by ingestion of contaminated food and water. Prevention of these diseases should be focused on good personal hygiene by all food handlers, including the consumer of the food. Some bacterial diseases such as anthrax, bovine tuberculosis and brucellosis are particularly related to foods of animal origin; these are described in detail in Study Session 12.

9.4.2 Viral infections

Several different viruses may be transmitted by contaminated food via the faeco-oral route. Foodborne viral infections usually have an incubation period of between one and three days. They cause illnesses which are self-limited in people who are otherwise healthy (i.e. they recover naturally) but occasionally severe illness and even deaths may also occur.

In the group of viral infections causing viral gastroenteritis (VGE), rotavirus is a common cause of vomiting and watery diarrhoea. Dehydration is the likely consequence unless appropriate rehydration therapy is used. Caliciviruses such as norovirus (also known as Norwalk virus) also cause diarrhoea.

Viral hepatitis caused by Hepatitis A and E viruses is almost exclusively transmitted by the faeco-oral route. Hepatitis A is distinguished from other viral causes by its prolonged (two to six week) incubation period and its ability to spread beyond the stomach and intestines into the liver. It often induces jaundice, or yellowing of the skin, and can occasionally lead to chronic liver dysfunction.

9.4.3 Tapeworms

Tapeworms are one of the most common causes of foodborne parasitic diseases in Ethiopia.

Beef tapeworm

You will learn more about beef tapeworm in Study Session 12.

Taenia saginata (the beef tapeworm) is the most common cause of tapeworm disease in Ethiopia. Immature forms of the tapeworm develop in the muscles of animals that have eaten tapeworm eggs while grazing on infected grass. People are infected when they eat raw or undercooked beef (Figure 9.2). The adult tapeworms develop in the person's small intestine and segments of the worms containing eggs are deposited in the environment when the person defecates. This is how the cycle is continued.

Figure 9.2 Eating raw beef can be dangerous because it might be infected with beef tapeworm. (Photo: Zegeye Hailemariam)

Dog tapeworm

Hydatid disease, caused by dog tapeworm, is transmitted when a person ingests the eggs of *Echinococcus granulosus* in food contaminated with dog faeces. This disease may cause symptoms in women that resemble 'false pregnancy', because its effect is to enlarge the liver and cause the abdomen to swell so the woman may appear to be pregnant. The infection may also lodge in the lung or the brain. The prevention of disease caused by dog tapeworm is through personal hygiene when handling food and thorough washing of raw foods, especially if they have come into contact with soil.

Fish tapeworm

Fish tapeworm (*Diphyllobothrium latum*) infects people through the consumption of raw fish and is more common in the lake areas of Ethiopia where the diet is highly dependent on fish. The symptoms of infection with the fish tapeworm are similar to those of other tapeworm infections, i.e. abdominal discomfort or pain, nausea, vomiting or diarrhoea, and loss of appetite and weight loss. People should be advised only to eat fish that has been properly cooked.

9.4.4 Bacterial food poisoning

In this section, we describe two of the most common sources of food poisoning in Ethiopia, and the advice you can give to people in your community on how to avoid being poisoned by these bacterial sources of contamination.

Staphylococcal food poisoning

Staphylococcal food poisoning is caused by one of the many species of staphylococcal bacteria and is the most common and major type of food poisoning you are likely to encounter. This type of food poisoning can result from the preparation of food more than half a day in advance of needs, storage at ambient temperature, inadequate cooling or inadequate reheating. It begins with symptoms such as nausea, vomiting, stomach cramping and diarrhoea. These can persist for days and lead to dehydration, loss of electrolytes and even death if not treated promptly. Control measures are promoting and monitoring the personal hygiene of food handlers, safe and hygienic conditions in food preparation areas, and keeping cooked or processed foods covered and in cool conditions until consumed.

Botulism

Foodborne botulism is a form of food poisoning caused by *Clostridium botulinum*. It occurs in poorly canned foods, including home-canned foods, and honey. It is advisable not to eat food from deformed or bulging cans and not to give honey to young children.

9.4.5 Chemical food poisoning

There are two main types of chemical poisoning. One is caused by chemical products and the other by heavy metals.

Pesticides

Common sources of chemical contamination of foods are pesticides including insecticides, herbicides and rodenticides, and detergents, or their containers. When these chemical products find their way into food they can cause poisoning. There are also many cases of intentional chemical poisoning in Ethiopia when people drink these chemicals to commit suicide. Many people die from chemical poisoning if they do not go to healthcare facilities in time.

Heavy metals

Metals cause poisoning when foods are stored in faulty or damaged containers made of materials like tin, lead, copper and zinc. These metals can dissolve in acid foods such as fruit juices and produce fast-acting poisons in the body when ingested. Possible sources of contamination include residues migrating into foods from soldered cans, leaching from utensils, contaminated water, glazed pottery, painted glassware and paints.

9.5 General management of foodborne diseases

The management approach to patients with foodborne diseases depends on the identification of the specific causative agent, whether microbial, chemical or other. There are many different kinds of foodborne diseases and they may require different treatments, depending on the symptoms they cause. Many episodes of acute diarrhoeal disease are self-limiting and require only fluid replacement and supportive care. If an antibiotic is required, the choice should be based on the clinical symptoms and signs.

You should refer all patients with acute diarrhoea that are not responding to rehydration and supportive care.

Patients with severe diarrhoea and vomiting may need oral rehydration salts (ORS) and antibiotics. In the most severe cases, for example in a cholera epidemic, intravenous fluids containing glucose and normal saline may have to be given to support rehydration. If the disease is due to food poisoning, there may be a need to give an antitoxin, or other antidote to neutralise the effect of the toxin, if such medicines exist or can be accessed in time. These more specialised interventions can only be done at a health facility. However, the limitations of health facilities in rural areas may restrict the choice of the specific management approach.

As a Health Extension Practitioner, you should educate the members of your community on how to recognise the symptoms of foodborne diseases, and to seek advice and supportive treatment from you. If there is a large number of cases, you should document them and report them as soon as possible to the District Health Office.

9.6 Investigation of foodborne disease outbreaks

Foodborne disease outbreaks, i.e. several similar cases occurring at the same time, are not uncommon. To identify the source and prevent reoccurrence of such outbreaks, systematic clinical and laboratory investigations have to be made. The investigation and control of foodborne disease outbreaks are multidisciplinary tasks requiring skills in the areas of clinical medicine, epidemiology, laboratory medicine, food microbiology and chemistry, food safety and food control, and risk communication and management. Many outbreaks of foodborne disease are poorly investigated, if at all, because these skills are unavailable, or because a field investigator is expected to master them all single-handedly without having been fully trained.

The surveillance and management of disease outbreaks is covered in detail in the *Communicable Diseases* Module.

If you have an unusually large number of people with symptoms of foodborne diseases in your community, you should follow the general steps and procedures summarised in Box 9.1.

Box 9.1 Steps in investigating a foodborne disease outbreak

1 Collect initial information about the number of cases and report this to the appropriate person at the nearest Health Centre or District Health Office.

2 Develop an initial case definition (who is ill, where are they, what are their symptoms, when did they become ill). You should also record the age and gender of all people affected.

3 Develop an initial questionnaire to determine if there is a common source of contamination (e.g. if everyone affected ate the same food, or food from the same place).

4 Collect specimens of faeces, vomit, etc. according to the procedures laid down by the Federal Ministry of Health (FMOH) and send them to the Health Centre for transport to the nearest Laboratory of Public Health. You will need to use a sterile container for the samples and store them in an icebox. Wear gloves and wash your hands thoroughly before and after taking samples. Send the samples to the laboratory immediately.

5 If you identify a particular location or event as the origin of the outbreak you should visit the exposure site for a field inspection and environmental sampling.

6 Take samples of the foods under investigation according to the procedures laid down by the FMOH. You will need to use sterile bags or containers and ensure that your sample is representative of the

food consumed. You may need to act quickly to obtain food samples in case any remainder has been used up or disposed of.

7 If the source of the outbreak is a workplace, you will need to interview the employers and employees. You should try to find out how many of them ate the same food, when they ate, how much they ate, and where the food came from.

8 Data analysis and interpretation. For example, does the data you have recorded indicate that any particular age group or gender is affected more than others?

9 Report. Summarise the findings from your investigation and compile into a brief report that should be submitted to the Health Centre or public health emergency management centre.

Summary of Study Session 9

In Study Session 9, you have learned that:

1 Foodborne diseases have long been a major public health problem and continue to be a significant cause of human ill health and death.

2 Foodborne diseases can be classified into two main types: food infection and food poisoning.

3 Food infections are classified as bacterial, viral, parasitic or fungal.

4 Food poisoning is classified according to the type of toxin that causes it which may be natural, bacterial, fungal or chemical.

5 General advice for the prevention of foodborne disease includes good personal hygiene by food handlers, careful food storage and proper cooking methods.

6 The management of foodborne disease depends on the particular symptoms and disease. Patients with acute diarrhoea should be treated with oral rehydration therapy and, if they do not respond promptly, they should be referred.

7 Any outbreak of foodborne disease needs to be investigated following prescribed procedures in order to identify the source of the outbreak.

Self-Assessment Questions (SAQs) for Study Session 9

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 9.1 (tests Learning Outcomes 9.1 and 9.2)

Explain the difference between foodborne diseases caused by infections and those caused by poisoning.

SAQ 9.2 (tests Learning Outcome 9.2)

Outline three factors that contribute to the widespread occurrence of foodborne disease in Ethiopia.

SAQ 9.3 (tests Learning Outcome 9.3)

Which of the following foodborne diseases is different from the others and why?

- typhoid fever
- amoebiasis
- shigellosis
- cholera.

SAQ 9.4 (tests Learning Outcome 9.4)

Imagine you received a report that several people had become ill after a recent wedding ceremony. You were told that at least 20 people had developed acute diarrhoea within 24 hours. What would be your first step in investigating this outbreak?

Appendix 9.1

Table 9.1 Foodborne infections, causative agents and commonly affected foodstuffs.

Disease category	Disease	Causative agent(s)	Foods commonly involved
Bacterial	Typhoid fever	*Salmonella typhi*	Raw vegetables and fruits, salads, pastries, unpasteurised milk and milk products, meat
	Paratyphoid fever	*Salmonella paratyphi*	
	Shigellosis	*Shigella* species	All foods handled by unhygienic workers, potato or egg salad, lettuce, raw vegetables
	Cholera	*Vibrio cholera*	Fruits and vegetables washed with contaminated water.
	Non-typhoid salmonellosis	*Salmonella* species, e.g. *Salmonella typhimurium*	Eggs, poultry, undercooked meals, unpasteurised dairy products, sea foods, sausages
	Brucellosis	*Brucella* species, mostly *Brucella melitensis*	Milk and dairy products from infected animals
	Anthrax	*Bacillus anthracis*	Contaminated raw and undercooked meat from sick and dying oxen, cows, sheep, goats, camels, etc
	Bovine tuberculosis	*Mycobacterium bovis*	Unpasteurised milk, dairy products or meat from tuberculosis-infected cows
	E.coli infection	*Escherichia coli*	Beef, dairy products, fresh products, raw produce (potatoes, lettuce, sprouts, fallen apples), salads
	Listeriosis	*Listeria monocytogenes*	Milk, cheese, ice cream, poultry, red meat
Viral	Viral gastroenteritis (VGE)	Rotavirus, caliciviruses including norovirus, astrovirus	Any food contaminated with the virus
	Viral hepatitis	Hepatitis A and E viruses	Raw shellfish from polluted water, sandwiches, salad and desserts
	Poliomyelitis	Polio virus	Any food contaminated with the virus
	Rift valley fever	Rift valley fever virus	Any food contaminated with blood or aerosols from infected domestic animals or their aborted fetuses
Parasitic	Taeniasis (tapeworm infection)	*Taenia* species	Raw beef, raw pork
	Amoebiasis	*Entamoeba histolytica*	Any food soiled with faeces
	Trichinosis	*Trichinella spiralis*	Insufficiently cooked pork and pork products
	Ascariasis	*Ascaris lumbricoides*	Foods contaminated with soil, especially foods that are eaten raw, such as salads, vegetables
	Giardiasis	*Giardia lamblia*	Any contaminated food item
	Toxoplasmosis	*Toxoplasma gondii*	Raw or undercooked meat and any food contaminated with cat faeces
	Cryptosporidiosis	*Cryptosporidium parvum*	Any contaminated food item

Parasitic	Hydatid disease	*Echinococcus granulosus*	Any food contaminated with dog faeces
	Diphyllobothriasis	*Diphyllobothrium latum*	Raw or uncooked fish
	Trichuriasis	*Trichuris trichuria*	Any food contaminated with soil
Fungal	Fungal infections	*Aspergillus* *Penicillium* *Yeasts*	Cereal, grains, flour, bread, cornmeal, popcorn, peanut butter, apples and apple products, mouldy supermarket foods, cheese, dried meats

Table 9.2 Food poisoning, toxin type, causative agents and commonly affected foodstuffs.

Disease category	**Diseases**	**Toxin type and causative agent**	**Foods commonly involved**
Natural toxins in foods	Neurolathyrism	Beta-oxalyl amino-alanine	*Lathyrus sativus* (*guaya*)
	Mushroom poisoning	Phalloidine and alkaloids found in some poisonous mushrooms	Poisonous mushrooms such as species of *Amanita phalloides* and *Amanita muscaria*
Bacterial toxins	Staphylococcal food poisoning	Entero-toxins from *Staphylococcus aureus*	Milk and milk products, sliced meat, poultry, legumes
	Perfringens food poisoning	Strain of *Clostridium welchii/ C.perfringens*	Inadequately heated or reheated meat poultry and legumes
	Botulism food poisoning	Toxin of *Clostridium botulinum*	Home-canned foods, low acid vegetables, corn and peas
	Escherichia coli food poisoning	Enterohaemorrhagic *Escherichia coli* O157:H7	Ground beef, dairy products and raw beef
	Bacillus cereus food poisoning.	Enterotoxins of *Bacillus cereus*	Cereals, milk and dairy products vegetables, meats, cooked rice
Fungal toxins	Ergotism	A toxin (ergot) produced by a group of fungi called *Claviceps purpurea*	Rye, wheat, sorghum, barley
	Aflatoxin food poisoning	Aflatoxin produced by some groups of fungus (e.g. *Aspergillus flavus, Aspergillus parasiticus*)	Cereal grains, groundnuts, peanuts, cottonseed, sorghum
Chemical toxins	Chemical poisoning	Heavy metals (e.g. lead, mercury, cadmium)	Fish, canned food. Foods contaminated by utensils or coated with heavy metals
		Pesticides and insecticides	Residues on crops, vegetables, fruitsAccidental poisoning where some chemicals may be mistaken for food ingredientsWhen contaminated containers are used to hold stored foods
		Additives	Various food items where unauthorised additives may be added as colouring agents, sweeteners, preservatives, flavouring agents, etc.

Study Session 10 Food Protection and Preservation Methods

Introduction

Food protection and food preservation have one aim in common they are intended to prevent contamination and spoilage of foods. Many of the methods of food protection and preservation used today are of ancient origin. Having an understanding of food microbiology (as you learned in Study Session 8) is important for food protection and preservation practice. In this study session, you will learn about the principles and methods of food protection and preservation, and also the details of safe ways of food processing and preparation.

Learning Outcomes for Study Session 10

When you have studied this session, you should be able to:

10.1 Define and use correctly all of the key words printed in **bold**. (SAQs 10.1 and 10.6)

10.2 Explain what is meant by food protection methods and what is achieved by using them. (SAQ 10.2)

10.3 Describe the requirements for safe food preparation. (SAQ 10.3)

10.4 Describe personal hygiene requirements for food handlers for preparing food safely. (SAQ 10.4)

10.5 Describe the basic principles and methods of food preservation. (SAQs 10.5 and 10.6)

10.1 Food protection, storage and preparation

10.1.1 General principles of food protection

Food protection methods are measures taken to protect food from being contaminated by any agent. All food must be protected at all times during storage and preparation from the following contaminants:

- any water that is not known to be safe, including overhead leaks and drips
- dirty hands
- coughing and sneezing
- dust and soot
- flies, rodents and other vermin
- insecticides and other chemicals
- unclean utensils and work surfaces
- cigarette smoke.

These factors either affect the food directly to make it unsafe (such as cigarette smoke or soot), or, like coughs and sneezes or insects, contaminate the food with microorganisms.

The most important way of preventing contamination is by adopting good **food handlers' hygiene**. This is the term for a group of practices that should be followed at all times by anyone handling food at any stage of the food supply process. Food handlers' hygiene in retail and commercial premises where food and drink is sold to customers is of critical importance and this is discussed further in Study Session 11.

The same principles also apply in domestic situations. The importance of promoting good food handlers' hygiene is:

- To prevent food contamination and spread of disease.
- To ensure the good health of people eating the food.
- To protect the health of the food handler.

Anyone handling food should avoid bad habits such as scratching, touching the hair, nose or mouth, having unclean hair, unclean and long fingernails, smoking, and coughing or sneezing in food handling and preparation areas. They should always wash their hands before starting to prepare food, and after every interruption, particularly after using the toilet. People who have skin infections, diarrhoea or sore throats should avoid handling food.

There are other general principles for preventing food contamination:

- All water used in food preparation should be wholesome.
- All dishes, glasses and utensils must be kept clean by regular washing in clean water, and clean utensils should be kept covered.
- All surfaces that come into contact with food should be meticulously clean (Figure 10.1).
- Food storage, preparation and serving areas should be free of pets, rats, mice and insects.
- Food should be covered, and kept separate from chemicals and poisons (which should be clearly labelled).
- Cloths that come into contact with dishes and utensils, and that are used to cover food, need to be changed daily and boiled before use.

10.1.2 Precautions for food storage

One critical aspect of food protection is appropriate food storage. Food storage areas should be well ventilated and illuminated, and protected from overhead drips. Floors, wall surfaces and tables should be easy to clean, and the floors should be well drained. The storage area should be kept free from insects and vermin, by screening if possible.

Food should be obtained from approved sources and should come in its original container. It should be kept free from contamination once it has been received from the supplier. Processed foods are often safer than unprocessed food, for example, pasteurised milk is safer than raw, untreated milk.

Whether in the home or in commercial premises, once in the food preparation area, food should be kept on shelves or clean racks. These should be sufficiently high off the floor, at least 50 cm, and be spacious enough to prevent contact spoilage or contamination. This is especially important for storing raw and cooked foods, which must never touch each other, because raw food can contaminate cooked food.

Figure 10.1 Food preparation surfaces and equipment should be kept very clean to avoid contamination.

- ■ Why is it important to store foods on a shelf above the floor?
- □ Food stored at floor level is more vulnerable to damage and contamination. For example, rats and mice are more likely to find it, and it may be accidentally knocked or kicked if people pass by.

Perishable and potentially hazardous foods that can be easily contaminated, such as milk and raw meat, should be stored at low temperature, preferably in a refrigerator at below 10^{o}C. Frozen foods should be stored in a freezer below -18^{o}C.

The general rule for food storage is to keep hot foods hot and cold foods cold. Cooked foods should be eaten immediately, but if there is a delay the foods should be kept at a temperature higher than 60^{o}C. Allowing cooked food to cool to room temperature allows microorganisms to start to grow and multiply; therefore, cooked food must be stored very carefully. If it cannot be eaten straight away it should be kept as cold as possible, ideally in a refrigerator, to avoid growth of microorganisms.

If any food has to be reheated, this must be done thoroughly. If food is only warmed and not reheated properly, microorganisms will multiply in it, so you need to heat it enough to destroy them. Infant foods should not be stored at all, but must be used immediately.

10.1.3 Precautions for food preparation

Food is particularly vulnerable to contamination while it is being prepared for eating. It is important to remember food handlers' hygiene and to ensure that all surfaces and utensils are clean.

Foods intended to be eaten raw, such as fruit and some vegetables, must be washed carefully in clean, safe water (Figure 10.2). Food that is to be cooked must be cooked thoroughly to kill all pathogenic microorganisms. All parts of the food must reach a temperature of at least 70^{o}C. You cannot tell how hot the food is just by looking, so it is important to cook the food for long enough to make sure that it is all cooked through. Cooking, as well as being a very important part of food preparation, is also used for preserving food; this is the subject of the next section.

Figure 10.2 Vegetables must be clean before cooking. (Photo: Janet Haresnape)

10.2 Food preservation

Food preservation includes a variety of techniques that allow food to be kept for extended periods of time without losing nutritional quality and avoiding the growth of unwanted microorganisms. There are three basic objectives for the preservation of foods:

- Prevention of contamination of food from damaging agents.
- Delay or prevention of growth of microorganisms in the food.
- Delay of enzymic spoilage, i.e. self-decomposition of the food by naturally occurring enzymes within it.

For storing or preserving food, one or several of the living conditions needed for the growth of microorganisms have to be removed. Like humans, microorganisms need a source of food and water, and they also need a suitable pH and temperature to grow, so food preservation techniques aim to target these requirements. Food preservation depends on procedures which effectively manage the microbial content of foods and on processes that alter or delay the activities of enzymes in the food. The techniques may be applied separately or in combination. Their aims are to prevent contamination in the first place, to remove or reduce the numbers of contaminants, and to prevent microbial growth. We describe them below.

10.2.1 Prevention of contamination (aseptic technique)

This technique simply means to prevent contamination of the food by spoilage agents or by contact with them. The word 'aseptic' means free from harmful bacteria, viruses etc.

The technique requires either using an artificial covering for the food, or keeping its natural protective covering if there is one. Examples of natural coverings are the shells of eggs, fat or skins in animals, and/or the skin or peel of fruits. Leaving the natural covering of the food intact, or applying a clean artificial cover, can prevent microorganisms from entering or dropping on to the food.

10.2.2 Removal or reduction of microorganisms

Microorganisms can be physically removed from food, or their numbers reduced, by techniques like washing, trimming, sieving and filtration. For example, vegetables and fruit should be washed in clean water; any damaged or dirty parts of vegetables should be trimmed off with a clean knife; flour can be sieved to remove any unwanted contaminants.

10.2.3 The use of high temperature

Heat is one of the oldest methods of destroying microorganisms in food processing and preservation. The greatest advance in food hygiene was inadvertently made when humans discovered the advantage of boiling, roasting, baking and other heat treatments of food, hence preserving the food for longer periods. Food is also rendered safe by the application of heat because most pathogenic microorganisms are comparatively heat-sensitive. Some of the methods of heat treatment used for food preservation are discussed below.

Cooking/boiling

Boiling is the process of applying heat to water until the temperature reaches about 100°C. Boiling foods in water cannot completely destroy all microorganisms, but the vegetative cells of bacteria, yeasts and moulds are generally quickly destroyed at temperatures of 100°C or above. Spores of some bacteria are extremely resistant to heat and are not killed at this temperature, although their growth is prevented. For this reason, boiling food can rarely be relied upon to ensure complete destruction of all organisms.

However, most pathogens are killed, provided that sufficient exposure time is maintained. Although the spores of *Clostridium botulinum*, which causes botulism, are extremely heat-resistant, the toxin produced by this organism is readily destroyed by boiling. However, some toxins produced by other bacteria such as staphylococci are not easily inactivated. Thermophilic (heat-loving) organisms may survive the effects of boiling and can cause food spoilage if environmental conditions are favourable for them.

Bacterial destruction by heat is affected by time and temperature variation. The higher the temperature, the more rapid is the destruction. On the other hand, as the temperature is lowered, the time of exposure (**holding time**) needs to be longer.

Cooking can have some disadvantages. It can damage the food's appearance, texture and flavour, and may also destroy some important vitamins. Nevertheless, the advantages of cooking outweigh the disadvantages because it inhibits spoilage and possible disease transmission.

Pasteurisation

Pasteurisation is a process of heat treatment of milk, beer and some other beverages. It requires sufficient holding time to assure the thermal destruction of pathogens and organisms responsible for spoilage, without altering the nutritional value. It involves heating the food to a specific temperature for a specific time and then cooling rapidly. Pasteurisation kills most but not all of the microorganisms present. It is a very useful method when more rigorous heat treatment could harm the quality of the product, as in the case of milk, and when the aim is to kill only the pathogens that are not very heat-resistant.

Pasteurisation is named after its inventor, Louis Pasteur, a French chemist.

The temperature applied and the holding time of pasteurisation vary with the equipment available and the type of food product. In milk pasteurisation, the time-temperature combination is selected on the basis of the thermal death time of the most resistant pathogens (TB bacilli) that may be present in raw milk, and the maximum temperature and time at which the taste, palatability and nutritive value of milk are maintained. Normally milk is pasteurised at 62.8°C for at least 30 minutes or at 71.7°C for at least 15 seconds, or, if using ultra-high temperature (UHT), at 135°C for 1–2 seconds. UHT milk is sterilised, meaning all forms of life are destroyed. This extends its storage time but does affect the taste.

Blanching

Blanching is a mild pre-cooking operation which can reduce the bacterial load on vegetables by 90%. It means the application of boiling water or steam for a short time. It wilts some bulky vegetables and prevents discolouring of others. It cleans peas of the moist and sticky material around them. Blanching vegetables prior to canning, freezing or drying helps to remove soil, insects and microorganisms, and destroys or slows the action of enzymes. It sets the green colour and generally facilitates dicing, peeling and packing.

Canning

Canning is one of the most widely used modern methods of processing and preserving food. It involves the careful preparation of food packed into a sealed tin, glass or plastic container which is subjected to defined high temperatures (above 100°C) for an appropriate period of time, and then cooled. Following the thermal (heat) processing, the sealed container must be cooled immediately to a temperature of about 38°C to prevent unnecessary adverse effects of heat on the texture, flavour or colour of the food.

The canning method involves the following steps: sterilising the food to be canned, packing it in sterile, air-tight stainless metal, glass or plastic containers, and then hermetically sealing (i.e. with a complete, airtight seal) the containers to prevent contamination during handling and storage. In the heat process, all vegetative bacteria are destroyed and spores cannot grow. Any can that is damaged or swollen should not be used. A swollen, bulging can indicates that gas is being produced on the inside and demonstrates there is microbial activity in the food, so it would not be safe to eat.

10.2.4 The use of low temperature

Unlike high temperature, cold is not an effective means of destroying pathogenic bacteria, viruses and toxins in foods, but it can retard their multiplication and metabolic activities.

No food or food product is rendered free from microorganisms by low temperature (by freezing or refrigeration). This explains the generally accepted danger of refreezing any kind of thawed foods. Certain parasites, such as *Taenia* cysts in beef and all stages of *Trichinella spiralis,* can be completely destroyed by storage of infected food at –18°C for periods of 20 to 30 days, depending upon the rate of cold penetration. The most important prerequisite for successful preservation by cold is that the food must be clean to start with.

Chilling

Figure 10.3 Using a refrigerator for keeping easily spoiled food items.

Chilling involves reducing food temperatures, but only to approximately –1°C. Refrigerators for cold storage/chilling are normally used at 0°C to +8°C for preservation of a wide variety of food products (see Figure 10.3).

Freezing

Freezing of food, when carried out properly, is one of the best methods of preserving foodstuffs in as nearly natural a state as possible. Freezing preserves the storage life of foods by slowing down enzyme reactions and the growth of microorganisms. A low storage temperature of at least –12°C is important if prolonged storage life is desired without losing flavour. Needless to say, freezing foods to preserve them is only possible with a freezer and reliable power supply.

Vegetables with a high moisture content do not freeze well because cellulose (in plant cell walls) tends to be broken down by enzymes regardless of the rate of freezing, making the vegetables soft. Therefore, for such food items, blanching to destroy enzyme activity is required prior to freezing.

10.2.5 Drying

This is a dehydration process by which the water/moisture content of the food is removed or decreased. Pathogenic and other bacteria cannot multiply in the absence of water. Most tend to die in foods that have been dehydrated to a moisture content of 10–20% of weight. Drying, however, may not kill spores. Drying also achieves food preservation by inactivating enzymes.

Drying or evaporation methods have been applied to nearly every kind of watery food, including milk. Although the loss in vitamins and nutritional value is usually minor, some foods change physically and chemically, and are sometimes altered in natural colour and flavour. Other dried products do not compare favourably with their fresh counterparts due to difficulties in reconstitution, i.e. adding water to return the food to its original form. One traditional form of dried food is *quanta* (Figure 10.4). *Quanta* is made from sliced meat which is hung in the air to dry.

Figure 10.4 *Quanta*: an example of food preserved by drying. (Photo: Pam Furniss)

10.2.6 Fermentation and pickling

Not all microorganisms are bad. Certain microorganisms are necessary in the preparation and preservation of many foods and beverages. Essentially, **fermentation** (a controlled microbial action) is a process of anaerobic or partially anaerobic oxidation of carbohydrates that produces acids and alcohol. It is one of the oldest methods of food preservation. In fermentation, food preservation is achieved by the presence of acid or alcohol, which creates unfavourable environmental conditions for decomposing and other undesirable bacteria.

Foods commonly processed and preserved by fermentation methods are milk and milk products, beef, vinegar, drinks like beer and wine, and pickled fruits and vegetables. Pickling is the process of preserving food by anaerobic fermentation either in brine (salt solution) or in an acid solution, usually vinegar. The concentrations of the pickling agents and the time needed for pickling are determined by the type of food. Fermented and/or pickled food products are semi-perishable and must be protected from moulds, which are able to attack the acids and permit the invasion of spoilage organisms.

10.2.7 Chemical preservation

It has been customary to classify chemicals incorporated into food for preservation purposes as ‘intentional additives’. Additives used at food industry level include vitamins, mould inhibitors, bactericides, emulsifiers, minerals, food colouring, synthetic flavours and sweeteners. Chemicals that get into food accidentally are referred to as ‘unintentional additives’. They include the unavoidable residues of agricultural chemicals, pesticides or antibiotics.

There are several traditional methods of food preservation used at the household level that can be classed as chemical methods. Substances such a sugar, salt, vinegar, spices and wood-smoke are generally regarded as safe and natural preservatives. Salting, sugaring and smoking are all methods of **curing** foods. Curing is a general term that covers all these types of food preservation.

Salting is the addition of salt (sodium chloride or NaCl) to food for the purpose of preservation. The growth of microorganisms is inhibited by the salt, which has the effect of drawing water out of the bacterial cells so they become dehydrated and die. In this manner, salt, in combination with other measures, acts as a preservative in many foods such as butter, cabbage, cheese, cucumber, meat and fish. It also gives a desired flavour to the food. Salting can be done by rubbing adequate quantities of dry salt into foods, or by immersion, where the food item is soaked in a concentrated salt solution (i.e. brine). For effective preservation, the concentration of the brine solution has to be maintained above 18%. This is approximately one cupful of salt to five cups of water.

Sugaring refers to the action of sugar in food preservation. It is similar to the action of salt in that it depends on the removal of water. In concentrations of at least 65%, sugar solution is widely used as a sweetening and preserving agent. However, care is needed because at low concentrations, sugar solution can support the growth of microorganisms. It has been found that microorganisms rarely survive in solutions above 20–25% sugar concentration.

Smoking is one of the oldest methods used to improve the quality of food and is commonly used to preserve meat and fish. The smoking process involves exposing food to smoke from burning or smouldering wood or other plant material. It partially preserves the food by surface drying, i.e. removing moisture from the surface of the food, but it is not a reliable method of preservation unless combined with some other method such as salting or drying.

Spices also have some uses in food preservation because they tend to inhibit the growth of staphylococci and other bacteria. However, they have a very limited application because they often get contaminated themselves by a number of bacteria.

10.2.8 Other methods of food preservation

There are some other methods of food preservation that are used in the food industry and require special equipment, for example, irradiation and vacuum packing. Irradiation is the process of exposing food to ionising radiation in order to destroy microorganisms. Vacuum packing depends on the removal of oxygen from food packaging to prevent the growth of aerobic bacteria that will decompose the food.

Summary of Study Session 10

In Study Session 10, you have learned that:

1. The aim of food protection is to protect food from all possible sources of contamination at all stages, including storage and preparation.
2. It is essential that all food handlers are aware of the need for good personal hygiene to protect the food from contamination and prevent disease.
3. Food must be stored correctly, in an appropriate space, at the correct temperature and avoiding contact with any source of contamination.
4. Food preservation methods are used to keep foods safe for extended periods of time.
5. Recommended methods for safe food preservation are aimed at preventing contamination, reducing microbial numbers, preventing microbial growth and delaying self-decomposition.
6. There are many different methods of food preservation that can be used for different foods.

Self-Assessment Questions (SAQs) for Study Session 10

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 10.1 (tests Learning Outcome 10.1)

Define food protection and food preservation.

SAQ 10.2 (tests Learning Outcome 10.2)

Explain why it is important to keep work surfaces clean in food preparation areas.

SAQ 10.3 (tests Learning Outcome 10.3)

Describe the best way to prepare (a) fruit and (b) meat for immediate eating.

SAQ 10.4 (tests Learning Outcome 10.4)

Emebet is preparing a meal, but has to stop to chase a dog out of the house. What should she do when she returns to the food preparation?

SAQ 10.5 (tests Learning Outcome 10.5)

Your community does not have a refrigerator to keep foods like meat safely. What traditional meat preservation method would you recommend for the community in order to keep meat safe for many days?

SAQ 10.6 (tests Learning Outcomes 10.1 and 10.5)

Which of the following statements is *false*? In each case, say why it is incorrect.

A Salting and sugaring are chemical methods of food preservation that rely on soaking food in a weak solution of salt or sugar.

B Pasteurisation of milk kills all microorganisms by rapidly heating the milk until it boils and then allowing it to cool slowly.

C Canned foods should not be eaten if the can is swollen and bulging.

D Fermentation is a method of food preservation that relies on keeping food in an alkaline environment.

Study Session 11 Hygienic Requirements of Food and Drink Establishments

Introduction

Food and drink establishments are places where an individual gets food in the form of breakfast, lunch, dinner or snacks, accompanied by some form of drink. Unhygienic practices in food and drink establishments affect the health of the clients. In this session, you will be introduced to the hygiene requirements in food and drink establishments that are likely to be found at *kebele* level. You will learn how food items and equipment are handled in a hygienic manner, the public health importance of food handlers, and what client-focused hygienic services are required.

Learning Outcomes for Study Session 11

When you have studied this session, you should be able to:

11.1 Define and use correctly all of the key terms printed in **bold**. (SAQ 11.1)

11.2 Describe the categories of food and drinking establishments. (SAQ 11.1)

11.3 Explain the hygienic requirements that are applicable in food and drink establishments. (SAQ 11.2)

11.4 Explain the hygienic behaviours required of food handlers. (SAQ 11.3)

11.5 List the sanitary facilities required in food and drinking establishments. (SAQ 11.4)

11.6 Describe the procedure for sanitary inspection in food and drinking establishments. (SAQs 11.2 and 11.3)

11.1 What is a food and drink establishment?

Food and drink establishments provide food and drink services to a relatively large number of users in the form of breakfast, lunch, dinner or beverages. Formal food and drink establishments are authorised to practise this service after being licensed by the local authorities. There also exist a number of informal food and drink establishments that provide a service without much interference from the local government. Food and drink establishments have a responsibility to provide safe food and drink to the consumers. The consumers have the right to demand safe food. Unless food is prepared and handled in hygienic conditions, it spreads foodborne disease that could affect a large number of people at a time.

The local government (*kebele*) takes actions to ensure the hygienic functioning of these establishments on behalf of the public. The Ethiopian Regional and National hygiene and environmental health regulations can be exercised in the *kebele* by the presence of an appropriate expert who is authorised to enforce them. As a Health Extension Practitioner you can make a link with this authority through regular reporting to ensure that the necessary actions are taken to maintain safe practice.

11.2 Categories of food and drink establishments

There are several types of food and drink establishment in rural areas. Some may provide only food; others provide food and drinks such as soft drinks, beer and other alcoholic drinks; some provide only snacks and hot drinks. We describe below those establishments that are likely to be found at *kebele* level.

Figure 11.1 A typical lunch served in an Ethiopian restaurant. (Photo: Basiro Davey)

Restaurants are food establishments that provide lunch and dinner (Figure 11.1) with accompanying drinks.

Cafés provide hot drinks and snacks. Hot drinks include tea, coffee, milk, or a blend of milk and coffee (*macchiato*). The café must have water boiling equipment for coffee and tea preparation. Cakes and doughnuts (such as *bombolino*, *chornake* and *sambusa*) are served as snacks.

Tea houses provide tea and snacks. Snacks are usually plain bread, *sambusa* and *bombolino*. Tea is served after mixing with boiled water in a kettle.

Tej bet is a drink establishment that offers a local light alcoholic beverage made of fermented honey in water, called *tej*, which is served in large measures.

Tela bet is an establishment that provides a local light alcoholic drink called *tela*. They are common in rural areas of Ethiopia.

Areki bet is a drink establishment that provides a local drink containing more alcohol than *tela* or *tej*. It is consumed in smaller quantities.

A *grocery* is an establishment that provides packed food and drink items. Groceries may also provide hot dishes.

Figure 11.2 A butcher's shop in Addis Ababa. (Photo: Basiro Davey)

A *butcher's shop* is a food establishment that offers meat for sale (Figure 11.2).

A *bakery* is a food establishment that offers plain bread for sale.

A *hotel* is a food establishment that offers food, drinks of all types, and bedroom services. The capacity of service and the quality of foods and bedrooms in a rural hotel are less than those of urban hotels.

■ Take a walk around the centre of your *kebele* or around the *kebele* office. List the number and types of food and drink establishments you observe. Categorise them according to the kind of service they offer.

□ The number of food and drink establishments in rural *kebeles* is commonly less than ten. Likely types are tea houses, *tej bet*, restaurants and small groceries.

11.3 Hygienic requirements of food and drink establishments

This section outlines the basic hygienic requirements that are applicable for the food and drink establishments found at the *kebele* level. Knowing them will help you to make decisions when visiting them for inspections.

11.3.1 Licensing

There should be a system for licensing food and drink establishments in *kebeles*. The *woreda* health office is responsible for this licensing system. As the local Health Extension Practitioner, you may be requested to do a preliminary assessment to check the hygienic requirements and report to the *woreda* health office. Most categories of food and drink establishments can be licensed, though *tela bet* and *areki bet* do not require it because of their lower level of health hazards. Please note that the licensing procedure must follow regional and local regulations.

11.3.2 Location of the food establishments

Food establishments need to be well away from any source of hazards such as marshy areas, waste disposal sites and flooding. The site must be conveniently accessible to staff and consumers. The establishments should be at a distance from public institutes such as schools and health facilities. Access to clean air and natural lighting is also important.

11.3.3 Condition of the building

The space available must be adequate to provide the kind of service that the establishment carries out. Depending on the nature of the establishment, the space may include kitchen, dining room, drinking room, food storage sites, and utensil washing site. Building structures and their interiors should permit good hygienic practices, including protection against cross-contamination of food surfaces between and during operations. The provision of a window for each room should ensure adequate lighting.

Structures within processing establishments should be soundly built of durable materials and be easy to maintain, clean and, where appropriate, disinfect. Floor and wall surfaces must be cleanable and washable. The surface of the walls must have a light colour that maximises the interior lighting. The roof must be cleanable and maintained free of dirt.

Dining rooms and coffee or tea drinking rooms

The dining room should be very attractive in terms of its cleanliness, lighting and natural ventilation. The cleanliness of the walls, floor and ceiling must be acceptable and the chairs and tables must be in good repair. Food remains must not be dropped on the floor but should be collected and disposed of in a garbage container. The provision of an appropriately-sized garbage container, about 10–15 litres, is important.

Hotel bedrooms

The principles of healthful housing that you have learned about in Study Session 4 are also applicable to hotel bedrooms. The cleanliness of the bedding (sheets, blanket, hard surfaces) and the cleanliness of floor, walls and ceiling are important. A chair and table are also useful for the client's comfort. A small waste bin must be available. Good ventilation and lighting are also essential components of a hygienic bedroom.

11.3.4 Sanitary facilities

Food and drink establishments need to offer sanitary facilities, which means handwashing facilities, latrines and urinals. The handwashing facility must have soap; a liquid soap is appropriate if this is available. Separate latrines for men and women are desirable. The number of these facilities depends on the number of clients visiting at peak hours. Generally, one handwashing facility and latrine for 30 clients is appropriate.

Figure 11.3 Soap is essential for proper handwashing. (Photo: Basiro Davey)

Food handlers should be provided with a separate latrine, handwashing and changing facilities at a convenient location. The availability of soap is essential for proper handwashing (Figure 11.3).

11.3.5 Access to water

Food and drink establishments require a sustained source of safe water to be used for personal hygiene, food preparation and utensil cleaning. A water tank is one option to ensure the availability of water at all times.

11.3.6 Waste management

Food and drink establishments produce organic wastes such as food remains, and liquid wastes as a result of hand and kitchenware washing. These wastes need to be handled properly without contaminating or polluting the immediate environment. Specific information on waste management can be found in the study sessions later in this module.

11.3.7 Kitchen and food preparation site

The space and lay-out of the kitchen must be appropriate to accommodate the food preparation and kitchen processes. There must be separate sections for raw food preparation and handling cooked food.

■ Why is it important to keep cooked and raw food separate?

□ The raw food will contaminate the cooked food if they touch each other.

The presence of a window and a chimney is essential in order to manage the indoor air pollution that is caused by biomass fuel burning.

The presence of facilities for washing hands and kitchenware is mandatory in a kitchen. Proper shelves for physically separating soiled and cleaned items are also a necessity.

The proper handling of kitchen refuse and liquid waste controls the spread of infestation and food contamination. Food scraps and leftovers must be placed in a covered container. The floor and tables need to be cleaned frequently during the processes of food preparation and cooking.

11.3.8 Cleaning dishes, drinking utensils and cutlery

The cleaning of soiled dishes is an important way of preventing communicable diseases. There is an established procedure that the person who is the dish washer must follow. 'Dish' in this section includes plates, cups, glasses, spoons, forks and other utensils.

The three bowl method for cleaning soiled dishes

The manual cleaning process requires three vats or bowls, each with a capacity of 20–30 litres (Figure 11.4). Washing equipment such as detergent (powdered soap) and a scraping cloth, sponge or cleaning brushes are also necessary.

Figure 11.4 The three bowl system for washing soiled dishes. (Photo: Abera Kumie)

The procedure shown in Box 11.1 uses the three bowl system, which is recommended for the rural setting where running water is unlikely to be available.

Box 11.1 Dishcleaning guidelines where there is no running water

1. Decide what to wash first: generally it is best to start with glasses and cups. However, the following description is for washing soiled plates.
2. Fill the first two bowls halfway with warm water (50°C). Hot water (80°C or above) is added to the third bowl. A detergent must be included in the first bowl.
3. Scrape the food from dish surfaces and collect it in a garbage container. Place the dish in the first bowl and wash with the detergent until the grease has gone. Washing plate by plate increases cleaning efficiency. Then place the washed item into the second bowl.
4. Rinse the dish well in the second bowl. Any remaining food particles and soap must be taken away by thorough rinsing. Then place the dish into the third bowl.
5. The process of dish washing in the third bowl is called **sanitising** which is a procedure to inactivate and remove the microorganisms that may be found on the surface of the dish. Sanitising is possible by rinsing the dish in hot water at a temperature of 80°C for 1–2 minutes. Rinsing in warm water that contains chlorine (50–100 ppm) can replace the use of hot water. Immersing the rinsed dish for 15 seconds adequately sanitises.
6. Dry the dish with a clean cloth or air-dry it. The cleaned and dried dish is then placed in a shelf or rack that has a cover. Dishes must be kept under cover until used. Remove dishes that are not in good condition and replace them with new ones.
7. The water used for washing must be changed frequently as needed. The used water in the first bowl is more frequently changed than that in the second bowl. Continued use of dirty water must not be encouraged. The water temperature in the third bowl must be kept high.

ppm stands for parts per million. It is a measure of the concentration of a substance in a solution.

Washing cups, glasses and spoons

The principle of cup washing is the same as that of washing soiled dishes. The three bowl system should be encouraged but two bowls is also acceptable, with warm water and detergent in the first bowl and hot water in the second. The first wash cleanses the grease, while the second bowl sanitises the cups. Cups must be dried with a clean piece of cloth or air-dried before use.

The glass-washing facilities for *birle* in *tej bet* should use a three bowl system. The first is used for washing with detergent, the second and third for rinsing.

When cold and hot running tap water is available, sinks with two compartments/bowls are sufficient because the hot running water is used for rinsing and sanitising (Figure 11.5).

Figure 11.5 Washing glasses in a sink with detergents, and cold and hot tap water. (Photo: Abera Kumie)

11.3.9 Maintaining hygienic kitchen equipment

All surfaces that come into contact with food should be constructed of appropriate materials and be well-maintained, for example, wooden boards must be smooth and metal tables should be plain and not corrugated. Any surface that is cracked, scored or has an irregular surface is difficult to clean and may harbour dirt. Chopping and cutting blocks for preparing meat or vegetables must be kept clean and covered. All utensils and equipment must be protected from possible contaminants including dust, dirt, insects, rodents and overhead drips. Equipment and food containers should be made of materials with no toxic effect and be designed to ensure that they can be easily cleaned, sanitised and maintained.

Surfaces such as chairs and tables that do not normally come into contact with food should also be clean and in good repair. Always use clean cloths to cover tables and change them whenever necessary.

11.3.10 Storing and serving foods

Perishable food items are easily spoiled if stored at room temperature. Foods such as meat should be kept in a refrigerator that can keep the temperature below 10°C. Semi-perishable foods, such as potatoes and carrots, which are used on a daily basis, need to be stored on a well-ventilated shelf. Shelves must be 50 cm from the ground and well away from wall surfaces. A distance of 1 metre is adequate between shelves. The serving of foods to clients should provide maximum health protection. Hot foods should be served while they are hot, and cold foods while they are cold. Foods must be thoroughly reheated if they have been at room temperature for longer than 1 hour.

11.3.11 Vector control

Vector management is a challenging task in food establishments.

- ■ What vectors are you likely to find in kitchens and food storage areas of food and drink establishments?
- □ Flies, cockroaches and rats are commonly observed in these places.

The control of these vectors was described in Study Session 6.

11.3.12 Meat handling and butchery

Butchery may be available in *kebeles*. The food handler (butcher) must satisfy the hygienic practice of personal hygiene. The meat must be from approved sources, be fresh and be sold within 1–2 days. The handling of meat needs to be in a well-ventilated area and the presence of flies around the meat must be controlled. Knives, chopping boards and wrapping materials must be clean: the use of newspapers and similar items for wrapping must be discouraged. The walls, floor and ceiling must be free from any dirt.

11.4 Food handlers' health and hygiene

As you have learned in previous study sessions, food handlers are a common source of foodborne diseases. The practice of good personal hygiene that you learned about in Study Session 3 is essential for anyone who handles food, especially in food and drink establishments where many customers could potentially be affected. A sick food handler with symptoms of diarrhoea, eye and ear discharges, skin infections, open cuts and wounds, or coughing should not continue working. They must be treated and be completely recovered before returning to work.

- ■ What are the main principles of food handlers' hygiene?
- □ To protect food from contamination and to protect the health of the consumers.

Food handlers must use personal protective devices such as clean aprons, overalls or gowns, footwear and hair cover. As a Health Extension Practitioner you should be involved in training food handlers on food safety. The strict rules of handwashing after using the latrine or touching dirt and before handling food must be followed. Box 11.2 indicates some bad habits of food handlers that should be avoided.

Box 11.2 Unhygienic practices by food handlers

- Poor personal hygiene practice
- Unguarded coughing or sneezing
- The habit of licking the fingers
- Nose picking or fingering the nose
- Handling of handkerchiefs
- Working in street clothing
- Spitting in food-handling areas
- Uncovered hair
- Smoking in kitchens
- Ignoring handwashing before starting work, after handling contaminated materials, after breaks and after using toilet facilities.

11.5 Sanitary inspection in food and drink establishments

Health Extension Practitioners have the responsibility of safeguarding the health of the public by ensuring safe hygienic practice in food and drink establishments. Inspecting the food establishments (sanitary inspection) is a means of identifying or monitoring unsafe practices of food handling.

11.5.1 What is the purpose of the inspection?

Sanitary inspection is a set of activities concerned with the preservation of public health and the investigation of environmental hazards in food establishments. Sanitary inspection aims to investigate and detect:

- Food spoilage and its sources
- Food contamination and its sources
- Provision for hygienic procedures (dish and handwashing, food storage)
- Provision of sanitary facilities (latrine, water, shower, handwashing)
- The proper location of the establishment
- The hygienic practice of food handlers
- Proper waste management (storage, collection and disposal)
- The presence of vectors.

Sanitary inspections are carried out for two reasons: first, to provide education and advice to the owners, and second, for the purpose of providing a licence if you are asked to do so in the absence of the *woreda* environmental health worker.

11.5.2 When to inspect

There must be a baseline survey of food and drink establishments using a survey checklist. Appendix 11.1 (at the end of this study session) is an example of the sort of surveillance form you could use for your survey. The survey result must enable you to classify the food establishments by hygienic status and to set priorities for inspection. The number of food establishments in your *kebele* determines the workload of the inspection. You do not have to inspect *tela bet* and *areki bet*, as noted above, because of their lower hazard level. Each food establishment should be inspected at least once every year. However, since the number of food and drink establishments in the *kebele* setting is probably low, often less than ten, then inspecting each four times a year should be possible.

11.5.3 Informing the owners about the sanitary inspection

It is always useful to warn the owners about your inspection visit, including the date, time and purpose. This is useful as your job is promoting food safety and hygienic practice, and your warning may encourage them to check and improve their practices. The kindness and help you get from the owner will facilitate your decisions about the appropriate hygienic instructions to give.

11.5.4 How and what to inspect

Upon arrival at a food and drink establishment you should introduce yourself and announce politely the purpose of your inspection in order not to embarrass the owner. Interviewing food handlers, physical observation and the use of a checklist are the main tools for data collection. Information is also collected by interviewing the owner and the food handlers. The sanitary inspection checklist in Appendix 1 can be used for subsequent visits as well as the baseline survey.

The inspection starts by checking the physical presence of latrines and handwashing facilities meant for the clients. The inspection is based on the food preparation flowchart and is carried out in a sequential manner: food storage, kitchen, dining room and drinking rooms (Figure 11.7).

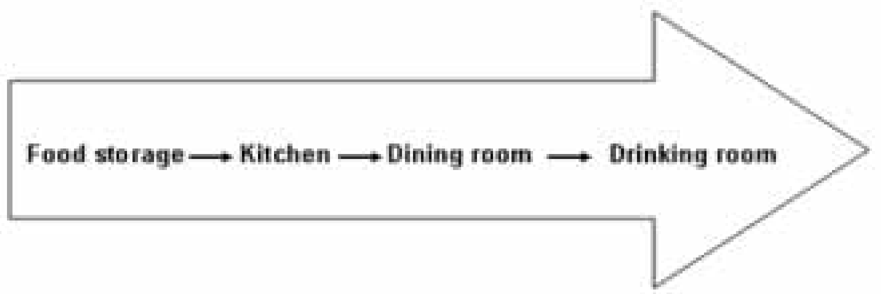


Figure 11.7 The food inspection flowchart.

The handling of raw food is inspected in the food storage room. The use of refrigerators for perishable food items (meat, eggs, juice, fruits and vegetables) is checked. Semi-perishable foods such as potatoes and onions need to be stored on shelves that are properly ventilated and free from any vectors.

In the kitchen the use of detergents, the presence of three dishwashing bowls (or a sink with running water) and the practice of personal hygiene must be closely checked. There should be no vectors such as flies and cockroaches in the kitchen area. The food handler's health is rapidly checked by doing a physical examination for the presence of active infections (skin, eye, ear infections or nasal discharges). The proper use of apron, gown or overalls, hair cover and appropriate footwear by the food handler is also investigated.

The strict separation of kitchen tables for cooked food items and raw food needs to be inspected. The presence of obvious indoor air pollution is also important to note.

In the dining room, the condition and cleanliness of the tables, chairs, floor, walls, and ceiling should be observed. The presence of vectors and proper waste management facilities must be inspected in all parts of the food processing and serving areas. The proper handling of kitchen waste in a garbage container, and the presence of a waste bin in dining areas should be checked.

As you make your inspection, record the information on the checklist. Do not write much on the checklist while inspecting because the owner may not be comfortable about it. Pay attention to critical situations such as dishwashing practice, handwashing practice, vectors and waste handling.

11.5.6 Concluding the sanitary inspection

Discuss your findings with the owner, and explain what hazards and unacceptable hygienic practice you have found. Please also point out what is good. Explain clearly your suggestions for improvement and the urgency of the timescale. It is important that you educate and persuade the owner to implement your advice. Tell the owner that you may revisit the food establishment in future to check what has been improved. You need to keep all the inspection reports for future reference and you should report to the *kebele* and *woreda* offices if improvement is not achieved after repeated efforts.

Activity 11.1 Sanitary inspection in practice

Sanitary inspection needs proper planning in terms of the purpose, timing, date and what to inspect. You need to know the sanitary requirements of the food establishments you want to inspect. At your next inspection, use an inspection checklist or survey questionnaire, which as you have seen is the basic tool for data collection. In addition, check for yourself that you can carry out the inspection in a methodical way. Did you find the checklist helpful?

Summary of Study Session 11

In Study Session 11, you have learned that:

1. There are several kinds of food and drink establishment that provide food and drinks to the public.
2. The operation of food and drink establishments needs to meet basic hygienic requirements in order to safeguard the public.
3. The Health Extension Practitioner needs to focus on the establishments that are relevant to the public at *kebele* level.
4. The basic hygiene requirements are the same in all food and drink establishments.
5. Sanitary inspection is a way of detecting potential hazards that could affect clients if they consume spoiled or contaminated food.
6. Sanitary inspection of food and drink establishments requires good planning. Its purpose is to promote food hygiene and safety by advising and instructing the owners of the establishments. Sustained follow-up and monitoring help to achieve hygienic practice.

Self-Assessment Questions (SAQs) for Study Session 11

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 11.1 (tests Learning Outcomes 11.1 and 11.2)

Match the following food and drink establishments with the services provided.

Type of establishment	**Service offered**
Butcher	Bedrooms
Tea house	Tibs for lunch
Restaurant	Plain bread or chornake
Hotel	Raw meat

SAQ 11.2 (tests Learning Outcomes 11.1, 11.3 and 11.6)

You are planning to do a sanitary inspection on a tea house. Outline the main areas of your inspection.

SAQ 11.3 (tests Learning Outcomes 11.4 and 11.6)

List the components of personal hygiene that need to checked during your inspection of the tea house, and describe the procedures you would use to check them.

SAQ 11.4 (tests Learning Outcome 11.5)

During your inspection of the tea house, you learn that at busy times they are catering for more than 50 people. What sanitary facilities must be available?

Appendix 11.1

Suggested sanitary surveillance form for food and drink establishments

Interviewer's name: ______________ Date of interview:______________

Woreda: ______________ Kebele: ______________

Name of establishment: ________________________________

1 Type of establishment	1) Hotel 2) Restaurant 3) Tea house 4) Tej bet 5) Other:
2 Licence	1) Yes 2) No
3 Water supply	
3.1 Source	1) Piped private 2) Piped shared 3) Piped public stand post 4) Private well, protected 5) Private well, unprotected 6) Unprotected source (describe):
3.2 Handwashing facilities	1) Washbasin 2) Water trough 3) Manual 4) Other, describe:
4 Excreta disposal (for public use only)	
4.1 Is there a latrine?	1) Yes 2) No
4.2 Type	1) Water carriage/Flush toilet 2) Dry latrine
4.3 Number of squatting holes for the above types	
4.4 Does the dry pit latrine have a vent pipe?	1) Yes 2) No
4.5 Is there a septic tank?	1) Yes 2) No
4.6 Maintenance condition of latrine at the time of visit	1) Needs minor repair 2) Needs major repair 3) No need of repair
4.7 Cleanliness of latrine at the time of visit	1) Clean and next person can use it 2) Unclean and next person cannot use it

5 Liquid waste management	
5.1 Where is the wastewater from the hand and dishwashing facilities disposed of?	1) Septic tank 2) Seepage 3) Storm pipe 4) Open ditch 5) Latrine
5.2 Are there any insects breeding around the liquid waste facilities?	1) Yes 2) No If yes, what vector:
5.3 Is there any overflowing liquid waste at the time of inspection?	1) Yes 2) No
6 Solid waste management	
6.1 Is there a refuse container for public use?	1) Yes 2) No
6.2 Is there a garbage container for kitchen use?	1) Yes 2) No
6.3 How is the refuse and garbage finally disposed of?	1) Burning 2) Refuse pit burial 3) Open field dumping 4) Municipal service 5) Other, specify:
7 Equipment washing facilities	
7.1 Soiled dish washing	
7.1.1 How many containers are used?	1) One 2) Two 3) Three
7.1.2 The above container is	1) Fixed type with a water tap 2) Bowls/buckets
7.1.3 Hot water used for soiled dish washing	1) Yes 2) No
7.1.4 Detergent used for soiled dish washing	1) Yes 2) No
7.2 Drinking glass washing facilities	
7.2.1 How many containers are used?	1) One 2) Two 3) Three
7.2.2 The above compartment is	1) Fixed type with a water tap 2) Bowls/buckets
7.2.3 Hot water used for soiled glass washing	1) Yes 2) No
7.2.4 Detergent used for soiled glass washing	1) Yes 2) No
8 Food handlers' personal hygiene	
Check the following in at least one food handler working in kitchen and dining area:	
8.1 Fingernails cut short	1) Yes 2) No
8.2 Hair covered during work	1) Yes 2) No
8.3 Finger ornaments worn during work	1) Yes 2) No

8.4 Any infection present at a time of visit	1) Skin (open wound) 2) Respiratory infection 3) Diarrhoeal infection 4) Discharge from the eye 5) Discharge from the nose 6) Discharge from the ear 7) Other, specify:
8.5 Outer garment (apron/gown) worn?	1) Yes 2) No
8.6 Colour of working outer garment	1) White 2) Blue 3) Red 4) Grey 5) Other, specify:
8.7 Is the outer garment visibly dirty?	1) Yes 2) No
9 Food servicing hygiene practice	
9.1 When is the food served?	1) Any time of day 2) At specified times (e.g. for breakfast, lunch and dinner)
9.2 How are perishable food items stored?	1) Prepared foods kept in fridges and then served 2) Hot foods served immediately 3) Food leftovers reheated and served 4) Other, specify:
10 Building conditions	
10.1. Kitchen	
10.1.1 Visible smoke (check the wall and ceiling/roof for smoke particles)	1) Yes 2) No
10.1.2 Is there overcrowding?	1) Yes 2) No
10.1.3 Handling of foods like injera at the time of visit	1) Cover 2) No cover
10.1.4 Presence of vectors	1) Yes 2) No If yes, specify:
10.2 Dining room	1) Yes 2) No
10.2.1 Walls in good condition	1) Yes 2) No
10.2.2 Ceiling in good condition	1) Yes 2) No
10.2.3 Adequate lighting	1) Yes 2) No
10.2.4 Adequate ventilation	1) Yes 2) No
10.2.5 Tables and chairs in good condition	1) Yes 2) No

11 Butchery	
11.1 Source of meat (check the presence of municipal stamp)	1) From Municipality abattoir 2) Private sources
11.2 Quality of meat on visual inspection (do not touch, but check colour and odour)	1) Fresh and good 2) Odourous, with discharges 3) Other, specify:
11.3 Knives kept in drawer when not used	1) Yes 2) No
11.4 Handwashing facilities present in the vicinity	1) Yes 2) No
11.5 Knife washing facilities in the vicinity	1) Yes 2) No
11.6 Latrine presence in the vicinity	1) Yes 2) No
11.7 Chopping block cleanliness	1) Clean 2) Unclean
11.8 Chopping surface cleanliness	1) Clean 2) Unclean
11.9 Offal kept separately from the meat	1) Yes 2) No
11.10 Vector presence on visual inspection	1) Yes 2) No If, yes specify:
1.11 Walls in good condition	1) Yes 2) No
11.12 Ceiling in good condition	1) Yes 2) No
11.13 Adequate lighting	1) Yes 2) No
11.14 Adequate ventilation	1) Yes 2) No
11.15 Dustbin availability	1) Yes 2) No
11.16 Meat wrapped when sold	1) Yes 2) No

Note any unhygienic practices observed and your suggestions:

Unhygienic practices:

1 ____

2 ____

3 ____

4 ____

5 ____

Suggestions, advice, actions taken

1 ____

2 ____

3 ____

4 ____

5 ____

Study Session 12 Hygiene and Safety Requirements for Foods of Animal Origin

Introduction

Foods of animal origin are perishable foodstuffs which need special attention during processing, preparation, transportation and storage to avoid them becoming contaminated and causing ill health to the consumer. In this session you will learn how to inspect and assure the quality of food items of animal origin, and how to keep and handle them safely, without contamination. You will also learn about diseases caused by contaminated perishable foods. We will look in turn at meat, fish, milk and eggs.

Learning Outcomes for Study Session 12

When you have studied this session, you should be able to:

12.1 Define and use correctly all of the key terms printed in **bold**. (SAQ 12.1)

12.2 Describe the public health importance of diseases derived from foods of animal origin. (SAQs 12.2, 12.6 and 12.7)

12.3 Describe meat inspection procedures. (SAQ 12.2)

12.4 Describe the procedures for meat and butchery hygiene (SAQs 12.2 and 12.3)

12.5 Describe the criteria for assessing fresh fish (SAQ 12.4)

12.6 Describe the procedures for milk hygiene and quality control (SAQs 12.5 and 12.6)

12.7 Describe the procedures for poultry and egg hygiene (SAQ 12.7)

12.1 Meat and its dangers

Meat is among the most highly nutritious foods. It is good source of protein, fat and minerals. It is also a highly perishable product because cooked and especially raw meat (Figure 12.1) is a good substrate (underlayer) for the growth and multiplication of harmful microorganisms. As a result several diseases may be transmitted to humans through the consumption of meat or meat products.

Figure 12.1 Raw meat being prepared for a special meal. (Photo: Zegeye Hailemariam)

- ■ What are the most common perishable food items?
- □ Common perishable foods are meat, milk, fish and vegetables.

Meat is the flesh of an animal used for human consumption. In this text 'meat' refers mainly to the flesh of bovine animals i.e. cattle and oxen, generally known as beef, although of course there are other types such as sheep meat (mutton), goat meat, and pig meat (pork).

Diseases transferred to humans from animals are known as zoonotic diseases. One route of transmission of zoonotic diseases is by the consumption of infected meat.

The most common zoonotic diseases found in Ethiopia are:

- Bovine tuberculosis
- Anthrax
- Salmonellosis
- *Taenia saginata*, beef tapeworm infection, also known as *kosso*)
- *Taenia solium*, pork tapeworm infection
- Hydatid disease
- Diphyllobothriasis, fish tapeworm infection
- Trichinosis
- Toxoplasmosis.

Tapeworm infections are discussed in detail in Part 4 of the *Communicable Diseases* Module.

Diphyllobothriasis is pronounced 'diff-ill-oh-both-rya-sis'.

■ Which of these diseases are caused by parasites?

□ All of them except the first three.

12.1.1 Beef tapeworm

Taenia saginata infection or beef tapeworm has been known in Ethiopia for many centuries. The disease is locally known as **kosso** and is related to the cherished tradition of eating raw beef, a common practice in most parts of the country (Figure 12.2). The disease is closely linked to its cure so the traditional *taeniacide* (agent that kills *Taenia*) is also known as *kosso*. *Kosso* is an Amharic word that describes both infection (beef tapeworm) and the treatment. The name comes from the tree (*Hagenia abyssinica*) whose flowers are active against tapeworm (Figure 12.3).

Figure 12.2 Eating raw meat is part of many Ethiopian celebrations. (Photo: Zegeye Hailemariam)

Figure 12.3 *Kosso*: flowers from the tree *Hagenia abyssinica* are used to treat tapeworm. (Photo: Pam Furniss)

The major factors contributing to the continuing existence of beef tapeworm infection in Ethiopia are lack of proper slaughtering practices and eating raw beef. Open defecation also spreads the disease. Open field defecation practices are widespread in rural areas and small urban centres. This means that if a person infected with *kosso* defecates on open fields, the infected faeces contaminate the environment, especially pastoral lands used for cattle grazing. The cattle then become infected. Once inside the animal, the larval stages of the tapeworm form *cysts*, also known as cysticerci, in the muscles and some other organs. The contaminated meat containing the cysts will infect people who eat it if it is not thoroughly cooked (see Figure 12.4).

The lack of proper slaughtering facilities and the absence of meat inspection in some slaughterhouses (abattoirs) means that contaminated meat can be sold, and people eat the infected meat. This practice results in a high frequency of tapeworm occurrence.

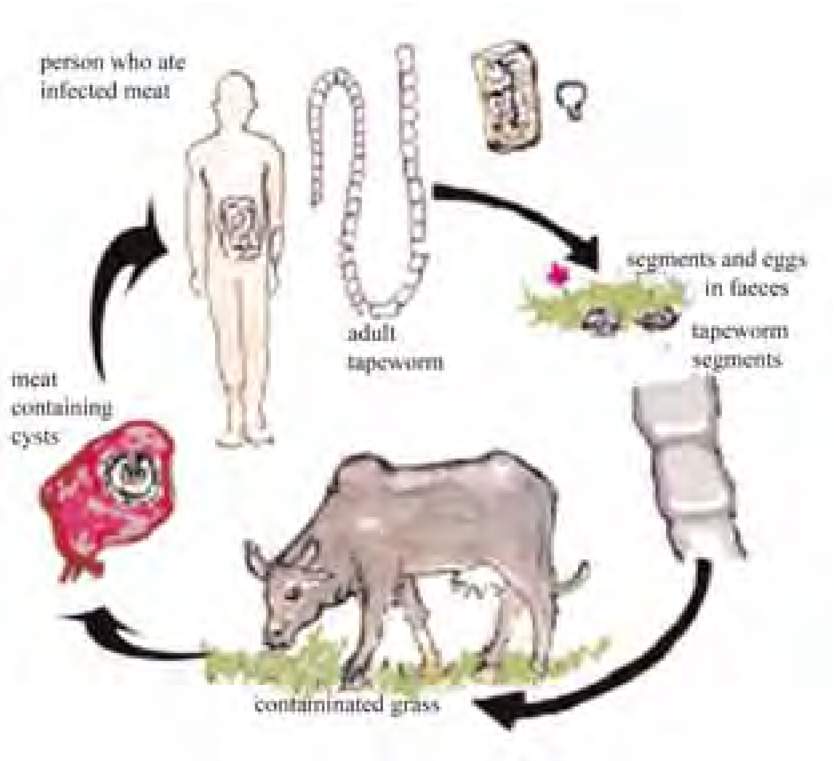


Figure 12.4 Life cycle of the beef tapeworm.

12.1.2 Anthrax

The bacterium that causes anthrax is called *Bacillus anthracis*. It is capable of producing very durable and long-lived spores which can cause disease by coming in contact with skin, by being inhaled and by being consumed. The three forms of disease are:

- *Cutaneous anthrax*: cutaneous means 'on the skin'. This is the most common form of anthrax. It is characterised by localised skin lesions with a black central scar of dead tissue and non-pitting oedema (oedema means swelling due to fluid building up in the skin; non-pitting means the swelling cannot be compressed when pushed down). The people most affected by cutaneous anthrax are skin and hide workers. Cutaneous anthrax can be treated with antibiotics.
- *Inhalation anthrax*: is caused by the inhalation of *Anthrax* spores. It is also known as woolsorters' disease becaus it was an occupational hazard for people who worked with unprocessed wool. It can cause severe pneumonia, cough, fever, difficulty in breathing and finally death.
- *Gastrointestinal anthrax*: is not uncommon in rural Ethiopia and results from consumption of sick and dying animals, and uncooked meat. Symptoms of intestinal anthrax are fever, nausea, vomiting, abdominal pain, bloody diarrhoea and rapid accumulation of fluid in the abdomen.

The control measures for anthrax are to advise people not to eat raw meat from sick and dying animals like cows, oxen, sheep, camels and goats, and to only eat thoroughly cooked meat and meat which is inspected and approved for consumption. Even handling hides and skins from these dead animals may result in cutaneous anthrax.

12.2 Meat hygiene

12.2.1 Abattoirs and meat transportation

Abattoirs, also known as slaughterhouses, are establishments where livestock are killed prior to human consumption. Slaughterhouses should be subject to inspection to ensure that the meat they produce is safe to eat. This includes inspection of live animals and also of the slaughtered animal carcasses. Before slaughter, the animals should be observed to check for any abnormalities in their appearance or behaviour that could indicate sickness. After slaughter, animal carcasses should be inspected by a qualified meat inspector who knows the signs of specific types of disease and which organs they may be found in. If the carcass passes the inspection it will be stamped with safe, indelible ink to indicate it has been approved for human consumption.

The carcass should be transported soon after slaughter, in a special vehicle, to a butchery or distribution centre. If such customised vehicles are not available, every precaution should be taken to avoid contamination of the meat during transport. Even if the meat travels in a wheelbarrow it should be kept absolutely clean.

12.2.2 Hygiene in the butcher's shop

Figure 12.5 The butcher wears a clean, white gown. (Photo: Zegeye Hailemariam)

Butcher's shops are the link between the inspected and approved safe meat, and meat products and the consumer. Therefore the hygienic practices used for handling meat in these shops determine the health of the meat consumer. For this reason, butcher's shops need licences to operate, confirming that they meet all the handling specifications that ensure the safety of the meat. For example, the licensed premises must have adequate working space. The walls and floor should be constructed of durable material and be smooth, impermeable, easily cleanable and light-coloured. There should be adequate ventilation and natural light. The utensils should be clean and kept in an appropriate place. The butcher should wear a clean white gown, preferably with an apron and a white hair cover (Figure 12.5). Importantly, an approved means for the disposal of meat waste should be provided inside or outside the butchery.

- ■ Suggest why waste meat needs to be disposed of carefully.
- □ The waste will attract insects, rodents and other animals, increasing the risk of contaminating the shop and its surroundings.

12.2.3 Meat preservation methods

As noted above, meat is highly perishable, so it must be preserved properly. One way of doing this is to chill the meat in a refrigerator. Temperatures for refrigeration of meat should be lower than the usually recommended 10°C and should be below 7°C for carcasses and below 3°C for offal. For long-term storage, meat should be frozen. However, since most rural people do not have a refrigerator or freezer, they should use traditional preserving methods.

■ You learned in Study Session 10 about some meat preservation methods used in rural communities in Ethiopia. What are they?

□ Common methods are smoking, salting and drying to prepare *quanta*.

12.2.4 Your role in controlling tapeworm infection

Ethiopia is a country with a lot of raw meat consumption and a high prevalence of tapeworm. Two rules must be enforced, and educating the community about them is an essential part of your role:

- No-one should offer any food for eating that is unsafe or unfit for human consumption.
- Meat for sale not bearing the stamp of approval of the public municipal slaughterhouse should be considered unsafe for human consumption.

Additionally there are measures that you can recommend in the community. Abstaining from eating raw or inadequately cooked meat is a good control measure. The Ethiopian dishes of *kitfo* or *lebleb kitfo* are not safe to eat. However, there are strong cultural reasons for this practice, so people may not take your advice.

The best control measure against meatborne zoonotic diseases is to cook the meat thoroughly before consumption. Exposing meat to a temperature above 56°C inactivates any *cysticercus bovis* (beef tapeworm cysts) present. Organised and strict meat inspection practices in abattoirs can ensure that meat is free from tapeworm infection as well as other meatborne diseases.

Finally, avoiding open defecation is a major control measure for zoonotic – and other – faeco-oral diseases.

12.3 Fish hygiene and its health impact

Globally, fish are a popular food item (Figure 12.6). With the abundant rivers, ponds and lakes in Ethiopia, fish is among the commonest foods in many parts of the country.

Figure 12.6 Freshly cooked fish are good to eat. (Photo: Pam Furniss)

12.3.1 Environmental conditions that can contaminate fish

Fish are generally considered clean and fresh, but several environmental factors can make fish unfit for consumption. The factors relate to the food of the fish itself – the fish is what it eats – and to the cleanliness/safety of the water body. Fish can also be contaminated by poor handling at any stage from being caught to being eaten.

Water bodies can be contaminated by:

- Industrial chemical wastes which may contain heavy metals.
- Farm chemical drainage containing pesticides which may bioaccumulate; for example, DDT accumulates in fish tissues.
- Domestic and commercial wastes, drainage and runoff, which may be contaminated with faeces or other pollutants.

Bioaccumulation is the gradual build-up of chemicals such as pesticides in the bodies of living organisms.

12.3.2 Diseases associated with poor fish hygiene

Fish is a perishable and potentially hazardous food item if not handled properly. There are many fish-borne diseases associated with the environment in which the fish is grown, and with the way it is handled after it is brought out of the water, particularly if it is kept at room temperature.

■ Why does temperature affect the condition of the fish?

□ Microbes and autolytic enzymes are more active at higher temperatures, so deterioration proceeds faster.

■ Do you remember what autolytic means?

□ Autolytic means ‘self-destroying’. Autolytic enzymes are naturally occurring proteins in an animal that cause its cells and tissues to break down automatically after death.

Some of the zoonotic fish-borne diseases include the following:

- Fish tapeworm, common in the Zeway, Arbaminch and Bahir Dar areas in Ethiopia. People are infected by eating raw and undercooked fish.
- Shigellosis, due to contamination with *Shigella* bacteria mostly during handling of the fish and via the faeco-oral route from water contaminated with faeces.
- Salmonellosis, due to contamination with *Salmonella* bacteria mostly during handling of the fish.
- Fish parasites, other than tapeworm, that contaminate the flesh.

12.3.3 Assessment of fish quality

Figure 12.7 These fish were caught just a few minutes before this photo was taken – definitely fresh! (Photo: Pam Furniss)

If you want to know whether fish is fresh, there are a number of signs you should look out for (Figure 12.7). Fresh fish has bright, convex (bulging) eyes with a dark pupil. The flesh of a fresh fish is translucent (almost transparent), but as it ages it gets darker and more opaque (you cannot see through it).

A fresh and sound fish shows the following typical characteristics:

- The gills are bright, usually closed and have no abnormal odour.
- The eyes are prominent with a transparent cornea (the outer surface of the eye).
- The scales are difficult to remove.
- The skin is free from malodorous (bad-smelling) slime and is not discoloured.
- The flesh is firm, the body stiff and the tail rigid.
- The carcass (body) sinks in water.

A fish that is not fresh and is starting to rot shows changes in all these signs. For example, the gills may be open and discoloured, and the skin slimy and malodorous. The eyes are opaque and sunken, the scales can be removed easily and the carcass floats in water. The flesh falls easily from the bones and is easily broken up.

12.3.4 Preservation of fish

There are traditional and modern ways by which fish can be preserved, such as chilling, freezing, smoking, drying, salting and canning. In all cases fish should be properly gutted, washed and chilled immediately upon removal from the water, and kept cold until consumed.

12.4 Milk hygiene

Milk is an important food, supplying us with proteins, fat, carbohydrates, minerals and vitamins (Figure 12.8).

Figure 12.8 Milk is an important food.

The provision of a safe supply of milk is of great importance for public health, with the following objectives:

- The improvement of nutritional status of infants, children, and mothers.
- The prevention of disease or physical defects arising from malnutrition.
- The prevention of communicable, zoonotic disease transmission.
- The control of milk adulteration.

12.4.1 Sources of milkborne diseases

Disease organisms in milk are derived from the dairy animal itself, the human handler, or the milk-handling environment.

■ What human behaviours might result in milk contamination?

□ Poor personal hygiene by the food handler including activities such as coughing, sneezing or scratching over the milk, and allowing objects, particularly fingers, to come into contact with the milk.

In terms of the environment, the milking and milk-handling processes must be carried out hygienically, avoiding contamination with soil, manure, animal hair or dirt from the cowshed. The milk containers must be clean and disinfected.

12.4.2 Diseases that may be transmitted from milk cows

Bovine tuberculosis

Bovine tuberculosis (bovine TB) is a very common infection of cattle. It is caused by the bacterium *Mycobacterium bovis*. Infection may be acquired by drinking raw milk from a cow that has bovine TB. The disease may reach the milk by contamination with faeces or from the coughs of infected cows. Diseased humans can also contaminate the milk during handling. Milk, therefore, should always be pasteurised or sterilised before drinking. Raw milk is the usual cause of the forms of human TB that affect parts of the body other than the lungs.

Brucellosis

Brucellosis is an infectious disease characterised by a high fever. It is caused by bacteria belonging to the *Brucella* genus, mostly *Brucella melitensis* (a disease of goats) and also *Brucella abortus* (a disease of cattle) and *Brucella suis* (a disease of pigs). It occurs mostly as a result of ingestion of contaminated milk and dairy products (such as cheese) from animals infected with *Brucella*. Brucellosis can also be transmitted by blood, urine or tissues of sick animals so good hygiene must be maintained at all times around animals.

Q fever

Q fever is an infection caused by the bacteria *Coxiella burnetii*, (formerly *Rickettsia burnetii*). Its name derives from the time when the cause of the fever was unknown – the 'Q' stands for 'query'. Only one bacterium is needed to cause the Q fever infection! The disease is transmitted through drinking the raw milk of infected cattle, goat or sheep, and it can also be transmitted in airborne droplets.

Anthrax

As you read earlier, anthrax is usually caused by spores of the bacterium *Bacillus anthracis*. The spores can remain in soil and dust for a long time and they can infect milk. The spores usually reach the milk via infected blood contaminating the milk, or by dust from the animal's coat or the environment.

12.4.3 Essentials of milk hygiene

Figure 12.9 Milking a clean and healthy cow.

Milk sanitation i.e. the protection of milk from dirt and contamination is essential to prevent milk infection. Clean milk (with a low number of bacteria) is a necessity, and is possible by using good milking hygiene (Figure 12.9).

The essential steps in hygienic milk production are summarised in Box 12.1.

Box 12.1 Hygienic milk production

- Animals must be clean and healthy.
- Milking should be done away from the herd.
- The milk handler should also be clean and healthy. S/he should wear clean outer garments during milking or processing the milk.
- The milking room should be clean, ventilated and dustless.
- Utensils and equipment for milking and milk handling must be clean.
- Immediately before milking the udder and teats of the cow must be washed with clean lukewarm water and dried with clean cloths – a separate one for each cow.
- Immediately after milking the milk must be removed from the shed, placed in a clean and covered receptacle and kept in a cool place.

12.4.4 Methods of making milk safe

Remember that raw milk should not be consumed without treatment to protect consumers from milkborne diseases. The following methods are recommended:

Boiling

This is the most widely practised domestic method of making milk safe. Milk must be boiled for 30 minutes and then cooled to below 10ºC. It must be protected from contamination by flies, dust, etc. Boiling in this way can prevent the transmission of bovine TB and brucellosis.

Sterilisation

This method ensures that all microorganisms and their spores are killed, but it also affects the nutritional quality of the milk as the process destroys vitamins, especially Vitamin C. Sterilisation is carried out by raising the temperature to between 110°C and 130°C for at least 20 minutes.

Drying

In the drying process all the water is removed by evaporation and what remains is solid, dry milk (powdered milk). The powder is not sterile, but once dry, it can be stored for extended periods.

■ Why does drying make it safe to store powdered milk?

□ Bacteria and other microorganisms need water to survive. Drying prevents the growth and reproduction of microorganisms that could contaminate the milk. But it must also be stored correctly. It must be kept in an air-tight container to ensure it remains dry and free from dust and dirt.

Pasteurisation

■ What is pasteurisation?

□ Pasteurisation is a process of heat treatment of food that kills most pathogenic organisms without altering the nutritional value.

Pasteurisation is not sterilisation but it is a process in which all pathogenic microorganisms, many other non-spore forming bacteria and many enzymes in the milk are destroyed or inactivated without much affecting the nutritive value and the chemical nature of the milk. In practice one expects to find no faeco-oral bacteria and not more than 10,000 microorganisms of any type per millilitre of pasteurised milk. You learned the details of pasteurisation in Study Session 10.

12.5 Poultry and egg hygiene

Poultry consumption has greatly increased in recent years (Figure 12.10). Due to poor hygiene, poultry and poultry products are responsible for a number of foodborne illnesses including salmonellosis, staphylococcal food poisoning and botulism. Other, less common diseases include *psittacosis* or *ornithosis,* also known as parrot fever, which is a zoonotic disease caused by the bacterium *Chlamydophila psittaci,* and 'bird flu' which is a viral disease that can affect both poultry and people.

Figure 12.10 Healthy, well-kept poultry are good sources of protein from eggs and meat. (Photo: Pam Furniss)

■ From your general knowledge, what symptoms may occur following the consumption of raw eggs if they are contaminated with *Salmonella*?

□ Common effects are diarrhoea, fever and headaches, which may be signs of salmonellosis.

12.5.1 Poultry keeping and processing

Correct sanitation procedures involve all stages in the operation from live poultry pens to retail establishments, including processing, packing, storage and transportation. Whether in large-scale commercial production, or domestic poultry keeping, the poultry handlers must be healthy and maintain food handlers' hygienic practices.

In the poultry farm, the housing, feed and water supply must be safe. The plant and equipment must be cleaned daily. In particular, any dead birds must be removed from coops. During processing, hygienic methods of killing and dressing must be used.

12.5.2 Handling eggs

Although most freshly laid eggs are sterile inside, the shells soon become contaminated by faecal matter from the hen and the lining of the nest. When collecting eggs, any visible dirt should be rubbed off the shells. During handling, contamination can also arise from washing water and from any packing material. However, some eggs will be spoiled on the inside, generally because of cracks in the eggshell through which bacteria can enter. It is important to test for egg spoilage, and this can be done in the following ways.

Inspection

Figure 12.11 These eggs are clean and have no cracks. (Photo: Basiro Davey)

Eggs should first be inspected for cracks, leaks, stains or dirt on the exterior and general bloodiness or translucent spots in the yolk when candled (see below). You are looking for freshness, soundness, size and cleanliness of the shell (Figure 12.11).

Shaking

A fresh egg makes no sound, but a stale (bad) egg makes a sound when shaken.

Candling

This is performed by holding the egg between the eye and a light such as a candle flame or the sun. As the shell is translucent, you can assess the internal quality and the size of the yolk.

Floating

Fresh eggs usually sink to the bottom of a bowl of water, whereas spoiled eggs float and can be removed. Floating occurs because, in spoiled eggs, the air cavity is bigger, which makes the egg more buoyant. The problem with this method is that the water may penetrate through the eggshell pores so it is important to use clean water, change it frequently and not to leave eggs in the water.

Breaking

In this test, around 10 eggs out of 100 are taken randomly and checked for spoilage by breaking them open to see what is inside. This is the most accurate testing method but it is not cost effective, so is only used when the other methods are not exercised, for example in large-scale operations.

12.5.3 Storing eggs

Since eggs are perishable food items they need proper storage. They should be kept cool and dry. Maintenance of the egg's internal quality depends on the time and conditions of storage, especially the temperature and the presence of tainting substances in the storage environment. Eggshells are porous and eggs can quickly absorb foreign odours which will taint the contents. It is therefore advisable to avoid storing strong-smelling and volatile materials such as kerosene or varnish near egg stores.

Summary of Study Session 12

In Study Session 12, you have learned that:

1. Meat, fish, milk and eggs are valuable foods, but they must be handled correctly to prevent spoilage and disease transmission.
2. Each type of food can transmit specific microorganisms or parasites, causing specific foodborne diseases.
3. Disease transmission is minimised by correct hygienic practices in preparing, processing and selling food.
4. Eating raw meat, fish, milk and eggs is not safe. The Ethiopian custom of eating raw beef during celebrations is not recommended.
5. Fresh fish can be recognised by their appearance; stale fish should not be eaten.
6. Milk can be treated by several methods to make it safe, of which pasteurisation is the most recommended.
7. Egg quality can be assessed by simple tests such as candling and shaking.

Self-Assessment Questions (SAQs) for Study Session 12

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 12.1 (tests Learning Outcome 12.1)

What is *kosso*?

SAQ 12.2 (tests Learning Outcomes 12.2, 12.3 and 12.4)

Explain why eating raw beef is inadvisable and how the risks can be minimised.

SAQ 12.3 (tests Learning Outcome 12.3)

Outline the main steps in abattoir inspection and explain why inspection is important for food safety.

SAQ 12.4 (tests Learning Outcome 12.5)

You bought some fish today but you will not eat it until tomorrow. Describe (a) how you will keep it overnight and (b) how you will tell if the fish is safe to eat tomorrow.

SAQ 12.5 (tests Learning Outcome 12.6)

Your brother has just bought two cows and wants to sell the milk to his neighbours. What advice would you give him so that everyone can be sure of the milk's safety?

SAQ 12.6 (tests Learning Outcome 12.6)

In a nearby community, it is common to drink raw milk from goats and there is a frequent problem of coughing among children and older people. Outline your advice to the community to help them avoid this illness.

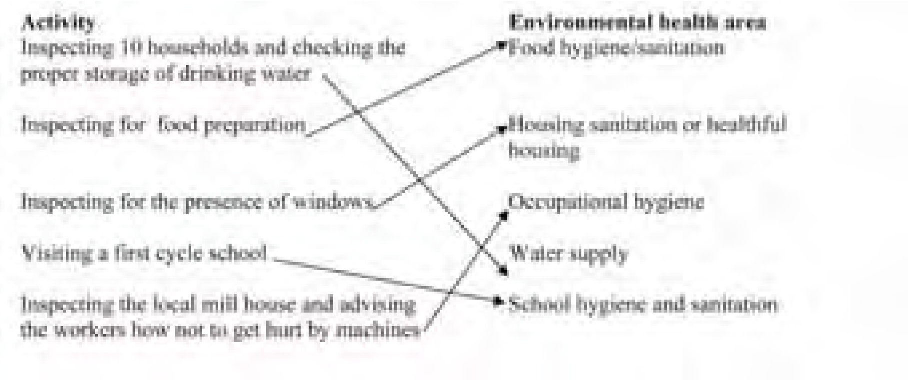
SAQ 12.7 (tests Learning Outcome 12.7)

There is an outbreak of an unknown bird disease, killing many chickens in your village. As a Health Extension Practitioner for your local community, what advice would you give in this situation?

Notes on the Self-Assessment Questions for *Hygiene and Environmental Health*, Part 1

Study Session 1

SAQ 1.1



SAQ 1.2

- Hygiene and sanitation law and practices existed in ancient as well as in modern times.
- Laws in different religions are important for hygiene practices in ancient and modern times.
- Ancient hygiene practices concentrated on personal hygiene and waste management (sanitation).
- Modern understanding and practices of hygiene improved as it was discovered that microorganisms cause disease.
- Improvements in housing, water supply and sanitation have improved health.

SAQ 1.3

You should have made your own list of hygiene and sanitation problems that you can see in your town or village. The list might include: poor handwashing, flies on the face, many flies around the house, excreta around the house, uncovered water container, poor solid waste management, animals are sleeping together with humans, slab of latrine is poorly maintained, children not using latrine, etc.

SAQ 1.4

You could list environmental factors such as open defecation, presence of flies, poor waste management that could support the breeding of flies, uncovered food, contaminated plates and cups, a mother not washing her hands after cleaning a child's bottom, a child eating with dirty fingers.

SAQ 1.5

Your answer will depend on your local situation but examples of economic developments include: mill house, dairy farm, hollow block manufacturing, wood work, metal work. Possible environmental hazards due to these undertakings depend on their nature but may include: liquid waste discharged to the immediate environment, presence of noise, presence of machines that cause accidents, absence of latrines, workers welding without eye protection, etc.

SAQ 1.6

Environmental health planning is needed:

1 To address what must be done effectively – to identify needs and gaps in environmental health
2 To utilise resources efficiently
3 To set priorities for environmental health
4 To implement changes wisely in a given time frame
5 To make a link with the overall *kebele* social development.

You will need to use an environmental health questionnaire to collect survey information and you will need to produce a planning report. You may also use previous planning and performance reports and results from earlier surveys.

Study Session 2

SAQ 2.1

Description	Key Term
A mill house is releasing its liquid waste into a nearby river. The community drinks the water below the discharge point. There was no complaint when people drank the water. There were no observations of fish dying. The amount of the chemical was not significant.	Contamination
Later a new industry releases its liquid waste into the same river. The mill house also continued to release its waste. Fishes in the river began to die. Fishing became difficult. The community downstream did not like the taste of the water.	Pollution
The amount of the chemical was not known. No one knows if the chemical in the waste is harmful or not.	Hazard

The first description is identified as contamination because there is no evidence of harm. This is in contrast with the second in which the wastewater causes death of fish and makes the water taste bad; therefore this is pollution. The appropriate term for the third description is hazard because we have little information about the agent involved or the probability of it causing harm, but we can say there is a danger.

SAQ 2.2

You may have identified a range of hazards; here are some possibilities.

Type of hazard	Source of hazard	Possible health effect
Biological hazard: pathogenic microorganisms (bacteria, fungi, protozoa, worms)	Infected discharges (e.g. blood, secretions, oral swabs, pus)	Communicable diseases such as TB, diarrhoea, typhoid fever
Physical hazard: slips and trips	Wet or slippery floor	Broken bones, muscle injuries, twists and sprains
Chemical hazard: drugs, detergents	Medicines and cleaning products used and stored in the health post	Poisoning, skin or lung damage

SAQ 2.3

The first step in hazard management planning is to identify the hazard including its type, source and the route of exposure. Then the potential to cause harm must be evaluated (risk analysis). When the hazard and risk have been assessed, this information must be shared with other people involved. Possible interventions to reduce the risk or measures to control or remove the hazard should be decided and then put into effect. The outcomes from the interventions or control measures must be monitored to check if they have been successful. Throughout this process, detailed records must be kept of the hazards and actions taken to control them.

Your list of appropriate interventions will depend on your own answer to SAQ 2.2. This is a response for the answer we provided.

Type of hazard	Source of hazard	Intervention
Biological hazards: pathogenic microorganisms (bacteria, fungi, protozoa, worms)	Infective discharges (blood, secretions, oral swabs, pus)	Personal hygiene (handwashing, hand disinfection); proper disposal of wastes; disinfection and sterilisation of medical equipment
Physical hazard: slips and trips	Wet or slippery floor	Ensure floors are cleaned properly; mop up spills; warn people of slippery floors
Chemical hazard: drugs, detergents	Medicines and cleaning products used and stored in the health post	Store detergents properly in labelled containers; use according to instructions; use protective equipment such as gloves

SAQ 2.4

(a) The types of pollution from a health centre could be air, water and land pollution. Water pollution may occur if sterilising fluids are discharged into a nearby river. Air pollution may arise from the burning of wastes. Land pollution is possible if health centre wastes are not disposed of correctly.

(b) There are two main approaches to pollution management: pollution prevention (which should be used to stop pollution being produced in the first place or reducing any waste generation at the source where possible) and pollution control (the measures taken to control pollution and wastes after they have been generated or produced).

Water pollution: chemical waste should not be discharged to a river but disposed of properly.

Air pollution: the amount of waste produced should be minimised where possible, by other methods of waste management such as reusing and recycling. If needed, waste burning should be carried out properly to reduce the likelihood of air pollution.

Land pollution: again waste management should be used to minimise the amount of waste produced. Proper waste management facilities should be used, especially as health centre wastes are likely to contain hazardous materials.

Study Session 3

SAQ 3.1

1 Hair hygiene; 2 Face hygiene; 3 Body hygiene; 4 Hand hygiene; 5 Feet hygiene; 6 Nail hygiene; 7 Armpit hygiene; 8 Oral hygiene; 9 Eye hygiene.

SAQ 3.2

Components	Diseases/conditions	Recommended frequency of cleaning
Eye hygiene	Trachoma, conjunctivitis	Daily every morning and when the face is dirty
Hair hygiene	Dandruff, *Tinea capitis*, infestation (lice, nits)	Twice weekly; preferably once every other day
Body hygiene	Bad smell, scabies	1–2 times a week
Oral hygiene	Tooth decay, gum infection, bad breath	Brushing twice a day; rinsing after each meal
Feet hygiene	Athlete's foot, wound	Every day
Hand hygiene	Diarrhoea, typhus fever, dysentery, ascariasis	Every time after touching contaminated surfaces; every time before eating and touching clean surfaces
Clothes hygiene	Bad smell, not good looking, relapsing fever, typhus	1–2 times weekly

SAQ 3.3

Your choice of components of personal hygiene depends on the burden of communicable diseases in your area. If diarrhoea and trachoma are prevalent in your locality, then hand and eye hygiene will be important to you. Many other answers are possible.

SAQ 3.4

Handwashing with soap is a good or acceptable personal hygiene practice, while not washing with soap and only washing with running water is poor handwashing practice. Not washing the hands at all is obviously not good!

SAQ 3.5

The stepwise procedure is:

1 Remove visible dirt with running water. Always wash hands under running water, preferably with hot water.
2 Apply soap after wetting the hands. Bar, powdered and liquid soaps can be used. Lather well.
3 Rub hands vigorously together for 15 to 30 seconds, paying particular attention to fingertips, thumbs, under the finger nails and between the fingers. Effective handwashing also includes the backs of the hand, palms, and exposed portion of the arm.
4 Rinse the hands with clean running water.
5 Dry with a clean cloth or disposable towel, or let them dry in the air.

Critical situations include

- After using the toilet (or disposing of human or animal faeces).
- After cleaning a child's bottom.
- Before preparing or handling cooked/ready-to-eat food.
- Before eating food or feeding children.
- Before and after coming in contact with an infected wound.

SAQ 3.6

Here are some of the elements and activities you should include in your plan for community hygiene promotion:

- Identify which components of personal hygiene need to be promoted.
- Identify the target audience.
- Prepare teaching and educational materials.
- Identify whom to involve in hygiene education.
- Engage actively in hygiene education.
- Identify indicators for monitoring and evaluation hygiene promotion performance.

SAQ 3.7

To monitor and evaluate the effectiveness of your promotion, you would need to identify indicators to show you if the performance of personal hygiene was correctly done or not. You would need to observe people's behaviour towards handwashing or ask them about their practice. If you can see that the household members are handwashing before and after critical times, i.e. good hygienic practice, then you could say your promotion had been successful. If not, and you observed poor hygienic practice by some people then you should consider how you might improve the situation. This might be more promotional work with the group of households, perhaps taking a slightly different approach if the initial training had had limited success.

Study Session 4

SAQ 4.1

The main factors leading to indoor air pollution are the structure and layout of the dwelling, the location of the fire and the type of fuel. If the fire is inside the living area of the house and there are no windows for ventilation, the air is likely to become polluted with smoke. The type of fuel is important because biomass fuels, such as animal dung, produce a lot of smoke, especially if they are not completely dry.

Smoke affects breathing and can lead to acute respiratory infections, bronchitis and chronic lung disease.

SAQ 4.2

Problem linked to housing	The basic requirements of healthful housing
Diarrhoea	Protection against infection
Lack of windows	Physiological satisfaction
No school in the village	Protection against psychological and social stress
Injury from falling	Protection against accident

SAQ 4.3

(a) Faeco-orally transmitted diseases. Examples: typhoid fever, acute watery diarrhoea. Poor housing may contribute to the spread of these diseases due to poor personal hygiene, absence of a latrine or poor utilisation of a latrine and poor waste management around the home.

(b) Droplet infections. Examples: TB, influenza, measles. Due to poor ventilation in the home and crowding as a result of limited housing space.

(c) Skin (contact) infections. Examples: scabies, ringworm. Due to crowding as a result of limited housing space.

(d) Vector-borne diseases. Examples: relapsing fever, typhus fever. Due to crowding, vectors such as lice can easily travel from an infected person to someone else nearby.

SAQ 4.4

The requirements for a model house are:

(a) It must be an adequate size depending on the number of people in the family.
(b) The window area to floor area proportion should not be less than 10%.
(c) The *tukul* must have partitions (sleeping, dining, kitchen and store rooms).
(d) The kitchen and animal sheds must be outside the main rooms.
(e) It must have a latrine and handwashing facilities.
(f) The kitchen has an improved stove with a chimney.
(g) The interior of the dwelling and the immediate environment is clean.

SAQ 4.5

Possible advice to give to Emebet would be:

(a) Separate the kitchen from the rest of the house.
(b) Install a window and open it while cooking.
(c) Have an improved stove with a chimney.
(d) Make sure that she uses dried dung and maize husk as they will burn more cleanly and not give off such harmful smoke as damp dung and husks.
(e) Make sure the children are not exposed to smoke during cooking.

SAQ 4.6

(a) Prepare a checklist and visit some *tukuls*. Fill in the checklist based on your observations. You will be able to judge the most common housing problems. You should then list all possible housing problems that could be shared in the community. Make priorities based on discussions with the community and local government staff. Check the availability of local materials and trained technicians that can carry out housing improvements. Design a plan of action for housing improvements and implement according to a schedule.
(b) The most important criteria are: size of a *tukul* based on family size; presence of partitions; presence of windows; presence of latrine; separated kitchen and animal sheds; presence of improved stoves.

Study Session 5

SAQ 5.1

Criteria	Parts of the school building
Physiological satisfaction	1 Window: facilitates good vision and ventilation 5 Smooth cleanable floor: avoids dust and vector breeding 4 Proper chairs and tables: facilitates proper sitting position
Disease prevention	3 Water: for drinking and handwashing for personal hygiene 6 Handwashing facility: for personal hygiene 7 Presence of latrine: for personal hygiene
Accident prevention	2 Tidy compound: no bushes that could harbour snakes and rats

SAQ 5.2

Your list may include kindergartens, 1st and 2nd cycle schools, junior high school, health posts, private clinics, mill house or possibly others.

SAQ 5.3

The health development of individuals, whether at home or in schools, prisons or other institutions, shares common needs. These are ensuring the physiological satisfaction, disease and accident prevention, and the psycho-social (mental) satisfaction in terms of the provision of basic hygiene and sanitation.

SAQ 5.4

The basic hygienic requirements of a school include: school compound cleanliness, proper solid waste management, access to safe and adequate water supply, access to adequate latrine provisions, classroom cleanliness, adequate lighting and ventilation, free from any external hazard such as noise, accident and pollution.

SAQ 5.5

Firstly, identify the number, type and location of the various different institutions in the *kebele.* Then, plan a schedule for visits and inspections of each institution in the coming year. This will require the preparation of checklists and arrangement with the heads of the institutions concerned. The visits are followed by writing and delivering feedback reports and discussing the findings with the relevant authorities. Finally, you should decide on possible follow-up activities such as meetings, hygiene education, mobilising resources etc.

SAQ 5.6

The inspection tools would include a checklist on which to note physical observations of the various aspects of the school environment. It could also be useful to interview the students and teachers and possibly use a questionnaire if a more thorough survey of personal hygiene was required.

Study Session 6

SAQ 6.1

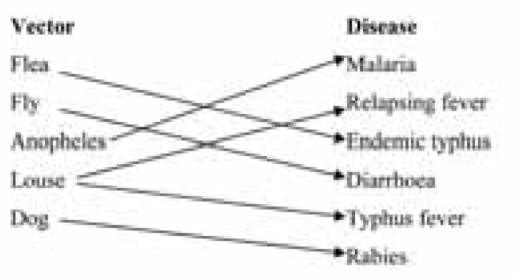
A is *false*. Insects have six legs and a body divided into head, thorax and abdomen. Arthropods are a larger grouping that includes insects but also includes many others such as arachnids and crustaceans.

B is true although diarrhoeal diseases can also be transmitted to humans by direct consumption of infected food or contaminated water.

C is *false*. Transmission by a biting insect is an example of biological transmission.

D is *false*. Fleas are the vectors of bubonic plague and their natural host is the rat. A person must be bitten by an infected flea to get the disease. Rats will eat stored food but that is not the mechanisms for transmitting bubonic plague.

SAQ 6.2



SAQ 6.3

Your answer will depend on the situation in your locality but may include poor personal hygiene (dirty clothing, unwashed body) for lice infestation; unclean floor, unplastered walls and poor ventilation for fleas; stagnant water for mosquitoes; cracks on the wall for bedbugs.

Possible checklist for vector assessment:

Name of vector	Breeding site	Number of affected households
Housefly		
Flea		
Louse		
Mosquito		
Rats		

SAQ 6.4

You may find the larva and pupa stages of *Anopheles* species in clean standing water; or *Culex* in dirty water.

SAQ 6.5

The most likely diseases are typhus fever and relapsing fever, both of which are transmitted by lice. The conditions inside a prison encourage the breeding and spread of lice because the inmates live in close proximity with each other and good personal hygiene may not be possible.

SAQ 6.6

Fresh dung (cow, ox, donkey, horse, mule), human excreta and decaying vegetables are all good organic matter that supports the breeding of houseflies. Diarrhoeal diseases are carried by flies.

SAQ 6.7

The first step in control of rats is to locate their breeding places and clean up any waste or debris that the rats are using for food or shelter. The aim is to starve the rats by removing their access to food sources and clearing any possible places of harbourage. Traps may also be useful. You may also have considered the use of rat poison as long as it is used with care.

SAQ 6.8

The key steps in your plan of action for vector management should be:

1 Identifying the type and magnitude of health problems caused by vectors.
2 Prioritising vectors and identifying their management/control options.
3 Identifying partners.
4 Implementing the plan of action.

Study Session 7

SAQ 7.1

- The diluted pineapple juice is potentially *contaminated*.
- The packet of tea with sand has been *adulterated* if the sand was added deliberately, or it could just be *contaminated*.
- The 100g packet of tea that only contained 70g was *misbranded*.
- The tilapia are *potentially hazardous*.
- The cooking oil is probably *contaminated*.

SAQ 7.2

Food hygiene means adopting practices and behaviours that protect food from being unsafe to eat. This is a very important aspect of public health because many diseases can be transmitted to humans via food that is unsafe.

SAQ 7.3

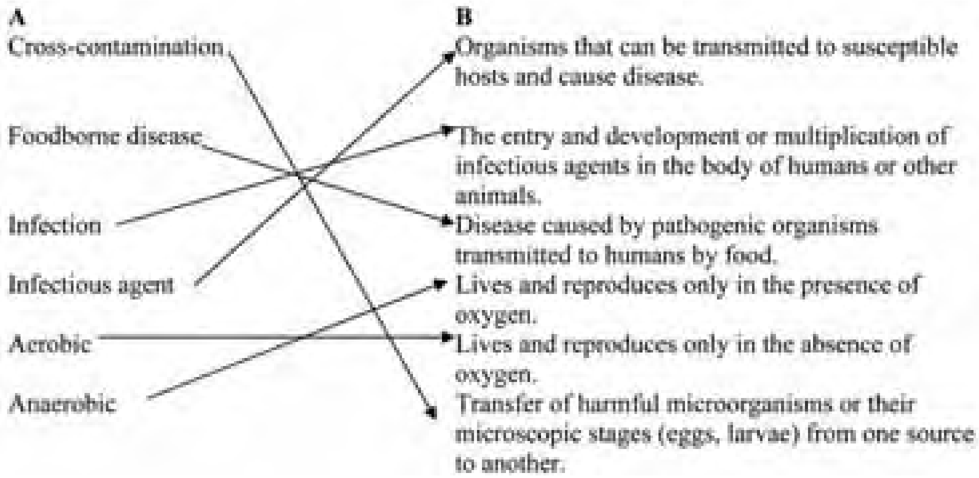
Food is essential to maintain all life processes i.e. for growth, tissue repair and all other physiological functions of the body. It also serves a social function in families and communities. Thirdly it can have an effect on the emotional feeling and psychological condition of an individual.

The first reason has to be the most important because we would die without food.

SAQ 7.4

Food control is the system that regulates the food industry by checking that food laws and regulations are followed. It is important to cover all stages in the food supply chain, from the producers on the farm, through all stages of processing and transport to the consumer where the food is eaten. This is important because food hazards may arise at any stage and, by monitoring the whole supply chain, preventive measures can be put in place at the appropriate point.

Study Session 8



SAQ 8.1

SAQ 8.2

Your plan should include the following points:

- Pathogenic microorganisms can cause foodborne illness when they contaminate the foods we eat.
- Pathogenic microorganisms which are transmitted through foods are serious public health problems, causing illness and death.
- These pathogens can grow and multiply in food items where there are favourable conditions including high moisture content (a_W), a neutral pH, available nutrients and a favourable temperature.
- There are many routes for food contamination, such as the food handler's personal hygiene, the cleanliness of utensils, and the ways of storing cooked and raw foods.

SAQ 8.3

You might suspect that the food handlers who prepare and serve food have been infected and have transmitted the infection through food to healthy people. Alternatively the food handlers' personal hygiene is so poor that transfer of pathogens to food items occurs often. The food might have become contaminated with chemicals like pesticides during transport, storage and preparation, or there may have been accidental or deliberate chemical contamination of food items.

Hence you should tell them how they can prevent their foods from any contamination by avoid cross-contamination, using correct food storage practice, frequent hand washing by food handlers, thorough cooking, separating raw from cooked food and avoiding coughing and sneezing over food.

SAQ 8.4

The two peppers look different because one has been spoiled by enzyme reactions, which have also allowed moulds to grow on the fruit. Enzymes are important to the normal functioning of living cells, but after the pepper is harvested and stored autolytic enzymes begin to spoil it.

Study Session 9

SAQ 9.1

Diseases caused by food infection result from ingestion of food that has been contaminated by microorganisms including bacteria, viruses, parasitic organisms and fungi.

Diseases caused by food poisoning result from ingestion of food that has been contaminated by a toxin or poison which may be of chemical or biological origin.

SAQ 9.2

There are many possible factors you may have identified including:

- Poor personal hygiene by food handlers.
- Dirty kitchen utensils and work surfaces
- Eating food that has been contaminated by washing with unsafe water.
- Poor storage of food so flies and other disease vectors can come in contact with it.
- Inadequate cooking or reheating of food.

SAQ 9.3

Typhoid fever, shigellosis and cholera are all bacterial foodborne infections. Amoebiasis is a parasitic infection.

SAQ 9.4

The first step would be to gather information about the outbreak. You would need to find out exactly how many people were affected, what their ages were and whether they were male or female. You would need to confirm that they had all been together at the wedding ceremony and ask what they had eaten and when they each became ill.

You may also need to consider further steps such as taking samples from the patients or samples of food.

Study Session 10

SAQ 10.1

Food *protection* is the set of methods used to prevent food from being contaminated.

Food *preservation* is the process of treating the food so that it can be kept unspoiled for a long time.

SAQ 10.2

Work surfaces need to be kept free of dirt and scraps of food, and out of reach of pets, rodents and insects. This is so that possible causes of microbial contamination are removed and food can be placed on the surfaces without danger to its quality.

SAQ 10.3

Fruit should be washed thoroughly in safe water.

Meat should be cooked at a temperature greater than 70°C, for as long as it takes to cook the inside properly – this depends on the exact temperature and the size of the meat pieces. It should be eaten as soon as cooked, or kept at above 60°C if there is a delay before it is eaten.

SAQ 10.4

After any interruption in the food preparation process, Emebet should wash her hands, even if she has not touched the dog. She is likely to have touched other contaminated surfaces and microorganisms could be transferred on to the food by her hands if she does not wash them.

SAQ 10.5

If meat cannot be kept chilled it could be smoked over a fire, or salted by rubbing in dry salt or by soaking the meat in brine. These methods will keep the meat safe for several days.

SAQ 10.6

A is *false*. For salting and sugaring to be effective food preservation techniques, a concentrated solution must be used and maintained.
B is *false*. Pasteurisation is a controlled process in which milk is heated to a specific temperature, not to boiling, for a specific time and then cooled quickly. It will kill most microorganisms but cannot be guaranteed to kill all.
C is true. Bulging or swollen cans indicate that gas is being produced inside by microbial activity.
D is *false*. Preservation by fermentation relies on the presence of acid or alcohol.

Study Session 11

SAQ 11.1

Butcher: raw meat

Tea house: plain bread or chornake

Restaurant: tibs for lunch

Hotel: bedrooms

SAQ 11.2

There are several important points to consider when conducting an inspection: condition of buildings, cleanliness of food handling areas, personal hygiene of food handlers, waste disposal, and of course sanitary and washing facilities. You should inspect all of these, but depending on what you find (or what you found if you have inspected this establishment before), you may wish to focus particularly on any one of these if there is a cause for concern.

SAQ 11.3

The points you should check with the food handlers are:

- Hair hygiene and hair cover
- Use of apron, gown or overalls
- Fingernail hygiene
- Hand hygiene
- Presence of active infections.

The first two items could be checked simply by looking from a distance. You would have to examine the food handler's hands closely to assess the condition of their hands and finger nails, and you should check with them (by interview) that they wash their hands before handling food, and after any interruption. To check for active infections you need to look closely at their skin, and check for eye, ear or nose discharges. Can you see or hear them sneezing or coughing? During your interview with them, ask them whether they have diarrhoea, and whether they understand that if they have any infections they should not be handling food.

SAQ 11.4

The sanitary facilities that should be available for the staff are a handwashing station, latrine, shower, and clothes changing cabinet. Additionally there should be one handwashing station and latrine for every 30 clients. Since the tea house can have 50 or more clients at busy times there should be two latrines and handwashing stations. It is better to have separate men's and women's facilities.

Study Session 12

SAQ 12.1

Kosso is a tree (*Hagenia abyssinica*) whose leaves contain a taeniacide (tapeworm-killing agent). It is also the common Ethiopian name for the tapeworm disease that occurs through eating raw beef.

SAQ 12.2

Raw beef could be infected with *Taenia saginata* and people who eat it could get beef tapeworm disease. Raw meat should not be eaten, but risks can be minimised by only eating meat from cattle that have been kept on pasture free of faeces or other contaminants. The cattle should then be slaughtered in a licensed abattoir where the meat is inspected and stamped as safe. The meat should be transported and stored hygienically unit it is eaten.

SAQ 12.3

Animals should be inspected before and after slaughter at the abattoir. Live animals should be observed for any signs of illness. Animal carcasses should be closely examined by experienced inspectors who can identify the visible signs of contamination such as tapeworm cysts. If the meat is healthy it will be marked with an indelible stamp to indicate it is safe for human consumption. The inspection process is important to ensure the health of anyone who eats the meat and to prevent the spread of disease.

SAQ 12.4

(a) Fish should be eaten as soon as possible after it is caught. If it needs to be kept, it should be chilled until use or kept as cool as possible.

(b) The fish should be examined for signs of freshness. Fish that is safe to eat is free of slime and odour. The body should be stiff and the eyes convex and clear. The gills should be closed and the scales should not be falling off. If the fish sinks in water it is probably safe to eat.

SAQ 12.5

Your brother should be advised to keep his cows clean and healthy, in a hygienic environment. He must milk the animals in a clean place, wiping the udder and teats before he starts and using disinfected utensils. He must only milk the cows if he is healthy and clean himself. After milking, the milk should be kept cold and sold as quickly as possible.

SAQ 12.6

There are many possible causes of coughing as a common problem in a community so you should consider other possible options, as well as the raw milk. Raw milk is a source of many diseases that affect the lungs, including TB, brucellosis and Q fever. This community should not drink raw milk but should treat it in some way. If there is no local treatment plant available, they should boil the milk for 30 minutes, then cool it quickly and keep it cold until it is drunk. They may not want to comply with this as boiling alters the flavour of the milk, but it does destroy the pathogens so is better for them.

SAQ 12.7

Poultry and their eggs should only be eaten if the animals are healthy. The sick animals should not be eaten, but should be disposed of by burning the carcasses. Good attention must be paid to the cleanliness of the poultry coops, and handlers should avoid approaching healthy birds after handling sick ones. Veterinary care should be given to the chickens if possible.

Federal Democratic Republic of Ethiopia
Ministry of Health

Hygiene and Environmental Health, Part 2

Blended Learning Module for the Health Extension Programme

HEAT
Health Education and Training
HEAT in Africa

unicef
unite for children

The Open University

AMREF
Better Health for Africa

Acknowledgements

Hygiene and Environmental Health is one of the 13 Blended Learning Modules for the Ethiopian Health Extension Programme. Together with the practical skills training sessions that accompany each of the supported self-study texts, this programme will upgrade the Health Extension Workers who complete the curriculum to Health Extension Practitioners at Level-IV of the Ethiopian Occupational Standards. The upgrading programme is sponsored by the Ethiopian Federal Ministry of Health (FMOH) and the Regional Health Bureaus (RHBs). The FMOH gratefully acknowledges the receipt of funding for this programme from the Ethiopian Office of UNICEF (the United Nations Children's Emergency Fund), The Open University UK, the Alan and Nesta Ferguson Foundation Trust UK, and AMREF (the African Medical and Research Foundation).

Hygiene and Environmental Health is in two separate Parts and was produced by a team of Ethiopian experts, who were trained and supported by experts in blended learning pedagogy from the HEAT (Health Education and Training) Team for Africa at The Open University UK. The contributors of original material are:

Dr Zegeye Hailemariam, Ethiopian Health and Nutrition Research Institute

Dr Abera Kumie (Module Academic Coordinator), Addis Ababa University, School of Public Health

Ato Worku Tefera, Addis Ababa University, School of Public Health

The Academic Editors of *Hygiene and Environmental Health* are Pam Furniss, Senior Lecturer in Environmental Systems in the Faculty of Mathematics, Computing and Technology, and Dr Sarah-Jane Davies, Lecturer in Environmental Sciences in the Faculty of Science, with contributions from Dr Hilary MacQueen, Dr Basiro Davey, Dr Stephen Burnley and Dr Suresh Nesaratnam, all at The Open University UK. The other members of the HEAT Team are:

Lesley-Anne Long, HEAT Programme Director

Dr Basiro Davey, HEAT Deputy Director (Ethiopia)

Alison Robinson, HEAT Programme Coordinator

Dawn Partner, HEAT Senior Production Assistant

Jessica Aumann, HEAT Programme Assistant

Ali Wyllie, HEAT Lead eLearning Adviser

We acknowledge the vital contributions of the Programme Coordinators within Ethiopia:

Ato Mohammed Hussein Abeseko, UNICEF Ethiopia and the Federal Ministry of Health

Ato Tedla Mulatu, AMREF Ethiopia

The cover design for *Hygiene and Environmental Health* is by Chris Hough, Learning and Teaching Solutions, The Open University UK. The cover illustration (large circle) and some other illustrations in this Module were produced by Terefe Wondimagegnehu from the Federal Ministry of Health. The small cover photo is reproduced with the permission of UNICEF Ethiopia.

We particularly wish to acknowledge our use in this Module of photographs supplied by WaterAid in Ethiopia and adapted extracts and illustrations from the following sources:

Bassett W.H. (ed.) (2004) *Clay's Handbook of Environmental Health* 19th ed, London, Spon Press.

Eawag: Swiss Federal Institute of Aquatic Science and Technology http://www.eawag.ch/index_EN

International Federation of Red Cross and Red Crescent Societies (2008) *Household water treatment and safe storage in emergencies. A field manual for Red Cross/Red Crescent personnel and volunteers*.
http://www.wsscc.org/sites/default/files/publications/ifrc_hwts_in_emergencies_2008.pdf

Stockholm Environment Institute (2007) *Toilets that make compost: Low-cost, sanitary toilets that produce valuable compost for crops in an African context*, by Peter Morgan, Stockholm Environment Institute, EcoDSanRes programme.
http://www.ecosanres.org/pdf_files/ToiletsThatMakeCompost.pdf

Sustainable Sanitation Alliance (SuSanA) (2007) *Fura kebele declared open defecation free environment*. http://www.susana.org/docs_ccbk/susana_download/2-297-open-defecation-free-environment-ethiopia-en.pdf

UNICEF (2009) *Community Approaches to Total Sanitation, Field Notes*.
http://www.unicef.org/evaluation/files/CATS_field_note.pdf

University of California Regents, Dermatology Glossary.
http://missinglink.ucsf.edu/lm/DermatologyGlossary/index.html

USAID/HIP (2007) *Preparing for Community-led Total Behaviour Change in Hygiene and Sanitation*. http://www.aed.org/Publications/upload/Health-Extension-Worker-Handbook.pdf

WaterAid in Ethiopia (2007) *The colour of change*.
http://www.wateraid.org/documents/plugin_documents/the_colour_of_changeweb.pdf

WHO (1994) *Health Laboratory Facilities in Emergency and Disaster Situations*.
http://helid.digicollection.org/en/d/Jh0193e/16.7.html

WHO (1996) *Participatory hygiene and sanitation transformation: A new approach to working with communities*. http://www.who.int/water_sanitation_health/hygiene/envsan/phast/en/

WHO (1997) *Vector control: Methods for use by individuals and communities*.
http://www.who.int/water_sanitation_health/resources/vectorcontrol/en/index.html

WHO (1997) *Guidelines for drinking water quality, Volume 3 Surveillance and control of community supplies*. http://www.who.int/water_sanitation_health/dwq/gdwq2v1/en/index2.html

WHO (1998) *Participatory Hygiene and Sanitation Transformation (PHAST) Step-by-step Guide: A Participatory Approach for the Control of Diarrhoeal Diseases*.
http://www.who.int/water_sanitation_health/hygiene/envsan/phastep/en/

WHO (2003) *Malaria entomology and vector control*.
http://whqlibdoc.who.int/hq/2003/WHO_CDS_CPE_SMT_2002.18_Rev.1_PartI.pdf

WHO and IRC Water and Sanitation Centre (2003) *Linking technology choice with operation and maintenance in the context of community water supply and sanitation: A reference document for planners and project staff*, by F.Brikke and M.Brodero.
http://www.bvsde.paho.org/bvsacd/cd41/agua.pdf

Contents

Study Session

Study Session 13 Provision of Safe Drinking Water

Introduction

Water is essential for life. An adequate, safe and accessible water supply must be available to all people, and improving access to safe drinking water can result in tangible benefits to health. Water is one of the factors which contribute to the transmission of many diseases. In this study session, you will learn and understand about the public health importance of water, the water (hydrological) cycle, the basic requirements for a safe, adequate and accessible drinking water supply, and the obstacles to safe water provision. You will also learn about different indicators for safe, adequate and accessible water supply. This study session will help you to recognise the basic requirements for safe water supply and to understand the transmission of waterborne diseases.

Learning Outcomes for Study Session 13

When you have studied this session, you should be able to:

13.1 Define and use correctly all of the key words printed in **bold**. (SAQs 13.1 and 13.3)

13.2 Describe the various types of disease associated with water. (SAQ 13.2)

13 3 Describe the hydrological cycle. (SAQ 13.3)

13.4 List and describe the basic requirements for safe, adequate and accessible drinking water. (SAQ 13.4)

13.5 Identify the groups of people who are particularly vulnerable to the lack of provision of safe water. (SAQ 13.5)

13.6 Describe the barriers to the provision of safe water. (SAQ 13.6)

13.1 The public health importance of water

We begin this study session by describing the public health significance of water. A satisfactory water supply must be available to all humans. By ‘satisfactory’ we mean water must be available in adequate quantity, be safe to drink and be accessible. Improving access to safe drinking water can result in tangible benefits to health so every effort should be made to achieve drinking water quality that is as safe as is practicably possible.

The great majority of water-related health problems are the result of microbial (bacteriological, viral, protozoan or other biological) contamination. Infectious waterborne diseases such as diarrhoea, typhoid and cholera are leading causes of death and illness in the developing world. There are many diseases associated with water, which can be classified as waterborne, water-washed, water-based and water-related (Box 13.1).

Box 13.1 Diseases associated with water

Several terms are used to describe the types of disease associated with water. These are:

- **Waterborne diseases** are those caused by ingestion of water that is contaminated by human or animal excrement and contains pathogenic microorganisms. Transmission occurs by drinking contaminated water. Waterborne diseases include most of the enteric and diarrhoeal diseases caused by bacteria and viruses, including cholera, typhoid and bacillary dysentery. They also include diseases caused by protozoa (single-celled microorganisms) such as giardiasis, amoebic dysentery and cryptosporidiosis.
- **Water-washed diseases** are caused by poor personal hygiene, and skin and eye contact with contaminated water. They are also sometimes known as water-scarce diseases because they occur when there is not enough water available for adequate personal washing. They include scabies, trachoma, typhus, and other flea, lice and tick-borne diseases.
- **Water-based diseases** are caused by parasites that spend part of their lifecycle in water. For example, schistosomiasis and dracunculiasis are both water-based diseases caused by helminths (parasitic worms). Schistosomiasis (also known as bilharzia) is caused by a worm that spends part of its lifecycle in the body of a particular species of water snail. People can become infected from swimming or wading in infected water. Dracunculiasis or guinea worm is transmitted by drinking water that is contaminated with copepods (very small crustaceans) that contain the larvae of the worm.
- **Water-related diseases** are caused by insect vectors, especially mosquitoes, that breed or feed near water. They are not typically associated with lack of access to clean drinking water or sanitation services. Water-related diseases include dengue fever, filariasis, malaria, onchocerciasis, trypanosomiasis and yellow fever.

Note that, rather confusingly, the term ‘water-related’ is sometimes used to mean all the above, i.e. all diseases associated with water.

Chemical contamination of water is another potential cause of health problems. In some places, water may contain naturally occurring toxic chemicals such as arsenic and fluoride. Other chemicals may get into the water supply because of pollution. Lead poisoning, for example, can result from water contaminated with lead. These diseases are also classified as waterborne diseases.

Safe water is water which is free from disease-causing agents and does not have any significant risk to health over a lifetime of consumption. The term **potable water** is also sometimes used; ‘potable’ means safe to drink. A related but different term is **palatable water**, which means water that is pleasant to drink. Palatable water is at a desirable temperature, completely transparent and free from tastes, odours and colours, but is not necessarily free from disease-causing agents. Safe drinking water is suitable for all usual domestic purposes, including personal hygiene. Access to safe and affordable water is considered to be a basic human right.

Many million individuals in Ethiopia have to get their water from unsafe sources and this makes them vulnerable to waterborne disease. Figure 13.1 shows the relative proportions of people in Ethiopia with access to improved and unimproved sources (see also Box 13.2).

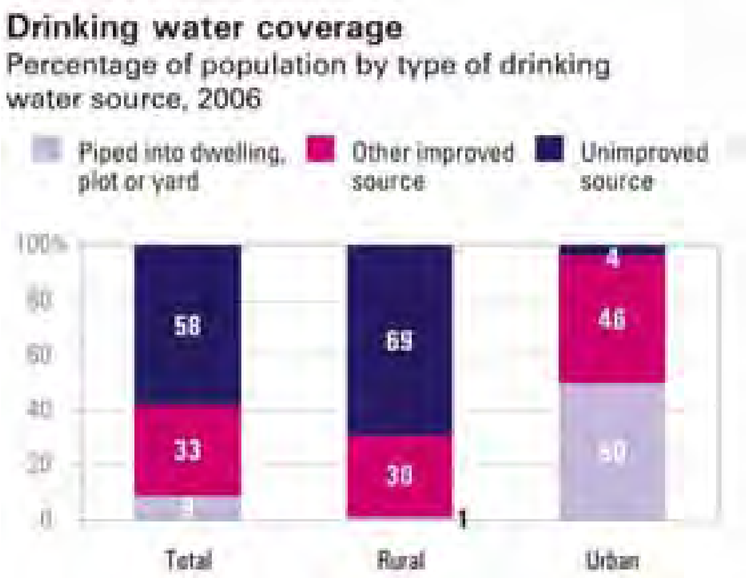


Figure 13.1 Drinking water sources for the population of Ethiopia. (Source: WHO/UNICEF JMP, 2008)

- ■ Look at the bar graph in Figure 13.1. What proportion of the rural population in Ethiopia obtains their water from unimproved sources? And what proportion of the urban population?
- □ 69% of the rural population and 4% of the urban population get their water from unimproved sources.

Box 13.2 Water sources

Water source simply means water in its natural environment that is used by people to meet their need for water. Common water sources are groundwater, surface water such as rivers and lakes, spring water, and rainwater.

Water sources can be described as protected or unprotected. **Unprotected sources** are those where there is no barrier or other structure to protect the water from contamination. **Protected sources**, on the other hand, are covered by stonework, cement or other material that prevents the entry of any physical, chemical or biological contaminant. Water from a protected source is likely to be safe to drink but water from unprotected sources cannot be considered safe.

The terms *improved* and *unimproved* sources may also be used, as in Figure 13.1. These terms are broadly equivalent to *protected* and *unprotected*. Improved drinking water sources include household connections, public standpipes and water points, boreholes, protected dug wells, protected springs and rainwater collections. Unimproved water sources include rivers, lakes, unprotected wells and unprotected springs.

- ■ Using the data in Figure 13.1, in general terms, what *fraction* of the rural Ethiopian population uses an unimproved water source?
- □ 69% of rural people use an unimproved water source. This is roughly equivalent to two-thirds of the population (two-thirds equals 66.7%).

The provision of safe water and sanitation is not only essential for disease prevention, it is also a key mechanism required to break the cycle of poverty, particularly for women and girls. Lack of access to water may limit the use of latrines because the need for handwashing creates an additional water requirement and therefore an additional burden on the person responsible for collecting water. With improved access to safe water, women and girls have more time to tend to crops and livestock, more time and resources to spend on improved food preparation, more time to attend school, and an opportunity to participate in the local economy. These are all mechanisms for breaking the cycle of poverty.

13.2 The uses of safe water

13.2.1 For drinking

All individuals need water for drinking every day. Inadequate consumption of water, either by drinking or through food, can lead to dehydration of the body and ultimately to death. The water requirement of individuals for drinking and food preparation will vary according to diet, climate and the type of work they do. Pregnant women and breastfeeding mothers need more water than other people. The minimum amount of water needed for survival ranges from about 2 litres **per capita** per day in temperate climates to about 4.5 litres for people in hot climates who have to carry out manual work.

Per capita means per person or per head of population

13.2.2 For food preparation and cooking

Water is an ingredient of many foodstuffs and is also needed for food hygiene to make certain that food is safe to eat. Most people need at least 2 litres of safe water per day for food preparation.

13.2.3 For hygiene

Providing safe water and encouraging people to practise good hygiene will achieve massive health benefits. For example, the *Shigella* bacterium causes dysentery or bloody diarrhoea and it is a major contributor to the millions of water-related deaths each year. However, the simple step of washing hands with soap and water will significantly reduce shigellosis and other diarrhoeal diseases. Moreover, providing clean water for washing can prevent trachoma, which is the leading cause of preventable blindness.

- ■ Why is hand hygiene so important for reducing communicable diseases?
- □ Our hands can be soiled by many different contaminants, for example, while visiting a toilet, during farming activities, cleaning children's bottoms and so on; hence washing hands with soap and water is very important.

13.3 The hydrological cycle

Water is in plentiful supply on our planet but most of it is not available for human use. Over 97% of the world's water is in the oceans and is salty. Fresh water, found in rivers, lakes and within the ground, accounts for less than 1% of the total (Figure 13.2). It is not distributed evenly around the world. There is a surplus in some places and scarcity in others.

Figure 13.2 Components of world water storage. The sizes of the segments in the circles represent the relative volumes of water in each category. (Source: The Open University)

Water is in continuous motion in a series of processes called the **hydrological cycle** or **water cycle** that governs the health of the planet. (Hydrology is the study of water, hence the alternative name for the water cycle.) Figure 13.3 shows a diagram of the water cycle. Without continuous evaporation from the oceans, precipitation on land and runoff back to the oceans, there would be no recharge (replacement) of surface and groundwater.

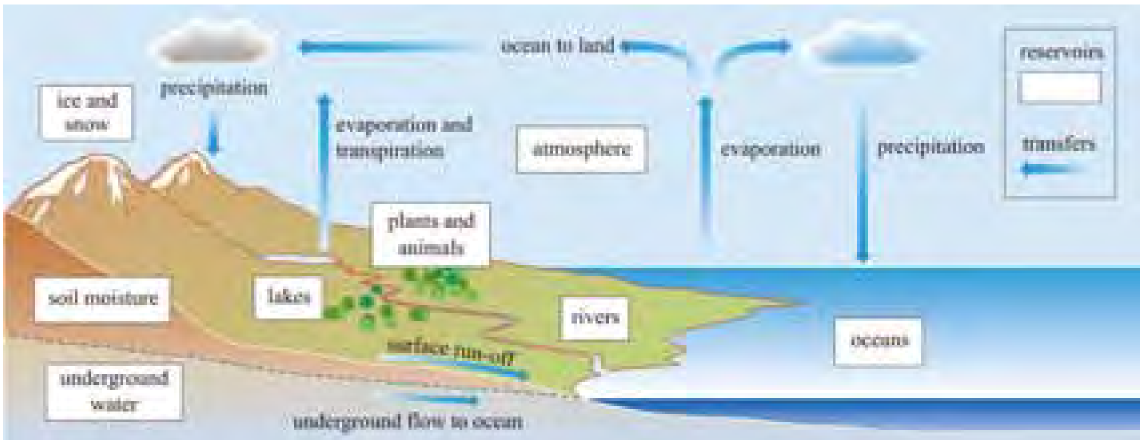


Figure 13.3 The hydrological cycle. (Source: The Open University)

There are several important terms here that need explanation. **Evaporation** is the change from a liquid to a gas. When the sun shines on the surface of water, water molecules evaporate from the water body into the atmosphere above. **Precipitation** simply means water falling from the atmosphere to the Earth's surface; mostly this means rain, although it also includes snow. **Runoff** includes all water that flows, under the force of gravity, across land in streams and rivers and across the surface, for example, of a field. **Groundwater** includes all water that is found underground within the rocks; some groundwater may be near the surface and some may be deep underground.

In Figure 13.3, the transfers (the movements or flows) of water are shown as arrows and the reservoirs (stores) as boxes. Note that the word 'reservoirs', in general speech, refers to artificial lakes that have been constructed to store water at the surface. In the context of the water cycle and hydrology, **reservoir** means all stores of water. Another term included in Figure 13.3 is **transpiration**, which is the release of water vapour (water as a gas) from plants and soils into the atmosphere. Evaporation and transpiration are sometimes referred to together as *evapotranspiration*.

13.4 Criteria for satisfactory water

- ■ What are the three main criteria for 'satisfactory' water supply?

- □ Satisfactory water means water that is available in adequate quantity, is safe to drink and is accessible.

Human beings have a right to have clean, safe water. Several criteria need to be satisfied to ensure that the people in your community have satisfactory access to water. These are discussed below.

13.4.1 Sufficient quantity

According to international and national guidelines, the quantity of water available in each household should be 50–100 litres per person per day, or an absolute minimum of 20 litres. In practice, the amount of water collected every day by households is considerably less than this and is largely determined by the distance of the source of water from the home. If the water source is outside the home, but within around 1 kilometre (or 30 minutes total collection time), about 20 litres per person per day will typically be collected.

Where water is supplied through a single tap within the confines of the household's living area, the water used is typically about 50 litres per person per day. At this level it is much easier to ensure good hygiene. For example, households may use 30 times more water for child hygiene compared with those who have to collect water from a communal source. Households that do not have to travel to collect water have more time for economic activity, food preparation, child care and education. Having access to a greater volume of water potentially encourages handwashing, general physical cleanliness and improved living conditions.

13.4.2 Safe and acceptable

Water must be safe for drinking and other household uses. Drinking water must be free from microbes and parasites, and free from chemical and physical contaminants that constitute a danger to a person's health. It must also be acceptable in terms of colour and odour.

- ■ The two photos in Figure 13.4 were taken at the same place. Do you think that water from the river in Figure 13.4 would be safe to drink? Is this an example of a protected or unprotected source?

- □ This river is likely to be contaminated with animal dung, urine and possibly other pollutants. It is not advisable to use this water for drinking and cooking without any treatment. The river is an unprotected source; there is nothing to protect the water from contamination.

Figure 13.4 Animals come to the river to drink at the same place as the women collect the water. (Photos: Nancy Platt, Pam Furniss)

13.4.3 Physically accessible

Water must be within safe physical reach, in or near the house, school or health facility. Accessibility to safe water can be classified as follows:

No access. You would say people do not have access to safe water when:

- The distance to the water source is more than one kilometre or more than a 30-minute round trip.
- The amount of water collected is very low (often below 5 litres per capita per day).

Basic access (see Figure 13.5). You would say people have a basic level of access to safe water when:

- The water source is within one kilometre/30-minute round trip.
- The amount of water to be collected on average is unlikely to exceed 20 litres per capita per day.

Figure 13.5 Public water point – an example of basic access, assuming the user lives within one kilometre distance. (Photo: Pam Furniss)

Intermediate access (see Figure 13.6). You would say people have an intermediate level of access to safe water when:

- Water is provided onsite through at least one tap (at yard level).
- Average volume of water collected is approximately 50 litres per capita per day.

Figure 13.6 Provision of safe water for a household with a single tap – an example of intermediate access. (Photo: Richard Adam)

Optimal access. You would say people have optimal access to safe water when:

- Supply of water is through multiple taps within the house.
- Approximately 100–200 litres per capita per day or more is available.

■ Earlier in this session it was said that the daily minimum water requirement was between 2 and 4.5 litres per person per day according to climate conditions. Why does this differ from any of the average consumption figures quoted above?

□ Because the average consumption refers to water used for all household purposes including washing, cooking and cleaning as well as drinking and eating. The requirement of 2 to 4.5 litres per person per day is the volume of water that must be *consumed* by a person to survive.

13.4.4 Affordable

As well as being physically accessible, water should also be reasonably priced and affordable for everyone. Buying water should not reduce a person's capacity to buy other essential goods. This means that essential amounts of water must sometimes be provided free according to the socioeconomic strength of the communities. Ensuring the affordability of water requires that services match what people can pay. For example, in most rural communities of Ethiopia protected water sources are freely provided by the government and other organisations.

13.5 Vulnerability due to lack of satisfactory water provision

As you know, the poor are among those most directly affected by unsafe water. They are not only less likely to have access to safe water and sanitation, but they are also less likely to have the financial and human resources to manage the impact of this deficiency. The majority of those who have no access to improved sources of drinking water are the rural poor. This lack of access is reflected in the day-to-day investment of time to collect water which means that women, in particular, do not have time for productive activity, for household tasks, for childcare or for education.

As well as the dangers arising from using water from unprotected sources, women's health may also be affected by the heavy burden of carrying water because carrying heavy loads may cause spinal injuries. Furthermore, women who collect water may be physically attacked while performing this task. Women also suffer from the lack of appropriate sanitation facilities. When there is little privacy or security for them, women and girls have to go into an inappropriate location where they may risk being attacked. Water facilities and services must be culturally appropriate and sensitive to gender, and privacy requirements.

Infants and children are particularly vulnerable to the lack of safe water provision. Lack of accessible safe water increases their vulnerability to diseases. Their immune systems are not fully developed and may not be able to respond to a water-related infection. They also have less body mass than adults, which means that a waterborne chemical may be dangerous for a child at a concentration that is relatively harmless for an adult. Children often share with women the responsibility for fetching water. This means they may miss school and it can affect their health and put them, especially girls, at risk of harassment. Other groups who may be more vulnerable to a lack of safe water include people who are ill or debilitated in some way because their immune system may already be weakened. The elderly may also be at greater risk.

13.6 Future impacts on provision of water

13.6.1 Population dynamics

Rapid population growth puts increasing pressure on our limited resources. The percentage of young children is increasing within the Ethiopian population. In 2007, a Central Statistics Agency report estimated the Ethiopian population as 73 million, of whom about half are under 15 years of age. This means an increase in the proportion of the total population at highest risk from infectious waterborne diseases (gastrointestinal illnesses disproportionately affect the health of the very young and very old).

The general increase in population means that more and more land is brought into use to support the growing number of people. This can have a serious impact on the environment and also on water resources. There is a close relationship between land use, and water quality and quantity. If land is cleared of natural vegetation, water will run off the surface more quickly and will not soak into the soil. This not only reduces the amount of soil water available for plant growth it also reduces replenishment of groundwater reservoirs. The water flows off into rivers before it has penetrated into the ground. The increased runoff resulting from loss of vegetation also causes soil erosion, especially in the rainy season, because the soil is washed away into the rivers. Erosion is especially likely on slopes and where the ground is ploughed, which loosens the surface layers. The eroded soil particles run off into the rivers and make the water very turbid (muddy). The loss of natural vegetation, especially forest, also means a loss of biodiversity, i.e. a reduction in the number of different types of living organisms of all types that exist in an area.

13.6.2 Poverty

Poverty is a major cause of public health problems in Ethiopia. Although we hope this will change, in reality it is likely that poverty will be a problem in the future as well. Poverty makes it difficult for people to access safe water and find solutions for the sanitation problems in the country. Lack of resources, lack of education and limited political, social and economic influence all have a significant impact on the provision of safe water.

13.6.3 Climate change

Climate change is the name given to the long-term change in global weather patterns caused by human activities. It is a global problem and its effects may not be easy to see at a local level. However, it may have an increasingly important impact on the future provision of safe water and therefore on human health and safety. The effects of climate change could include more frequent and intense rainfall events that can mobilise disease-causing organisms and other contaminants. It could also mean increased frequency and magnitude of flood events which would affect the availability of clean water. On the other hand, it could also mean reduced rainfall. Climate change could have profound impacts on the burden of illness associated with waterborne diseases. Increasing water shortage will lead to an increase in sickness and death amongst the populations of developing countries. In Ethiopia, although it is difficult to make exact estimates of the impacts of climate change, declining rainfall could lead to reduced water sources and depleted groundwater, climate sensitive disease could increase, and food insecurity could become an increasing problem.

13.6.4 Globalisation

Today's world is becoming a big village in which people are increasingly mobile and goods and materials are transported further and faster. Globalisation has both advantages and disadvantages. Infectious and vector-borne diseases associated with water are moving from place to place in a shorter time, and pathogens and vectors can also travel around the globe.

13.7 Major barriers to the provision of safe water

Capacity and finance are the main factors that prevent the effective provision of water. *Capacity*, in this context, means having the ability to do something. It can be described in terms of the human, technological, infrastructural, institutional and managerial resources required at all levels from the individual through to national governance. Capacities have to be built within each of these levels and they should be institutionalised, meaning formal organisational structures will be needed to bring about effective change. Individuals and groups of people can act together informally but this is less likely to succeed. Local communities need to be empowered to build their capacity and use infrastructure effectively, or the provision of safe water will be difficult.

13.7.1 Lack of community capacity and engagement

Engagement of local people is essential for finding sustainable solutions and increasing the chances of long-term success. People need to be made aware of the possibilities and have the autonomy to create their own favourable conditions within the community. For example, they need to identify their own problems, prioritise them and put forward their own solutions. Considering cultural and societal norms of the community, the involvement of influential people, and the collaboration of local institutions and organisations are important. The participation of women is especially important to improve the success of project outcomes.

13.7.2 Lack of technological capacity

Technological capacity includes both existing and new technologies. The provision of water and sanitation could be significantly improved with the wider application of existing technologies, if other constraints could be overcome. These benefits could be extended even further with the development and application of new technologies that help specifically with the provision of safe water at household and community level. These technologies need to be user-friendly and designed so it is easy to understand how they should be effectively constructed, operated and managed.

13.7.3 Lack of institutional capacity

Collaboration between different sectors of the population is required to plan and implement actions in a coordinated way. For example, the health sector, agricultural sector and local administrators should all work together. This collaboration is the basis for multi-sectoral approaches to ensure that planned goals are achieved to solve environmental, water and health problems.

13.7.4 Insufficient financing

A lack of global investment in water and sanitation has limited the attainment of the Millennium Development Goals (MDGs). The United Nations MDGs, set in 2000, consist of eight goals for international development. Goal 7 is to ‘ensure environmental sustainability’ and within that, target 7c is to ‘halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation’.

Good progress has already been made towards meeting this goal in some parts of the world but there is still a long way to go, especially in sub-Saharan Africa. Water and sanitation continue to suffer from severe underfunding. At a local level, the potential sources of finance are government, non-governmental organisations and others. You can try to make a difference firstly by understanding who these different potential sources of funds are and then working with your colleagues and others in the community to seek financial support.

Summary of Study Session 13

In Study Session 13, you have learned that:

1. Water is essential to sustain life and a satisfactory (adequate, safe and accessible) water supply must be available to all human beings.
2. Waterborne, water-washed, water-based and water-related diseases are the four main types of disease associated with water.
3. Water is in continuous motion by the processes of the hydrological cycle.
4. Improved access to clean water can reduce diarrhoea and waterborne diseases. The provision of safe water and sanitation is a key mechanism required to break the cycle of poverty, particularly for women and girls.
5. Sufficient, physically accessible, affordable and safe water are the main criteria for measuring whether your locality has satisfactory water provision or not.
6. Your local community's access to water can be assessed as no access to water, basic access, intermediate access or optimal access.
7. The poor, women and children, and people who are sick or elderly are more vulnerable to lack of safe, adequate and accessible water.
8. Rapid population growth, poverty, climate change and globalisation are likely to have negative impacts on the provision of safe, adequate and accessible water.
9. Capacity and finance are the major barriers that inhibit the enhancement of provision of safe, adequate, affordable and accessible water supply.

Self-Assessment Questions (SAQs) for Study Session 13

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 13.1 (tests Learning Outcome 13.1)

Match the words in list A with the definitions in list B by drawing an arrow between them.

A	B
Accessible	Provision of water without payment or at a low price
Safe	Water free from disease-causing organisms or contaminants
Affordable	A minimum of 20 litres per person per day
Adequate	The source of water is near to one's house

SAQ 13.2 (tests Learning Outcome 13.2)

Which of the following statements is *false*? In each case, explain why it is incorrect.

A Water-washed diseases are caused by drinking water that has been contaminated with pathogens.
B Diarrhoea and typhoid fever are diseases that occur when water is scarce.
C Children may become infected with bilharzia if they swim and play in lakes where there are many snails.
D Malaria is an example of a waterborne disease.

SAQ 13.3 (tests Learning Outcomes 13.1 and 13.3)

Rewrite the paragraph below using terms from the list provided to fill the gaps.

The terms to use are: atmosphere; evaporation; hydrological cycle; ocean; precipitation; surface runoff; transpiration.

Water on the Earth's surface moves in an unceasing cycle through rivers, oceans, clouds and rain called the ______________. The heat from the Sun causes _____________ of water, principally from the ___________ and also from lakes and wetlands on land. Plants also lose water through their leaves by the process of ____________. Water vapour in the ____________ forms into clouds which are moved around by wind. Rain and snow, collectively known as __________, fall from the clouds. Some water that falls on land soaks into the ground and some collects into streams and rivers which form ______________ that flows back to the ocean to complete the cycle.

SAQ 13.4 (tests Learning Outcome13.4)

Suppose you are working in a village and you want to assess whether the village has satisfactory access to water. Name three things you would need to find out about.

SAQ 13.5 (tests Learning Outcome 13.5)

Suppose you are working in a village where sources of water are inaccessible and people walk a long distance to fetch water. This means that clean water is in short supply in the village. As a Health Extension Practitioner you need to identify the most vulnerable individuals in order to ensure they have sufficient clean water. Which members of the community would you include in your list?

SAQ 13.6 (tests Learning Outcome 13.6)

Which of the following statements is *false*? In each case, explain why it is incorrect.

A Community empowerment has no input in provision of safe water.

B New technologies can help to overcome the barriers to the provision of safe water.

C Local government should not be involved in finding sustainable solutions for provision of safe water.

D Provision of safe water improves the lives of infants and children.

Study Session 14 Treatment of Drinking Water at Household and Community Level

Introduction

Water has always played a prominent role in human civilisation. Water was, and continues to be, needed for drinking, preparing food, bathing, cleaning, irrigating crops and a variety of other tasks. Having ready access to water, therefore, has always been important. However, the water sources used for supplying water were not always clean. Treating drinking water to improve smell and taste and to remove disease-causing organisms has been necessary throughout human history.

Water must look and taste clean, i.e. have eye appeal and taste appeal, if we are going to want to drink it, and it must also be safe to drink. Water is the breeding ground for an unbelievably large variety of organisms that get into water through a variety of routes. Microbial contamination is the most common and widespread health risk associated with drinking water; therefore treatment of water to eliminate pathogenic microbes is of vital importance. In this study session, you will learn about the public health significance of water treatment, the characteristics of raw (untreated) water that determine the treatment methods, types of household/community–based water treatment and a selection of treatment processes.

Learning Outcomes for Study Session 14

When you have studied this session, you should be able to:

14.1 Define and use correctly all of the key words printed in **bold**. (SAQs 14.1 and 14.5)

14.2 Explain the purpose of water treatment at household, community and municipality levels. (SAQ 14.2)

14.3 Describe the methods of water treatment at household and community levels. (SAQs 14.3 and 14.4)

14.4 List the stages of large-scale (municipal) water treatment. (SAQ 14.5)

14.1 Waterborne diseases

Diarrhoea, infectious hepatitis, typhoid and paratyphoid enteric fever are all examples of waterborne diseases that are common problems in our country. These are all caused by microbial contamination. Lead poisoning and fluorosis, caused by chemical contamination, are also classified as waterborne diseases.

■ What distinguishes waterborne diseases from other types of disease associated with water?

□ Waterborne diseases are caused by *consumption* of water that has been contaminated by human or animal wastes, or chemicals. Other types of disease may be caused by external contact (water-based), or infection by an insect vector (water-related), or by limited availability of water for washing (water-washed).

Waterborne diseases can also be classified in a different way as either acute (short-lived) or chronic (long-lasting). **Acute health effects** occur when the levels of some contaminants in drinking water are high enough to cause acute (immediate) health effects within hours or days of consumption, for example, vomiting. **Chronic health effects** occur after long-term exposure to a contaminant that may be present only in small amounts. Examples of chronic health effects are liver and kidney damage.

14.1.1 Causes of waterborne disease outbreaks

There are a lot of possible causes for an outbreak of waterborne disease. The use of untreated spring water and surface water, and inadequately or interrupted disinfection of surface water, spring water and well water may all be responsible. These are all causes associated with the source of water but other problems can arise at points in the system after the source. For example, cross-connections of pipework, contamination of water in the household, contamination during the construction of water source protection, contamination of storage facilities including private storage tanks are all contributors. Consumption of water that was not intended for drinking, contaminated bottled water and ingestion of water while swimming are also possible causes.

14.2 Water treatment

The purpose of **water treatment** is to reduce or remove all contaminants that are present in the water and to improve water quality so that it is completely safe to drink. Water is unlikely to be completely free of contaminants at the original source. The types of water treatment processes depend on the characteristics of the **raw water** (untreated water direct from its source) and required water quality standards. Suspended solids, bacteria, algae, viruses, fungi, minerals such as iron and manganese, and fertilisers are among the substances that are removed during water treatment. (**Suspended solids** are tiny particles of solid material that are carried along or suspended in the water.) Effective treatment should ensure the removal of all disease-causing agents and so reduce the possibility of the outbreak of waterborne disease.

Water treatment systems can be categorised as small-scale water treatment, which includes community and household treatment methods, or large-scale water treatment that might be found in towns and cities.

14.3 Small-scale water treatment systems

Household- and community-level treatment systems are the methods most likely to be used in rural areas.

Household-level water treatment is appropriate when:

- A relatively small amount of water is obtained from a well or spring and is collected and transported by hand.
- The source is contaminated and simple protective measures can neither improve water quality nor stop the contamination.
- Community resources are inadequate to meet the cost of a simple community treatment system and make it difficult to develop a centralised treatment system.

- An emergency situation causes disruption of the service and contamination of the water supply so that a long-term rapid solution is needed.

Community-level water treatment is appropriate when:

- A water source serves a larger population than can be served by household level or individual treatment systems.
- A community water source is contaminated and simple protective measures can neither improve water quality nor stop the contamination.
- Community resources are adequate to cover the cost of construction, operation and maintenance of a simple community-level treatment system.

There are several different methods of small-scale water treatment that can be employed at the household and community level. Broadly speaking these can be grouped either as **filtration** methods, in which water passes through a porous barrier (filter) that traps tiny particles including pathogenic microorganisms and other impurities, and **disinfection** methods, in which contaminants are removed by the use of various chemicals or by energy from the sun.

14.3.1 Household sand filter

Household filters are an attractive option for household treatment because these filters can usually be made from locally available and inexpensive materials like clay pots or barrels. They are simple and easy to use. The upper pot contains layers of sand and gravel. Water is poured in at the top and, as it passes through the layers of sand, any particles within it are filtered out. The thickness of the layers should be approximately 5 cm of gravel, 5 cm of coarse sand and 10 cm of fine sand. The bottom of the upper pot should be perforated (have tiny holes in it) so the clean water can drip into the lower pot. The lower pot should have a tap (faucet) to draw off the clean water easily (see Figure 14.1). The sand and gravel should be changed when the rate of filtration starts to slow; at minimum it should be changed every two or three months.

Figure 14.1 Household water filter using two clay pots placed on top of each other.

Figure 14.2 Cloth filtration. (Source: International Federation of Red Cross and Red Crescent Societies, 2008, *Household water treatment and safe storage in emergencies*)

14.3.2 Cloth filtration

Cloth filtration is a common water treatment technique that is easy to use and inexpensive (Figure 14.2). Cloth filtration can be very effective against cholera, guinea worm (dracunculiasis) and other disease-causing agents. By following the procedures and practice yourself, you can demonstrate this for communities you are working with. The steps in cloth filtration are:

- Use a large cloth, preferably made of finely-woven cotton. The cloth must be big enough to easily cover the opening of the container once it has been folded.

- Fold the cloth at least four times so there are multiple layers of fabric and place this over the opening of the storage vessel.
- Fasten the cloth securely around the rim of the opening and tighten the string. If reusing the cloth, always use the same side up each time.
- Filter all water immediately at source as it is being collected.
- Always keep filtered water separated from non-filtered water.
- Rinse the filter cloth after each use, with a final rinse using cloth-filtered water, and then leave the cloth in the sun until it is dry.
- Clean the cloth regularly using soap and replace it as soon as there are any visible tears or holes.

14.3.3 Other filtration methods

There are other filtration methods such as ceramic filters and biosand filters that are not currently widely used in Ethiopia but are also appropriate for household and community use.

Micron is another name for the micrometre–which is one millionth of a metre, i.e. a thousandth of a millimetre.

Ceramic filters of various types have been used for water treatment throughout the world. The majority of bacteria are removed mechanically through the filter's very small (0.6–3.0 microns) pores. Ceramic filters are easy to use, relatively low cost and have a long life if the filter remains unbroken. They are good for reduction of bacteria and protozoa but lack residual protection so recontamination is possible.

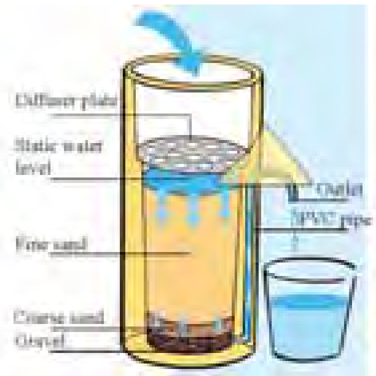


Figure 14.3 Biosand filter. (Source: as Figure 14.2)

Biosand filters differ from the other types of filter described above in that they make use of biological activity as well the mechanical filtering of particles. The most widely used version of the biosand filter is a concrete container about one metre in height and filled with sand (Figure 14.3). The container is filled with water so the water level is above the sand layer. The water allows a 'bioactive' layer to grow on top of the sand. This bioactive layer consists of algae, plankton and other microscopic plant life that helps reduce disease-causing organisms, particularly protozoa and bacteria. The biosand filter is fairly easy to use, can be produced from locally available materials, needs little maintenance and has a long life but it has a high initial cost and is difficult to transport. It will improve the look and taste of the water and is good for removing protozoa but has a low rate of virus inactivation and does not remove 100% of bacteria so recontamination is possible.

14.3.4 Solar disinfection

Solar disinfection, also known as SODIS, relies on energy from the sun to kill pathogenic organisms, especially bacteria. Ultraviolet light from the sun is an effective bactericide for water.

Turbidity is a measure of the cloudiness of water. It is caused by very small particles (suspended solids) that are individually too small to see with the naked eye.

This simple technique requires only a few plastic bottles and sunlight. Firstly, collect several bottles (0.3 to 2.0 litre) made of clear plastic, remove all labels and wash them thoroughly. Fill the bottles with water of low **turbidity** and shake for about 20 seconds to aerate the water. Expose the bottles to the sun by placing them on a roof or rack for at least six hours (if sunny) or two days (if cloudy) (see Figures 14.4 and 14.5). The water is now ready to drink.

Figure 14.4 Solar disinfection. (Photo: Eawag)

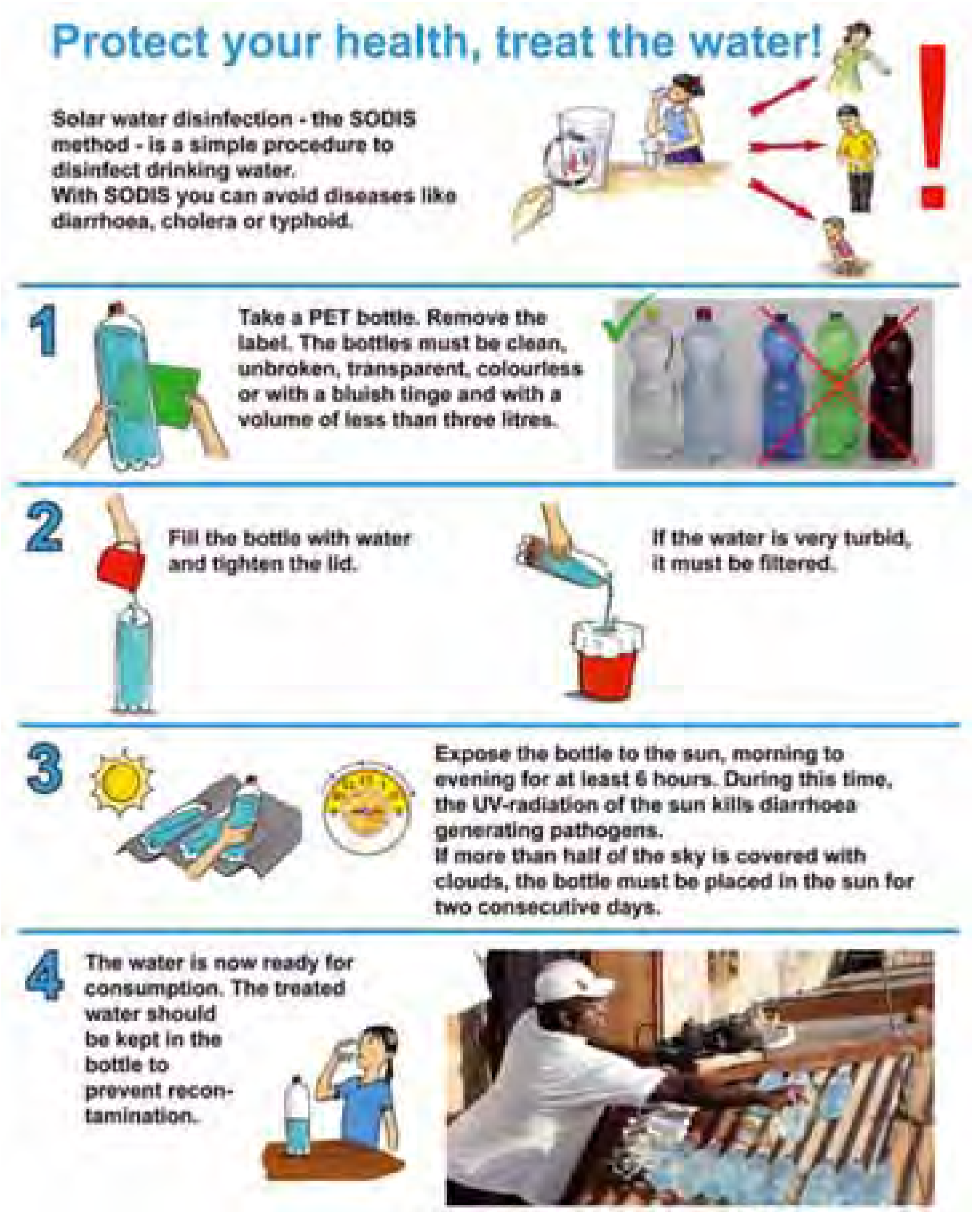


Figure 14.5 The SODIS method of water treatment. (Source: Eawag)

The *benefits* of solar disinfection include:

- proven reduction of bacteria, viruses and protozoa
- acceptability to users because of the minimal cost to treat water, ease of use and minimal change in water taste
- unlikely recontamination because water is consumed directly from the small, narrow-necked bottles (with caps) in which it is treated.

The *drawbacks* include:

- requires relatively clear water (if the water is too cloudy it has to be filtered first)
- only a limited volume of water can be treated at one time
- the length of time required to treat it.

14.3.5 Chemical disinfection methods

There are several commercially available products designed for treating water at household level.

Chlorine solution

Contact time is the amount of time that elapses when two substances are mixed. Chlorine contact time means the time between the introduction of chlorine and using the water.

Chlorine solution, also known as sodium hypochlorite solution or bleach, is the most affordable, easiest to produce, and most widely available chemical for household water treatment. It is supplied in bottles and has easily interpretable instructions for use on the side of the bottle. Typically, the procedure is to add a capful of chlorine solution to a 25 litre water storage container, then shake and wait for 30 minutes **chlorine contact time** before drinking. Double dosing is advisable if the water is visibly dirty.

Aquatabs

Aquatabs are a specifically formulated and branded solid form of sodium dichloroisocyanurate (NaDCC) (see Figure 14.6). NaDCC is stable in Aquatabs form as a solid which gives it a longer shelf life and makes storage, handling and transport much easier than with liquid bleach. One Aquatab contains 67 mg of NaDCC and treats 20 litres of clear water. For visibly turbid water, two tablets per 20 litres are needed. It is very important to mix well and leave for 30 minutes contact time before consumption.

PUR

Flocculation is a process in which suspended solids are removed from water and turbidity is reduced. The solid particles lump together to form 'flocs' which slowly settle to the bottom of the container. A flocculant is a substance that can be added to water to encourage this process.

'PUR Purifier of Water' is the brand name of a combined *flocculant* and disinfectant product produced by Procter and Gamble (Figure 14.7). It is now on the market in Ethiopia although it may not be widely available across the country. PUR can be used to treat raw source waters with a wide range of turbidity and pathogen load. This water treatment chemical allows flocculation to take place and helps to remove *Giardia* and *Cryptosporidium* cysts that are resistant to chlorine disinfection. (A *cyst* is a dormant stage in the life cycle of some protozoa and bacteria that is resistant to adverse environmental conditions and therefore difficult to destroy.) PUR comes in sachets with one sachet needed to treat 10 litres of water.

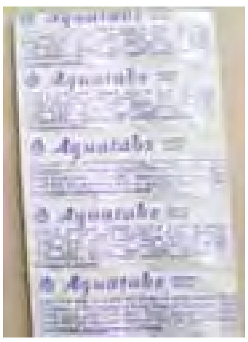


Figure 14.6 Aquatabs tablets for household water treatment. (Photo: Abera Kumie)

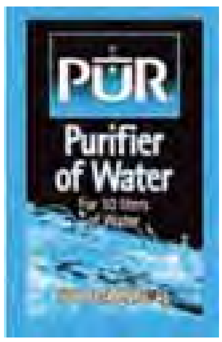


Figure 14.7 PUR Purifier of water. (Source: as Figure 14.2)

Wuha Agar

Wuha Agar is a chlorine-based water treatment solution that is used in Ethiopia (Figure 14.8). The procedure is very similar to other chemical treatment methods. For a 20 litre jerrycan, add one capful of Wuha Agar, cover and shake. After 30 minutes contact time you can use it.

Figure 14.8 Wuha Agar for household water treatment. (Photo: Abera Kumie)

14.3.6 Boiling

Boiling is also an optional water treatment at household level. Boiling is a simple way of killing any ova (eggs), cysts, bacteria and viruses present in contaminated water. Water should be heated until large bubbles are continuously coming to the surface of the water. The disadvantage of boiling as a treatment method is that it requires large amounts of fuel, so cost may prevent people from using this method. Also, boiling may give an unpleasant taste to the water, which may be unacceptable, and very hot water can cause accidents in the home. Boiled water can become recontaminated once it has cooled.

14.4 Safe storage

Whatever type of treatment method is used, it is essential that water is stored safely and hygienically. Even if water has come from an improved source, this will not guarantee that it is safe because contamination can occur in the household due to poor storage and handling practices. The principal health risk associated with household water storage is the ease of recontamination, particularly where the members of a family or community do not all follow good hygiene practice. Safe storage is especially designed to eliminate sources of recontamination by keeping objects, including hands, out of the system.

Figure 14.9 Safe storage containers.

- ■ What is it about the two containers shown in Figure 14.9 that make them safe for storing water?
- □ They both have lids which prevent dust and insects from falling in the water and they both have taps so people can take water without removing the lid or dipping their hands or a smaller container, which may be dirty, into the water.

It is important to recognise that unsafe water is not made safe just by using safe storage methods. Safe storage helps to ensure that post-treatment recontamination does not occur within the household.

14.5 Large-scale water treatment

Large-scale or municipal water treatment is not common in rural communities but you may find it in larger towns and cities where there is a network of pipes and pumps to distribute water from the treatment works. There are several steps in municipal water treatment intended to remove solids, kill pathogenic organisms and make water safe to drink. The main stages are usually aeration, sedimentation, coagulation, filtration and disinfection.

Aeration simply means to mix air with the water. It is used to remove volatile (easily evaporated) substances from drinking water. Air and water are put into contact with each other, i.e. air is bubbled through the water, so that the volatile substances are evaporated into the airstream and removed from the water. Aeration can be carried out in towers or aeration basins to provide the necessary contact time between air and water. **Sedimentation** is the settling out of comparatively heavy suspended material (suspended solids) in water because of gravity. The settling takes place in a quiet pond or a specially constructed tank (Figure 14.10). A minimum 24-hour retention time is necessary to have a significant reduction in suspended matter. (**Retention time** means the length of time the water is kept (retained) in the tank.) Sedimentation can be used alone or in combination with coagulation.

Figure 14.10 Sedimentation tank at a municipal water treatment works. (Photo: Pam Furniss)

Coagulation is the formation of particles in a liquid by adding chemicals. Its meaning is similar to flocculation. The flocculant used in large-scale treatment plants is usually alum (hydrated aluminum sulphate). This chemical is mixed with turbid water and then allowed to remain still in a sedimentation tank or basin so that the larger particles, or floc, settle to the bottom.

Filtration is the removal of suspended material from water as it passes through beds of porous material. This is exactly the same principle as filtration methods at household level. Filters can be made of layers of sand, gravel or charcoal. Filtration cannot completely remove all bacteria.

Disinfection kills most harmful organisms including pathogenic bacteria. Without disinfection, the risk from waterborne disease will remain. Disinfecting agents include chlorine, ultraviolet light, ozone, iodine and others but, of these, chlorine is the most frequent treatment agent. The process is called chlorination.

14.6 Chlorination

Chlorination, used at both household and large-scale levels, is one of the most effective and widely used methods for disinfecting water and making it safe to drink. Whatever the level, it is important that the correct quantity of chlorine is added to remove all impurities.

■ Which of the water treatment methods described earlier for household use involve chlorination?

□ Three of the four chemical disinfection methods described are chlorination methods. Chlorine solution, PUR and Wuha Agar all use chlorine as the disinfecting agent.

At municipal level, various terms are used to describe aspects of the chlorination process. **Chlorine dosage** is the amount of chlorine added to the water system in milligrams per litre (mg/l). **Chlorine demand** is the amount of chlorine that combines with the impurities and therefore is no longer available as a disinfecting agent. The chlorine that remains in the water after the chlorine demand has been satisfied is called free **chlorine residual**. A certain amount of residual chlorine is a good idea because it protects against future recontamination.

The **orthotolidine-arsenite test** (OTA) is used to determine the amount of free chlorine residual. When orthotolidine reagent is added to water containing chlorine, a greenish-yellow colour will appear. The intensity of the colour is measured against a chart to determine the amount of free available residual chlorine in the water. The amount of residual chlorine needs to be in the range of 0.2–0.5 mg/l if it is to prevent recontamination with bacteria. The OTA test requires a special test kit. If required, this should be available from your district environmental health office.

The *benefits* of point-of-use chlorination include:

- Chlorine is proven to be effective in the reduction of bacteria and most viruses.
- The residual chlorine is effective in protection against recontamination.
- It is easy to use.
- Chlorine is easily available at low cost.

The *drawbacks* of chlorine treatment include:

- It provides relatively low protection against some viruses and parasites.
- Lower effectiveness in water contaminated with organic and certain inorganic compounds.
- Potential objections to taste and odour.
- Some people have concerns about the potential long-term carcinogenic effects of chlorination byproducts.

Summary of Study Session 14

In Study Session 14, you have learned that:

1 Drinking water is treated to improve smell, taste, clarity and to remove disease-causing pathogens.

2 If water from an unprotected source is not treated before it is used for drinking, this may cause an outbreak of waterborne disease. Disease outbreaks may also occur because of contamination at some point after collection from the source.

3 The main objectives of water treatment are to:

- reduce or remove all contaminants that are present in the water
- raise water quality to the highest possible level for long-term use
- meet water quality standards
- reduce waterborne diseases.

4 Household water treatment technologies include dilute bleach solution, Aquatabs, solar disinfection (SODIS), cloth filters, ceramic filters, the biosand filter, PUR and Wuhu Agar. Safe storage is also essential.

5 Conventional large-scale water treatment is feasible for urban areas where the population is dense. There are several steps in the treatment process at this level.

Self-Assessment Questions (SAQs) for Study Session 14

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the following questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 14.1 (tests Learning Outcome 14.1)

Match the words in list A with the corresponding phrases in list B, by drawing an arrow between them.

A	B
Chlorination	Free residual available chlorine in treated water
Chlorine contact time	Water not yet treated
Raw water	Time required to wait to drink after chlorination
Chlorine residual	Process of treating with chlorine

SAQ 14.2 (tests Learning Outcome 14.2)

Suppose you went to a village to promote household water treatment. Mr. Abebe, a local farmer, asks you why he needs to treat the water for drinking. What would you say to him as an explanation?

SAQ 14.3 (tests Learning Outcome 14.3)

Suppose you have a group of women in your area who want to know about household water treatment by chlorine solution, particularly Wuha Agar. What are the key points you would explain to them?

SAQ 14.4 (tests Learning Outcome 14.3)

A man comes to see you and explains that his family obtains water from a protected water source and that it has been treated with chlorine. He asks you how he can find out whether the chlorine still protects his family or not. How could you find out if his water was still safe to drink?

SAQ 14.5 (tests Learning Outcomes 14.1 and 14.4)

Filtration and disinfection are important water treatment processes. Briefly describe each of these processes and explain their role in making water safe to drink.

Study Session 15 Community Drinking Water Source Protection

Introduction

Every public drinking water source should be protected from possible contamination. In this study session, you will learn about different sources of water, the basic techniques of developing small-scale drinking water schemes (i.e. springs, hand-dug wells, rainwater harvesting and surface water). You will also learn how to identify water sources that need protection and how they can be protected from potential contaminants through community mobilisation, regular inspection, proper maintenance, hygiene promotion and periodic treatment of water to prevent waterborne diseases from affecting the community.

Learning Outcomes for Study Session 15

When you have studied this session, you should be able to:

15.1 Define and use correctly all of the key words printed in **bold**. (SAQ 15.1)

15.2 List the different sources of drinking water. (SAQ 15.2)

15.3 Describe the main activities when planning and developing water source protection. (SAQ 15.2)

15.4 Describe the methods of preventing contamination of well and spring water. (SAQs 15.3 and 15.4)

15.1 Sources of drinking water

The sources of drinking water that are practicable for public and domestic purposes are classified as:

- rainwater
- surface water such as lakes, rivers and ponds
- groundwater from springs, wells and boreholes.

15.1.1 Rainwater

Rainwater can be used for domestic purposes in areas where there are no alternative sources of water such as springs, rivers and lakes, or where these sources of water are contaminated. The term **rainwater harvesting** is sometimes used. It simply means collecting, or harvesting, rainwater as it runs off from hard surfaces such as rooftops and storing it in a tank or cistern (Figure 15.1).

The main advantage of rainwater is that it is free. It is fairly reliable though obviously dependent on the amount of rain that falls. It does not usually require pumps or pipes and is available at the doorstep. Using rainwater can reduce the burden on women and children who typically are the water carriers in Ethiopia and walk long distances to fetch inadequate supplies.

Figure 15.1 Rainwater is collected from the roof of this health centre and stored in a covered, watertight cistern. (Photo: Pam Furniss)

15.1.2 Surface water

Surface water supplies are taken from rivers, lakes or ponds. Surface water can provide a consistent and manageable source of water. However, it is subject to greater risk of contamination than groundwater and therefore usually requires treatment. Contamination is most likely to be with microbiological pathogens from human and animal excreta. There is also the possibility of accidental or deliberate pollution by industries or the agricultural community.

Figure 15.2 A surface water source that is likely to be polluted. (Photo: Richard Adam)

- ■ What are the likely sources of contamination in the river in Figure 15.2?
- □ Excreta from the cattle will be washed into the river water. Their hooves have disturbed the ground so soil is also likely to be washed in. The road passing over the bridge in the background could be a source of pollution from cars and lorries.

15.1.3 Groundwater

Groundwater is water found beneath the ground surface held in the spaces within porous soil and rock. Groundwater can be obtained from springs, boreholes or wells. A borehole is a particular type of well with a narrow shaft. Usually a drilling rig is needed to drill (bore) the hole into the rock.

The depth that water is taken from and the types of rock it has passed through are important factors that affect the quality of the groundwater. Groundwater, particularly from deep sources, may provide water of good microbiological quality. This is because bacteria, protozoa, viruses and helminths are filtered from the water as it passes through the layers of soil and rock into the groundwater. Groundwater sources are therefore preferable to surface water sources. However, groundwater can contain chemical contaminants, such as arsenic, fluorides and nitrates.

Springs

A spring occurs at the point where the boundary between a **permeable layer** of underground rock and an **impermeable layer** reaches the ground surface. Rainwater percolates (trickles down) through the soil into permeable layers of subsoil or underground rock. The downward **percolation** will be stopped if this layer sits on top of an impermeable layer and the water can go no further. Depending on the slope of the layers, the water will run along the top of the impermeable layer to a point where it reaches the surface and emerges as a spring (see Figure 15.3). A spring may vary in volume and contamination levels according to the amount of rainfall.

Permeable rocks have tiny spaces between the solid rock particles that allow water and other fluids to pass through and be held within the rock structure. Impermeable rocks do not have these spaces and water cannot pass through them.

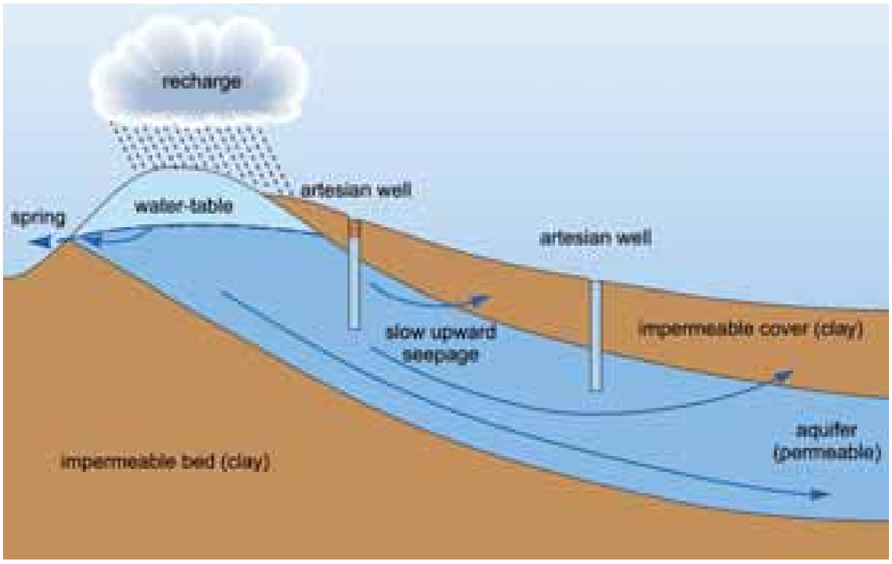


Figure 15.3 Diagram of groundwater formation with spring and artesian wells. (Source: The Open University)

Springs are likely to be polluted by direct contamination through the topsoil unless the surrounding land area is protected. A spring supply issuing from a deep, water-bearing layer, rather than a permeable layer near the surface, can produce both a consistent volume and a better quality supply. Whether the spring originates from shallow or deep rock layers, animals should be excluded from the surrounding area by a stock-proof fence, and any water running off the land after rain should be diverted to a suitable ditch away from the spring.

Wells

The practice of obtaining water from wells is common and well water is an important source of supply in many developing countries like Ethiopia. A well should be located uphill from any possible sources of pollution. Wells are classified based on the depths of the water-bearing layers as follows:

- *Shallow wells* tap into water held in **aquifers** (layers of water-bearing rock) above the first impermeable layer. 'Shallow' is not a definite depth, but an indication of the layer of rock from which it is abstracted.
- *Deep wells* obtain water from aquifers below at least one impermeable layer. A deep well must be constructed so as to exclude subsoil water and contamination from above. It should be watertight down to a point slightly below the level of the deep supply.
- *Artesian supply*. Water in aquifers is sometimes under pressure because of the surrounding impermeable layers and this can cause the water to flow upwards to the surface. In Figure 15.3, the water level in the two artesian wells is determined by the level of the water table. In the well on the right, water rises to the land surface but in the well on the left it does not.

15.2 Planning the development and protection of sources of water

As you learned in Study Session 13, nearly 70% of the rural population of Ethiopia get their water from unimproved sources. There is, therefore, a widespread need to develop new sources of water and to ensure they are adequately protected. Several issues need to be taken into consideration when planning the protection and development of water sources.

15.2.1 Assessing needs

Water source protection should be based on needs identified by the community themselves. The community should identify its own water and sanitation needs through a process of internal discussion and external negotiation. The internal discussion would involve you, other health experts, community leaders and other members of the community. Local people have local knowledge and it is important to draw on this knowledge when planning new developments. The external negotiations may involve local government offices, NGOs and other partners who can assist with the assessment of the communities' needs with information and technical guidance.

15.2.2 Water source identification

All potential water sources should be considered and checked. Issues to consider are the sources of possible contaminants, the amount of water available to users annually and the consistency of the supply. Other important issues are social acceptance, cost effectiveness and community health. All potential water sources need to be assessed in order to identify the best solution.

For instance, whenever rivers and streams are considered for use and development, the communities immediately upstream and downstream should be consulted and involved in the decision-making process prior to implementation. This is because both quality and quantity of surface water can be affected by the activities of the people living upstream (toward the source of the stream or river). If the upstream users abstract large volumes or pollute the water, this will have a damaging effect on the downstream users (Figure 15.4). All communities have an interest in having good quality and adequate quantities of water; therefore, it is important that proposed surface water developments should be discussed with and agreed by both the upstream and downstream communities.

Figure 15.4 Upstream and downstream: the upstream users usually have the upper hand in terms of both (a) quantity and (b) quality. (Source: the Open University)

15.2.3 Water quantity

Whenever a new protected water source is proposed it should have the capability of supplying at least 20 litres of water per person per day to the target population. The protected water source should provide sufficient quantities of water to meet essential health-related household and personal needs, including drinking, cooking, personal hygiene, clothes washing and cleaning for all community members.

15.2.4 Sanitary surveys

Before any new water source protection is developed or maintenance is planned on an existing source, it is important to conduct a **sanitary survey**. A sanitary survey is an evaluation of the physical environment to identify possible health hazards and sources of environmental contamination. It will reveal the potential risks to the health of people that may arise from the proposed water source. The risks may be negligible or they may need to be controlled with specific correction activities. This sanitary survey will be part of the baseline information for the water source development and should include the nature of the water-bearing layer, the **hydraulic gradient** (i.e. the variations in underground water pressure that affect the natural flow of water), topography, vegetation, potential sources of contamination, and the adequacy of the yield particularly for dry seasons. (You will learn more about sanitary surveys in Study Session 16.)

15.2.5 Health and hygiene education

Before developing any water protection, the health benefits of an improved water supply and sanitation need to be accepted by the local community. You can provide hygiene education for the people in order to promote their behavioural change.

■ What good hygiene practices would you encourage so that the local community get the full benefit of an improved water supply?

□ The most important aspects of good hygiene education would be:

- Washing their hands after using the latrine and before preparing meals or feeding babies and eating their food.
- Protecting water supplies at the source and in the home.
- Using an appropriate latrine rather than the open fields.

Water and sanitation activities should be integrated with community health developments if it is possible. Individual and community health are the major beneficiaries of improved water supplies and sanitation.

15.2.6 Water quality

Water quality should be a primary concern in all water projects. Water quality is a description of the chemical, physical and biological characteristics of water, usually with respect to its suitability for drinking. The quality of drinking water must be uppermost in the planning and implementation of water and sanitation activities. Water source development projects should draw water from the best available sources. Water quality assessment is discussed in more detail in Study Session 16.

15.3 Protection of wells

15.3.1 Types of well

There are several different ways of constructing a well in order to access groundwater sources. These include dug wells, bored wells (also known as boreholes), and driven and jetted wells.

Dug well

A dug well is usually excavated by hand, but may be dug by mechanical equipment. They are usually 90–180 cm in diameter and 4.5–10.5 m deep, depending on where the water-bearing layer or groundwater is encountered. Wider and deeper dug wells are less common. Dug wells have a relatively large diameter and therefore have large storage capacity, but the water level will be lower at times of drought and the well may go dry. On the other hand, during heavy rain, dug wells are susceptible to contamination by pathogens which may be deposited on the surface or naturally present in the soil and are washed in to the well, particularly if it is improperly constructed. Handpumps placed over the well need to be built so the surrounding ground is covered and protected (Figure 15.5). Any pipework associated with pumps that enters the well needs to have watertight connections so there can be no contamination from surrounding soil.

Figure 15.5 Protected handpump over a dug well. Note the concrete surround and the fence to keep out animals. (Photo: Pam Furniss)

Bored well

Bored wells or boreholes are constructed with a hand- or machine-driven auger and tend to be used in relatively soft soils and rocks. An auger is a device with a rotating blade that is used to drill holes and draw out the loosened rock and soil. Bored wells vary in diameter from 5–75 cm and in depth from
7.5–18 m. A lining, known as a *casing*, of concrete, metal, or plastic pipe is necessary to line the hole and prevent the soil and rock from caving into the well. Bored wells have characteristics similar to dug wells in that they have small yields, may be easily polluted, and are affected by droughts.

Driven and jetted wells

These types of well consist of a metal pipe with a screen attached at the bottom end. A well screen is a device that allows water to pass in to the pipe but keeps out soil particles. The pipe is *driven* or *jetted* into a water-bearing rock layer found at a comparatively shallow depth. For a driven well, the end of the pipe is shaped into a point and it is hammered into the ground. The jetted well is constructed by directing a high velocity stream of water through the bottom of the pipe, thereby loosening and flushing out the soil which is forced back up to the surface as the pipe is lowered. Driven wells are commonly 2.5–5 cm in diameter and less than 15 m in depth. Jetted wells may be 5–30 cm in diameter and up to 30 m deep. Larger and deeper jetted wells can be constructed. Following development, the well should be tested to determine the dependable well yield (i.e. the volume of water reliably produced). The well is then disinfected and the project completed.

15.3.2 Protection of well water from pollution and contamination

Before and during water source development, care should be taken to minimise possible risks. The well should be located on a higher level than possible sources of contaminants such as latrines and cesspits (a pit for collection of waste matter and water especially sewage). This is because the liquid from the pit may seep into the surrounding ground and into the groundwater. If the latrine is higher up a slope than the well then the contaminated groundwater is likely to flow downwards and into the well. The natural flow of the groundwater (the hydraulic gradient) should be away from the well and towards the sources of contaminants, and not the other way round. In normal soils, the minimum distance between the well and the source of contaminants should never be less than 15 metres and a distance of 30–50 m is recommended. However for limestone and some other soil formations this distance needs to be greater because groundwater can pass very easily through some rocks and soils.

The inside wall of the well should be made waterproof by constructing a well casing. As noted above, in small diameter bored wells the casing can be a pipe, but in larger wells the casing needs to be constructed by cementing from the top of the well down to a minimum depth of 3 metres. The casing of the well should also be extended for a minimum of 60 cm above the surrounding ground level to prevent the entrance of surface runoff. A concrete cover should be fitted over the casing to prevent dust, insects, small animals and any other contaminants from falling in (Figure 15.6).

Figure 15.6 Two wells with concrete protection. Note the removable covers. (Photos: Pam Furniss)

A pump should be installed, but if a pump is not available then a sanitary bucket and rope system may be used. The immediate area of the well should preferably be fenced to keep animals away (see Figure 15.5). The area surrounding the well should be graded off (i.e. should slope away from the well) in order to prevent the flow of storm water into the well.

15.3.3 Contamination of well water

The causes of bacterial contamination in a well are usually due to:

- Lack of, or improper, disinfection of a well following repair or construction.
- Failure to seal the space between the drill hole and the outside of the casing.
- Failure to provide a tight sanitary seal at the place where the pump line(s) passes through the casing.
- Wastewater pollution caused by contaminated water percolating through surrounding soil and rocks into the well.

At the time when a new well is constructed or repairs are made to a well, pump or piping, contamination from the work is possible. Therefore, it is important that the well, pump, piping and associated structures should be regularly disinfected using chlorine solution.

Tracing the source of contamination

There are different methods which help to identify a possible source of groundwater contamination. One method is sodium or potassium **fluorescein.** This is a brightly-coloured, fluorescent, water-soluble dye and can be used as a tracer when a sewage disposal system is suspected of contaminating groundwater. A solution flushed into the disposal system or suspected source may appear in the well water within 12–24 hours. It can be detected by sight, taste or analysis.

15.4 Spring source protection

There may not be many opportunities to develop new spring sources but, if the opportunity does arise, there are certain procedures to follow to ensure the spring water is protected and safe to drink. You would be working with others if a new spring source was to be developed but the same principles will apply to existing spring sources because the protection needs to continue to work into the future.

Before using a spring a thorough sanitary survey needs to be carried out at the site to assess the quantity and quality of water, and the possible contamination. (Sanitary surveys are described in Study Session 16.) If the results of the sanitary survey are satisfactory, the eye of the spring (the point where the water emerges from the ground) should be located by digging out the area around the spring down to the impermeable layer.

Different types of spring protection can be constructed but in general they are as follows:

- A concrete waterproof protection box, also known as a spring box, should be constructed over the spring to prevent all actual and potential sources of contamination.
- A retention wall in the front part of the protection box should be constructed to keep water flowing to the delivery pipe. In Figure 15.7 (on the next page) you can see the retention wall of this spring with the delivery pipe emerging from it.
- In some situations, if the flow is not constant, a collection box may also be constructed in order to ensure adequate water storage.

- The intake and overflow pipes should be screened to prevent the entrance of small animals. The spring and collection box, if there is one, should have a watertight top, preferably concrete. Water will move by gravity flow or by means of a properly-installed mechanical pump. An inspection hole should be tightly covered and kept locked.

Springs should be protected from flooding and surface water pollution by constructing a deep *diversion ditch* above and around the spring. The ditch should be constructed so it collects surface water running towards the spring and carries, or diverts, it away. It needs to be deep enough to carry all surface water away, even in a heavy rainstorm. The surrounding area should be fenced to protect it from animals (see Figure 15.7).

Figure 15.7 A protected spring. Note the concrete retention wall with two delivery pipes and the surrounding fence. (Photo: WaterAid in Ethiopia)

15.5 Rainwater source protection

A lot of care must be taken to ensure rainwater that is used for water supply is not contaminated by improper methods of storage or by bird droppings and leaves from the roof the water is collected from. Rainwater may be also be contaminated by pollutants in the air, dust, dirt, paint and other material on the roof or in roofing materials. All of these contaminants can be washed into the storage tank or cistern.

To protect the water, various precautions are needed. The tank must be completely covered and well maintained. The roof and gutters should be cleaned regularly, especially before the start of the wet season. It may be necessary to divert the first rainwater away from the tank so the dust and dirt is washed away. Leaves and other larger debris can be prevented from entering the tank by placing a mesh screen between the guttering and the pipe that leads to the tank; the mesh screen will need to be cleaned regularly.

15.6 Surface water sources

All surface water sources are subject to continuous or intermittent pollution and must be treated to make them safe to drink. One never knows when the organisms causing diseases such as typhoid fever, gastroenteritis, giardiasis or infectious hepatitis A will contaminate surface water sources. The extent of the treatment required will depend on the results of a sanitary survey made by an experienced professional, including physical, chemical and microbiological analyses. Protecting surface water from pollution is difficult because, as noted earlier, the activities of upstream users of the river water will affect the quality of the water for downstream users and the land use in the surrounding area will also have an impact. Surface waters are, by definition, unprotected sources.

Summary of Study Session 15

In Study Session 15, you have learned that:

1 Rainwater, surface water (from lakes, rivers, ponds) and groundwater (from springs, wells and boreholes) are the sources of water for public and domestic purposes.

2 Groundwater sources are generally preferable to surface water sources. They tend to be safer and less in need of costly water treatment.

3 There are number of issues to be considered before the development of a new water source, including assessment of the quantity and quality of the available water, and consideration of the needs and involvement of the community. A thorough sanitary survey is an important part of this process.

4 Dug wells, deep wells, bored wells, and driven and jetted wells are some of the methods of groundwater source development.

5 Protection of well water and spring water from contaminants and pollutants is very important.

6 After construction, or when repairs are made, the spring, well, pump or piping should be disinfected with chlorine solution.

7 Sodium or potassium fluorescein is a water-soluble dye that can be used as a tracer when a sewage disposal system is suspected of contamination of groundwater.

8 Rainwater harvesting is very important when the quantity or quality of other water sources is inadequate. Rainwater must be stored in a closed tank and kept free of contaminants.

Self-Assessment Questions (SAQs) for Study Session 15

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 15.1 (tests Learning Outcome 15.1)

Match the following words in list A with the corresponding phrases in list B by drawing an arrow between them.

A	B
Surface water	Water trickling down through soil
Groundwater	Underground water-bearing rock layer
Aquifer	Freshwater supply beneath the Earth's surface
Percolation	Rivers and lakes

SAQ 15.2 (tests Learning Outcome 15.2 and 15.3)

A community leader in a village comes to your office claiming the villagers use water from an unprotected source. He asks if you can help in the development of a new water source. What steps need to be taken to investigate if a new water source was possible for this village?

SAQ 15.3 (tests Learning Outcome 15.4)

Suppose inhabitants of a village obtain water from a spring. What advice do you give to the users about the prevention of contaminants?

SAQ 15.4 (tests Learning Outcome 15.4)

Look at Figure 15.8 which shows a handpump over a well. What are the potential sources of contamination of the water in this well? What would you recommend should be done to improve protection?

Figure 15.8 For use with SAQ 15.4. (Photo: Janet Haresnape)

Study Session 16 Sanitary Survey of Drinking Water

Introduction

Diseases related to contamination of drinking water constitute a major burden on human health. The great majority of water-related health problems are the result of microbial (bacteriological, viral, protozoan or other biological) contamination. Sanitary surveying of drinking water is an important tool for reducing the risks of water contamination and waterborne illness. In Study Session 15 you learned that undertaking a sanitary survey is an important part of the process to develop a new water source. Sanitary surveys are also essential for monitoring the condition of existing water sources to ensure they continue to be safe to use.

Learning Outcomes for Study Session 16

When you have studied this session, you should be able to:

16.1 Define and use correctly all of the key words printed in **bold**. (SAQ 16.1)

16.2 Describe the purpose and benefits of a sanitary survey. (SAQ 16.2)

16.3 Describe the purpose and benefits of water quality analysis. (SAQs 16.3 and 16.4)

16.4 Explain the methods of conducting a sanitary survey at different water sources. (SAQ 16.5)

16.1 Rationale for a sanitary survey

In Study Session 15 you learned that a sanitary survey is an evaluation of the physical environment to identify possible health hazards and sources of environmental contamination. The survey should include an inspection of the entire water system, including the water source, facilities, equipment, operation and maintenance. It can be a complex technical task if carried out at a detailed level and may require expert help but you can conduct an onsite survey of the key elements, which are the water source itself, sources of contaminants and water handling by household members. There are many different aspects to a sanitary survey and different questions to be answered, so having a checklist of the necessary items is a useful aid. Some example checklists are included later in this session.

There are several reasons for conducting sanitary surveys of drinking water. Sanitary surveys are a comprehensive inspection of the entire water delivery system from the source to the mouth and are, therefore, the best means of identifying potential problems and changes in the quality of drinking water. They play a fundamental role in ensuring that consistent and safe drinking water supply is provided to the community by identifying and correcting any deficiencies in the system, and helping to identify public health risks related to drinking water.

The benefits of a sanitary survey, therefore, are that they can:

- Assure the long-term quality and safety of drinking water.
- Help to protect public health.
- Reduce the risk of waterborne disease outbreaks.
- Help source protection.

After conducting a sanitary survey you will be able to describe the extent of problems and consider possible solutions, which will vary depending on the circumstances. You can discuss these with the community leaders, religious leaders and local administrators, and perhaps find a rapid solution, if it is controllable by you. If the problems are more difficult to handle, you can report to the experts who are working at the district level.

A sanitary survey or inspection is a relatively simple technique that depends on gathering information, principally by observation and also by making enquiries. A more detailed assessment of water quality would require chemical and microbiological analysis, which would need specialised equipment and qualified staff, and would be more expensive than a sanitary survey. Some analytical equipment is portable and can be taken to the site but other tests can only be done in a laboratory. The recommended tools for field use are a portable pH meter with digital readout, a hand-held colorimeter, portable spectrophotometer and residual chlorine test kit.

16.2 Elements of a sanitary survey

One of the most important functions of the onsite sanitary survey is to determine whether the existing facilities are adequate to meet the needs of the users at all times. This is one of several elements that are considered essential in the proper conduct of a thorough sanitary survey. The two key elements that you should focus on are the *water source* (its physical components, protection and condition of any associated structures) and the *use of water at home*.

16.2.1 Water source (components, protection and condition)

As you know, the water supply source is the beginning of the drinking water system. Preventing source water contamination is the most effective means of preventing contaminants from reaching consumers. Source water protection also helps you to ensure the least expensive method is used for treatment of water. Hence, a sanitary survey should be designed to assess the control of contaminants and determine the reliability, quality, quantity and vulnerability of the source of water.

During a sanitary survey, you need to consider the terrain (the slope of the land), soil types, land cover, rainfall and runoff, and animals, which can all affect the water quality. In particular the potential sources of contamination by pathogens need to be assessed.

■ What pathogens might be a problem for water quality and what are the sources of those pathogens?

□ The pathogens are bacteria, protozoa, viruses and helminths. The primary source is human waste which gets into the water because of open defecation, discharge of sewage to water bodies, poorly sited latrines, etc.

In addition to contamination by pathogens from human body waste, there are many other human activities that can affect water quality. Runoff from barnyards and other areas where animals are kept will contain animal wastes and can cause significant problems. Farming activities can also lead to contamination from pesticides that may percolate into groundwater or wash off from fields into surface waters. Construction activities can result in large amounts of sediment being washed into rivers and streams.

Flooding is a natural event that may also be a source of contamination to sources of water supply. Surface runoff, which is a major contributor to flooding, can carry dirt, oil, pesticides, fertilisers and other contaminants that might be washed off from surrounding land.

16.2.2 The use of water at home

As you know, water is said to be safe to drink when it is free from pathogens, physical contaminants and chemical contaminants. This needs to apply right up to the point when water goes in the mouth**.** Identifying and assessing the potential risks associated with the collection and use of water is therefore a very important part of the survey (Figures 16.1 and 16.2). You need to ask users, or observe their practice, on:

- How they collect the water and the types of vessel they use (e.g. whether jerrycan, buckets or pots).
- How the vessels are handled and stored when not in use.
- Whether the vessels are used for purposes other than water collection that may contaminate them.
- Whether users know how to collect safe water and keep it safe.
- Whether the water is treated or disinfected after collection and assess the hygiene practices of users, especially young children.

Figure 16.1 Collecting water in jerrycans and traditional pots. (Photo: Richard Adam)

Figure 16.2 Water storage at home. (Photo: Nancy Platt)

16.3 Vulnerability assessment at a water source

A vulnerability assessment is used to determine the likelihood that potential contaminant sources in the drinking water protection area will degrade the source water quality. A vulnerability determination will include consideration of several factors including hydrological sensitivity, the source of contaminants, how these sources can be managed, and the condition of any water source protection.

Hydrological sensitivity means assessing how sensitive a water source is to contamination. Higher sensitivity ratings apply if geological conditions allow contamination to move quickly from its place of origin through the rocks and soil to water sources. Lower ratings apply when contamination moves more slowly.

Another factor is vegetation and surrounding land use. If the land around a water source has no vegetation it is more susceptible to contamination than a water source surrounded by land with thick vegetation. This is because plants and trees can act as a physical and biological barrier to pollutants.

You also need to look at the condition of source water structures. For example, at a well you need to check the well casing, joints, delivery structures and equipment to move water from the well and assess their integrity. 'Integrity' means the quality of design, construction, maintenance and state of repair of the structure.

Factors affecting vulnerability to contamination include:

- Drinking water wells located close to potential sources of contamination have more risk than wells located further away.
- Whether the potential source of contamination is from a single identifiable point which would be easier to manage but could have greater potential for major contamination than diffuse contamination spread over a wider area.

■ Can you think of an example of a possible source of contamination of a water well?

□ Contamination could be caused by a pit latrine or other waste disposal pit if it is sited at a higher level than the well and/or is too close. The wastewater from the pit could slowly seep through the rocks into the groundwater.

16.4 Source water quantity

The quantity of water for users is also an important part of a sanitary survey. An adequate quantity of source water should be available to meet the community's needs. The quantity must be sufficient to meet the anticipated demand of the community. The location of source water supply facilities is also an important factor in determining the ability of the water system to meet the community's needs at all times. The source should be within 1 km or a 30-minute round trip.

■ What is the recommended minimum volume of water needed per person per day?

□ The minimum volume is 20 litres per person per day.

16.5 Sanitary survey of wells

Wells should have a well casing (a liner pipe or tube or stone wall), protective devices such as good fences, and warning signs to discourage human and animal activities that might disturb the well area. Figure 16.3 shows what you should be looking for when you are doing a sanitary survey of a well, and Box 16.1 (on the next page) has a list of questions to be asked. The numbers in the diagram demonstrate particular points and correspond to the questions in the checklist. Answering 'yes' to any of the questions would be a cause for concern.

Note that the minimum safe distance (MSD) between the well and potential sources of pollution will vary depending on the local conditions, particularly the soil type, geology, hydraulic gradient and slope of the land. It should never be less than 15 metres but 30–50 metres is recommended.

In addition to the observations of the physical condition of the well and its surroundings, you should also find out and make a note of the maintenance programme for the well, for example, the frequency of cleaning and disinfection.

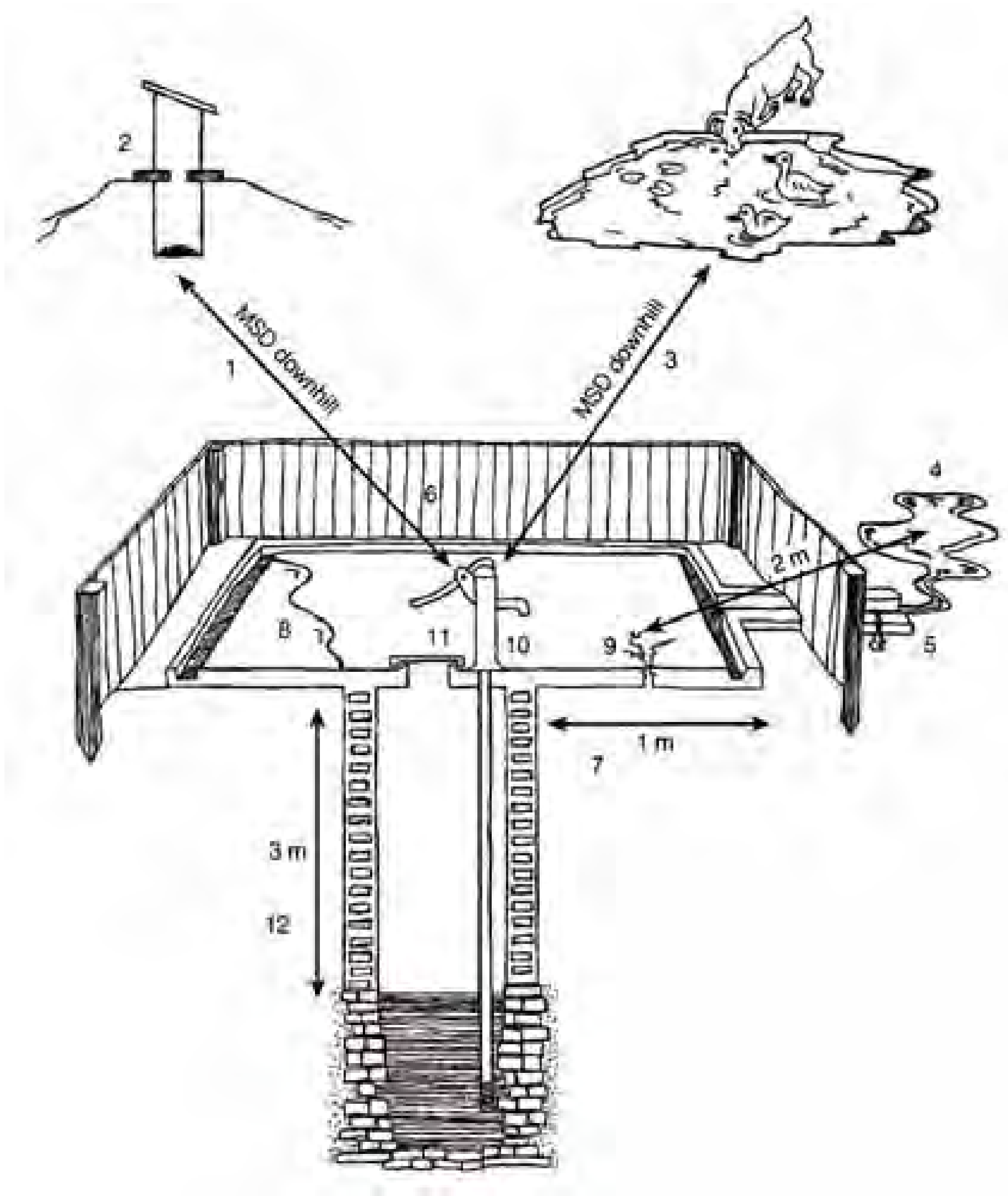


Figure 16.3 Sanitary inspection of a well with handpump. The numbers refer to the questions in Box 16.1. Note: MSD means 'minimum safe distance'. MSD will vary depending on local conditions but should not normally be less than 15 m. (Source: World Health Organization, 1997, *Guidelines for drinking water quality*, Volume 3)

Box 16.1 Sample checklist for well water sanitary inspection

Name of Health Post ____________________

Village name and location of well/handpump

____

Questions to be asked during survey:

1 Is there a latrine within 15 m of the well and handpump?

2 Is the nearest latrine on higher ground than the handpump?

3 Are there any animal excreta or rubbish within 15 m of the handpump?

4 Does the drainage channel contain stagnant water within 2 m of the handpump?

5 Is the drainage channel broken allowing a pool of water to form?

6 Does the wall or fencing around the handpump have any breaks that would allow animals in?

7 Is the concrete floor less than 1 m wide all around the handpump?

8 Are there any pools of water on the concrete floor around the handpump?

9 Does the concrete floor around the handpump have any cracks that could let water in?

10 Is the handpump loose at the point of attachment to the base which could let water enter the casing?

11 Is the cover of the well unhygienic (unclean)?

12 Are the walls of the well poorly sealed at any point for 3 m below ground level?

Name ____________________

Signature ____________________

Date ____________________

16.6 Sanitary survey of springs

When a spring is chosen for a water supply, the sanitary survey should determine that the water quality is acceptable, the quantity of water available is adequate to meet the needs of the community and the spring is protected from contamination. The quantity of water available from a spring can vary significantly due to changes in groundwater storage.

Like wells, springs should have protective devices such as good fences and warning signs to discourage human and animal activities that might disturb the spring area. The spring box or storage tank and cover need to be watertight to prevent undesirable water from entering. Since most springs never stop producing water, an overflow is needed to ensure that water pressure does not build up and damage the spring box. The end of the overflow drain should have a screen to prevent the entrance of animals. Springs should have a diversion ditch located at the uphill end of the site which keeps rainwater from flowing over the spring area. A good impervious barrier, such as clay or a plastic liner, can help ensure high quality water by preventing potential contaminants from entering the collection facilities. Figure 16.4 shows what you should be looking for when you are doing a sanitary survey of a spring and Box 16.2 has a list of questions to be asked. The numbers in the diagram demonstrate particular points and correspond to the questions in the checklist.

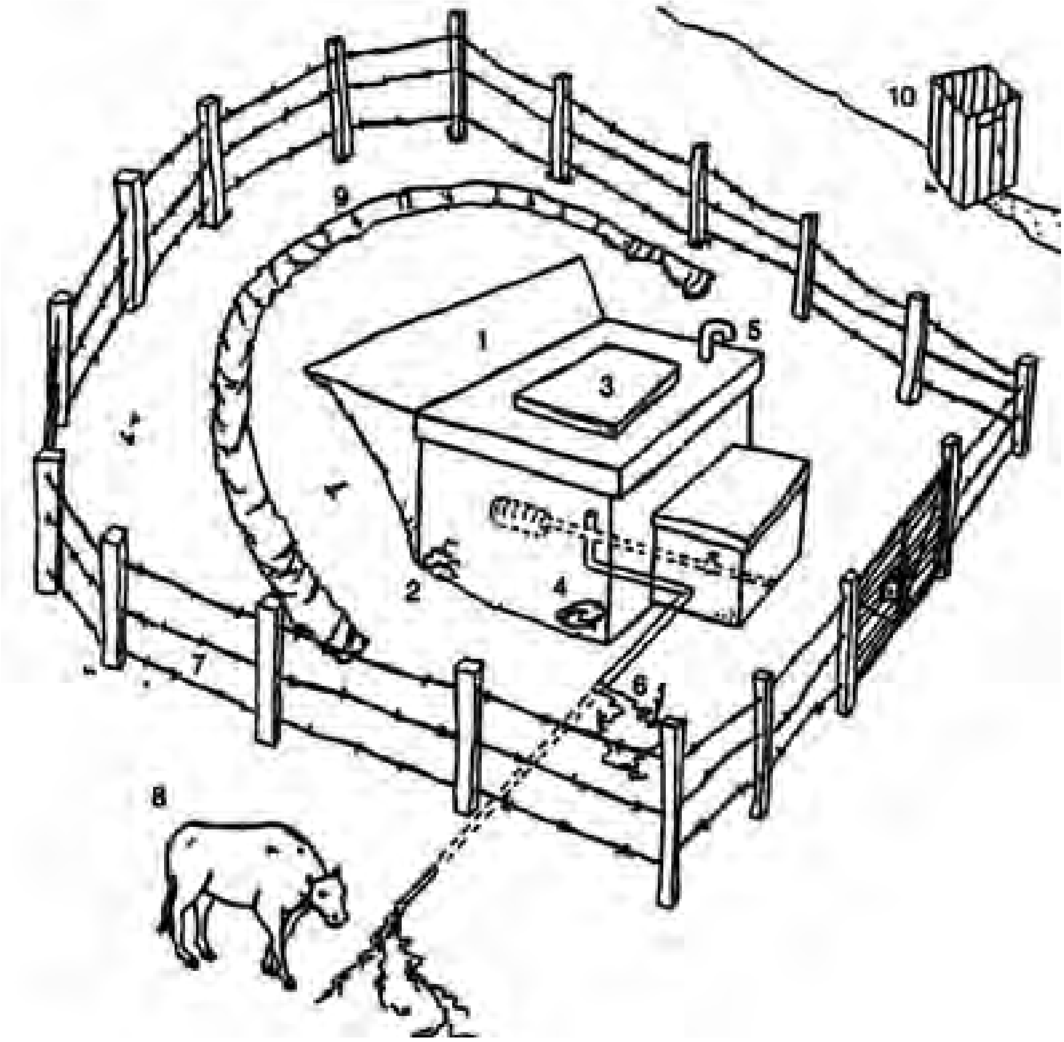


Figure 16.4 Sanitary inspection of a protected spring. The numbers refer to the questions in Box 16.2. (Source: as Figure 16.3)

Box 16.2 Sample checklist for protected spring source inspection

Name of Health Post ____________________

Village name ____________________

Questions to be asked during survey:

1 Is the spring source open to any contamination?
2 Is the stonework protecting the spring broken anywhere?
3 Could contaminants get into the box through the inspection hole?
4 Does the spring box have any contaminating silt?
5 If the spring box has an air vent, could it let in any contaminants?
6 If the spring box has an overflow, is it unsanitary (unclean)?
7 Is the area around the spring unfenced?
8 Do animals have access to within 15 m of the spring source?
9 Is a diversion ditch above the spring absent or non-functional?
10 Are there any latrines uphill of the spring?

Name ____________________

Signature ____________________

Date ____________________

16.7 Sanitary survey of rainwater collection and storage

As you learned in Study Session 15, rainwater harvesting is applicable for areas that have a shortage of other water sources. The roof from which rain is collected should be free from contaminants. There also needs to be a clean and well-constructed tank with no cracks in the walls and a properly covered inspection hole. Figure 16.5 shows what you should be looking for when you are doing a sanitary survey of rainwater collection and Box 16.3 has a list of questions to be asked. As before the numbers in the diagram demonstrate particular points and correspond to the checklist of questions. Any ‘yes’ answers would be a cause for concern.

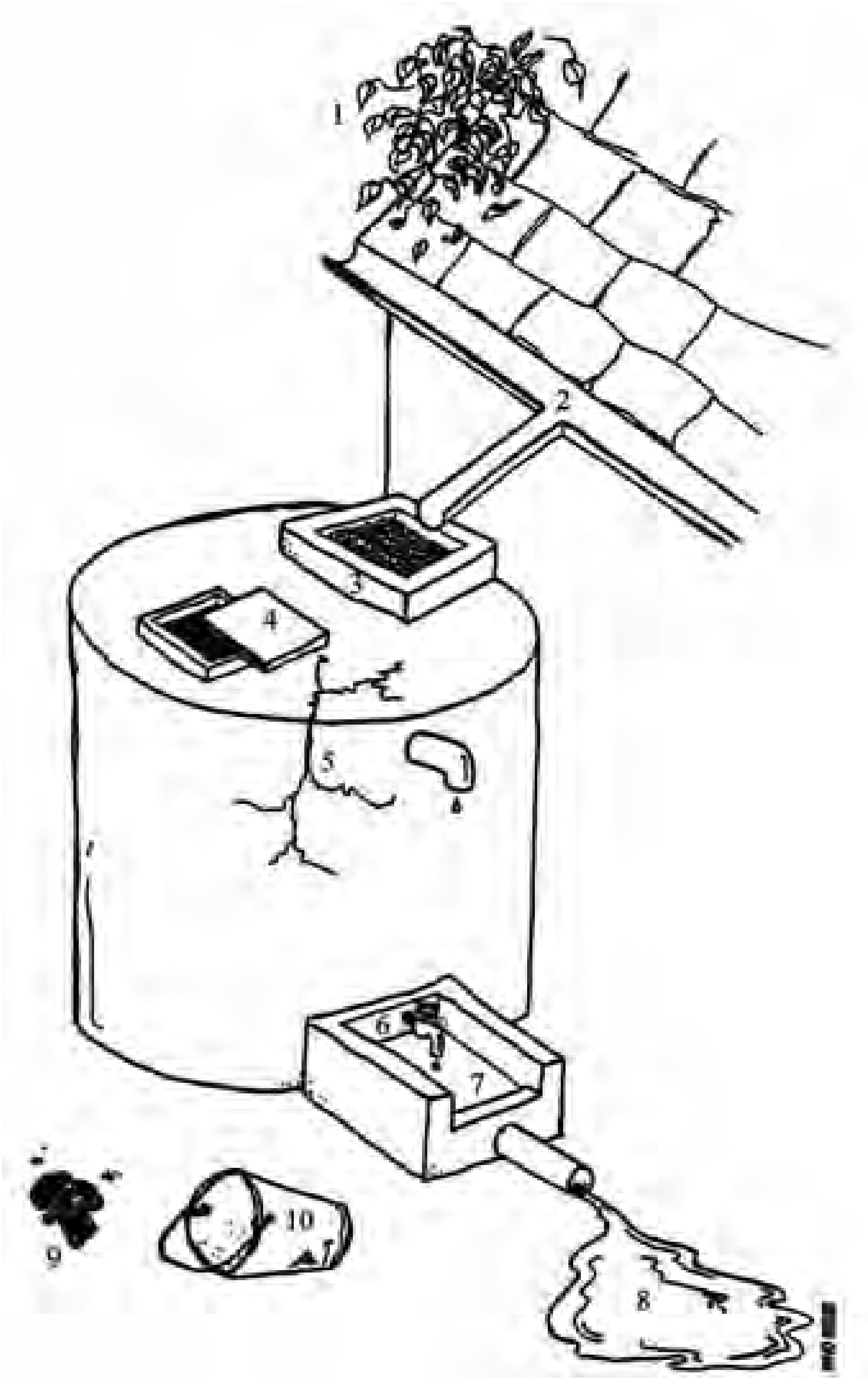


Figure 16.5 Rainwater collection and storage. The numbers refer to the questions in Box 16.3. (Source: as Figure 16.3)

Box 16.3 Sample checklist for rainwater collection and storage inspection

Name of Health Post ____________________

Village name ____________________

Questions to be asked during survey:

1 Does the roof have any visible contaminants (plants, dirt or excreta)?

2 Are the guttering channels that collect the water dirty?

3 Does the filter box at the tank inlet have any defects that could let in fine dusts?

4 Does the tank have any other point of entry which is not properly covered?

5 Do the walls or top of the tank have cracks or holes that could let water in?

6 Does the tap leak or have any defects?

7 Does the concrete floor under the tap have any defects?

8 Does the water collection area drain inadequately?

9 Does the area around the tank or water container have any source of pollution like faeces?

10 If a bucket is in use and left in place, is it exposed to contamination?

Name ____________________

Signature ____________________

Date ____________________

16.8 Water quality assessment

As you know, water can be polluted by chemical or biological contaminants and the water may be harmful to humans when consumed. There are many analytical methods used to test for the presence and concentration of possible pollutants. You are not expected to carry out microbiological and chemical tests of drinking water but it will help you if you understand the principles.

If at all possible, drinking water should not contain any pathogenic microorganisms. It would be very difficult and time-consuming to test for all the possible pathogens. The source of the pathogens is usually human faeces; therefore, tests have been devised that detect the presence of faecal contamination. If faecal contamination is found, this indicates that pathogenic organisms may be present.

The most widely used tests for faecal contamination are total coliforms, faecal coliforms and *Escherichia* coli (*E.coli*). Coliforms are a group of bacteria found in human and animal faeces and also in soils and some other natural environments. '**Total coliforms**' includes all bacteria in this group. The presence of 'total coliforms' indicates contamination of some sort but, because of their relatively wide distribution, cannot be used to confirm if the contamination is from faeces.

Faecal coliforms are a sub-set of total coliforms and, as the name suggests, are typically found in faeces. However, even this group includes some species that are not necessarily faecal in origin. ***E.coli*** is a type of faecal coliform bacterium that is found only in faeces of humans and other warm-blooded animals. If *E.coli* is present in a water sample, this indicates faecal pollution and the possible presence of pathogenic types that often occur in the intestines as well; the absence of *E.coli* from a sample shows that the chances of faecal contamination of the water, and therefore of pathogens being present, are negligible. Thus the presence or absence of *E.coli* in a water sample provides an important indicator of pollution and public health. However, it is important to realise that *E.coli* is only an indicator and its absence cannot give complete assurance that water is safe. Some pathogens such as *Giardia, Entamoeba histolytica* and some viruses are more resistant to disinfection than *E.coli;* therefore, the absence of *E.coli* will not necessarily mean that water is totally free from other organisms.

Although the great majority of health-related water quality problems are the result of bacteriological contamination, chemical contamination of water sources can also cause serious health problems. For example, the presence of nitrate and nitrite in water may result from the excessive application of fertilisers or from seepage of wastewater into surface water and groundwater. Fluorosis is a common problem in children living in the Rift Valley region of Ethiopia caused by exposure to high levels of naturally occurring fluoride in the water which can lead to mottling of children's teeth (Figure 16.6), skeletal fluorosis and crippling.

Figure 16.6 Fluorosis causes mottling of children's teeth (Photo: Basiro Davey)

Some health effects may occur as a result of specific chemical deficiencies in the diet, of which water forms a part, for example, goitre caused by iodine deficiency and dental caries resulting from low fluoride intake.

Turbidity, colour, taste and odour (smell), whether of natural or other origin, affect people's perceptions of water. As you know water should be free of tastes and odours that would be unpleasant to the majority of people. In extreme cases, people may avoid water that does not look or taste good – even if it is otherwise safe – in favour of more pleasant looking and tasting water that may actually be contaminated. Colour in drinking water occurs due to the presence of organic matter and metals such as iron and manganese. Odour in water is due mainly to the presence of organic substances. Taste is the combined perception of substances detected by the senses of taste and smell. Changes in the normal taste of a municipal water supply can be important as they may signal changes in the quality of the raw water source or deficiencies in the treatment process. Onsite testing is essential for the determination of turbidity and residual chlorine, which change rapidly during transport and storage.

Summary of Study Session 16

In Study Session 16, you have learned that:

1. Sanitary surveys play a major role in prevention and correction of water system deficiencies.
2. Sanitary surveys begin at the source of the water. Preventing source water contamination is the most effective means of preventing contaminants from reaching consumers.
3. Source water quality, quantity, location of water source and condition of the water source facilities are the key elements of a sanitary survey.
4. Sanitary surveys also include assessment of water use in the home and ensuring that household practices do not allow recontamination.
5. Wells, springs and rainwater cisterns are important sources of water to which you need to pay attention when you are doing sanitary surveys.
6. Faecal coliform bacteria and *E.coli* are used to test for the presence of faecal contamination and to indicate the likelihood of the presence of pathogenic organisms in drinking water.

Self-Assessment Questions (SAQs) for Study Session 16

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the following questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 16.1 (tests Learning Outcome 16.1)

Which of the following statements is *false*? In each case explain why it is false.

A *E.coli* is a type of virus found in faeces.
B Faecal coliforms are typically found in human and animal faeces.
C The presence of *E.coli* in a water sample means the water is safe to drink.
D The absence of *E.coli* in a water sample means the water is safe to drink.

SAQ 16.2 (tests Learning Outcome 16.2)

In a village there is a protected dug well. The water is treated frequently by chlorine and contamination is avoided. However, you hear that there are several cases of diarrhoea in children. Where would you suspect the water could possibly be recontaminated and what would you do?

SAQ 16.3 (tests Learning Outcome 16.3)

Suppose you have a joint plan with environmental health experts to assess the quality of water from a well. What tests would you do?

SAQ 16.4 (tests Learning Outcome 16.3)

The people in Agita village have two possible water sources available to them – a protected well and a river. Water quality surveys were undertaken by you and environmental health experts. The results indicate that the river water is highly contaminated with pathogenic microorganisms, but it has a good taste. The well water is tasteless but is not contaminated with pathogenic microorganisms. How would you explain to the villagers that they should use water from the well?

SAQ 16.5 (tests Learning Outcome 16.4)

You are about to set off from your Health Post for a neighbouring village to conduct a sanitary survey of a protected spring. What would you take with you? Name four things you will be looking for during your survey.

Study Session 17 Water Pollution and its Control

Introduction

In the previous study sessions you have learnt about the importance of protecting water from contamination and the techniques for undertaking a sanitary survey of drinking water. In this study session, you will learn about the sources and types of water pollution, the public health impacts and indicators of water pollution and approaches to the control of pollution.

Learning Outcomes for Study Session 17

When you have studied this session, you should be able to:

17.1 Define and use correctly all of the key words printed in **bold**. (SAQ 17.1)

17.2 Describe the sources and types of water pollution. (SAQ 17.2)

17.3 Explain some techniques for the control of water pollution. (SAQ 17.3)

17.4 Describe techniques for taking samples from drinking water sources. (SAQ 17.4)

17.1 Sources of water pollution

Water is a good solvent. This is the reason why many different chemical substances are found dissolved in water. Gases in the atmosphere will dissolve in rainwater as it passes through the air. By the time water reaches a stream or river, it will contain a variety of chemical compounds dissolved within it from the air and from the rocks and soil through which it has percolated. These compounds may be completely harmless, naturally occurring substances, but they may also include pollutants.

Pollution can be defined as the introduction into the natural environment (air, water or land) of substances (**pollutants**) that are liable to cause harm to human health or to animals, plants and the wider environment. **Water pollution** occurs when a river, lake or other body of water is adversely affected due to the addition of pollutants (Figure 17.1).

Water quality can be affected by pollution from point sources and non-point sources. **Point sources** are identifiable points or places, such as a pipe or channel, which discharge directly into a body of water. This might be from wastewater treatment plants, factories and industrial plants, latrines, septic tanks or piped discharge from barnyards and other places where livestock are confined. **Non-point sources** are those where pollution arises over a wider area and it is often difficult to locate the exact place of origin. For example, fertiliser or pesticide washed from a field by rain may seep into a river or stream at many places both on the surface and through the soil. Pollution from non-point sources, also known as *diffuse pollution*, contributes most of the contaminants in rivers and lakes. Other non-point sources are pollution from construction sites and other land disturbances. The problems in identifying the exact point of origin make non-point sources much more difficult to control.

Figure 17.1 Washing lorries and cars in rivers is a source of water pollution. (Photo: Nicholas Watson)

- ■ Look at Figure 17.1. What pollutants are likely to be washed into the river from the lorry? Is this a point source or non-point source of pollution?
- □ Dust and dirt from the lorry will be washed into the river. Some oil and fuel may also be washed from the underside. The lorry is the single source of pollution so this is an example of a point source.

17.2 Types of water pollutants

17.2.1 Sediments and suspended solids

Sediments consist of fine particles of mostly inorganic material such as mud and silt washed into a stream as a result of land cultivation and construction. They may also arise from demolition and mining operations where these activities take place. The presence of solid particulate material suspended in the flowing water is the reason why many rivers look brown in colour, especially in the rainy season. The particles are called suspended solids while they are carried (suspended) in flowing water. When they settle to the bottom, they are called sediments.

Organic matter means anything that is derived from living organisms, i.e. all plants and animals. Inorganic matter has a mineral, rather than biological, origin meaning it comes from rocks and other non-living sources.

Large quantities of **inorganic matter**, in the form of suspended solids, may reduce light penetration into the water which can affect the growth of plants. Sediments may even suffocate organisms on the river bed. River water may also contain **organic matter**, such as human and animal wastes, which can deplete (reduce) the oxygen in the water if the river is slow-flowing (see Box 17.1). This can lead to anaerobic conditions which may create unsightly conditions and cause unpleasant odours.

Box 17.1 Oxygen in water

Many aquatic (water living) organisms depend on oxygen dissolved in the water to survive. Aquatic animals include fish, amphibians and many invertebrate species such as insect larvae, snails and worms. Their supply of oxygen in the water is maintained from atmospheric oxygen in the air above the water and from oxygen produced by green aquatic plants by the process of *photosynthesis*. Fast-flowing, turbulent water will be aerated (gain oxygen) more than still water because the boundary between air and water is more active.

If organic pollutants such as human and animal wastes are released into a water body, bacteria will use the waste as food and break it down into simpler, less harmful substances. As they do this, the bacteria will use up the dissolved oxygen from the water. This is called **deoxygenation**. If the quantity of organic pollution is high, then all the oxygen from the water may be used up leading to anaerobic (without oxygen) conditions. This is unlikely in a river where the water is moving but can happen in lakes or slow-flowing channels.

Inorganic solids, such as mud and silt, do not have this effect because they are inert (stable and inactive) and cannot be used as food by bacteria.

17.2.2 Nutrients

Phosphorus and nitrogen are common pollutants generated from residential areas and agricultural runoff, and are usually associated with human and animal wastes or fertiliser. Nitrogen and phosphorus are plant nutrients required by plants to grow. They are spread on farmland in the form of fertilisers. Rain washes these nutrients into rivers, streams and lakes. If the nutrients are present in large quantities, they can encourage excess plant growth in the water causing the phenomenon known as an *algal bloom*, which means a sudden increase in the population of microscopic algae. If a water body has high nutrient levels it is said to be eutrophic; the process is called **eutrophication**. The main problem of eutrophication is that the suddenly increased population of aquatic plants can die off equally quickly. The decay of the plant material by bacteria can cause deoxygenation of the water.

■ Can you think of a reason why eutrophication is more likely to be a problem in lakes than in rivers?

□ Because flowing water in a river will disperse the nutrients; in the still water of a lake, the nutrients will accumulate.

17.2.3 Biological pollutants

Biological pollutants are microorganisms (bacteria, viruses, protozoa and helminths) that are harmful to humans and other forms of life. Infectious diseases caused by biological pollutants, such as typhoid and cholera, are the most common and widespread public health risks associated with drinking water.

Microorganisms may get into water with dust from the air as rain falls, and when water passes through soil which is polluted with human and animal wastes. The contamination of water supplies with raw sewage (human and domestic wastes generated from residential areas) is the most common route for biological pollutants to enter water.

When contaminated river water moves downstream it is possible that any pollutant will be diluted as more water flows in and so increases the total volume of water in the river. This dilution may be enough to reduce the contaminants sufficiently to minimise the possible health effects but this process may not work for all pathogens.

Bacteria

Many different types of bacteria are found in fresh water. They are not all pollutants because many are not harmful in any way and play a valuable role in the natural breakdown of organic matter and the cycling of nutrients. Other bacteria, however, as you have learnt in other sessions, are pathogens, and are the cause of many waterborne diseases. The presence of faecal coliform bacteria in drinking water, and *E.coli* in particular, can indicate a possible presence of harmful, disease-causing organisms.

Viruses

Enteric (intestinal) viruses are produced by infected persons and excreted in faeces. Viral contamination may come from sewage effluent discharged into a river or from open defecation by an infected person which may be washed by rainwater to a river or stream. Some enteric viruses are resistant to chlorination. The common waterborne viruses are polio, hepatitis A and rotavirus. The presence of any enteric virus in water bodies can be taken as an indication of the possible presence of other harmful viruses.

Protozoa

There are several protozoa that can be discharged into water bodies from infected persons. For example, *Cryptosporidium* and *Giardia* are common problems in rural parts of Ethiopia.

■ What type of household water treatment is appropriate for removing protozoa from drinking water?

□ A home sand filter is appropriate for removing protozoa from drinking water. The layers of sand and gravel will trap the protozoa.

Helminths

Helminths or parasitic worms can also cause ill health in humans. Infection occurs through ingestion of the helminth eggs which may be present in food. For example, helminth eggs may be present in the meat of cattle grazing on land contaminated by faeces.

■ Can you think of an example of a helminth infection that is transmitted by polluted water?

□ Guinea worm (dracunculiasis) is transmitted by drinking water that contains copepods infected by the larvae of the worm.

17.2.4 Chemical pollutants

Heavy metals

Arsenic, copper, lead, mercury and cadmium are chemical pollutants that may be found in lakes, rivers and groundwater. Fortunately these are not common problems in rural Ethiopia. These heavy metals can harm aquatic organisms and humans. Farmers who use river water polluted by urban wastes for irrigation of fruits and vegetables may find their crops affected by the accumulation of these chemicals.

Pesticides

Pesticides include insecticides, herbicides and fungicides. There are several thousand different types in use and almost all of them are possible causes of water pollution. For example, DDT, malathion, parathion, delthametrine and others have been sprayed in the environment for long periods of time for the control of disease vectors such as mosquitoes, and to control the growth of weeds and other pests.

17.2.5 Types of pollutant defined by their source

Pollutants from certain sources may be a mixture of the types described above and therefore need a separate category because they combine several possible impacts. Municipal wastewater and agricultural wastes are in this category.

Municipal wastewater is generated from residential areas and often contains high concentrations of organic matter, phosphorus and nitrogen, pesticides, toxic chemicals, salts, inorganic solids such as silt, as well as pathogenic bacteria and viruses.

Agricultural wastes are generated from livestock and poultry farming and from growing crops. They can be the source of many organic and inorganic pollutants in surface waters and groundwater. Agricultural wastes include sediment from erosion of cropland, and phosphorus and nitrogen compounds that originate in animal wastes and commercial fertilisers. Animal wastes require oxygen to be broken down in water bodies and can also harbour pathogenic organisms. The extensive use of fertilisers and pesticides in agricultural regions means that both surface and groundwater are affected by these pollutants.

■ What is likely to happen when fertiliser is washed off agricultural fields into a lake?

□ Fertiliser contains nitrate and phosphate, which are plant nutrients. If these are washed into a lake the water will become eutrophic (high concentrations of nutrients).

17.3 Public health impacts of water pollution

Waterborne infectious diseases are transmitted primarily through contamination of the water sources with excreta of humans and animals who are either active cases or carriers of disease. Carriers do not show any signs of disease although they have disease-causing agents in their body that can be transferred to others; active cases are people who are displaying visible signs of disease. Use of contaminated water for drinking or cooking, or contact with contaminated water during washing or bathing, may result in infection.

The dose or amount ingested that is necessary to cause illness depends on the type of pathogen. Exposure to a single pathogenic organism does not always result in infection and disease. Sometimes many pathogens, perhaps several hundred, must be ingested to cause infection. The minimum infectious dose also varies with the age, health, nutritional and immunological status of the exposed individual. Infants and young children, people who are debilitated, people who are living in unsanitary conditions, people who are sick and the elderly are at greatest risk of waterborne diseases.

17.4 Indicators of water pollution

The physical, chemical and biological characteristics of water are changed when the water is contaminated with different pollutants. Water is colourless, odourless and tasteless, as you know, but when it is polluted with physical and chemical pollutants the water may have colour, odour and taste.

- ■ If water is completely clear and has no colour or odour, is it safe to drink?
- □ Not necessarily, because it may contain microorganisms or dissolved chemicals that cannot be seen.

To know whether water is polluted with specific bacterial contaminants, samples should be taken and sent to a laboratory for analysis. As noted in Study Session 16, *E.coli* is the standard indicator organism for faecal contamination of water and for the possible presence of faecal pathogens. For water intended for drinking, the World Health Organization (WHO) recommends that *E.coli* must not be detectable in any 100 ml sample. In most developing countries like Ethiopia the priority is to get from 'bad' quality (more than 1,000 faecal coliforms per 100 ml) to 'moderate' quality (less than 10 faecal coliforms per 100 ml). 'Good' quality is classed as zero faecal coliforms per 100ml.

17.5 Effects of pollution on water sources

17.5.1 Streams and rivers

Streams and rivers are not only potential water sources for humans, they are also important aquatic habitats for many plants and animals. Pollution can have a damaging effect on aquatic ecosystems (see Box 17.1) as well as potentially on human health.

Box 17.1 Aquatic ecosystems

Ecosystem was defined in Study Session 2. It means a community of living organisms that interact with each other, plus the environment in which they live and with which they also interact. An ecosystem therefore includes plants, animals and microorganisms and their physical environment which may be land, trees, soil, ocean, freshwater, etc., and also includes the relationships between all these components. Aquatic ecosystems can be categorised as marine ecosystems in the ocean, and freshwater ecosystems in rivers, lakes and other surface water bodies (Figure 17.2).

Figure 17.2 Lakes and rivers are important aquatic ecosystems supporting many forms of life in and around the water. (Photos: Pam Furniss)

The effect of pollution on streams and rivers depends on the type of pollutant. Some substances are acutely toxic to aquatic plants and animals and will cause dead zones downstream from the pollutant source in which no living organism is found. Other pollutants are health concerns to humans, but have little impact on aquatic communities.

One of the most common types of freshwater pollutant is biodegradable organic material. When a high concentration of organic material such as raw sewage (human excreta) is discharged into a stream, the levels of dissolved oxygen in the water may fall so low that the water is completely deoxygenated.

■ Why does the dissolved oxygen level fall if organic material pollutes a river?

□ Bacteria that break down the organic material require oxygen to survive. They use the oxygen dissolved in the water causing the level to fall.

17.5.2 Lakes

The effect of pollution on lakes differs in several respects from the effect on rivers. Water movement in lakes is slower than in rivers so re-aeration is slower. The reduction in flow rate as a stream enters a lake also causes sediments to settle out of the water and slowly accumulate on the bottom of the lake. Some pollutants are bound to the solid particles and will therefore also accumulate in the sediment.

17.5.3 Groundwater

Water that moves through the soil will, to some extent, be purified naturally. However, this is not always true because soil cannot remove all pollutants. Many soils have the ability to remove certain types of pollutants, including phosphorus, heavy metals, bacteria and suspended solids. However, pollutants that dissolve in water, like nitrate and ammonia from fertilisers and animal wastes, can pass through soils into the groundwater. This may cause high concentrations of pollutants in local drinking water wells. Leaking from underground storage tanks, solid waste landfills, improperly stored hazardous waste, careless disposal of solvents and hazardous chemicals on ground surfaces are other potential sources of groundwater pollution.

- ■ Why is it important for pit latrines to be located at least 15 metres from the nearest well and at a lower level?
- □ Because, depending on the local geology, liquid from the pit could flow through rock and soil into the groundwater and to the well. If the latrine is at a lower level than the well, the effect of gravity will make groundwater contaminated from the pit flow away from the well.

17.6 Problems of using polluted water

The impacts of using contaminated water for drinking have been discussed in other study sessions. However, we use water for other purposes that can also be affected by water pollution such as irrigation, for livestock and for recreation.

Contaminants in irrigation water (Figure 17.3) may accumulate in the soil and, after a period of years, render the soil unfit for agriculture. Even when the presence of pesticides or pathogenic organisms in irrigation water does not directly affect plant growth, it may potentially affect the acceptability of the agricultural product for sale or consumption.

Figure 17.3 An irrigation channel carries water from the river to the fields. (Photo: Pam Furniss)

Poor quality water can affect livestock by causing death, sickness or impaired growth. Some substances, or their degradation products, present in water used for livestock may occasionally be transmitted to humans. The purpose of good quality water used for livestock watering is, therefore, to help protect both the livestock and the consumer.

Contaminated water also has health problems for those who swim in it. They may become ill if the water is contaminated with faecal material or with microorganisms that could cause gastrointestinal illness or ear, eye or skin infections. For example, schistosomiasis is contracted simply by swimming or standing in water that is contaminated with the *Schistosoma* worm.

17.7 Control of water pollution

The control of pollution should ideally take place at the point of generation, or, in other words, it should be prevented at source. As you have learned from the sanitary survey, you should look out for possible sources of pollutants in your locality.

The control of excess nutrients is an important issue both from a public health perspective and to keep natural waters free from eutrophication. An increasing proportion of water pollution originates from diffuse (non-point) sources, such as agricultural use of fertilisers. Farmers may need guidance on good agricultural practices that will help reduce water pollution from agriculture. For example, the amount of fertiliser used and the timing of its application can make a significant difference.

- ■ Imagine you are a farmer thinking about the best time to apply fertiliser to your field. Would it be better to spread the fertiliser before or after heavy rain?
- □ It would be better after the rain because if the fertiliser was spread beforehand then much of it would probably be washed away. This would not only pollute the nearest river but would, of course, also reduce the effectiveness on the crop.

Pollution prevention is best achieved by ensuring that each potential point source is properly sited, designed, constructed and managed; the aim being to contain the pollutants and prevent their uncontrolled release to the environment. Sources of pollution should be sited as far from watercourses as possible (at least 15 m away) and below any water sources on the site. Appropriate use of excreta disposal, solid waste disposal and animal waste disposal will help prevent contamination of both surface and groundwater. (You will learn more about this in the waste management study sessions that follow.)

Springs usually become contaminated when latrines, animal yards, sewers, septic tanks, cesspools or other sources of pollution are located on higher land nearby. In areas with limestone rocks, contaminated material can enter the water-bearing channels in the rock and descend through cracks and holes or other large openings and may be carried along with groundwater for long distances. Other rock types can have a similar effect so it is important to have knowledge of the local geology to assess the probability of groundwater contamination.

- ■ What are the key preventive measures that will help to ensure that spring water is of a consistently high quality?
- □ The key measures are:
  - Dig a diversion ditch above the spring that will take surface water away from it.
  - Build a fence to keep animals away from the spring.
  - Design and build a protection box for the spring that will prevent contamination.
  - Monitor the condition of the spring and the quality of the water regularly.

Monitoring of the quality of spring water and other sources would be done by you and environmental health experts.

For rainwater harvesting, pollution control means proper maintenance of the roof and gutters and careful cleaning at the beginning of every wet season. Some form of mesh should be placed between the guttering and the pipe that leads to the storage tank to prevent the entry of coarse debris; it then becomes important to clean the screen regularly to prevent blockage. The worst fouling of roofs occurs when they are situated under trees in which birds roost. A rainwater storage tank should be completely covered and well maintained.

The *catchment area* of the water source is the total area of surrounding land that slopes towards the source. Water can become polluted from sources in the catchment even though they may be some distance away. Ideally, the whole catchment area should be protected to avoid pollution and erosion. Preserving the vegetation in the surrounding area can help protect the spring from pollution and from siltation caused by soil erosion.

17.8 Sampling methods for bacteriological testing

During the course of an investigation into a disease outbreak or as part of routine monitoring, you may be required to take water samples to be sent for microbiological or chemical analysis. It is important that samples are taken carefully and correctly to ensure they can be used for an accurate assessment of the condition of the source. When water samples are collected for analysis, you should take care to ensure that there is no external contamination of the samples. Glass bottles, rather than plastic, are best used for sampling. Both bottles and stoppers (caps) must be sterilised. Bottles should be clearly labelled with the place where the sample was taken and the date. You should be able to obtain sample bottles from your regional public health microbiology laboratory or your local environmental health office.

You may need to take water samples from a tap, river, lake, water tank or dug well, and each has a slightly different procedure to follow.

17.8.1 Sampling procedure from a tap or pump outlet

To obtain a representative sample of water, you should carefully follow the sampling procedure described below and illustrated in Figure 17.4. The steps are:

- Clean the tap/outlet using a clean cloth to remove any dirt.
- Open the tap and turn on at maximum flow and let the water run for 1 to 2 minutes; then turn it off.
- Sterilise the tap for a minute with the flame from a cigarette lighter, or an ignited alcohol-soaked cotton-wool swab.
- Open the tap again and allow the water to flow for 1 to 2 minutes at a medium flow rate.
- Open a sterilised bottle by carefully unscrewing the cap or pulling out the stopper.
- Immediately hold the bottle under the water jet and fill.
- While filling the bottle, hold the cap face downwards to prevent entry of dust, which may contaminate the sample.
- Place the stopper in the bottle or screw on the cap. A small air space should be left to make shaking before analysis easier.

Figure 17.4 Procedures for sampling water from a tap. (Source: WHO, 1997, *Guidelines for drinking water quality*, Volume 3)

17.8.2 Sampling procedure from a watercourse or reservoir

The steps are:

- Open the sterilised bottle as described above.
- Fill the bottle by holding it by the lower part and submerging it to a depth of about 20 cm, with the mouth facing slightly upwards. If there is a current, the bottle mouth should face towards the current (Figure 17.5).
- The bottle should then be capped or stoppered.

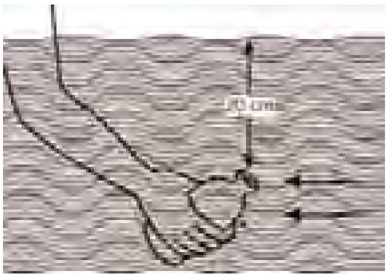


Figure 17.5 Sampling of water from surface water (rivers, ponds etc.). (Source: as Figure 17.4)

17.8.3 Sampling procedure from dug wells and similar sources

The steps are:

- Prepare the bottle with a piece of string and attach a clean weight to the sampling bottle. (Figure 17.6)
- Take a 20 m length of clean string rolled around a stick and tie it to the bottle string.
- Open the bottle as described above.

- Lower the bottle, weighed down by the weight, into the well, unwinding the string slowly. Do not allow the bottle to touch the sides of the well.
- Immerse the bottle completely in the water and lower it well below the surface but without hitting the bottom or disturbing any sediment.
- Raise the bottle when it is judged to be filled, rewind the string on the stick to bring up the bottle. If the bottle is completely full, discard some water to provide an air space.
- Stopper or cap the bottle as described previously.

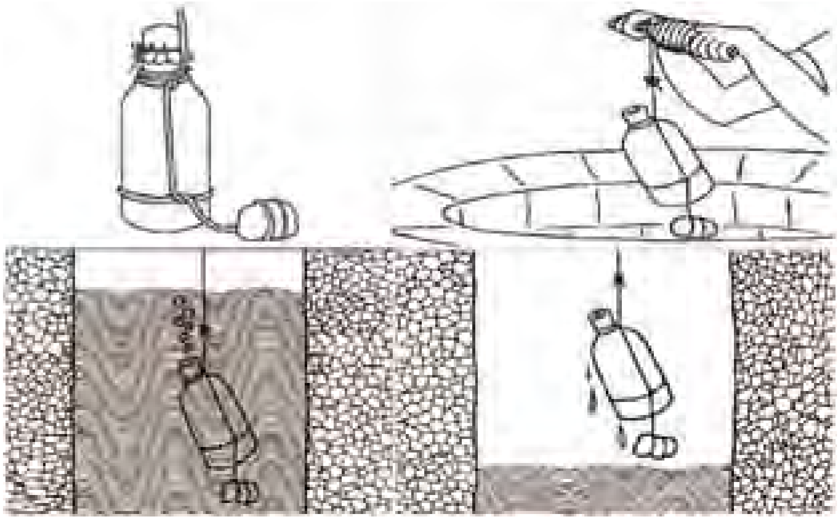


Figure 17.6 Procedure for sampling water from a well. (Source: as Figure 17.4)

Summary of Study Session 17

In Study Session 17, you have learned that:

1 Water pollution is any contamination of water with substances that are detrimental to human, plant or animal health.

2 Water pollutants can be of point or non-point source depending on whether substances are discharged directly into a body of water or indirectly from diffuse sources.

3 There are various types of water pollution including organic and inorganic sediments, nutrients, biological and chemical pollutants.

4 Biological pollutants include bacteria, viruses, protozoa and helminths. They enter the water from human faeces from infected people and are the cause of many water-related diseases.

5 The effects of water pollution on an aquatic ecosystem depend on the type of pollutant and the type of water body.

6 Ideally pollution control should take place at the point of origin, i.e. pollution should be prevented at source.

7 There are specified procedures to follow when taking a water sample for analysis to ensure the sample is representative.

Self-Assessment Questions (SAQs) for Study Session 17

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the following questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 17.1 (tests Learning Outcome 17.1)

Match the words in list A with the corresponding phrases in list B, by drawing an arrow between them.

A	B
Contaminant	Diffuse source of pollution
Eutrophication	The source of pollutants is visible at time of discharge
Point source pollution	A foreign component in a substance
Non-point source pollution	High levels of plant nutrients in water

SAQ 17.2 (tests Learning Outcome 17.2)

In the village of Felashit, there are two dug wells. Some villagers fetch water from the eastern well and another group fetches water from the well dug on the western part of the village. The residents in the eastern part of the village are suffering from an outbreak of diarrhoea. What might be the possible reasons for this?

SAQ 17.3 (tests Learning Outcome 17.3)

Suppose you are working in a village and the community members want to know how they should protect their water source from pollution. What pollution control techniques would you tell them about?

SAQ 17.4 (tests Learning Outcome 17.4)

Imagine that you have been asked to take water samples from the two wells in Felashit village for chemical and microbiological analysis. What would you do to ensure that accurate samples were taken?

Study Session 18 Introduction to the Principles and Concepts of Waste Management

Introduction

In this study session you will learn about the basic concepts and principles of waste management. The definition of common terms and discussion of the concepts, principles and classification of wastes will help you understand the subject of waste management. You will also learn about the public health importance of solid waste and liquid waste management, and be introduced to the basic principles and process of waste decomposition. This is relevant for you to understand how waste is decomposed and can be treated or made safe from pathogenic organisms.

Learning Outcomes for Study Session 18

When you have studied this session, you should be able to:

18.1 Define and use correctly all of the key words printed in **bold**. (SAQ 18.1)

18.2 Outline the basic concepts and principles in waste management. (SAQs 18.2 and 18.3)

18.3 Describe the public health importance of solid and liquid waste management. (SAQ 18.4)

18.4 Identify the main types of waste and their sources. (SAQ 18.5)

18.1 Basic principles and concepts of waste management

Waste is introduced into the environment due to the day-to-day activities of humans. **Waste management** refers to the many methods and processes of dealing with waste at every stage from generation and collection through to final disposal.

Waste needs to be managed in order to prevent contact with humans or their immediate environment. Therefore, the main purpose of waste management is to isolate waste from humans and the environment, and consequently, safeguard individual, family and community health. In addition, the aesthetic value of a better outlook and a clean physical environment is important for our emotional wellbeing.

The waste we produce can be categorised as **liquid waste** or **solid waste** depending on its physical state. It can also be categorised as hazardous or non-hazardous (see Box 18.1).

Box 18.1 Hazardous and non-hazardous waste

Hazardous wastes are not classified by their physical state (solid, liquid or gas) but by their properties and potential to cause harm. Hazardous wastes are defined as wastes that have one or more of the following properties. They may be:

- corrosive (substances that cause damage on contact, e.g. acids)
- ignitable (materials that can catch fire easily like benzene)
- toxic (materials that can be poisonous to humans when inhaled or ingested, or come in contact with skin or mucous membranes)
- reactive (substances that can yield a harmful chemical if they react with other substances)
- infectious (substances that are capable of causing or communicating infection).

Potential sources of hazardous waste in rural households include obsolete pesticides, herbicides or rodenticides.

Non-hazardous wastes include all other types of waste.

18.1.1 Liquid waste

Liquid waste includes human waste, runoff (storm water or flood water), sullage, industrial wastewater and other forms of **wastewater** from different sources. Human waste is mainly composed of faeces and urine, which together are known as **excreta**. All human body waste is classed as liquid waste. The mixture of human waste with wastewater is known as **sewage** and also sometimes known as **blackwater. Runoff** is simply rainwater that collects on the ground and runs off into channels, ditches and rivers. **Sullage**, also known as **greywater,** is water that has been used for washing in bathrooms and kitchens; it does not include human waste.

Human waste is **biodegradable** (see Box 18.2) and when contained in a waste containment facility (for example, a pit latrine or septic tank) it undergoes a biological digestion process by which microorganisms, particularly bacteria, decompose the organic matter. The decomposing bacteria found in pit latrines and septic tanks do not require oxygen and are called *anaerobic* bacteria. The digestion process may take from several days to a few months, depending on the atmospheric temperature and other local conditions, before it is completely decomposed or degraded. The digested waste matter is called **sludge.**

Box 18.2 Biodegradable and non-biodegradable wastes

Biodegradable wastes are those that can be broken down (decomposed) into their constituent elements by bacteria and other microorganisms. The term can be applied to both liquid and solid waste. Human and animal wastes, food waste, paper, and agricultural wastes are all biodegradable. This natural biological decomposition process ensures that, under the right conditions, these wastes do not accumulate in the environment.

Many plastics are not biodegradable and these create environmental problems because they remain unchanged for many years (Figure 18.1). The bacteria responsible for biodegradation may be **aerobic**, meaning they require oxygen, or **anaerobic**, meaning they do not need oxygen to survive. Decomposition of biodegradable wastes by anaerobic bacteria is sometimes called digestion.

Figure 18.1 Non-biodegradable plastics are a problem because they persist in the environment and do not decompose. (Photo: Pam Furniss)

- ■ Do you think human waste is a danger to health?
- □ Yes it is. Human waste must be considered as potentially infectious matter because it may contain pathogenic organisms.

Although human waste is a potential source of disease, the amount of human faeces disposed of indiscriminately in open fields and under bushes, mostly in rural settings of Ethiopia, is a major problem. In rural areas, a large proportion of households do not have pit latrines and although this situation is changing, open defecation continues to be widely practised. Open defecation can spread disease, contaminate the soil and pollute drinking water sources, as discussed in previous study sessions. To avert these risks, households and communities should work towards community goals to be ‘open defecation free’. This can be achieved through the building, and consistent use of, onsite communal or human waste disposal facilities. You will learn more about this in later sessions of this Module. Onsite facilities are, for example, pit latrines built in the compound of households; communal or public facilities are latrines built in streets or in market places. These public latrines are also referred to as municipal facilities.

18.1.2 Solid waste

Solid waste is defined as any waste that is dry in form and is discarded by people as unwanted. You can describe the solid waste from general housekeeping as residential waste, refuse, household waste or domestic waste. Waste produced in other areas is defined as industrial, commercial, institutional or agricultural waste, or street sweepings, depending on its source. In urban settings, municipal waste refers to the solid waste that is collected by local government (the municipality) and may include household, commercial, industrial waste and street sweepings. The solid waste that is produced as a result of food preparation, or any foodstuff leftover after eating, is called kitchen waste or garbage.

Understanding the appropriate methods for the management of solid waste is closely related to the characteristics of the waste and therefore to its source. Considering the sources one by one:

(a) Residential waste or domestic waste is generated from households. It is mostly characterised as non-hazardous wastes, especially in rural households. It may include rubbish, such as packaging materials, kitchen wastes, ash, etc.

(b) Agricultural solid wastes could include food residues, animal dung, crop residues, grass and leaves. Such wastes are mostly non-hazardous and biodegradable in nature. However, containers for used or obsolete pesticides, herbicides and rodenticides could be a health hazard to families and sprayers. Therefore, these items should be safely removed in collaboration with the agricultural development extension agents in your *kebele*.

(c) Commercial wastes are those generated from business establishments, food and drink service establishments, shops, or open market places. These vary a great deal but may include packaging paper, cardboard, electronics, timber, wire, metals, plastic bags (*festal*), tin cans, garbage and other wastes that are generally of non-hazardous nature.

(d) Industrial waste can be produced from small, medium or large-scale industries. The type of waste produced may vary depending on the raw material used and the product of the industrial process. These wastes may be hazardous or non-hazardous, depending on the process. The solid waste produced could contain chemicals, wood, metal, ceramic or other components.

(e) Institutional solid waste is produced from public or government institutions, offices, schools, universities, religious institutions, sporting fields, etc. It can be very mixed in its components.

(f) Healthcare waste is produced from healthcare facilities such as Health Posts, health centres and hospitals. This category of waste is composed of both hazardous (infectious) and non-hazardous wastes (also referred to as general waste). The management of healthcare waste needs special attention and is discussed in Study Session 23.

The rate of production and characteristics of residential or domestic solid waste depends on cultural habits, urbanisation, season of the year and the agro-ecological zone of the area.

- ■ Can you think of some differences in the kitchen waste produced in the dry and wet seasons?
- □ Your answer will depend on where you live and the type of foodstuff that is ripe during that particular season but you may have answered leaves of maize and maize husk, peelings of potatoes or sweet potatoes during the wet seasons and pods of chick peas (*shimbra tirtir*) during the dry season.

Urban and affluent societies tend to produce greater quantities of solid waste than rural communities. Rural waste comes from households and agricultural activities and is mostly organic and biodegradable in nature. This makes it suitable for making **compost**. Compost is a mixture of decomposed organic matter, mostly of plant origin, that can be used to improve soil structure and to return nutrients to the land.

Solid waste generated from households in your community will consist mostly of organic decomposable matter that will be broken down through bacterial action. In urban areas, where there is a large amount of solid waste, it is usually taken to a **landfill site** for disposal. Landfill sites, also known as dumps or rubbish dump sites, are sometimes located in places such as former quarries where the waste can be used to fill in a hole in the ground, hence the name 'land fill'. In landfill sites and some community waste disposal sites, the solid waste decomposition process will produce **leachate**. Leachate is formed when the liquid fraction from a mixed solid waste is separated by gravity from the solid component. Unless controlled, the leachate will seep out from the bottom of the waste tip and can pollute surface and groundwater. It may contain toxic chemicals in addition to pathogenic microorganisms. The **biosolid**s (the solid fraction) as well as the leachate formed in this process need to be disposed of safely in a way that will not affect the environment or human living conditions.

18.2 Public health importance of waste management

How does waste management affect public health and the environment? Improper disposal of wastes, such as solid waste, human excreta and sewage, is one of the major risk factors that affect the health and comfort of individuals in rural Ethiopia where municipal or onsite facilities do not exist, or are not functional.

- ■ Name three diseases or pathogens that are transmitted in human waste.
- □ There are many possible answers. You could have said diarrhoea, trachoma, amoebic dysentery, giardiasis, rotavirus, cholera, salmonellosis, shigellosis and other diarrhoeal diseases. In addition, you may have mentioned hookworm, roundworm, whipworm, tapeworms, schistosomiasis, filariasis, leptospirosis and many more. A very long list!

Poor waste handling and disposal can lead to environmental pollution, encourage the breeding of disease-vector insects, animal scavengers and rodents, and result in a range of diseases through different routes of exposure such as faeco-oral and soil transmitted mechanisms.

Figure 18.2 shows these routes of exposure diagrammatically; you may remember this diagram from Study Session 1. In this figure, you can see that faeces are the common source of contamination to the other 'Fs' – fluids, fingers, fomites and flies. These then contaminate our food and, consequently, a new susceptible human host.

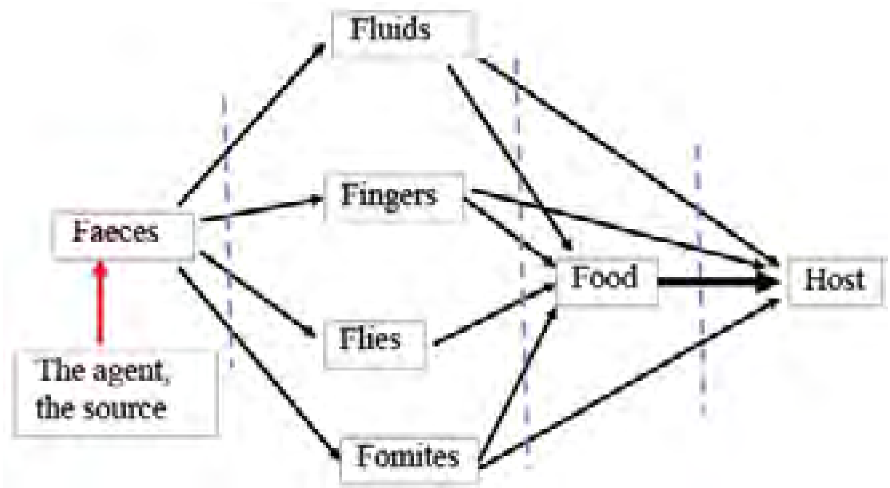


Figure 18.2 The 'F-diagram' showing the faeco-oral disease transmission pathways.

Survey studies conducted in different parts of Ethiopia indicate that there are many highly prevalent faeco-orally transmitted intestinal parasites and other infectious agents (bacteria and viruses) in our environment. To break the transmission route of these disease agents, there needs to be **total sanitation**, which means prevention of any human contact with waste, i.e. no open defecation and the proper handling of solid waste. The broken lines in Figure 18.2 show the points at which a barrier or intervention can be made to prevent transmission. The first line of defence is to contain the faeces. The second is to protect the food from contamination and the third is to protect the potential host, the person who may become infected, from contaminated food, fingers, drinking water or other objects. To achieve total sanitation, the community needs to be involved in any plan to clean the local environment and must initiate its own waste disposal methods. You will learn some of the techniques that are used to encourage this sort of behavioural change in Study Session 21.

In addition to the dangers of disease transmission, health hazards associated with improper solid or liquid waste disposal include:

- Public or community nuisance due to foul odour and unsightliness of open defecation faecal matter and openly dumped solid wastes.
- Obstruction of drainage systems leading to creation of favourable conditions for disease vector breeding sites.
- Fire hazards.
- Psychological health hazards.

18.3 Main components of waste management

In any waste management process, there is a stage when waste will be temporarily stored or contained onsite (i.e. in the place where the waste is produced). This may be temporary or be a final disposal site. If storage is temporary, then subsequent stages will be the transfer or transport to a treatment facility or technology, followed by final disposal offsite (i.e. away from the waste generation site).

18.3.1 Liquid waste management

Liquid waste management will include both onsite sanitation and offsite treatment and disposal methods. The most usual method of onsite liquid waste containment in rural Ethiopia is the pit latrine. Pit latrines are simple drop-and-store systems in which the liquid waste collects in a pit below. There are many different designs of pit latrine (Figure 18.3 and Figure 18.4), which are described in more detail in Study Session 20.

Figure 18.3 A traditional pit latrine. (Photo: Worku Tefera)

Figure 18.4 Ventilated improved pit (VIP) latrine. (Note the vent pipe emerging through the roof). (Photo: Worku Tefera)

In places where water is more easily available, typical methods are drop-flush-and-discharge systems, also known as water carriage systems, such as the pour-flush latrine (Figure 18.5) or a water closet (WC) (Figure 18.6).

Figure 18.5 Pour-flush latrine. (Photo: Eawag)

Figure 18.6 Water closet (WC) toilet. (Photo: Worku Tefera)

Wastewater from water carriage systems may be piped into a septic tank or into a community or municipal treatment system, if one exists. The various types of latrine and methods of liquid waste management are discussed in more detail in Study Sessions 19 and 20.

18.3.2 Solid waste management

Solid waste management can be classified into five main stages. These stages are also referred to as the *functional elements* of solid waste management. These are:

- onsite handling, storage and processing
- collection
- transfer and transport
- resource recovery and processing
- disposal.

Onsite handling, storage and processing methods are undertaken at household level. This includes compacting waste by squashing it and changing its size and shape for easy handling. It also includes sorting the waste in order to separate the items that can be reused or recycled. For example, organic wastes should be separated out for composting as part of onsite handling. Bottles and cans can be reused. Collection and transfer or transport activities are not common in rural areas because the waste is usually disposed of immediately onsite in a prepared waste disposal or composting pit. (The five functional elements of solid waste management are discussed in more detail in Study Session 22.)

Ideally, waste management should go beyond pollution prevention and disease prevention for humans and should benefit society by providing economic gain for families and communities. The preferred approach for dealing with solid waste is **integrated solid waste management** (ISWM). ISWM means considering not only the appropriate disposal of solid waste but integrating this with other management options such as minimising waste production, recycling, composting and other waste recovery options. The advantages of ISWM are that it considers all options and aims to manage waste in ways that are most effective in protecting human health and the environment. ISWM can also have many economic and social benefits for your community. For example, you could consider composting of human waste and animal manure to produce natural fertiliser for gardening and for cultivating vegetables and crops. Some solid wastes can be recycled or reused. You could also consider helping your community in the development of a **biomass** waste digestion plant that will produce **biogas** to be used for cooking and lighting energy. Biomass is any biological material from living or recently living plants that is used to generate energy, usually in the form of biogas.

18.4 Compare the different waste management methods

There are a range of **sanitation technologies** currently in practice that you may want to recommend to institutions, communities and households in your area. ‘Sanitation technologies’ is a general term used to describe any kind of waste treatment and disposal. It can refer to specific infrastructure, methods or services that are designed to contain, transform or transport waste. It therefore includes the facility used by the person, such as pit latrines, WCs, etc. and also the storage/treatment processes such as septic tanks, biogas reactors etc.

The effectiveness and efficiency of waste management facilities varies greatly because of the advantages and disadvantages each one of them has in terms of capacity to remove pathogenic organisms, cost of the technology, acceptability of the sanitation technology by the end users such as families and individuals, and the skill level needed for proper operation and maintenance of the scheme. If you have a good understanding of the different sanitation technologies then you will be able to identify those that are appropriate for your community. An appropriate sanitation technology is one that is economically affordable, socially acceptable and environmentally sustainable. You will then be in a good position to offer advice to household heads, community leaders, *kebele* leaders, sectoral government officers, local institutions such as schools and private firms about their choice of technology.

In later sessions we will discuss the advantages and disadvantages of different solid and liquid waste disposal methods that can be used at communal and individual household level so that you can apply your knowledge to your local situation.

Summary of Study Session 18

In Study Session 18, you have learned that:

1 Waste can be categorised as solid or liquid waste based on its physical state. It can also be categorised as hazardous and non-hazardous waste.

2 Liquid waste includes human waste, runoff (flooding), sullage (or greywater) and other forms of wastewater from different sources.

3 Solid waste is any dry waste that is discarded by people because they no longer need it. It can arise from households, industrial, commercial or agricultural activities, or from streets.

4 Human waste is biodegradable, meaning it will decompose by a biological process due to microorganisms, particularly bacteria.

5 The type, generation rate and characteristics of solid waste depend on the source of the waste and on cultural habits, urbanisation, season of the year and the agro-ecological zone of the area.

6 Poor waste management could result in various diseases, accidental fire or nuisance conditions for the environment and families.

7 Properly managed waste could benefit your community socially and economically by recycling and reusing waste, where possible.

8 The main components of solid waste management include onsite handling, storage and processing; waste collection; transfer and transport of solid waste; and waste recovery and final disposal.

Self-Assessment Questions (SAQs) for Study Session 18

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 18.1 (tests Learning Outcome 18.1)

The Glossary Game: Write down each of the key words printed in **bold** in this study session. Cut the paper into strips, with one word on each strip; fold them and put them into a bowl. Take a strip, read the word and write a definition in your Study Diary. Then check your definition with those in the study session.

SAQ 18.2 (tests Learning Outcome 18.2)

Waste can be categorised as solid or liquid, and as hazardous or non-hazardous. Give an example of a:

1 solid non-hazardous waste
2 liquid non-hazardous waste
3 solid hazardous waste
4 liquid hazardous waste.

SAQ 18.3 (tests Learning Outcome 18.2)

What is the main purpose of waste management?

SAQ 18.4 (tests Learning Outcome 18.3)

Outline three benefits for public health that can be provided by proper waste management.

SAQ 18.5 (tests Learning Outcome 18.4)

Match the types of solid waste in list B with the sources in list A by drawing an arrow between them.

A	B
Agricultural	Coffee bean shells
Commercial	Needles and other sharps
Healthcare	Manures
Coffee processing	Packaging materials, plastics

Study Session 19 Liquid Waste Management

Introduction

In general, in Ethiopia the management of liquid waste is poor. In the previous study session, you were introduced to the concepts and principles of waste management. In this session, you will learn the definitions of key terms in liquid waste management. You will also identify the types and sources of liquid waste and learn about the different liquid waste disposal methods. We will also consider the issues to be taken into account when choosing sanitation technologies.

■ Do you remember the definition of sanitation used in Study Session 1?

□ Sanitation was defined as the prevention of contact between humans and waste.

According to the World Health Organization, sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. It therefore means much the same as liquid waste management. Sanitation methods aim to decrease the spread of disease by ensuring that wastewater, excreta and other wastes are adequately treated. This session will help you to respond to the sanitation needs of families and institutions.

Learning Outcomes for Study Session 19

When you have studied this session, you should be able to:

19.1 Define and correctly use the key words printed in **bold**. (SAQ 19.1)

19.2 Identify the types and sources of liquid waste. (SAQ 19.1)

19.3 Describe some different methods of liquid waste disposal. (SAQ 19.1)

19.4 Identify issues to be considered when choosing sanitation technologies. (SAQ 19.2)

19.1 Types and sources of liquid waste

In Study Session 18 you learned that liquid waste includes human waste, sullage, industrial waste and runoff (also referred as storm water or flood water).

■ What is the difference between sewage and sullage?

□ Sewage includes human wastes (i.e. faeces and urine), as well as wastewater from various sources. Sullage is the wastewater that arises from domestic activities such as washing in bathrooms and kitchens, including water from food preparation and dishwashing; it does not contain human excreta.

Human waste and sullage can arise from public institutions such as schools, as well as from individual households. Industrial waste arises from different industries as a result of processes to produce goods and services. The content of industrial waste may vary depending on the type of industry, the raw materials (inputs) used and the processes undertaken. Industrial waste may be toxic and thus hazardous in nature, or it could contain non-hazardous substances. Therefore, unlike the other types of liquid waste, some industrial wastes may require special treatment before discharge from the industry.

Runoff is simply flood water that arises from rain or the release of collected water from a pond or dam. It can carry many types of wastes along with it, including human waste. Therefore, it is potentially harmful to the health of the community. Liquid waste is also produced in healthcare facilities but this will be dealt with in detail in Study Session 23.

19.2 Management of liquid waste

Management of liquid waste focuses on finding a way to dispose of the waste in a way that is safe for humans and the environment. For this reason, the word 'disposal' is often used to mean the same as management in this context.

19.2.1 Human waste management

The basic requirements expected from a human waste (excreta) disposal method are:

- Surface water must not be contaminated.
- There should be no contamination of groundwater that may, in turn, contaminate springs or wells.
- Excreta should not be accessible to flies or other animals.
- There should be no handling of excreta; where this is unavoidable, it should be kept to a minimum.
- There should be no odours or unsightly conditions.
- The method used should be simple and inexpensive in construction and operation.
- The method should last for at least five years to be cost-effective.

In Study Session 18 you were introduced to some of the sanitation technologies that are used for human waste management. You may recall that WCs and pour-flush facilities were classed as wet or water carriage systems, also called drop-flush-and-discharge systems. The **aqua privy** or water privy is another in this group. Aqua privies consist of a latrine constructed above a watertight tank containing human waste and water. The wastewater from these systems is usually discharged to a septic tank or to sewers which carry it to a liquid waste treatment plant. The presence of adequate water is essential for all wet systems. For this reason, and also because of the cost involved, they are not recommended in most rural places where there is inadequate running water. For such areas, the recommended methods of sanitation are dry or non-water carried systems where there is no water needed to carry the waste offsite. In Study Session 20 you will learn more about the construction of pit latrines and other dry systems. Pit latrines are the most common type of latrine in Ethiopia.

Sanitation facilities have been classified in a different way by the WHO/UNICEF Joint Monitoring Programme (JMP), as 'improved' or 'unimproved'.

Improved sanitation services or methods include:

These improved sanitation methods are described in Study Session 20.

- WC or flush toilet to piped sewer system or septic tank
- pour-flush latrine
- pit latrine with slab
- ventilated improved pit (VIP) latrine
- ecological sanitation (a type of latrine that converts human waste into useful material without damaging the environment or endangering human health).

Unimproved sanitation methods are all those that do not ensure there is no human contact with human excreta (see Figure 19.1). They include:

- service or bucket latrines (where excreta are manually removed)
- pit latrine without slab
- open latrines
- excretion in the environment (or simply, open field defecation).

Figure 19.1 An open latrine with no privacy for the user and an insecure cover of logs – an example of unimproved sanitation. (Photo: Pam Furniss)

■ Pit latrines may be classed as either improved or unimproved depending on the presence of a slab. Why does the presence of a slab make this important difference?

□ The slab that covers the pit is essential for ensuring there is no contact between the waste in the pit and the person using the latrine. This defines the difference between improved and unimproved sanitation.

Figure 19.2 shows the sanitation data for Ethiopia and indicates the relative proportions of the population with access to improved and unimproved facilities. In this graph, open defecation is classified separately from unimproved methods. A fourth category, shared facilities, means sanitation that is otherwise acceptable but is shared between two or more households.

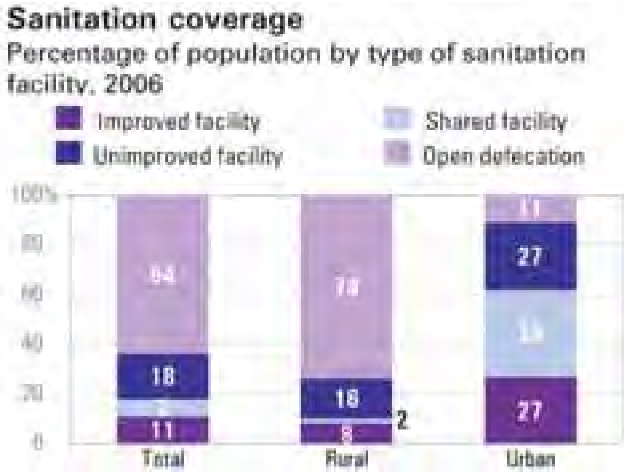


Figure 19.2 Sanitation coverage in Ethiopia. (Source: WHO/UNICEF JMP, 2008)

■ From Figure 19.2, what percentage of the rural population does not have access to improved facilities? How does this compare to the urban population?

□ 74% of rural people use open defecation and a further 16% only have access to unimproved facilities. Therefore, a total of 90% of people in rural areas of Ethiopia do not have access to improved sanitation facilities. In urban areas, 38% of people (11% + 27%) do not have access to improved facilities.

19.2.2 Sullage management

Some people may think they can simply throw used cooking and washing water away but it should not be disposed of indiscriminately because of its negative health effects on families and community members. Proper collection and disposal of sullage is advised. Some of the disadvantages of improper disposal of sullage include the potential to contaminate the soil, pollute water sources and create favourable breeding conditions for disease vectors.

■ Which vectors do you think might be encouraged by sullage collecting on the ground?

□ Mosquitoes are likely to be attracted as they use stagnant water as breeding sites. Flies and rats might also appear as the sullage would be a source of drinking water.

Unsightliness and bad odour affect the aesthetic value of our environment, therefore proper handling and disposal of sullage is required. Sullage can be discharged to sewers or septic tanks in areas where they exist. However, in many rural areas there is no sewer system so it is necessary to construct a pit near the household to dispose of sullage properly. The pit should be filled with gravel or sand and the sullage can be allowed to percolate into the ground. A sullage pit keeps the wastewater in one place and encourages it to soak quickly into the ground. It also avoids bad odour and unsightliness in the environment.

19.2.3 Industrial wastewater management

Effluent means wastewater of any type that is discharged (flows out) from a pipe or other structure.

Effluent produced by an industry should meet the national guideline values of wastewater quality before it is released into rivers, streams or even municipal sewer systems. However, it is beyond your mandate to check on this. If you have any concerns, you should request inspection by experts such as occupational and environmental health officers in the district or higher administrative bodies. Given the expansion of agricultural-led industrialisation in rural Ethiopia, the challenge of industrial pollution is likely to increase in the future. In accordance with the law vested with the Ethiopian Environmental Protection Authority (EPA), industrialists have to undertake an Environmental Impact Assessment (EIA) and produce an Environmental Impact Statement (EIS) before they commence the construction of any new industrial development (see Box 19.1). In your role as a community healthworker, you can assist a relevant expert by providing the necessary information to your immediate supervisor to facilitate the enforcement of environmental law in your locality. You are not expected to take actions by yourself. Public health complaints by community members should also be communicated to the relevant officers for timely action.

Box 19.1 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a preliminary step in in the planning phase of major development projects. It is a systematic process of assessing the possible impacts that a proposed project may have on the environment. The process usually requires the preparation of an Environmental Impact Statement (EIS) that should report on the findings of the EIA and recommend ways of reducing or mitigating any negative environmental impacts, including possible alternative actions.

In Ethiopia, the Environmental Protection Authority (EPA) is responsible for ensuring EIAs are undertaken for major projects. Established in 2002, the EPA's mission statement is to enhance good environmental governance through 'removing the constraints faced by public agents, individuals, civil society and the private sector to know, explore and utilize fully their own potentials to enlarge their choices for understanding their respective functions in an environmentally sound manner'.

19.2.4 Runoff management

Runoff or storm water needs to be properly managed to ensure it does not have a damaging impact on property or health. In some areas, mostly in towns and cities, runoff is directed into stormwater canals; these need to be used properly and kept clear of debris. In rural areas, stormwater canals are rarely present; therefore, there needs to be pre-planning to effectively prevent runoff from entering households and public buildings, and running over the roads, as is frequently the case. Improperly managed flood water could cause a physical hazard to the community and can also cause outbreaks of waterborne diseases due to contamination of drinking water sources and food stocks.

To prevent the damaging effects of stormwater in your community, the likely routes of stormwater should first be identified, i.e. the location and direction of channels that tend to form in heavy rain. Once the scope of the problem is identified, then development agents, in consultation with the community leaders, can design and implement a solution. Where the community lives near dams or river banks that frequently burst during the rainy season, it is advisable to devise an early warning system at village level. This should be based on a study of past experiences and use relevant information from the local Meteorology Office and/or Agricultural Office.

19.3 Collection, storage and treatment of liquid waste

There are different sanitation technologies used to collect and store liquid waste. Some of them also treat the waste and produce useful byproducts. The various different systems are used in different circumstances depending on the location, available resources and type of waste. In this section, we will describe septic tanks and anaerobic biogas reactors. We will also briefly describe the type of centralised treatment system that may be found in larger towns and cities.

19.3.1 Septic tanks

Septic tanks are used with water carriage sanitation systems. The human waste is washed into the tank, where it is stored and partially treated. A septic tank is a watertight chamber, usually made of concrete, and is mostly under the surface of the ground (Figure 19.3). They have inlet and outlet pipes. Fibreglass, PVC or plastic tanks can also be used. The retention time of the wastewater in septic tanks should be a minimum of 19 hours but can be a great deal longer.

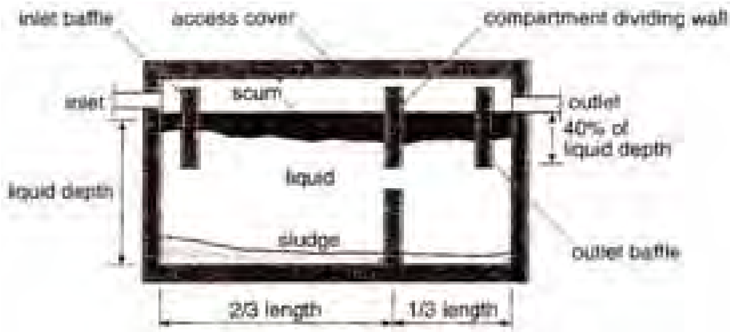


Figure 19.3 Diagram showing the typical internal structure of a septic tank. (Source: The Open University)

The purpose of septic tanks is for the solids to settle out of the wastewater and for anaerobic decomposition of organic solids to take place. However, the treatment in a septic tank is only partial. The solids will be broken down in the tank and diluted in the wastewater but this will still contain high levels of organic pollutants. Septic tanks should only be used in places where water is plentiful and where vacuum trucks are available to remove sludge periodically from the chamber (Figure 19.4). The process of removing sludge from the septic tanks is called **desludging**.

Figure 19.4 A tanker pumping out sludge from a septic tank or latrine. (Photo: Nicholas Watson)

Septic tanks are a storage and treatment unit to complement such facilities as WCs (cistern flush toilets), pour-flush toilets and aqua privies. The effluent from septic tanks is usually piped into a soak pit, also known as a **seepage pit** (Figure 19.5). A seepage pit is lined with open-jointed or porous material such as bricks or stone without mortar, which allows the wastewater to seep out slowly into the soil. Alternatively the wastewater may be spread across a drainage field using an array of pipes buried below the surface.

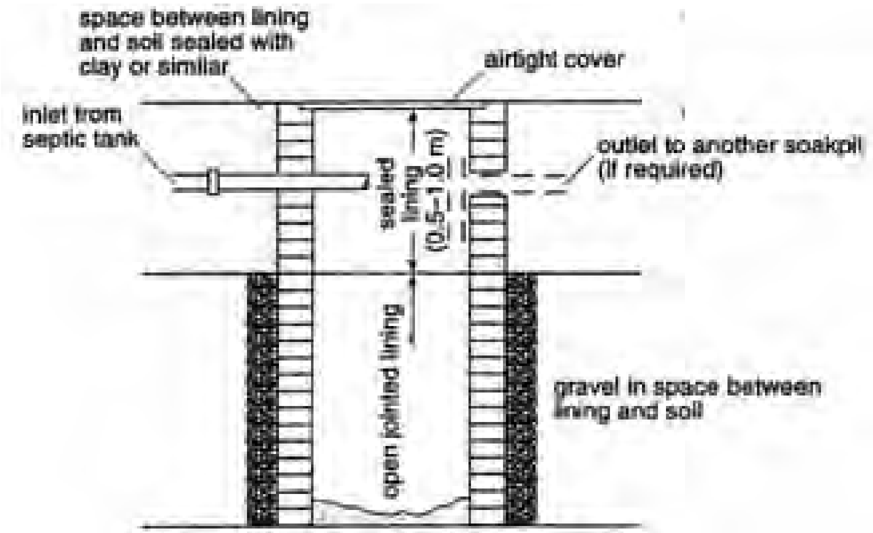


Figure 19.5 Diagram of a seepage pit. (Source: The Open University)

A septic tank has the following advantages:

- can be built and repaired with locally-available materials
- has a long service life
- presents no problem of flies and odour, if properly used
- has a relatively low capital cost (though it may not be affordable by rural households), and moderate operating costs
- does not require electrical energy because it uses gravity flow.

However, the constraints of a septic tank include the following:

- only applicable for water carriage sanitation systems
- treatment is only partial and the effluent may still contain pathogens
- sludge must be removed periodically.

19.3.2 Anaerobic biogas reactor

An anaerobic biogas reactor, also known as an anaerobic digester, uses **anaerobic digestion** to convert liquid wastes and other organic matter into sludge and biogas. The sludge can be used as a soil fertiliser and the biogas can be used for energy to produce heat (for use in cooking) or electricity. This affordable technology can easily be adapted by rural families and communities if appropriate training is given to local artisans and masons in the design and construction of the reactor (Figure 19.6).

The reactor consists of a chamber usually below the ground. It has an inlet for inputs (mainly human excreta) and two outlets (one at the centre for biogas, and the other on one of the sides for outlet of sludge). Addition of animal manure and vegetation will improve the efficiency of the reactor.

Figure 19.6 An anaerobic digester under construction. (Photo: WaterAid in Ethiopia)

Neighbourhoods can join together to share a digester. However, if sufficient wastes are generated, individual households can each have one and get the benefit of biogas production. You should explore if local loaning enterprises could help households install an anaerobic biogas reactor.

19.3.3 Centralised wastewater treatment systems

In larger towns and cities, liquid waste may be conveyed via a sewerage network to a centralised wastewater treatment plant; for example, Addis Ababa's waste is treated at the Kality Wastewater Treatment Facility. Simple small-diameter sewers convey sullage and sewage from individual households to larger main sewers and then to the treatment plant. (Note that the word 'sewerage' refers to the network of pipes and 'sewage' refers to the liquid waste that flows through the sewers.) This method is not likely to be used in rural and peri-urban areas of Ethiopia. In addition to sewage, industrial waste may be discharged into the sewerage network – although it may have to have special treatment (technically called pre-treatment) onsite beforehand.

19.4 Choosing appropriate sanitation technologies

By now you will have realised there are many different sanitation technologies that can be used for liquid waste management. Part of your role, in collaboration with others, is to encourage the installation of sanitation systems and help people in your community decide on the appropriate technology to use. The Federal Government's role is limited to issuing regulations, setting standards, providing technical assistance and financing public facilities. It is solely the responsibility of the district or *kebeles* to mobilise the community and coordinate the activities of sanitation at grassroots level. In this process, you should understand that sanitation should be driven by informed household demand. This means that apart from technically helping households to achieve sanitation, your role is to encourage them to *demand* sanitation.

There are many factors to consider in the choice of technologies but before we describe these, there are some general principles to bear in mind as well.

19.4.1 General principles

Involve the users in decision making

As you now know, in its broad definition, sanitation doesn't mean simply latrines; it involves hygiene and environmental behaviour as well. In the past, sanitation interventions used to focus on 'hardware' (the construction of latrines and other waste disposal facilities) instead of integrating 'software' (hygiene promotion and health behavioural change) components of the programme. This approach has been heavily criticised because it prescribes a single or limited technological option for the user community without involving them in the decision. People who will use the facility need to participate in the planning process, because technological choices that are imposed on them are unlikely to succeed.

Your local community

As a member of your local community, you should consider ways to stimulate and encourage local innovation and enterprise. Technologies that are accepted by people will not only meet their preferences and be affordable but also use the possible mix of local and external materials and skills, ideally emphasising the use of local resources first. Locally sourced technologies are more likely to involve local people in your village in their development, construction, marketing and use.

Sustainability

An important principle of sanitation is that it protects the environment. A *sustainable* sanitation system will safeguard the environment and be durable, affordable and socially acceptable. When you facilitate the implementation of human waste management, you must make sure that provision of sanitation avoids unacceptable impacts on the environment, especially surface and groundwater resources.

Finding the resources

Installing a sanitation system will require funding and human resources. The sanitation strategy of the Federal Ministry of Health of Ethiopia basically suggests 'no subsidy' for household sanitation.

Users or households will need to pay for the installation, operation and maintenance of latrines. However, some organisations such as The World Bank and some NGOs recognise that some people might require some form of support to achieve total sanitation. Targeted subsidies that consider, for example, people with disabilities or old people may be appropriate.

Integration with water supply and hygiene

Sanitation improvement cannot be achieved in isolation; it needs to be integrated with improvements to water supply and hygiene promotion. You should try to make a coordinated effort to combine hygiene and water supply promotion along with that of sanitation, in order to influence the behaviour of individuals and families in your community. You should work together with your local water supply and other related services to achieve better sanitation in your community.

19.4.2 Questions to consider

Now, let's discuss factors that are important for households to consider in the selection of liquid waste disposal facilities. When families are selecting a sanitation technology with your help, there are many interrelated and variable factors that they should take into consideration. Some of these factors are decided by the geographical location you are working in and you will not be able to influence these, although it is important that you take them into account. Others are determined by the people involved and by the local situation.

What is your location?

Your geographical location will influence factors such as:

- Climatic conditions: for example, in highland areas with heavy annual rain, latrines should be constructed in such a way that prevents flooding.
- Topography and geological formations: the depth of the water table, type of rock and the permeability of the soil; sandy soils, for example, are more permeable than clay soils.
- Abundance or scarcity of water: WCs and other water carriage systems are not appropriate in areas where there is no piped water.

Who will use the facility?

The number of people, their characteristics and attitudes will all need to be considered. For example:

- Cultural acceptability: social and cultural beliefs, and the values and practices of a community, are important considerations for households when selecting a sanitation technology.
- Affordability: the choice of technology will depend on the ability and willingness to pay; the cost should be fairly low for most people to be able to afford it.
- Safety to users: a latrine should not be constructed in ways that endanger the safety of children, women or other family members who use the facility.
- Accessibility: children, elderly people and people with disabilities may need special consideration to ensure the chosen facility is easily accessible to them without discomfort or inconvenience.

What local resources are available?

It's important to consider the local context and whether local resources can be used. This includes:

- Availability of resources and infrastructure: the presence of human skills, construction materials and other resources may make one technology more appropriate than another. In general, sanitation technologies that need less skill are important for rural households.
- Energy source and pit emptying requirements: in rural areas where a pit emptying service is not available, households will need to depend on traditional latrines.
- Demand for reuse of the waste: facilities that ultimately help households to recycle and use waste, such as composting and biogas reactors, are important considerations as well.

These are the main factors that determine the appropriateness of the sanitation technology that households choose and use. In general, the technology we choose must give a complete barrier to the liquid waste in order to protect the family's health, while being acceptable in terms of cost (i.e. installation, operation and maintenance costs) and be socially and culturally sound.

Summary of Study Session 19

In Study Session 19, you have learned that:

1. Sanitation can be defined as the means by which human excreta, as well as community wastewaters, are collected and disposed of so that they do not cause any harm to the community. It involves protection both of human health and the environment.
2. Liquid waste can be classified as human waste, sullage, industrial waste or runoff. Different methods of waste management apply to these different categories.
3. Human waste can be contained using wet or dry sanitation systems. Wet or water-carriage methods require easy access to a water supply and are not usually appropriate in rural areas. Sanitation systems can also be classified as improved or unimproved.
4. Septic tanks offer partial, anaerobic treatment of liquid waste. The sludge has to be removed periodically and the effluent has to be disposed of via a soak pit.
5. Anaerobic biogas reactors convert liquid wastes into a sludge and biogas through anaerobic processes. The sludge can be used as a fertiliser and the biogas as a source of energy.
6. In urban areas, wastewater may be conveyed via sewers to centralised wastewater treatment plants.
7. Choosing appropriate sanitation technologies requires consideration of many factors including the needs and wishes of the local community, local environmental conditions, costs and the availability of resources.

Self-Assessment Questions (SAQs) for Study Session 19

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 19.1 (tests Learning Outcomes 19.1, 19.2 and 19.3)

Which of the following statements is *false*? In each case, explain why it is incorrect.

A The decomposition of human waste in a septic tank is an aerobic process.

B A seepage pit is a watertight underground pit for containing liquid waste.

C Anaerobic digestion is a method of waste treatment that converts waste into useful products.

D Runoff does not cause environmental problems because it is only rainwater that runs off the land surface.

E Protection of groundwater from contamination is an essential requirement of human waste management.

SAQ 19.2 (tests Learning Outcome 19.4)

Explain why the following factors are important when choosing a sanitation technology.

(a) local geology

(b) local climate

(c) the age range of people using the facilities.

Study Session 20 Latrine Construction

Introduction

In Study Session 19, we described the various methods of liquid waste management and discussed the issues that need to be considered when choosing appropriate sanitation technologies. In most rural situations, a dry latrine of some sort will probably be the most appropriate technology to choose. This study session will provide some practical details about the different types of latrine and how they should be constructed.

It should be noted that we do not have space here to include all the technical construction details. This is not a construction manual. Although the techniques described are not complicated, the latrines need to be designed and built in the correct way and you may need to seek out further details or expert advice if you wish to promote the installation of some of these different types of latrine. *Latrine Technology Options*, published by the Federal Ministry of Health, is a useful reference.

Learning Outcomes for Study Session 20

When you have studied this session, you should be able to:

20.1 Define and correctly use the key words printed in **bold**. (SAQ 20.1)

20.2 Describe the main features of simple pit latrines and VIP latrines. (SAQs 20.2 and 20.3)

20.3 Describe ecological sanitation systems. (SAQ 20.1)

20.4 Describe standard construction techniques for latrines with handwashing facilities. (SAQs 20.2 and 20.4)

20.5 Help families select appropriate sanitation technologies. (SAQ 20.5)

20.1 Types of latrine

In Study Session 19, sanitation facilities were classified as improved or unimproved, and alternatively as wet or dry systems.

■ Three types of dry sanitation technology were included in the list of improved facilities in Study Session 19. What were they?

□ Pit latrine with slab, ventilated improved pit (VIP) latrine and ecological sanitation.

Pit latrines are basic structures that can be adapted easily into different types of latrines such as VIP latrines and ecological sanitation systems. These other latrines share many common features of simple pit latrines; therefore, focusing first on pit latrines will help you to understand the other sanitation technologies as well.

20.2 Pit latrine with slab

Pit latrines are the simplest form of dry latrine. They consist of a pit dug in the ground and a cover slab or floor above the hole (Figure 20.1). Pit latrines must have a cleanable cover slab in order to be considered as improved sanitation systems. The excreta (both faeces and urine) drop through the hole to enter the dry pit. Pit latrines should be constructed on a slight mound so they are higher than the surrounding ground and water at the surface will flow away from the hole. They should also have a lid that can be placed over the hole to reduce problems with flies and odours. They may have a squat pan or a raised footrest to make using the latrine more convenient. The pit is often lined but the bottom remains open, allowing the liquid to drain into the soil and leaving the solids behind.

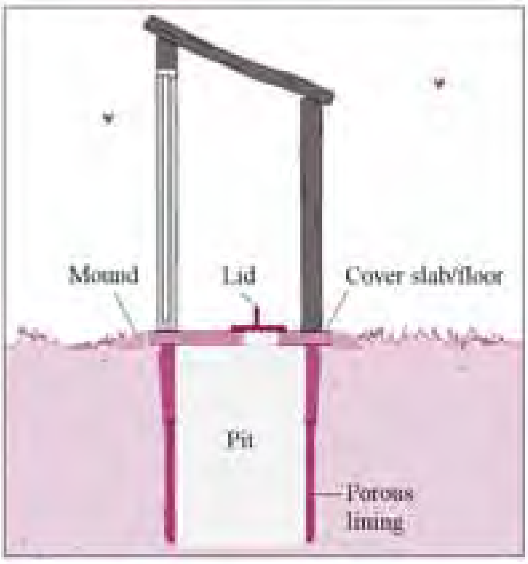


Figure 20.1 Diagram of a simple pit latrine. (Source: WHO and IRC, 2003, *Linking technology choice with operation and maintenance in the context of community water supply and sanitation: A reference document for planners and project staff*)

Pit latrines should also have an upper part, called the **superstructure**, to provide protection from the rain and sun, and privacy and comfort for the user (Figure 20.2).

Figure 20.2 Pit latrine superstructures can be built of different materials as long as they provide privacy and protection from the weather. (Photos: Pam Furniss, Abera Kumie, Worku Tefera)

Pit latrines can have a single pit or double pit. In double pits, while one is filling with excreta, the second pit remains out of service. When the first pit is filled with excreta up to about 50 cm below the slab, it is taken out of use and the remaining space is filled with grass and vegetation materials that can be composted. You then use the second pit until that is full. Meanwhile, the first pit will stay sealed for a period of 6–9 months, during which time the waste will decompose and any pathogenic microorganisms will die. After this period, the material (humus soil) in the first pit can be taken out manually. (Humus or humic is used to describe organic matter that has been stabilised by decomposition processes.) It is safe to handle and readily used as fertiliser in agriculture or can be disposed of safely. This is the principle of ecological sanitation that is described further in Section 20.4.

20.2.1 Advantages and disadvantages of pit latrines

In general, pit latrines with a slab are effective sanitation systems because they isolate human excreta from the surrounding environment and prevent the transmission of faeco-orally transmitted diseases. They also have other advantages:

- They do not require water so are appropriate in areas where there is no adequate water supply.
- Squatting is normal to many people and thus is acceptable to users.
- Alternating double pits will allow the excreta to drain, degrade and transform into a nutrient-rich, safe humic material that can be used to improve soils.
- They avoid contamination of surface water and top soil if properly installed and maintained.
- They can be constructed with minimum cost using local material and local skills.
- The presence of properly constructed slabs will allow easy cleaning and avoid flies and unsightliness.

However, pit latrines are not without limitations. There may be a foul odour from the pit and they can be a favourable place for the breeding of flies and mosquitoes. With single pits, a new pit needs to be dug every time one gets full. They can be susceptible to failure/overflowing during floods. Other disadvantages can be overcome by proper design, construction and usage. For example, if the superstructure is not properly constructed, it may discourage use of the latrine by family members. Children may be discouraged from using the latrine if the slab is not designed with them in mind and is too big for them. Use of excess water or less compostable materials for anal cleansing should be avoided because it may affect the decomposition rate of human excreta.

20.2.2 Siting, designing and constructing a pit latrine

The site of a latrine should preferably be in the backyard of the house and away from an alley in the village. It should not be nearer than 6 m or farther than 50 m from the house. The direction of the wind should be away from the main house. If there is a well in the compound, the latrine should be located as far away from it as possible on the downhill side to avoid possible seeping and contamination of groundwater. The faecal microorganisms may migrate from the pit through the soil, however, the degree that this happens varies with the type of soil, moisture levels and other environmental factors. It is, therefore, difficult to estimate the necessary distance between a pit and a water source, but 30–50 m is the recommended minimum, with an absolute minimum of 15 m.

The size of the pit depends on the number of people using it and the design period, i.e. the length of time before it is full. Typically, the pit should be at least 3 m deep for a family of five for a design period of three to five years. The diameter should be at least 1 m; up to 1.2 m diameter will make it easier to dig but if it exceeds 1.5 m there is an increased risk of collapse, especially in sandy soils.

As you may remember from Study Session 19, you need to consider the geology, soil type and topography (the slope of the land) when considering sanitation technologies. In flood-prone areas, it is advisable to raise the mound of the latrine and prepare diversion ditches around it. When the soil condition is rocky and it is impossible to dig a deep pit, the depth of the pit can be extended by building upwards with concrete rings or blocks. However, care must be taken to ensure the structure remains watertight. The level of the water table must also be taken into consideration. The pit must be entirely above the water table at all times of the year. If the water table is near the surface of the ground, the waste in the pit may contaminate the groundwater.

Lining the pit prevents it from collapsing and provides support to the superstructure. The pit lining material can be brick, rot-resistant timber, concrete, stones, or mortar plastered on to the soil. If the soil is stable (i.e. no sand or gravel deposits or loose organic materials), the whole pit need not be lined. The bottom of the pit should remain unlined to allow the percolation of liquids out of the pit.

The superstructure should be built using locally available materials. These may include a masonry wall made of cement blocks, bricks, or stone with cement or mud bindings; or a wooden structure covered with timber, bamboo, grass/thatch, sticks, leaves of banana or *enset* trees, or canvas made of sacks. However, the type of superstructure depends on several factors such as a household's financial capacity, the availability of construction material locally, local customs and traditions, and the availability of skilled artisans.

- ■ Look again at Figure 20.2. What materials have been used for the different superstructures in these four pictures?

- □ The latrine in the picture at top left has sticks with leaves for the walls and a plastic roof. The latrine at top right is made of sticks and grasses. At lower left, the latrine has walls of mud with a corrugated plastic or metal roof. The latrine at lower right is made of corrugated metal.

The cover slab needs to be strong and have a smooth surface so it can be cleaned easily. It may be made of concrete or termite- or rot-resistant timber, with or without stones and mud covering. Various designs of slab are used (Figure 20.3).

Figure 20.3 (a) Slab with raised footrest in a pit latrine. (b) Round cement slab with keyhole-shaped squat hole and footrests. Note also the vent pipe and lid. (Photos: Pam Furniss)

20.2.3 Maintenance of pit latrines

Pit latrines must be properly maintained to function properly. You should advise families to keep the squatting or standing surface clean and dry. This will help to prevent pathogen/disease transmission and limit odours.

If the pit has been dug to an appropriate size for the number of users, then it may never become full. The liquid will drain into the soil and the solid waste will slowly decompose so the volume remains stable.

20.3 Ventilated improved pit (VIP) latrine

The VIP latrine is an improvement over the simple dry pit latrine. The distinctive feature that gives the VIP latrine its name is the vent pipe installed into the pit, which is used to exhaust the foul odour from the pit and control flies (Figure 20.4). If you look back at the photos in this study session, you can see vent pipes in several of the latrines.

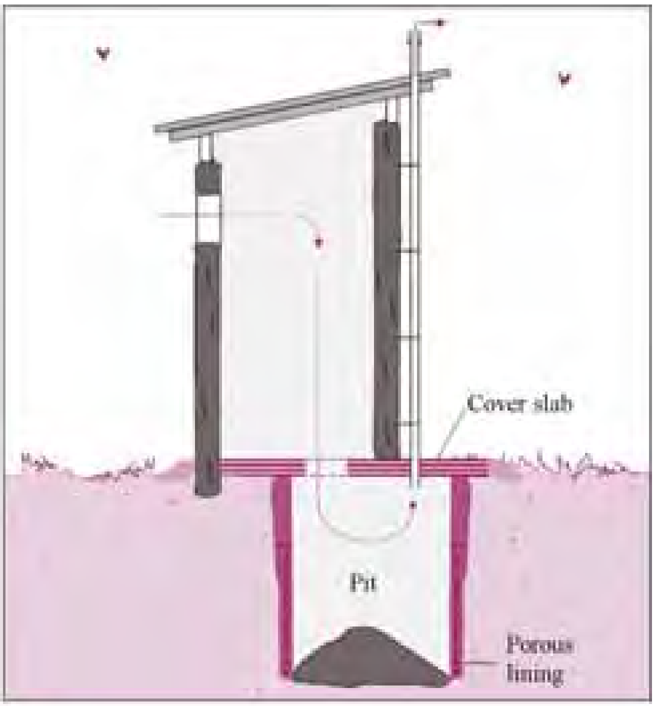


Figure 20.4 Diagram of VIP latrine (Source: as Figure 20.1)

The principle is that a continuous flow of air comes in through the superstructure and enters the pit through the hole. This cold air will go down into the pit displacing (pushing up) the hot smelly air upward through the vent pipe. The other advantage of the vent is controlling flies. As we discussed earlier, dry pit latrines potentially serve as breeding places for flies. Newly-emerging adult flies will try to escape through the vent pipe because the pipe allows sunlight to enter into the pit and flies are photopositive (meaning they move towards light) by nature. A mesh screen tied at the top of the vent pipe will prevent flies from escaping to the outside of the latrine.

VIP latrines can have a single pit or double pit. They share the advantages of simple pit latrines with slabs described above but they also have unique advantages that improve on the limitations, namely, that flies and odours are significantly reduced. It should be noted, however, that the health risks from flies are not completely removed by ventilation.

20.3.1 Constructing a VIP latrine

As it is based on a simple pit latrine, we will discuss only the improved features of VIP latrines. The vent pipe should have an internal diameter of 110–150 mm and reach more than 300 mm above the highest point of the superstructure. The vent works better in windy areas but where there is not much wind its effectiveness can be improved by painting the pipe black. This makes the vent pipe warmer and the heat difference between the pit (cool) and the vent (warm) creates an updraft that pulls the air and odours up and out of the pit. To test the efficacy of the ventilation, a small, smoky fire can be lit in the pit; the smoke should be pulled up and out of the vent pipe and not remain in the pit or the superstructure. The mesh size of the fly screen must be large enough to prevent clogging with dust and allow air to circulate freely. Aluminum screens with a holesize of 1.2–1.5 mm have proved to be the most effective.

20.3.2 Maintenance of VIP latrines

The maintenance requirements are similar to simple latrines. In addition, dead flies, spider webs, dust and debris should be removed from the ventilation screen to ensure a good flow of air.

20.4 Ecological sanitation

Ecological sanitation, also known as ecosan, describes an approach to human waste management rather than a single method. In ecosan systems, human excreta is considered to be a resource, not waste. The principle is to make use of excreta by transforming it into an end product that can be used as a soil improver and fertiliser for agriculture. Ecological sanitation aims to decrease contamination of the environment caused by human excretion and to prevent faeco-orally transmitted diseases. An additional benefit of using waste in this way is that the amount of artificial fertiliser used in cultivation of fields is decreased. This saves money for the farmer and protects lakes and other water bodies from eutrophication caused by runoff of these additional fertilisers.

There are, however, some constraints for communities to consider before adopting the ecosan approach. Ecosan systems require a little more space than conventional latrines. At the end of the process the decomposed waste, known as compost or ecohumus, has to be dug out before it can be spread on the land. There may be a cultural taboo against handling of excreta, even though it should be more like soil than waste by this stage. Some people may be unwilling to use the crops and foods produced. Nonetheless, ecological sanitation is a more sustainable approach to waste management than other systems and should therefore be promoted as the preferred option. You may need to convince families that it is safe and has no negative health effects. Model families may be able to help if they demonstrate to others that the compost produced is safe and acceptable to use.

20.4.1 Arborloo – a single pit method

A simple form of ecological sanitation is the **Arborloo** (Figure 20.5). This consists of a single, unlined shallow pit with a portable ring beam (circular support), slab and superstructure. It is used like a normal latrine but with the regular addition of soil, wood ash and leaves. When it is full, it is covered with leaves and soil and a small tree is planted on top to grow in the compost. (The tree gives the system its name; 'arbor' is Latin for 'tree'.) Another pit is dug nearby and the whole structure is relocated over the new pit. No handling of the waste is required. If a fruit tree or other useful variety is grown there is the added benefit of food or income.

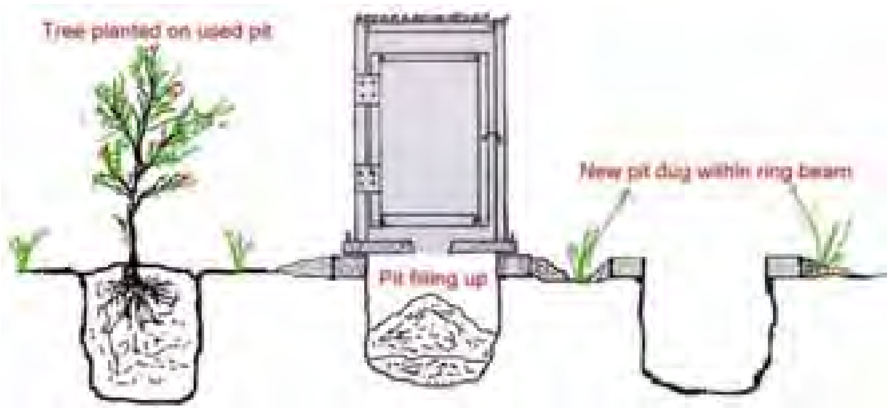


Figure 20.5 Arborloo – a single pit ecosan system. (Source: Stockholm Environment Institute, 2007, *Toilets that make compost: Low-cost, sanitary toilets that produce valuable compost for crops in an African context*)

20.4.2 Fossa Alterna – a double pit method

The double pit latrine system described in Section 20.2 can be constructed to be an ecosan system. The alternating waterless double pit is also known as **Fossa Alterna**, which means alternate ditch. The physical structure is constructed in a similar way to a single pit latrine except that it has two pits and they are shallower than a normal pit with a maximum depth of 1.5 m. The slab and superstructure may be movable between the two pits (Figure 20.6) or may be a larger permanent structure that covers both pits.

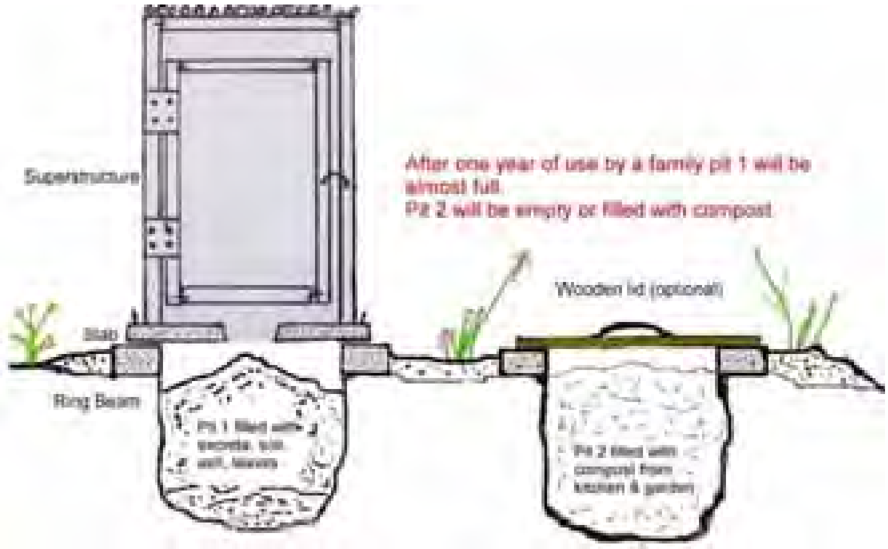


Figure 20.6 Fossa alterna – double alternating compost pit toilet. (Source: as Figure 20.5)

Like the Arborloo, soil, wood ash, vegetable kitchen waste and leaves are added regularly. A small amount should be added after each defecation (not urination). This introduces necessary plant material to mix with the human waste and also adds a variety of organisms like worms, fungi and bacteria that help in the degradation process.

When the first pit is full, after about 12–24 months depending on the size of the pit and the number of users, everyone starts using the second pit instead. The first pit is covered and the material in it will degrade into a dry, earth-like mixture. This takes about 6–12 months. After this time, the composted mixture is dug out manually and can be used to spread on soil. It is important in the construction to make sure the slab is movable or has a manhole large enough to allow access to the pit for digging out. The health risk for the people who empty the compost is minimal if the pit has been left for over one year. However, good personal hygiene should always be promoted in activities related to sanitation.

Figure 20.7 Cistern flush toilet: in this example, the cistern or tank is behind the raised lid. (Photo: Worku Tefera)

20.5 Water carriage systems of human waste disposal

20.5.1 Cistern flush toilet

The cistern flush toilet, also known as a water closet or WC, is usually made of ceramic material (Figure 20.7). The flush toilet consists of two parts: a tank (cistern) that supplies flushwater for carrying away the excreta and a bowl into which the excreta are deposited. It also needs connection to constant running water and a discharge pipe to take the wastewater away to a sewer or septic tank. WCs are rarely found in rural households but are quite common in government offices, some schools and health facilities.

The attractive feature of the flush toilet is that it has a water seal to prevent odours from coming back up through the plumbing. A skilled plumber is needed to install a flush toilet. From the users' perspective, it is a safe and comfortable toilet to use provided that it is kept clean, but the high capital cost for installation and the need for skilled personnel makes it not affordable by every family, especially those living in rural areas.

20.5.2 Pour-flush toilets

A pour-flush toilet is like a cistern flush toilet except that instead of the water coming from the cistern above, it is poured in by the user. When the water supply is not continuous, any cistern flush toilet can become a pour-flush toilet. Water is simply poured into the bowl manually from a bucket or a jug to flush the excreta; approximately 2–3 litres of water is usually sufficient. Pour-flush toilets share all the advantages of cistern flush toilets but use a lot less water. The wastewater should be disposed of to a septic tank or seepage pit, also known as a leach pit (Figure 20.8).

The pit will contain excreta, cleansing water and flush water. As this leaches from the pit and migrates through the soil, faecal organisms are removed. In some geological conditions, there is a risk of groundwater pollution; therefore, this method is not always recommended.

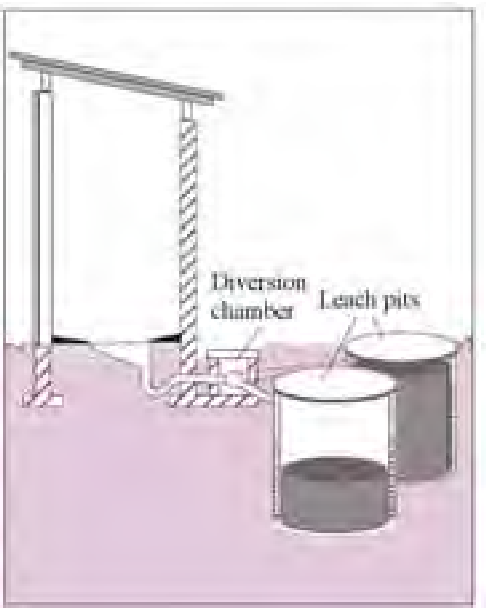


Figure 20.8 Pour-flush latrine design. (Source: as Figure 20.1)

20.5.3 Aqua privy

The aqua privy is a single pit latrine which has a watertight pit filled with water. Excreta drops into the pit and wastewater is displaced into a storage chamber, a seepage pit or a sewer line. It needs to be topped up regularly, so a nearby water supply is required.

20.5.4 Urinals

Urinals, used by men and boys, are only used for collecting urine. Urinals are either wall-mounted units or a drainage channel constructed on the floor in connection with the wall. Most urinals use water to flush although waterless urinals are now becoming popular. In public places and schools, urinals for men and boys help to keep toilets cleaner and decrease the demand for more toilet-seats.

20.6 Handwashing facilities

Every latrine or toilet must have handwashing facilities. As you know, hygiene is an essential component of health promotion and one of the critical times for handwashing is after visiting the toilet. A latrine without a proper handwashing facility will not serve its ultimate objective of disease prevention.

If there is no running water, handwashing stations can be made using jerrycans (Figure 20.9), tin cans, wooden bowls, or pottery depending on the local culture and custom of your community. Simple devices can be made using very basic materials (Figure 20.10).

Figure 20.9 Handwashing facility outside the latrine at a Health Post. (Photo: Pam Furniss)

Figure 20.10 Simple handwashing facility placed conveniently outside a household latrine. (Photo: Pam Furniss)

To make a handwashing station similar to the one in Figure 20.10, follow these easy steps: (Source: adapted from USAID/HIP, 2007)

1 Find a plastic container of approximately 5 litres capacity. A jerrycan or gourd can also be used.

2 You will also need a hollow tube to make the spout. You can use a pen casing (as shown in Figure 20.10), a pawpaw stem or anything that is hollow. You will also need a sharp knife, nail or screwdriver.

3 Decide on the design of your handwashing station before you begin working. Will your container sit on a platform or hang and tip?

4 Wash the container and tube so they are free from visible dirt.

5 Heat the knife, nail or screwdriver to make piercing a hole for the tube easier.
6 Make a small hole for inserting the tube. Make it as low on the container as you can, about 2 cm (two finger widths) from the bottom. Be careful to make it smaller than the tube.
7 Slowly and carefully push the tube into the hole. Be very careful not to push the hole so big that it leaks.
8 Test the water flow:

   When using a plastic bottle: water is delivered when the bottle cap is unscrewed and stops flowing when the cap is tightly shut.

   When using a jerrycan or gourd: water comes out when the cap on the pen or plug in the container is removed. If you don't have the original pen cap, find an old stick to 'plug' the flow.

Finally, set up the station right by the latrine by hanging it from a string around the neck, or setting it on a stable platform. You should also provide soap or ash for washing.

20.7 Your role in latrine construction

Your role is to promote latrine construction by giving advice and encouragement to people in your community to install or improve sanitation systems. In Section 19.4 of Study Session 19 we discussed some of the general principles to be considered when choosing sanitation technologies. This study session has provided further details about the different types of latrine. Figure 20.11 is a decision tree that has been designed to help you answer questions from households such as 'what type of latrine/toilet can I construct?' Start with the question at the top left corner and follow the arrows according to the answers. Be aware this is only an outline guide that summarises the key points.

As part of the process of latrine construction, you can help develop skills in your local area. With the help of district health offices, you should be encouraging local artisans and entrepreneurs to create a sanitary service chain of, for example, prefabricated slabs. You can also promote training of local people on proper latrine construction techniques, especially for improved types of latrine. You can also assist with training of model family household members in your community. Although they may not be common in rural Ethiopia, you should also be familiar with the concepts in higher level sanitation facilities such as water carried systems because you may be involved in advising households that want to upgrade their facilities up the sanitation ladder, step by step. Whichever type of latrine is used, your role is to promote good sanitation and hygiene wherever possible.

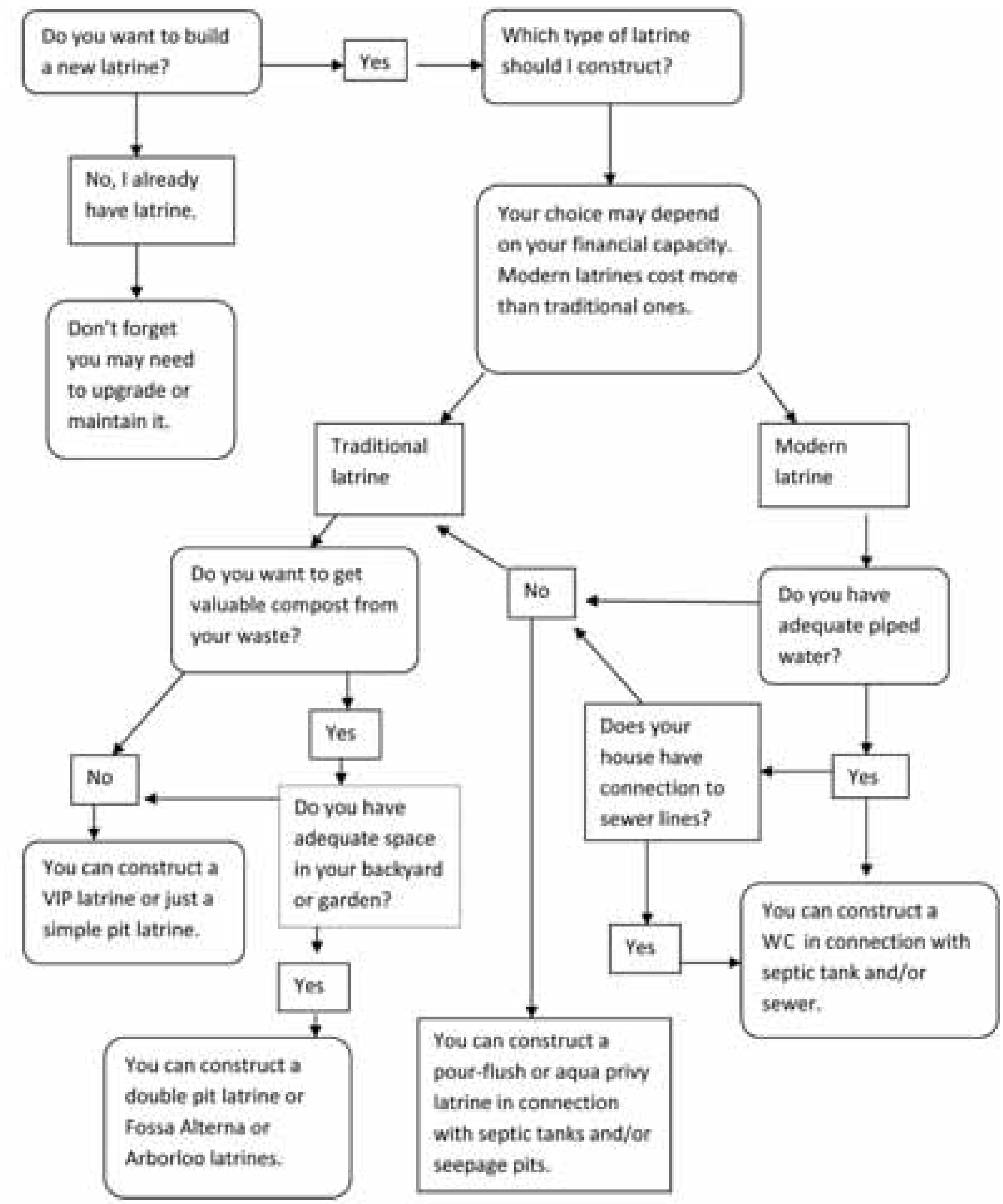


Figure 20.11 Decision tree for latrine options.

Summary of Study Session 20

In Study Session 20, you have learned that:

1. Pit latrines with slab, VIP latrines and ecological sanitation systems are all types of improved sanitation facility.
2. Pit latrines consist of a pit, slab and superstructure. The slab is essential to separate waste from the people using it. The superstructure ensures privacy; it can be constructed of many different locally available materials.
3. Latrines must be sited with due consideration of the type of rock/soil, the location of water sources, the location of houses and the wind direction.
4. VIP latrines are better than simple pit latrines because the vent pipe reduces smells and flies.

5 Ecological sanitation systems, also known as ecosan systems, have the added benefit of producing useful compost material that can be spread on fields as fertiliser.
6 Arborloo, with one pit, and Fossa Alterna, with two pits, are two types of ecosan system.
7 Water carriage systems such as WCs, pour-flush latrines and aqua privies have some advantages over dry systems but they require a regular water supply and are more expensive.
8 Handwashing facilities are essential for use with all types of latrine. They can be easily constructed from simple materials.
9 You can help families and others by providing advice on siting and choice of latrine.

Self-Assessment Questions (SAQs) for Study Session 20

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 20.1 (tests Learning Outcomes 20.1 and 20.3)

Explain the difference between an ecosan latrine and a standard pit latrine.

SAQ 20.2 (tests Learning Outcomes 20.2 and 20.4)

Figure 20.12 For use with SAQ 20.2.

What improvements would you suggest to the latrine shown in Figure 20.12?

SAQ 20.3 (tests Learning Outcome 20.2)

What are the potential risks posed to the environment in using dry pit latrines?

SAQ 20.4 (tests Learning Outcome 20.4)

List the materials you would need to make a simple device for handwashing.

SAQ 20.5 (tests Learning Outcome 20.5)

Ato Tedila, a local farmer, consults you about building a latrine in the compound of his house. He is an open-minded man who is keen to improve life for his family. He has a wife and three young children and his elderly mother also lives with them. They get their water from a well in the compound. The area has a heavy soil and the rock below is impermeable.

(a) Which types of latrine are possible choices for him?
(b) Which types of latrine would you recommend, and why?
(c) What other advice would you give him about the location, design and construction of the latrine?

Study Session 21 Latrine Utilisation – Changing Attitudes and Behaviour

Introduction

There is poor utilisation of latrines among individuals and families in some communities in Ethiopia. In the previous study session, you have learned about the alternative types and construction of latrines. In this study session, you will learn how to encourage latrine utilisation. You will be able to identify and take into account the factors that may influence people against using latrines. Involving model families to share their experiences and participate in regular inspections will help households to properly use their latrines, to seek technical advice when they need it and to solve any problems they encounter. The purpose of this study session is to teach you about approaches that are currently being used to achieve behavioural changes of individuals, families and communities towards good practice of hygiene and sanitation.

Learning Outcomes for Study Session 21

When you have studied this session, you should be able to:

21.1 Define and use correctly all of the key words printed in **bold**. (SAQ 21.1)

21.2 Identify various factors that affect the utilisation of latrines and handwashing facilities. (SAQ 21.2)

21.3 Describe ways of motivation used to enhance latrine utilisation. (SAQ 21.2)

21.4 Explain to selected model families, how to share their experiences of latrine utilisation to others. (SAQ 21.3)

21.5 Describe some approaches to community behaviour change. (SAQ 21.4)

21.6 List the tools used to conduct baseline surveys and regular inspections of latrine utilisation. (SAQ 21.5)

21.1 Benefits of hygiene and sanitation behaviour change

In the previous sessions of this Module you have learned that proper hygiene, adequate sanitation and safe drinking water have significant benefits for human health. You have also learned about the need to practise positive behaviours. Any change from bad habits to good practice is described as **behaviour change**.

■ When are the critical times for a person to wash his/her hands?

□ Critical times for handwashing are after visiting the latrine, after cleaning a child's bottom, before preparing food and before eating meals or feeding children.

Did you know? A gram of human faeces can contain 10 million viruses and 1 million bacteria.

Promotion of hygiene and proper sanitation is the single most important way to improve the health of your community (Figure 21.1). However, the right approaches need to be used to change behaviour and get people to take better care of themselves, their family's health and their environment. As health is an asset to a community, its improvement enhances economic development and brings wealth to a society.

Figure 21.1 Adults and children should always wash their hands after using the latrine. (Photos: WaterAid in Ethiopia)

21.2 Factors affecting the use of latrines and handwashing facilities

21.2.1 Latrines

The possession of an improved latrine, on its own, will not halt the transmission of faeco-orally transmitted diseases among the people of your community. For this to have an impact on health, the people have to use their latrines and handwashing facilities effectively.

- ■ What factors do you think affect the utilisation of latrines in your community?
- □ There are several possible answers including the bad smell of a latrine, lack of privacy if the shelter is inadequate, childhood habits that are hard to break and many more.

The factors will vary from place to place depending on the local context. Behavioural, demographic, geographic, climatic, social, cultural and economic reasons can deter families from using latrines. For example, elderly or uneducated people in rural areas may find it difficult to get used to new technologies and may resist the adoption of new behaviours. In some local cultures, people may not want to share latrines with others; for example, women may not want to share the same facility as their father-in-law and there are some cultural practices that inhibit the use of one latrine by both the husband and wife. Children's faeces are often mistakenly considered not to be a potential health hazard and it may be considered unimportant for children to use the latrine. Household members may be discouraged from using the latrine at night because of the fear that 'evil' or 'devils' inhabit the latrine during that time. Another factor is the misconception that prevails among some farmers that using the 'cat-system' (i.e. burying excreta or leaving it open in a field) will improve the soil condition.

There are other more practical reasons such as the use of inappropriate materials for latrine construction, the collapse of latrines due to termites, flooding problems or loose soil conditions, and the need for frequent maintenance.

You need to identify the factors affecting the use of latrines that are relevant in your community. Once these are defined, then you can discuss them in a transparent way. Open discussion of these issues within the community will ease the construction and use of latrines.

21.2.2 Handwashing facilities

Despite the health benefits, some family members in rural households may not practise proper handwashing.

■ Why do you think that some people in your village don't wash their hands properly?

□ Possible reasons include they can't afford to buy soap, they have a poor attitude to handwashing and can't be bothered to do it, they lack the utensils and equipment, the inappropriate placement of the handwashing facility or lack of water, but other reasons are also possible.

You should focus on individual and communal communication to change the attitude of people towards the direct (health) and the indirect (economic) benefits of handwashing. You can recommend the use of locally available materials such as ash for detergent purposes, and tin cans or jerrycans as handwashing devices (as described in Study Session 20). You can check that the handwashing facility is conveniently placed near latrines and that the water is clean to avoid further contamination.

21.3 Motivating people to change their behaviour

Health education is frequently delivered by someone lecturing about hygiene and sanitation in health facilities and community gatherings. However, such an approach is not recommended as the sole means to achieve individual behaviour change. Because human behaviour is influenced by the surrounding environment and social context, *specific* messages instead of *universal* messages of hygiene and sanitation are more important. Hygiene messages must be contextually and culturally suitable, and comfortable, for your community.

If you are trying to change behaviour by targeting individuals, you need to consider not only their prior experience but also their learned behaviours. These are the habits gained by **social learning** channels, i.e. from parents, friends and opinion leaders in their community. Each individual has their own beliefs, values and knowledge about health practices. People may ask themselves, before adopting a new behaviour, if the new practices are going to fit with their ideas and way of life. They need to be convinced that there will be important benefits from changing their behaviour.

Different motivational techniques can be used to good effect (see Box 21.1).

Box 21.1 Case study: Reasons for building latrines

In villages of Achefer *woreda*, different promotional techniques were used to encourage households to build pit latrines. Community members were asked which of these techniques was most effective. They were asked to choose the three most important reasons out of seven techniques that had been used. Table 21.1 shows the responses from 300 people.

Table 21.1 Reasons for building latrines in Achefer *woreda*.

Rank	Motivator/Reason	Points	%
1	House-to-house promotion of latrine building	92	31.3
2	Coffee ceremony to bring people together for discussion	73	24.8
3	Rewarding good practice with a coloured flag to be publicly displayed	39	13.3
4	Government enforcement	36	12.2
5	Influence of friends and neighbours (peer pressure)	27	9.2
6	Video show that demonstrated positive behaviour by others	23	7.8
7	Fear of being publicly shamed	4	1.4

House-to-house promotion by Health Extension Practitioners and health promoters, and holding coffee ceremonies specifically for hygiene promotion, were more effective than other methods in Achefer. Health promoters, including you, should use all possible ways of hygiene promotion in order to bring positive behaviour at community level.

(Source: adapted from WaterAid in Ethiopia, 2007, *The colour of change*)

In order to have an impact on health, any change in health practice needs to be adopted by many individuals in your community. Shared behaviour is only achieved when the community members themselves feel there is a problem, and are motivated to solve the problem by jointly taking actions that would permanently improve health conditions.

21.3.1 Using model households

Model households and families, also known as household models or role models, provide a valuable opportunity for you for to improve the exchange of learned behaviours to others. These households are often early adopters of new behaviours. You can select and recruit these families on the basis of their expressed interest and willingness to be involved in the promotion of hygiene and sanitation.

Your role would be to ensure they have the necessary knowledge and skill, and develop the right attitude, to help other households in learning about hygiene and sanitation. It is also important that model households are recognised and rewarded by the community leaders, both traditional and formal, and acknowledged by community members, friends and neighbours in order to sustain the existing achievements and encourage others to progress well.

21.3.2 Community motivation

UNICEF uses the term **Community Approaches to Total Sanitation** (CATS) to encompass a range of different community-based sanitation programmes. The aim of these approaches is **total sanitation** which means the complete separation of wastes from humans, i.e. no open defecation and 100% of excreta to be hygienically contained. An important goal for villages and other communities is to achieve **open defecation free** (ODF) status. Box 21.2 summarises the key elements of CATS.

Box 21.2 Essential elements of Community Approaches to Total Sanitation (CATS)

- CATS aim to achieve 100% open defecation free (ODF) communities through affordable, appropriate, acceptable technology and behaviour change.
- CATS depend on broad engagement with diverse members of the community, including households, schools, health centres and traditional leadership structures.
- Communities lead the change process and use their own capacities to attain their objectives.
- Subsidies – whether funds, hardware or other forms – should not be given directly to households.
- CATS support communities to determine for themselves what design and materials work best for sanitation infrastructure rather than imposing standards.
- CATS focus on building local capacities to enable sustainability.
- Government participation from the outset – at the local and national levels – ensures the effectiveness of CATS and the potential for scaling up.
- CATS have the greatest impact when they integrate hygiene promotion into programme design.
- CATS are an entry point for social change and a potential catalyst for wider community mobilisation.

(Source: UNICEF, 2009, *Community Approaches to Total Sanitation*)

The next section describes two particular approaches to community motivation that are becoming increasingly popular throughout the developing world.

21.4 Two approaches to communal behaviour change

Participatory Hygiene and Sanitation Transformation (PHAST) and **Community-Led Total Sanitation (CLTS)** are among the CATS techniques used to achieve total sanitation. These methods introduce community mobilisation and behaviour change as their core principles to improve sanitation and integrate hygienic practices.

Traditional methods of sanitation and hygiene promotion were teacher-driven, i.e. the educator taught by lecture and the community listened passively. CATS approaches are demand-driven, community-led and emphasise the sustainable use of user-friendly, affordable and safe sanitation. The following sections outline the basic principles of PHAST and CLTS but to be a facilitator of these techniques requires further study and training to develop the skills required. Such training might be sought from NGOs involved in water and sanitation (also known as WASH) projects.

21.4.1 Participatory Hygiene and Sanitation Transformation (PHAST)

PHAST is a widely used community approach to hygiene promotion. It uses participatory techniques to promote good hygiene behaviours, sanitation improvements and community management of water supply and sanitation facilities. It is derived from a *community appraisal* method of health practice that, in the process, empowers community members (participants) to be able to identify their community problems. Community appraisal is a process for analysing the existing community health problems by mapping water and sanitation, and identifying good and bad hygiene behaviour in relation to community hygiene practices and the spread of diseases. Figure 21.2 shows PHAST participants involved in group discussion and Figure 21.3 represents a group using a map they have drawn to identify the sanitation problems.

Figure 21.2 PHAST Community conversation. (Source: Addis Continental Institute of Public Health Students presentation, 2010)

Figure 21.3 PHAST participants looking at WASH mapping.

The next step in the process is for participants to make plans for solutions. During this planning process, they will look at the ways of blocking the paths for the spread of disease. Men and women share the tasks and select options for sanitation improvements and improved hygiene behaviour. This is followed by identifying who does what and noting what might go wrong. They also put in place the monitoring and evaluation process. Monitoring is meant to check the progress of the implementation of WASH activities, while evaluation looks at what improvements (health, social or economic) were brought about at community level. In all these steps, the facilitator's role is to guide the participants as they work through the PHAST process.

Box 21.3 describes a case study of the PHAST process.

Box 21.3 Case study: PHAST in Amba *kebele*

Tsehaye is a Health Extension Practitioner in Amba *kebele*. The *kebele* does not have adequate access to improved drinking water. A baseline survey of giardiasis prevalence was conducted and was found to be 25% among children under 10 years old.

Tsehaye had received training in the PHAST approach so that she could train others. She decided to put this training to good use and trained nine village volunteers in hygiene promotion specifically aimed at the prevention of giardiasis. These volunteers then mobilised 2,500 community members, both adults and children, in the *kebele*. During the training, the community members identified the bad behaviour they were aware of (such as open field defecation, disposal of child faeces in open spaces, not washing hands after visiting latrines and after cleaning a child's bottom). The community members, with the help of the nine village volunteers, planned to avoid those bad practices and in contrast, adopt and sustain good behaviour. The training and community mobilisation continued for one year. People started to change their behaviour as a result of increased awareness and a positive attitude towards healthy behaviour. Consequently, the prevalence of giardiasis among children in the Amba community was reduced to 10%.

Amba *kebele* is now planning to achieve open defecation free status within the coming 3–6 months. The achievement of Tsehaye and the volunteers was recognised and they took the best practitioner prize of the year from the *kebele* leader. They are highly motivated to work more to overcome the public health challenges in Amba *kebele*.

(Source: adapted from WHO, 1996, *Participatory hygiene and sanitation transformation*: *A new approach to working with communities*)

This case study demonstrates the use of PHAST as a tool for identifying the community WASH problems, planning the solutions and finally monitoring and evaluating the WASH performance. You should notice that the focus of PHAST is always on the involvement of the community to determine and solve its problems.

21.4.2 Community-Led Total Sanitation (CLTS)

CLTS aims to bring community-wide elimination of open defecation by raising awareness and promoting affordable technology options. NGOs, multinational organisations and government health programmes in many countries in developing regions of the world (including Ethiopia) are adopting this approach. It has become the most successful community approach to total sanitation.

Like PHAST, the core principle of CLTS is that it is a community-driven approach. The role of outsiders, possibly including you as a Health Extension Practitioner, is to guide the community to assess its sanitation situation, determine a strategy for improvement, implement the solution and develop a way to measure success.

CLTS relies on the skill of the facilitators using a set of activities and demonstrations to communities to study their situation (Figure 21.4). This includes open defecation patterns in their village and faeco-oral contamination that occurs in their community.

Figure 21.4 Sanitation profile mapping using a participatory approach. (Photo: WaterAid in Ethiopia)

CLTS encourages community members to change by going through an 'ignition' moment when they are 'triggered' into action, for example, the moment when they collectively realise that open defecation amounts to eating each others' faeces. In the 'ignition' process, the facilitator talks to a gathering of all community members (including men, women, children, youth and elderly) in direct language about sanitation in a way that is normally taboo in the community. By engaging them in frank and transparent discussions, for example asking them to assess the amount of faeces they produce, you will 'trigger' them by creating a sense of shame and disgust, which in turn mobilises the community to take immediate action to end open defecation. The facilitator will guide (not prescribe!) the participants in developing their own low-cost latrine designs and a sanitation plan of action for their villages. Hopefully, with the help of locally available expertise and resources, the participants can immediately start constructing latrines.

As part of the CLTS process, activists and enthusiastic members of the community called 'natural leaders' should emerge and take the lead. Natural leaders will play a vital role in encouraging communities to adopt and go through with the planned activities. These natural leaders could subsequently become 'consultants', triggering and providing engagement and support to communities other than their own.

School-Led Total Sanitation (SLTS) is a related form of community approach to total sanitation. You can engage school teachers and students in similar sanitation activities with the aim to clean up the school environment and promote hygiene among school children and staff. School sanitation clubs can be actively engaged in SLTS. Though the targets are slightly different, the techniques are similar to the CLTS approach.

In CLTS, it is very important for you to consider and understand the cultural and contextual differences between communities. There might be incidences when the community members may be angry or sensitive to discussions at times of triggering and when they are ignited. You must know how to handle these events in order to get back on track. So instead of adopting the whole practice of CLTS applied elsewhere, you may need to adapt it to fit your community's cultural and social conditions.

Box 21.4 Case Study: CLTS in Fura *kebele*

Fura *kebele* declared Open Defecation Free (ODF) status in September 2, 2007.

Fura is in Shebedino Woreda in the Southern Nations Nationalities People's Region of Ethiopia. Like other areas of Ethiopia, Shebedino suffered with open defecation in the fields, around the home, on footpaths and in the bush. Plan Ethiopia Shebedino Programme, an NGO, technically facilitated the implementation of CLTS in this *kebele* in February 2007. Local leaders and the Health Extension Workers and health promoters were first trained in CLTS approaches and then community members were involved. With CLTS training, the participants were overwhelmed with shame and disgust because of their open defecation practices. They promised to end open defecation and they achieved this within four months. CLTS mobilised community residents to identify their problems and design their own solutions to improve hygiene and sanitation behaviour. CLTS also facilitated development of local rules, such as 'any person caught defecating in the open, will be forced to shovel and carry his faeces to the nearest latrine'. All households, 1265 of them, had latrines and 7 communal latrines were constructed along the main road to the market place to be used by passers-by. About one third of household latrines were constructed after CLTS was introduced.

The progress towards total sanitation and the year when 100% coverage was achieved is shown on a chart on the wall of Fura Health Post (Figure 21.5).

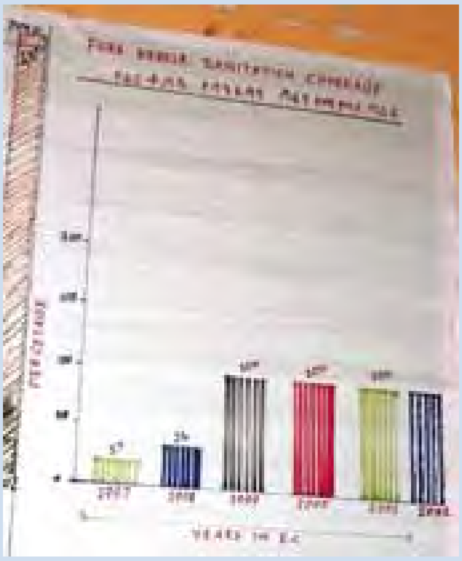


Figure 21.5 Wallchart at Fura Health Post showing the rapid increase in sanitation coverage in the *kebele*. 100% coverage was achieved in 1999 in the Ethiopian calendar, 2007 in the European calendar. (Photo: Pam Furniss)

Box 21.4 continues on the next page

Open Defecation Free was declared and celebrated on September 2, 2007. Project personnel, local leaders and the *kebele* residents, in total about 500 people, participated in the celebration which was organised in the compound of Fura School. Poems, drama, songs and posters that condemn open defecation were presented. One of the dramas (Figure 21.6) focused on the need to punish anyone who defecates in the open air.

Figure 21.6 Community members demonstrating in drama how they punish open defecators.

Slogans and sign boards that strongly promote the importance of hygiene and sanitation adorned the school compound. One slogan read: 'Fura: the *kebele* where all households constructed pit latrines on their own initiative, and where all use latrine, saying no to open defecation'. Other slogans read: 'Bury faeces not people'; 'Fura enters the New Ethiopian Millennium open defecation free'. Community members were very happy about the recognition they had for being Open Defecation Free. They were highly committed and promised to keep their *kebele* ODF in the future. Neighbouring *kebele* leaders and Health Extension Workers were invited to share the experience of the Fura ODF event. This resulted in the establishment of school clubs, advocating CLTS in churches and mosques, and establishment of CLTS Committees in other communities.

(Source: adapted from SuSanA, 2007, *Fura kebele declared open defecation free environment*)

21.5 Latrine utilisation monitoring and evaluation

Any programme that is promoting behaviour change needs to have a process for assessing how effective it is – in other words, a monitoring and evaluation process. Latrine utilisation promotion and other WASH projects therefore need to include monitoring and evaluation activities. This means setting specific, measurable and achievable objectives, and clearly stating the monitoring activities and indicators to be used.

There is an important preliminary step which is to gather baseline data of the situation *before* the intervention for comparison with the data gathered by the monitoring activities. The same indicators should be used both before and after so you can compare like with like. Important measurable indicators for latrine use and handwashing include:

- no visible human excreta in likely sites
- percentage of households that have a latrine and which is seen to be in use

- percentage of latrines with no faeces and urine soiling on walls and floors
- presence of handwashing facility and water near the latrine
- presence of soap, ash or other cleaning agent near latrine
- percentage of communities/villages certified as ODF
- percentage of households that have upgraded their latrine to an improved system
- percentage of households with clean compounds without any excreta.

A sample checklist for these indicators is shown in Box 21.5.

Box 21.5 Sample checklist for latrine utilisation

Name of *kebele*	
Name of village	
Questions to asked	**Response (yes/no)**
Is there a latrine?	
Is the latrine functioning?	
Is there faeces and urine around the latrine?	
Is there faeces and urine around the house?	
Is there a handwashing facility near the latrine?	
Do the family members wash their hands after latrine use? (observe)	
Is there water available for handwashing at the time of your visit?	
Is there soap or ash in the handwashing facility for handwashing?	
Do you observe fresh faeces inside the latrine?	
Is the footpath to the latrine free from any barrier?	
Name of data collector	
Date	
Signature	

Summary of Study Session 21

In Study Session 21, you have learned that:

1 Proper community hygiene and sanitation programmes have useful health and socio-economic benefits.

2 Identifying the possible reasons for not using latrines and handwashing facilities properly is important in order to promote and sustain positive hygiene behaviours.

3 Latrine utilisation and handwashing practices are affected by behavioural, cultural, social, custom, demographic and economic factors.

4 Motivating individuals, families and community members using various stimulating techniques will help to bring and sustain hygiene behavioural changes.

5 There are different behaviour change models and practical approaches that are applicable for hygiene and sanitation practice.

6 CLTS and PHAST approaches are community-driven, facilitator-guided methods for promoting total sanitation and good hygiene practices.

7 Monitoring and evaluating the performance of changed behaviour is always important in order to sustain established healthy behaviours.

Self-Assessment Questions (SAQs) for Study Session 21

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 21.1 (tests Learning Outcome SAQ 21.1)

Rewrite the paragraph below using terms from the list provided to fill the gaps.

The terms to use are: PHAST; behaviour change; CLTS; CATS; total sanitation; ODF status.

Improving latrine utilisation requires ________ by the people in the community. Some people may need to be persuaded that ________ and _______ are valuable aims that will help prevent the spread of disease. There are various approaches that can be used to try to achieve _________. Two examples of these approaches are _______ and _________. Both these methods depend on involving the whole community in the process and they are grouped together as _______.

SAQ 21.2 (tests Learning Outcomes 21.2 and 21.3)

Imagine a small village of about 20 households where open defecation is the normal practice. You have visited the village and, from discussions with the people there, you know that most of them are ignorant of the importance of sanitation. They say to you that they have always lived in this way and so did their parents and grandparents before them. They are reluctant to change their habits. What methods would you consider to motivate change in their behaviour?

SAQ 21.3 (tests Learning Outcome 21.4)

In the same village as SAQ 21.2, imagine there was one family that had their own latrine. You think they might be willing to be a model household to demonstrate good hygiene and sanitation to the others. What would you say to them to encourage them to volunteer as a model household?

SAQ 21.4 (tests Learning Outcome 21.5)

Identify one similarity and one difference between PHAST and CLTS approaches.

SAQ 21.5 (tests Learning Outcome 21.6)

Assume you have successfully implemented a CLTS programme. How do you really know if you have been successful?

Study Session 22 Solid Waste Management

Introduction

The common practice for household refuse disposal in rural areas is to dump solid wastes openly in backyard gardens or in an open space. Such indiscriminate disposal is an environmental hazard and can threaten human health and safety. Solid waste that is improperly disposed of can result in a number of problems. It can create a breeding ground for pathogenic microorganisms and vectors of disease, and cause a public nuisance due to unsightliness and bad smell. It can cause contamination of surrounding soil, groundwater and surface water, and it can also create fire hazards, physical hazards and have poisoning effects (from pesticides and insecticides). However, these problems can be avoided by using appropriate management techniques. For all waste management issues, your role should be to engage community members and families in awareness of the solid waste problems in their area and try to change their behaviour. In doing so, it should be possible to have a clean, attractive and sustainable environment.

In this study session, you will learn about the different types of solid waste and their common sources. You will also learn about the stages in solid waste management and appropriate disposal methods. Proper management of solid waste will help your community prevent communicable diseases and safeguard the environment in a sustainable manner.

Learning Outcomes for Study Session 22

When you have studied this session, you should be able to:

22.1 Define and use correctly all of the key words printed in **bold**. (SAQ 22.1)

22.2 Describe the different sources and characteristics of solid waste. (SAQ 22.2)

22.3 Describe the functional elements of solid waste management. (SAQ 22.3)

22.4 Describe the different methods of solid waste management. (SAQs 22.3 and 22.4)

22.5 Survey solid waste management practices. (SAQ 22.5)

22.1 Sources and classification of solid waste

Solid wastes include household refuse, agricultural remnants, food leftovers, plastic bags, tin cans, ash and packaging, such as cartons and used *jonya* sacks. They become waste once they have been discarded because they are no longer needed in their present form. Refuse, garbage, litter and street sweepings are all terms used to describe solid wastes in various situations.

In rural parts of Ethiopia, the type of solid waste generated will vary depending on the particular location and the socioeconomic and cultural conditions of the area.

In general, rural households produce wastes that are mostly *organic* in nature and result from agricultural production and processing activities. They include crop residues, food remnants, leaves and grass from clearing of sites, animal manures and dung, ashes, dead animal carcasses, etc. Other solid wastes could include glass, plastic containers, metal scraps, tin cans, plastic bags, condoms and obsolete agricultural pesticides and insecticides. These solid wastes need to be managed properly in a way that avoids the potential risks to the environment and to human health.

The type of waste will determine the choice of possible disposal methods. Therefore, it is important to be able to classify solid waste according to its characteristics (Table 22.1).

As you may remember from Study Session 18, solid waste can be classified based on its source as residential, agricultural, commercial, industrial, institutional or healthcare waste. You were also introduced to the classification of waste as hazardous or non-hazardous and also as biodegradable or non-biodegradable. Another word used in the context of biodegradable solid waste is *putrescible,* which means the waste decomposes (rots down) quite quickly. Waste can also be described as combustible or non-combustible depending on whether it will burn or not. Table 22.1 classifies waste using these different properties.

Table 22.1 Classification of solid waste.

Main classification	**Type**	**Short description**	**Examples**
Hazardous waste	Solid or semi-solid	Substances that are either ignitable, corrosive, reactive, infectious or explosive	Some obsolete pesticides such as DDT, dieldrin, etc.
Non-hazardous waste	Putrescible	Easily decomposable/ biodegradable solid waste	Food wastes
	Non-putrescible	Non-biodegradable solid waste, it includes combustible and non-combustible waste	Plastic bags, bottled water containers, tin cans, etc.

Putrescible wastes are generated by growing, handling, preparation, cooking and consumption of food. These kinds of wastes tend to be more abundant during the summer (rainy) seasons. Non-putrescible wastes do not decompose easily; they may or may not be combustible. Because they do not break down, they persist in the environment and are often the cause of nuisance and aesthetic problems.

- ■ Can you think of any non-putrescible wastes that cause environmental problems in your community?

- □ We don't know exactly what the waste problems are in your area but a probable answer is plastic bags because they are a widespread problem in Ethiopia.

Plastic bags are commonly known as *festal*. They are widely used to carry goods from market to home in all areas because they are convenient, cheap and easy to use. Plastic bags are usually non-biodegradable and persist in the environment for a very long time. Moreover, when discarded indiscriminately, they pollute the land surface of your community, prevent rainwater from percolating into the soil, can easily be blown all over the place by wind, and create unsightly and nuisance conditions. The bags can also be easily swallowed by animals, which may block their digestive system and kill them (Figure 22.1). In malaria-prone areas, there is also a potential to create breeding places for mosquitoes because the bags may trap small pools of water.

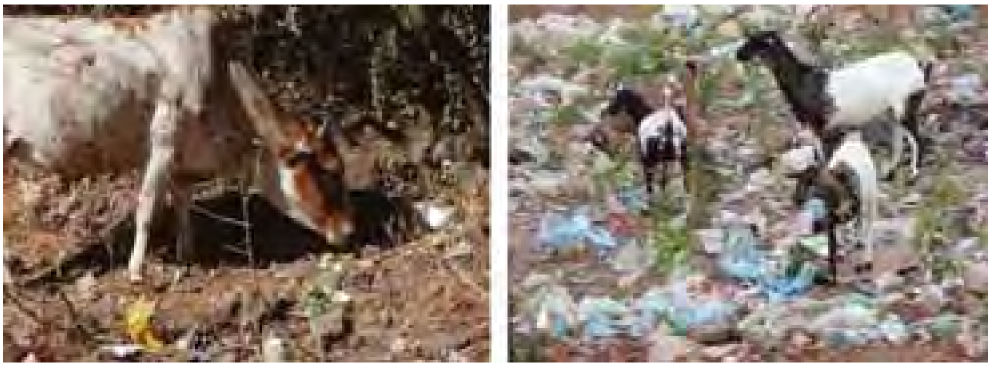


Figure 22.1 Discarded plastic bags are a health hazard for grazing animals. (Photos: Pam Furniss)

22.1.2 Hazardous waste

Hazardous wastes are treated as a separate category of waste because special management and disposal methods are required. The main sources of hazardous substances are agricultural offices/stores, health offices/stores and possibly also private firms, homes and retail shops. The toxic, corrosive, ignitable, explosive and/or infectious characteristics of these wastes require careful and stringently controlled methods of handling, storing and transportation. Hazardous wastes, because of their particular environmental health hazard, should be identified, quantified and reported to a higher level for further action.

- ■ What is an environmental health hazard?

- □ An environmental health hazard is any environmental factor or situation that can cause injury, disease or death.

In Study Session 2 you learned about the causes and types of environmental health hazards. The immediate health effects from hazardous wastes range from bad smells and simple irritation of eyes, skin, throat and breathing (lungs), to serious health conditions that affect the nervous system and could cause paralysis of the functional body parts. Some hazardous solid wastes have teratogenic (birth defects) and carcinogenic (cancer causing) effects.

The long-term effects of hazardous wastes can be devastating to community health and wellbeing. However, it is difficult to quantify the exposure level and predict the health consequences as a result of exposure because the types of hazardous waste are so variable. If you observe or get reports from others about the presence of any hazardous waste, you should report this to the environmental health office and/or the agricultural development agent in your locality.

If you know there are stores of hazardous materials in your community, you should monitor them regularly using observation checklists and by asking for information, and then report your findings if you have any concerns. You should not attempt to bury, burn or dispose of hazardous wastes. Hazardous solid wastes require specialised methods of handling, collection, transportation and disposal. Some wastes, such as obsolete pesticides or radioactive material, may need to be transported out of the country for final disposal. (Hazardous solid wastes from health institutions will be dealt with separately in the next study session.)

22.2 Functional elements of solid waste management

In Study Session 18 you were introduced to the functional elements (stages) of solid waste management which are:

- onsite handling, storage and processing
- collection
- transfer and transport
- resource recovery and processing
- disposal.

The complete set of functional elements will apply in urban centres managed by municipal authorities but not all of them will be relevant in rural areas.

22.2.1 Onsite handling, storage and processing

Figure 22.2 Waste basket provided by the local Guides Association at a Lake Tana monastery. (Photo: Pam Furniss)

Onsite means these functions are concerned with solid waste at the place where the waste is generated. For residential waste this means at home in the household. Onsite handling is the very first step in waste management. It involves individual family members, households and communities, all of whom need to know how to handle waste properly at this level. 'Handling' means the separation of wastes into their different types so they can be dealt with in the most appropriate way, for example, separating putrescible waste for composting. The benefits of appropriate onsite handling include reducing the volume of waste for final disposal and recovering usable materials.

Onsite storage means the temporary collection of waste at the household level. It is important that waste is stored in proper containers. These could be baskets, preferably made from locally available materials, plastic buckets or metal containers (Figure 22.2). Larger containers or dustbins, especially those used for food waste, should be leakproof, have tight lids and be long-lasting. The size of the container should be sufficient to hold at least the amount of solid waste that is generated per day at household level. Institutions and businesses should consider having onsite storage facilities with greater capacity. The proper location of storage containers and the frequency and time of emptying are important factors to be considered for efficient onsite storage.

Some wastes will need some sort of onsite processing before the next steps, for example, in areas where false banana (*enset*) is used as a staple crop, the byproducts should be chopped into pieces before composting to speed up the rate of decomposition.

22.2.2 Collection, transfer and transport of solid waste

In urban centres, collection is a function that has its own process and services. Waste is collected and held at central transfer stations where waste is stored before it is transported to a final disposal site. In rural areas, waste is not normally collected in this way and disposal is limited to onsite processing options, although sometimes there may be communal collection of solid waste using animal carts.

22.2.3 Resource recovery and processing

Resource recovery means finding a way to use the waste so it becomes a valuable resource, rather than just a disposal problem. This is a very important part of waste management. Resource recovery includes a range of processes for recycling materials or recovering resources from the waste, including composting and energy recovery. Converting the waste into a new product may require energy and equipment; therefore, there needs to be a careful assessment of inputs and outputs in case it is not economically sensible to do it. Resource recovery options are discussed further in the following sections of this study session.

22.2.4 Disposal of solid waste

Even after recycling and resource recovery there will almost certainly be some residual waste that needs final disposal. Methods of disposal can be sanitary or unsanitary. Open field dumping is the most unsanitary method of refuse disposal and is most likely to cause a health hazard. Sanitary methods – including controlled tipping or controlled burial, incineration and sanitary landfill – are discussed later in this study session.

22.3 Integrated solid waste management

The concept of **integrated solid waste management (ISWM)** mostly applies to municipal solid waste management in urban centres. The principles can, however, be applied to some extent in rural and peri-urban solid waste management.

In Study Session 18, it was explained that an ISWM approach means considering not only the appropriate disposal of solid waste but integrating this with other management options such as minimising waste production, recycling, composting and other waste recovery options. These different options can be ranked in order of their desirability as management options. This is often represented in a diagram known as the waste management hierarchy (Figure 22.3) that you first met in Study Session 2.

Figure 22.3 The waste hierarchy. Waste management options are listed in order of desirability from most desirable at the top to least desirable at the bottom.

At the top of the hierarchy is **reduction**, which means keeping the production of waste to a minimum. Next comes **reuse**, which simply means using something more than once. The third option in the hierarchy is **recovery,** which includes several separate processes that enable material or energy resources to be recovered from the waste. These include recycling, composting and energy from waste. Finally, the least desirable waste management option is **disposal,** which includes landfill, tipping and incineration (burning) without energy recovery.

We will now look at the options for waste management in the hierarchy in a little more detail.

22.3.1 Reduction strategies

Reduction strategies are the ways that a household or community may use to try to reduce or minimise the amount of solid waste they produce. This approach is generally more relevant in affluent homes and societies with a wasteful lifestyle. For example, people with more money may not worry about throwing household items away when they can afford to buy replacements. In a business context, using two-sided photocopying of a document reduces the paper used and also therefore the waste produced.

22.3.2 Reuse strategies

Reuse refers to the act of using an item more than once, either for the same or similar purpose. Figure 22.4 shows used plastic bottles and other containers for sale to be reused. Unlike recycling and other recovery options, reuse does not require reprocessing and therefore requires less energy.

Figure 22.4 Plastic containers are frequently reused. (Photos: Pam Furniss, Janet Haresnape)

- ■ What sort of materials or products are reused for the same or different purposes in your community?
- □ Using plastic bottles or glass containers for water, oil or gasoline are possible answers though there are a number of others from household utensils to personal uses.

22.3.3 Recovery strategies: recycling, composting and energy

Recycling

Recycling is a process by which waste is processed in some way to be reformed into new or similar products. The principle is to make a usable product from the waste. Plastic bottles, newspapers, cardboard and tin cans can all be reprocessed and made into new items. Plastic bags can also be recycled and used to make mats, carpets and other products. Waste metal has a number of possible uses because it is relatively easy to reshape (Figure 22.5). Careful separation of the waste into its different types is important for the efficiency of recycling processes. Recycling not only reduces the quantity of waste but also saves money, so there is an economic, as well as an environmental, incentive to recycle.

Figure 22.5 Waste metal can be recycled by using it to make new and different products. (Photos: Janet Haresnape, Basiro Davey)

Composting of organic solid wastes

Non-hazardous, putrescible solid wastes such as crop residues, leaves, grass and animal manures can be managed onsite by **composting**. Composting is a controlled process in which this type of waste is collected in an open pit or heap and is decomposed by natural biological processes. The waste is broken down by the action of a variety of microscopic and other small organisms. The waste is converted into a stabilised material that can be used as fertiliser. Composting is an environmentally friendly way of recovering value from organic waste.

As we discussed in previous sessions, both human waste and organic household waste can be composted. However, the process is different. Human waste can be composted in alternating double pit latrines and in ecological sanitation systems. This process of composting is anaerobic. In the case of organic household waste composting, it is an aerobic process.

■ What is the difference between aerobic and anaerobic processes?

□ Aerobic processes require oxygen or air to be present. Anaerobic processes take place without oxygen.

The pit for composting should be dug about 50 m away from a dwelling. The pit needs to be about 1 m deep and at least 1 m breadth and 1 m length. However, the size can vary with the amount of waste generated. The pit depth should be slightly less on one side, about 90 cm, to make a slope so that water does not collect at the bottom. To make the compost, organic matter such as grass, leaves and kitchen/food waste should be thrown into the pit in a shallow layer. It is very important that only biodegradable material is added, so care is needed to sort the waste beforehand. No plastic should be included and bones should be avoided. The waste should then be covered with a thin layer of soil. Covering with soil encourages the composting process and prevents the breeding of flies and other vermin. Air must be allowed to mix with the compost so the contents of the pit need to be turned frequently by digging. The compost needs a small amount of water to keep it moist. The time for the compost to be ready will vary depending on the temperature and the mix of waste among other factors but it should be ready within a few months.

Composting is mostly practised in rural communities. In Ethiopia, it is becoming customary for households to prepare compost from their household organic wastes and you should encourage this practice.

Energy from incineration

To incinerate something is to burn it. In waste management terms, however, **incineration** means burning in a controlled and managed process – usually at high temperature. Incineration cannot be implemented at household level; it is mostly used for institutional waste management purposes.

Different types of incinerator are used for burning waste. They differ by the temperature at which they operate, the cost of construction, the method of operation and the maintenance requirement. Incinerators can be used for disposal of wastes in health institutions/Health Posts and government and private institutions/offices/industries. Incineration can reduce the volume of refuse by up to 90%; the only remaining residual waste is ash. This significantly reduces the volume of material needing final disposal. Incineration is only classed as 'recovery' in waste management if the energy (heat) that is produced is used in some way.

22.3.4 Final disposal: landfill, controlled tipping and burning

Sanitary landfill means the *controlled* filling of compacted layers of solid waste and soil into pre-prepared land. Large-scale landfill sites for municipal waste need to be designed to protect surface and groundwater from contamination by **leachate**, the liquid waste that may seep out into the ground underneath the layers of waste. Sanitary landfill sites are not just rubbish dumps for open field dumping. To be classed as sanitary the site must be managed to minimise any negative environmental impact.

Controlled tipping or controlled burial is similar in principle to sanitary landfill but at a smaller scale that is appropriate in rural areas. In controlled tipping/burial, solid waste is disposed of into a dug pit and is regularly covered with soil to avoid attracting disease vectors such as flies and rodents. Covering the waste also stops it from being blown by the wind and avoids bad smells – hence 'controlled'.

Note that various similar terms may be used to describe different types of waste disposal pit. A refuse pit is a simple pit used to dispose of household refuse, which may or may not be used for controlled tipping (with soil). Some wastes will need to be buried under soil as soon as they are disposed of, in which case the pit may be referred to as a burial pit.

When there is a need for preparing a refuse pit for households, you should advise them that sites for controlled tipping should be 10 m away from the house (preferably at the back of the house), at least 15 m and preferably 30–50 m away from water wells and at a lower ground level. At community level, a communal refuse pit should be 100 m away from houses and they will also need to consider the direction of wind. The site should be easily accessible, with adequate space, and should be fenced so that it is not accessible to children and domestic animals (Figure 22.6).

Figure 22.6 Refuse pit with a fence to prevent people or animals from accidentally falling in. (Photo: Pam Furniss)

Care must be taken to avoid creating places that could harbour rats or encourage the breeding of flies and other insects. Waste from individual households should be taken to the site in suitable containers such as sacks, plastic bags or buckets. For a community waste disposal pit, it should be a collective responsibility to keep communal areas clean.

Animal carcasses need to be disposed of carefully because they can encourage the breeding of flies and rodents, and attract scavenger animals. They can be disposed of in a common burial pit for the community.

Burning of waste is another possible, though less desirable, method of final disposal. A burning site should be sited downwind and well away from houses. Non-combustible materials such as broken bottles, bones, etc. should be separated and buried at a safe location, not used by farming. Ashes that remain after burning can be used as fertiliser or, if mixed with mud, can be used for plastering of earth walls or floors.

22.4 Surveying solid waste management

The management of solid waste can have a significant impact on human and environmental health. You need to be able to survey the ways that solid waste is managed in your area so that you can assess the situation and identify possible areas for improvement. The list of questions below indicates some of the issues that should be covered in your survey; you may think of other questions to include.

How many of the households in your *kebele* have a compost pit?

Do households without compost pits have adequate space to make one?

Are there other opportunities for recycling or reuse of waste material?

Does the community have a communal refuse disposal pit?

How many people use each refuse pit?

Is there a need for another communal pit?

Are the refuse pits fenced and properly managed?

Is there adequate equipment in your *kebele* for managing solid waste?

Is there any open dumping of waste in your *kebele*?

Answering these questions will provide you with the baseline data you will need for planning improvements to the solid waste disposal facilities. If households do not manage their waste properly you may want to try to find out the reasons for this. It may be lack of resources such as money, space or labour, or there may be behavioural reasons that make people unwilling to use compost pits, for example. Understanding the reasons for the behaviour will help you to give advice to the family and indicate the most effective ways to promote good waste management practices.

After analysing your survey results, you may want to prepare an action plan. There are several possible measures that you could consider including in your plan to lessen the problems. You may want to promote general good practice by ensuring all households have adequate waste containers at home. You may need to ensure all pits are fenced and properly managed. You may need to mobilise the community to dig a new refuse pit, if your survey suggests that one is needed. You may want to focus on a specific problem like plastic bags. You could advise people to collect their plastic bags in one place for recycling and it may also be possible to encourage individuals and enterprises to undertake this profitable activity. You could encourage more reuse of plastic bags by suggesting that people take bags with them to the market or shop to be used again. You could promote other types of bag such as paper bags because they are made of biodegradable materials or permanent bags like cloth bags. You could get the local school involved and initiate a campaign among the children to collect waste bags to clean up the local environment.

Keep in mind that any action plan should be drawn up with the involvement of your community because it will not succeed without their full cooperation. You should include regular monitoring in your plan so you can assess if progress is being made.

Summary of Study Session 22

In Study Session 22, you have learned that:

1 In rural communities of Ethiopia, the type of waste produced is mainly agricultural and household waste, which is organic and compostable in nature.

2 There are several different ways of classifying waste, including putrescible or non-putrescible, hazardous or non-hazardous, and combustible or non-combustible.

3 Hazardous chemicals such as obsolete pesticides are concerns in rural communities.

4 The functional elements of solid waste management are onsite storage, processing and handling, collection, transfer and transport, resource recovery, and final disposal.

5 Landfill as a means of disposal of solid waste is used in urban situations but may not apply in rural settings. Controlled tipping/burial and composting methods are preferred.

6 Disposal of plastic bag wastes (*festal*) is a cause of concern and needs special attention to be managed sustainably.

7 Care should be given in selection of disposal sites at residential or communal level.

8 Surveying and community involvement is needed in order to prepare viable action plans to improve solid waste management practices.

Self-Assessment Questions (SAQs) for Study Session 22

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 22.1 (tests Learning Outcome 22.1)

Which of the following statements is *false*? In each case, say why it is incorrect.

A Recycling is the best approach to solid waste management.
B Composting is an aerobic decomposition process for converting organic solid waste into useful compost.
C Reusing plastic water bottles is an example of waste recovery.
D Controlled tipping is so called because only a limited quantity of waste can be tipped at any one time.

SAQ 22.2 (tests Learning Outcome 22.2)

Categorise the different kinds of waste listed below as hazardous or non-hazardous, and as compostable or non-compostable.

Tin cans, manure, grass, obsolete herbicides, paper bags, plastic *festal*, expired drugs, potato peelings.

SAQ 22.3 (tests Learning Outcomes 22.3 and 22.4)

List the functional elements of solid waste management. Which of these are relevant to rural settings? Explain why these are relevant but the others are not.

SAQ 22.4 (tests Learning Outcome 22.4)

Briefly describe the preparation of compost.

SAQ 22.5 (tests Learning Outcome 22.5)

Identify two important indicators used to monitor solid waste management in a community. Describe how you would assess them.

Session 23 Healthcare Waste Management

Introduction

Improper handling and disposal of healthcare wastes (also sometimes called medical waste) puts the health worker, the patient and the community at large at risk through transmission of pathogens via blood or body fluids, contaminated medical equipment, or sharp instruments. In this study session, you will learn to identify the types and sources of healthcare waste. The session also describes the components of waste management and the disposal methods for these wastes. Recognising the health risks involved in poor healthcare waste management and practising proper medical waste disposal will help protect everyone from the hazards of healthcare waste.

Learning Outcomes for Study Session 23

When you have studied this session, you should be able to:

23.1 Define and use correctly all of the key words printed in **bold**. (SAQ 23.1)

23.2 Distinguish between the types, and identify the risks, of medical waste. (SAQ 23.2)

23.3 Describe the handling and disposal requirements for healthcare waste. (SAQs 23.3 and 23.4)

23.4 Describe the health risks to health workers or patients related to sharps injuries. (SAQ 23.4)

23.1 Sources and classification of healthcare waste

Healthcare waste can be defined as any waste produced by healthcare activities. It may also be known as medical waste, hospital waste or infectious waste. The major sources include hospitals, Health Posts, emergency medical care services, healthcare centres and dispensaries, obstetric and maternity clinics, outpatient clinics, and the like. Other sources are dental clinics, psychiatric hospitals, cosmetic ear-piercing and tattoo parlours, and illegal drug users. Healthcare waste can be put into one of two broad categories; non-hazardous ‘general waste’ and hazardous ‘healthcare risk waste’.

Between 75% and 90% of the waste produced in healthcare establishments is general waste. This includes papers, packaging materials, dust and the like. This can be disposed of in the same way as other non-hazardous wastes, but only if is not contaminated by contact with hazardous wastes. The remaining 10–25% of waste is hazardous and could be composed of sharps (needles, lancets, etc.), syringes, blood or body fluid, contaminated surgical instruments, delivery bowls, used gauzes and gloves, plasters, etc. It may also contain expired drugs, lab reagents and other chemicals. Your main concern here should be on managing the hazardous wastes in a safe way. However, you should not ignore non-hazardous wastes, because poor handling and segregation can lead to them being contaminated with hazardous materials.

You can categorise hazardous healthcare waste into:

- Infectious waste: waste that may contain pathogens. This includes used dressings, swabs and other materials or equipment that have been in contact with infected patients or excreta. It also includes liquid waste such as faeces, urine, blood and other body secretions.
- Pathological waste: human tissues including placentas, body parts, blood and fetuses. Anatomical waste is a sub-group of pathological waste and consists of recognisable body parts.
- Sharps: needles, infusion sets, scalpels, blades and broken glass.
- Pharmaceutical waste: expired or no longer needed pharmaceuticals; items contaminated by or containing pharmaceuticals (bottles, boxes).
- Genotoxic waste: substances with genotoxic properties (meaning they can cause genetic damage) such as certain drugs and genotoxic chemicals.
- Chemical waste: wastes containing chemical substances such as laboratory reagents, film developer, disinfectants that are expired or no longer needed, and solvents.
- Waste with high content of heavy metals: includes batteries, broken thermometers, blood-pressure gauges, etc.
- Pressurised containers: gas cylinders, gas cartridges and aerosol cans.
- Radioactive waste: containing radioactive substances from radiotherapy or laboratory research.

You should note that the last five on the list may not necessarily apply at Health Post level; however, you should be aware of these hazards in case you encounter them elsewhere.

Note also that infectious waste and pathological waste are overlapping categories. Blood, for example, is in both categories. All pathological waste should be considered as potentially infectious. Following the precautionary principle, pathological waste must be handled and disposed of as if it were infectious.

■ What is the precautionary principle?

□ In Study Session 2, you learned that if you follow the precautionary principle, this means you take precautions to avoid environmental damage, even if you are not certain that damage will result.

23.2 Public health importance of healthcare waste

Healthcare waste is varied in type and the amount produced is increasing each year. Moreover, if there is little or no segregation of non-hazardous and hazardous waste, it is inevitable that the general waste component will become contaminated and must then be regarded as hazardous.

Everyone in the community is potentially at risk from exposure to healthcare waste, including people within the healthcare establishment and those who may be exposed to it as a result of poor management of the waste.

- List all the people who could be at risk from healthcare waste produced at a village Health Post.

- Your answer will depend on where your Health Post is and on the local conditions, but your list might include yourself as the Health Extension Practitioner; your patients and people accompanying them; anyone who takes the waste away for disposal; anyone who lives or works close to the disposal place; children who may play in the area and pick up contaminated items.

23.2.1 Hazards from infectious waste

Infectious wastes may contain a variety of pathogenic microorganisms. The route of entry into the body for microorganisms may be through a puncture, abrasion or cut in the skin, possibly caused by sharps contaminated with pathogens. Entry may also be through the mucous membranes (such as eye, mouth or nose), by inhalation, or by ingestion.

There is a particular concern about infection with human immunodeficiency virus (HIV) and hepatitis viruses B (HBV) and C via healthcare waste. These viruses are generally transmitted through needlestick injuries contaminated by human blood. Needlestick injuries are piercing wounds usually caused by the point of a needle but also by other sharp objects. To avoid the risk of HBV, it is recommended that all personnel handling healthcare waste should be immunized. Unfortunately, no vaccine is yet available against hepatitis C.

23.3 Management of hazardous healthcare waste

The aim of healthcare waste management is to contain infectious waste and reduce risks to public health. The steps to achieve this goal include waste minimisation, identification and segregation, recycling, adequate packaging, handling and storage, and proper treatment and disposal.

22.3.1 Waste handling

There are a number of basic guidelines for waste handling. All healthcare waste should be segregated and placed into waste bins by the person generating the waste at the point where waste is generated. All specific healthcare waste segregation, packaging and labelling needs to be explained to the medical and supporting staff. Information should be displayed in charts on the walls of each room. Carts and recyclable containers used for transport of healthcare waste should be disinfected after each use. Sanitary staff and sweepers must wear proper protective clothing at all times when handling infectious waste including face masks, aprons, boots, and heavy duty gloves, as required.

23.3.2 Waste minimisation

Waste minimisation is the first and most important step in any waste management plan. Minimising the amount of waste produced will help the environment by reducing the amount of waste to be disposed of or burned in incinerators, and consequently reduces air pollution. For effective waste minimisation, you should always bear in mind that the materials and supplies purchased should create no or minimal waste. However, it is important to note that minimising waste should never be carried out if it compromises patient care or creates any other risk of infection.

23.3.3 Segregation of healthcare waste

Segregation is the process of separating different categories of waste. Healthcare waste is usually segregated into colour-coded waste bags or bins. This should take place at the source (when the waste is created). You should follow the guidelines for segregation of waste so that the different types of waste are kept separate and each can be handled safely and economically.

Healthcare facilities should provide coloured waste receptacles specifically for each category of waste. The colour-coding system aims to ensure immediate, easy and unambiguous (clear) identification and segregation of the waste which you are handling or going to treat. Based on the type of hazards involved, a different colour code and type of container is assigned and should be used as follows:

- Black: all bins or bags containing non-hazardous healthcare waste.
- Yellow: any kind of container filled with any type of infectious healthcare waste, including yellow safety boxes for sharps.
- Red: any kind of container filled with heavy metal or effluent.
- White: any container or bin filled with drug vials, ampoules or glass bottles for glass recycling or reuse.

You should also note that in a resource-limited Health Post, red containers can be omitted and heavy metals and other effluents can be handled as any other infectious waste using yellow containers. However, please don't forget that heavy metals and other effluents should *not* be incinerated (burned) in final disposal sites. The Ethiopian Food, Medicine, Health Professionals Control and Regulatory Authority guidelines should be referred to about the disposal of pharmaceutical wastes. You should be able to obtain these guidelines from your supervisor or district health office.

23.3.4 Recycling and reuse of healthcare waste

■ What is the difference between reuse and recycling of waste?

□ Reuse means using the same item again and again without changing its physical form or appearance. Recycling of waste requires processing of some sort, usually in another location, to create a new and different product.

Reuse of some healthcare waste such as glassware is possible but only after cleaning and disinfection. Items should be immersed in a 0.5% chlorine solution for 10 minutes and carefully washed with a brush and soap, rinsed and dried before use. During the disinfection process, you should always protect your hands with appropriate gloves. It is also recommended that you autoclave the glassware at 121°C for at least 30 minutes after washing to ensure complete sterilisation/disinfection (see Section 23.4.1). Only unbroken glassware should be reused; if it is broken it will be sharp waste and must be disposed of.

Materials such as non-contaminated glass and plastic items can be recycled. Recycling may increase the segregation criteria and require more effort on your part because separate containers are needed for materials to be recycled.

23.3.5 Use of safety boxes

You should always collect sharp wastes immediately after use in a safety box. This helps you avoid injuries.

A safety box is used only for sharps (Figure 23.1). It is designed as a puncture- and leak-resistant container for their collection and disposal. The advantage is it confines all sharps in one place and helps prevent reuse. The correct use of safety boxes can prevent needlestick injuries to you and the community. The role of health workers (you) and waste handlers in proper use of safety boxes, starting from assembly through to final disposal, is critical. You should follow these guidelines for effective use of safety boxes:

- Follow the instructions printed on the box.
- Keep safety boxes within your reach at each place where you give injections.
- Dispose of the used syringes into the safety box *immediately* after use.
- Do not recap and do not collect syringes for future disposal.
- Never place fingers inside the box.
- Stop using the box and close the flap (cover) when it reaches three-quarters full; do not overfill.
- When handling the safety box, always wear gloves.
- Once a safety box contains any sharps, it should be stored in a locked room or cupboard to prevent the public from coming into contact with it.
- Finally, do not forget to wash your hands using antiseptic or hand rub and dry them after using the safety box.
- When the safety box is three-quarters full it should be incinerated (see Section 23.4.2 for further details) and the remains disposed of in a sharps pit (see Section 23.4.4).

Figure 23.1 Safety box in use at a Health Post. (Photo: Pam Furniss)

23.3.6 Packing healthcare wastes before disposal

Some healthcare wastes need to be placed into special containers or packed up in a particular way before they are transported or disposed of. A safety box for sharps is one example. Liquid infectious wastes need to be placed in capped or tightly stoppered bottles or flasks; large quantities would need a containment tank. Solid or semi-solid wastes should be packed in durable, tear-resistant plastic bags. Special packaging is required for items to be incinerated. These need to be put in combustible containers. Similarly items to be sterilised by steam need containers that allow the passage of steam and air. Clean clothes can be used to wrap items that need to be autoclaved or sterilised.

23.3.7 Waste storage

Some waste may need to be stored carefully onsite until such time as it can be disposed of appropriately. The guidelines for healthcare waste storage that you should follow are:

- A specified place in each room where waste is generated for placing bags, bins or containers.
- Separate central storage facilities for yellow bags should be provided with clear indication that no other materials be stored there.
- No waste shall be stored for more than two days before being treated or disposed of. (This does not include safety boxes, where filled boxes can be kept locked up for up to one week if no onsite incinerator is available.)
- The universal biological hazard symbol (Figure 23.2) should be posted on the storage door and on waste containers.

Figure 23.2 Biological hazard symbol.

kPa is the abbreviation of kiloPascal, a unit of pressure.

23.4 Methods of healthcare waste treatment and disposal

23.4.1 Steam sterilisation (autoclaving)

Steam sterilisation is one of the most common methods of treatment of waste. It uses saturated steam within a pressurised vessel called an **autoclave** (see Figure 23.3) at a temperature that is high enough to kill pathogenic microorganisms. Contaminated items or waste should be sterilised for 30 minutes at 121°C at a pressure of 106 kPa. You should note carefully that the timing should start only after it has reached the necessary temperature and pressure.

Figure 23.3 Autoclave in a Health Post. (Photo: Pam Furniss)

23.4.2 Incineration

Incinerators convert combustible materials into ashes or residues. Gases are ventilated through the chimney stack into the outer air. If the incinerator is properly designed, maintained and operated, it serves the purpose of destroying infectious microorganisms in the waste.

You may remember from Study Session 22 that, in the context of waste management, incineration means more than just burning. It means controlled and managed burning, usually at high temperature. A waste incinerator needs to reach very high temperatures in order to completely destroy needles and syringes. This type of high temperature incinerator is unlikely to be available to you but other options for burning can be used at Health Post level. With the help of others in your community, you may be able to build a low temperature incinerator, also known as a *protected hearth*, like the one shown in Figure 23.4.

Figure 23.4 An incinerator used for healthcare waste. (Photo: Muluken Azage)

If a brick-built incinerator is not available, you may be able to burn the waste in a converted metal drum or barrel. To do this, you will need a metal drum with both ends removed to make a cylindrical container. You will also need four bricks and two rigid metal screens that are large enough to cover the open ends of the drum. You will need to place the drum in a fenced area away from the Health Post buildings. Place the bricks on the ground, with spaces between them and a metal screen or grate on top. Place the open base of the drum on the metal screen and put another screen on top. The metal screens are to allow air to flow around the burning waste so the fire gets hotter, and to reduce the amount of ashes flying out of the top. Put the safety box or other waste with some paper, dry leaves, or small sticks into the drum and sprinkle them with a small amount of kerosene (if available). Put paper under the drum, between the bricks, and set light to it so the flames rise through the metal screen.

If there are no incinerators, then open pit burning is also possible, and frequently used in rural Health Posts (Figure 23.5). The pit must be protected with a fence to prevent people or animals from gaining access to it. It is advisable to watch the fire until everything is burned to be sure that no waste is blown around by the wind or left unburned. The ash or residue must be buried for final disposal.

Figure 23.5 Open pit burning of healthcare waste. (Photo: Muluken Azage)

23.4.3 Chemical or high-level disinfection (HLD)

Chemical disinfection, also known as high-level disinfection (HLD), is the preferred treatment for liquid infectious wastes. It can also be used for solid infectious waste treatment. The chemical disinfectants are hazardous to skin and mucous membranes, and it should not be applied without wearing gloves and goggles. Chlorine and glutaraldehyde are the best chemical disinfectants; the most appropriate being 0.5% chlorine solution for 10 minutes. The ultimate disposal of chemical waste must safeguard users, the community and the environment. It should be disposed of into a seepage pit and the bottom of the pit should be not less than 3 m from the water table in order to prevent contamination of the groundwater.

Training on handling techniques of chemical disinfection should be provided for persons involved in healthcare waste treatment to minimise personal exposure of hazards and handling of sterilised materials.

23.4.4 Final disposal: burial pits

Burial pits are acceptable for some wastes but ideally, there should be separate pits for general healthcare wastes and for hazardous healthcare waste. The general waste could be transported to community refuse pits, if there are any. Burial pits for hazardous waste should be properly fenced to prevent access by people or animals. They should not be used, however, in areas with a high groundwater table. The bottom of the pit should be at least 1.5 m higher than the groundwater table for disposal of solid waste. You should make sure that the final disposal of hazardous waste by reputable waste handlers is performed according to applicable federal and local regulations.

Sharps pit

A sharps pit is a particular type of burial pit that should be used only for the final disposal of needles and other sharps. Safety boxes should be incinerated to sterilise the contents before carefully collecting the residue for disposal in the sharps pit. A properly constructed sharps pit should have a cover at the surface and be lined with cement to make it watertight in order to avoid contamination of groundwater and soil. It must have a fence around it. For a Health Post, the pit need not be large and can take many years to fill.

23.4.5 Anatomical waste and placentas

The visual impact of anatomical wastes (especially for observable body parts) is very sensitive and may alarm the general public. The wastes are also a health hazard. Therefore, it is mandatory to properly contain anatomical wastes based on the local custom or cultures of your society. Special care and sensitivity is needed when considering the appropriate disposal of fetuses from stillbirths. You should make sure, while considering the local contexts, that the method you choose should not contaminate the environment.

Anatomical waste and placentas need a special placenta pit. The placenta pit should also be used for blood, vomit and other bodily secretions. This burial pit should be sited inside the Health Post compound and dug down to at least 1 m deep. The pit should be fenced and locked. The waste should be collected in a plastic or galvanised metal container with a tight-fitting cover and immediately transported to the pit using dedicated trolleys or carts. The waste should be covered with a layer of soil immediately after disposal into the pit.

Due to cultural conditions, and the low temperature incinerators present in Health Posts, you should avoid using incinerators for anatomical waste. You should wear heavy-duty gloves while handling and transporting the waste. Wash and dry the gloves after use.

23.5 Prevention and control of risks to healthcare workers

All healthcare workers, including the waste handlers and maintenance workers, should be instructed to use personal protective equipment (PPE) such as gloves while working in contaminated areas and with contaminated materials, and to wash their hands thoroughly after removing the gloves. The workers should be aware of the fact that other people may not have followed the correct procedures while disposing of gloves, blades or needles; therefore, they need to be careful when handling all healthcare waste bags and containers.

People working in healthcare facilities may get accidental injuries because they are in a hurry to help their patients, or in an emergency, or simply due to ignorance or not being able to practise what they know. The following guidelines should be followed for the prevention and control of risks to healthcare workers:

- Keep desks and countertops free from sharps.
- Discard needles and other sharps into safety boxes, never into waste bins or plastic bags.
- Never try to recap needles (i.e. use once and dispose of immediately).
- Regularly review the rules for safe disposal and collection of sharps or other hazardous materials.
- You (or any healthcare worker) should always examine and handle soiled linens and similar items *as if* they were hazardous.
- Workers should receive periodic instruction at least once a year to keep them aware of the specific hazards of healthcare waste.
- Workers should take appropriate measures to limit further contagion from waste by practising universal precautions of self-protection from exposure to infectious wastes.

23.6 Planning and monitoring healthcare waste management

Managing the safe and proper disposal of healthcare waste is an essential part of infection protection and control for you (the healthcare worker), your clients/patients and the general public. In addition to meeting national and local guidelines on infection prevention, it helps you prevent **nosocomial** infections (i.e. healthcare facility/hospital acquired diseases).

Planning and preparation for proper waste disposal will help you ensure the availability and correct functioning of infection control facilities in the Health Post, including sanitising materials and hazardous healthcare waste management and disposal equipment. Forward planning can also help reduce the likelihood of accidents; for example, the chance of needlestick injury will be reduced if you always think ahead and have the sharps box close to you when you give an injection.

Table 23.1 is a template for waste management planning in the Health Post. It lists various waste management activities and indicates how often they should be done, the materials and equipment needed and who is responsible. You may wish to adapt this for your own Health Post and draw up your own management plan. Having a plan similar to this will help to ensure that waste is managed correctly.

Table 23.1 Example template for a Health Post waste management plan.
Key: R = routinely (at a specific time, if possible); BP = before procedure; AP = after procedure; O = occasionally.

Activity	**When?**	**Equipment/materials needed**	**Who?**	**Comments**
Handwashing	R, BP and AP	Water, soap, disinfectant/alcohol	Health Extension Practitioner	Sullage should be disposed of into a seepage pit
Disposing of sharps	R (when the safety box gets ¾ filled), AP	Safety box, incinerator, sharps pit	Health Extension Practitioner	Avoid needle recapping
Disposing general waste and solid infectious waste	R	Waste bin, incinerator, gloves, matches, burial pit	Health Extension Practitioner and others	Incinerate in a brick incinerator, or metal drum or burn in an open pit
Inspecting waste disposal facilities	O	Heavy-duty gloves, protective clothes	Health Extension Practitioner	
Sterilisation of instruments/materials	AP	Autoclave, indicator	Health Extension Practitioner	An indicator is a strip or tape that changes colour when the material/equipment reaches sterilising temperature
Disposal of liquid/ semi-liquid infectious waste	AP	Placenta pit	Health Extension Practitioner	Pit should be fenced and locked
Disposal of expired drugs	O	List of drugs expired, reporting, disposal pit	Committee from district office, *kebele* and Health Extension Practitioner	You need to notify the committee if you have drugs that need to be disposed of
Cleaning the Health Post	R	Water, detergents, disinfectants, gloves, protective clothing, broom, mops, dustbin, etc.	Health Extension Practitioner and others	

You can monitor the management of healthcare waste at your Health Post and identify possible improvements that you could make by checking your current practices. For example:

- Could you reduce the amount of waste produced in your Health Post (waste minimisation)?
- Do you separate infectious from non-infectious waste?
- Is infectious waste packaged before disposal to reduce contact and exposure?
- Do you have adequate supplies of gloves, colour-coded bins and other waste management supplies?

- Is everyone at the Health Post properly trained in correct healthcare waste management procedures?

There may be other questions you can think of to include on your checklist.

Concluding note

We have now reached the end of the *Hygiene and Environmental Health* Module. In these 23 study sessions, you have been learning about personal and environmental hygiene, how to keep food hygienic, about the provision, use and treatment of safe water, and how to manage wastes in the household, community and healthcare facility.

As you know, poor hygienic and environmental health conditions are the major cause of illness and death in Ethiopia and other developing countries. It is our sincere hope that this Module, along with other Modules in this curriculum, will enable you to understand the concepts and principles of hygiene and environmental health. By putting these concepts and principles into practice, your community disease profile will improve significantly to a level that common infectious diseases that arise due to poor hygiene and environmental health, such as diarrhoea, intestinal parasites, malaria, pneumonia and TB, will not be major causes of morbidity or mortality in your area. Moreover, as well as learning about the protection of human health, you have also learned how to keep our environment safe.

Summary of Study Session 23

In Study Session 23, you have learned that:

1. Healthcare waste is any waste produced in a healthcare facilty and is also known as medical waste, hospital waste or infectious waste. It includes hazardous and non-hazardous waste.
2. Health hazards from pathogens are the major concern in waste from Health Posts.
3. Waste minimisation is the first and most important step in healthcare waste management.
4. Healthcare waste must be segregated into different categories and colour-coded containers used for storage.
5. Safety boxes are important devices for safe collection of sharps. A sharps pit is also required for final disposal.
6. Personnel involved in handling and storage of healthcare waste should be trained in correct procedures and provided with the necessary PPE to protect their health.
7. Autoclaving, incineration, placenta/burial pit and HLD using chemicals are the most commonly used final disposal methods.

Self-Assessment Questions (SAQs) for Study Session 23

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 23.1 (tests Learning Outcome 23.1)

Which of the following statements is *false*? In each case, explain why it is incorrect.

A Healthcare waste contains hazardous and non-hazardous waste.

B Infectious healthcare waste is kept in red containers.

C Chemical disinfection involves treating waste with 0.5% chlorine solution for 10 minutes by immersing in an autoclave.

SAQ 23.2 (tests Learning Outcome 23.2)

Which items in the list below are classed as pathological waste?

Syringes, used swab, placenta, used gauze, expired drugs, body parts, paper packaging, blood.

SAQ 23.3 (tests Learning Outcomes 23.3)

Gadissa, a local farmer, had an accident last week while working in his fields and cut his leg. He came to the Health Post immediately afterwards and you treated the wound with a dressing and bandage. Today he is returning to the Health Post to have the dressing changed. What should you do before examining his wound? What should you do with the used dressing?

SAQ 23.4 (tests Learning Outcome 23.3 and 23.4)

Read Case Study 23.1 and then answer the questions that follow it.

Case Study 23.1 A story of a busy rural Health Post

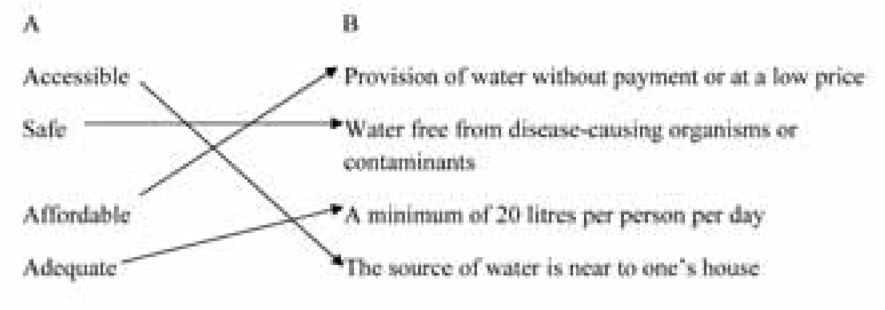
Hirut, a Health Extension Practitioner in Robit rural *kebele*, is working in a Health Post. One busy day, the Health Post was full of clients for family planning, children who need immunization, and children having diarrhoeal problems. Hirut started her day by giving health education for mothers on the importance of family planning, hygiene and environmental sanitation. Her workmate, Almaz, was preparing the schedule for their subsequent activities. Because of the workload, the Health Extension Practitioners could not go home for lunch on time. They were too exhausted. At this time, Hirut was giving an injection of Dipo Provera to a woman. She accidentally pricked her finger with the used needle while trying to recap it.

What did Hirut do that was procedurally wrong? What should she have done?

Notes on the Self-Assessment Questions for *Hygiene and Environmental Health*, Part 2

Study Session 13

SAQ 13.1



SAQ 13.2

A is *false*. Water-washed diseases are caused by poor hygiene when there is insufficient water for thorough washing, and not by drinking contaminated water.

B is *false*. Diarrhoea and typhoid fever are examples of waterborne disease and are caused by consumption of water or food contaminated with pathogens.

C is true. Bilharzia is transmitted via water snails.

D is *false*. Malaria is an example of a water-related disease.

SAQ 13.3

Water on the Earth's surface moves in an unceasing cycle through rivers, oceans, clouds and rain called the *hydrological cycle*. The heat from the Sun causes *evaporation* of water, principally from the *ocean* and also from lakes and wetlands on land. Plants also lose water through their leaves by the process of *transpiration*. Water vapour in the *atmosphere* forms into clouds which are moved around by wind. Rain and snow, collectively known as *precipitation*, fall from the clouds. Some water that falls on land soaks into the ground and some collects into streams and rivers which form *surface runoff* that flows back to the ocean to complete the cycle.

SAQ 13.4

Satisfactory water supply is water that is safe, adequate and accessible.

Your answer could include any three of the following:

- You need to know where the source of the water for the village is.
- You need to know if the source of the water is protected.
- You need to estimate the average distance the residents travel to fetch water or estimate the time taken for a round trip for fetching water.
- You need to know the amount of water collected per person per day.
- Finally you can assess whether the status of village is classed as no access, basic access, intermediate access or optimal access.

SAQ 13.5

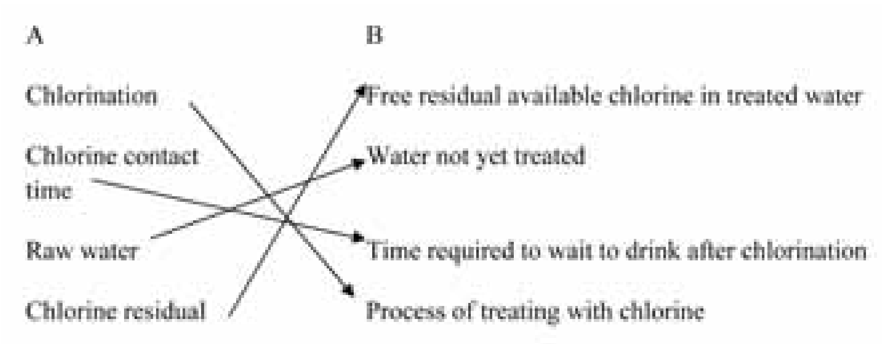
Vulnerable groups include children and infants, the elderly, and people who are ill or debilitated.

SAQ 13.6

A is *false*. Local communities' empowerment will increase the provision of safe water.
B is true. New technologies can help with the provision of safe water.
C is *false*. Local government involvement is important for the success of safe water provision projects.
D is true. Safe water improves the lives of infants and children.

Study Session 14

SAQ 14.1



SAQ 14.2

Nearly all river and stream water may be contaminated with at least one of the three types of potentially disease-causing microorganisms, namely protozoa, bacteria and viruses. These can be removed by treating the water.

If Mr. Abebe used one of the methods of household water treatment he would be protecting his family and himself from many unpleasant, debilitating and possibly life-threatening diseases.

SAQ 14.3

Wuha Agar is a type of chlorine solution that is commonly available. To use it you add one capful of Wuha Agar to a 20 litre jerrycan of water, replace the lid and shake. After 30 minutes of contact time you can use the water for drinking and other domestic purposes. This will kill bacteria and help to reduce diarrhoeal diseases.

SAQ 14.4

You should do the orthotolidine-arsenite test (OTA) to measure the residual chlorine. The residual chlorine helps to prevent recontamination of pathogenic bacteria if it is between 0.2–0.5 mg/l.

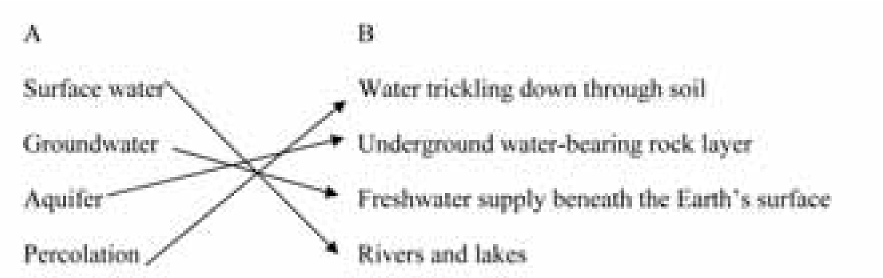
SAQ 14.5

Filtration means passing water through a layer of sand, gravel, cloth or other barrier that allows the water to pass through, but holds back any small particles. The particles may be dirt, soil and other contaminants including many pathogenic microorganisms that make the water unsafe to drink. However, some bacteria can pass through filters, so filtered water is not completely safe to drink.

Disinfection is a process for removing contaminants from water and killing most of the harmful microorganisms that may be present. It usually involves treatment with chlorine or other chemicals.

Study Session 15

SAQ 15.1



SAQ 15.2

A plan for the new water source would need to be prepared. This would involve the community, the community leaders and the local administration. The following steps would be needed:

- Identify the community's water and sanitation needs.
- Identify possible sources of water, which could include groundwater from springs or wells, and rainwater.
- Identify potential sources of pollutants of the proposed water source.
- Identify the amount of water that would satisfy the needs of all community members.

SAQ 15.3

The users of the spring should be advised to:

- Avoid open defecation around the spring.
- Not construct latrines above the spring because of the danger of contaminated groundwater.
- Use latrines properly.
- Keep animals away from the spring.

SAQ 15.4

The wall and fence has been broken down so animals could get in and contaminate the area around the pump. The stone wall and wooden fence should be repaired and a gate fitted so that people can gain access but animals cannot.

Study Session 16

SAQ 16.1

A is *false*. *E.coli* is a type of bacteria, not a type of virus.

B is true. Faecal coliforms are found in faeces.

C is *false*. If a water sample is positive for *E.coli* this indicates faecal contamination, which means it is likely that pathogens are present in the water.

D is also *false*. The absence of *E.coli* indicates the water is not contaminated with bacteria of faecal origin but it does not mean it is safe to drink because the water may contain other pathogens.

SAQ 16.2

You would have to do a sanitary survey to check the possible reasons for the childhood diarrhoea. This would include checking how the water is handled because it may be exposed to recontamination after it is collected from the protected well. Pots and buckets used for collection and storage should be checked to see if they are left open or not. If they are open, and people dip smaller containers into them, there is greater chance of recontamination. A jerrycan is preferable because it has a small opening that cannot be used for dipping. The cleanliness of the containers may be poor because of improper washing or the container may be used to collect both unclean and clean water. You may need to educate the families concerned about good hygiene and the proper handling of water.

SAQ 16.3

Together with the environmental health experts you would conduct tests to measure the colour, taste and odour. You may test pH and for certain chemicals such as nitrate, fluoride and chloride, using portable water field test kits where available. You might also test turbidity (suspended solids). Water analysis would include microbiological tests as well as chemical tests. To do this a water sample would need to be taken and sent to a central laboratory for *E.coli* assessment and other microbiological tests.

SAQ 16.4

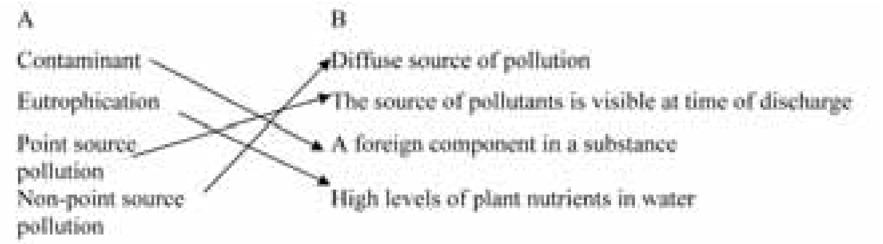
You should tell the villagers that the river water is contaminated with pathogens and will cause waterborne diseases. Without any treatment, the surface water should not be used for drinking and domestic purposes. The water from the well may not taste so nice but it is safer to drink and use for domestic purposes. You will need to advise them that the tests reveal more about water quality than taste does.

SAQ 16.5

You would need to take an appropriate checklist of questions to ensure that you survey thoroughly and don't forget anything. You will also need a notebook and pen or pencil to record all the information you collect. Important things to look for include the location of any latrines or other possible sources of contamination relative to the spring, a sound fence, the condition of the concrete/stone box that protects the spring, the presence of a diversion ditch and any other defect in its construction that could affect the water quality. Your answer could include any four of these or related issues.

Study Session 17

SAQ 17.1



SAQ 17.2

Assuming there were no other differences to consider than their respective sources of water, it would seem likely that the eastern well has become contaminated. The possible sources may be point sources from a latrine, if there is one located above the dug well or from an overflow of the latrine into the dug well. Possible non-point sources might be open defecation around the village causing contamination of the well after rain. Further investigation would be needed to identify the cause for certain.

SAQ 17.3

It would be important to ensure there was no contamination of the samples during or after sampling and that they were a representative sample of the water in the wells. The sampling bottles and their stoppers must be sterilised. The sample bottles for the two wells would need to be clearly labelled so that there was no danger of confusion between them. The sample should be taken by weighting the bottle and lowering it on a string into the well, lowering it below the surface of the water but not hitting the bottom, waiting until it is filled, then raising the bottle and capping it immediately.

SAQ 17.4

Your answer will depend on the local situation but the same general rules will apply anywhere. You should advise them to be aware of the importance of proper disposal of human excreta, which means avoiding open defecation and constructing latrines that are at least 15 m away from water sources and at a lower level; appropriate disposal of animal wastes; appropriate disposal of solid waste; and the possibility of pollution from agricultural activities such as spreading fertiliser. In some locations there may also be potential hazards from industry, roads and other sources of pollution.

Study Session 18

SAQ 18.1

This game is intended to familiarise you with the technical terms you will meet again in subsequent study sessions. To find the right answer, you can check the definition written in your own words with that in the study session.

SAQ 18.2

You may have come up with different suggestions but we thought of these examples:

1 vegetable peelings and waste from food preparation
2 water that has been used to wash clothes
3 used dressings and bandages from the Health Post
4 diesel fuel leaking from a damaged can.

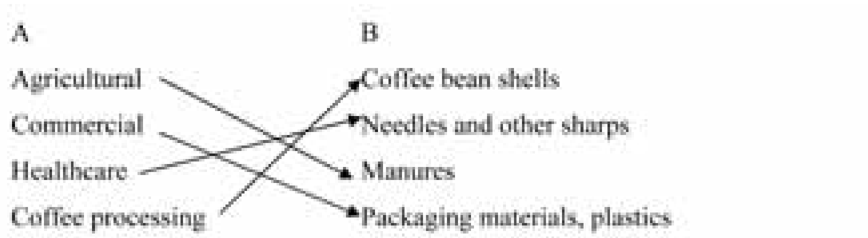
SAQ 18.3

The main purpose of waste management is to isolate waste from humans and the environment, and protect human health.

SAQ 18.4

There are many public health benefits including prevention of faeco-orally transmitted diseases, reduction in public nuisance from wastes in the environment, creation of a more aesthetically pleasant environment, and the possibilities of generating income from creating economically valuable products from the treatment, recycling and reuse of waste.

SAQ 18.5



Study Session 19

SAQ 19.1

A is *false*. Decomposition in a septic tank is an anaerobic, not aerobic, process.

B is *false*. A seepage pit must not be watertight. Liquid must be able to seep slowly out of the pit into the surrounding ground.

C is true. Anaerobic digestion of waste produces biogas and digested sludge that can be used as a fertiliser.

D is *false*. Runoff is rainwater running off the land but it may contain human and other types of waste that have been washed off the land surface. It can also cause flooding problems.

E is true. Human waste management must ensure the protection of groundwater from contamination.

SAQ 19.2

(a) Local geology is important because the type of rock will need to be considered for any technology that relies on liquid waste percolating into the ground. For example, a pit latrine must be sited further away from a water source if the rock is permeable.

(b) Climate can make a difference if the usual rainfall pattern causes frequent flooding. This will need to taken into consideration when locating and building the chosen latrine.

(c) The sanitation technology must be comfortable and convenient for all the people who are going to use it. Small children may need special arrangements that allow them to use the latrine without danger. Elderly people may not be fully mobile and may also need special consideration to ensure the latrine is accessible for them.

Study Session 20

SAQ 20.1

In an ecosan latrine, human waste is mixed with plant material, ash and vegetable waste so that when it has decomposed it produces a useful product. It converts the waste into a resource. The compost can be used for growing a tree in the Arborloo system or it can be dug out to be used to spread on fields as a fertiliser. This does not happen in a standard pit latrine, which simply contains the waste.

SAQ 20.2

This latrine is very basic. It would be improved by the proper installation of a concrete slab over the pit. The slab should have a lid over the squat hole. It could also be improved by installing a vent pipe in the proper way to convert it into a VIP latrine. There should be a handwashing facility just outside the door.

SAQ 20.3

The liquid waste seeps out of pit latrines into the ground beneath. This could cause pollution of groundwater and surface water.

SAQ 20.4

The materials needed to make a handwashing device are a water container that can hold about 5 litres with a lid, a hollow tube of some sort for the spout, something sharp to make the hole with and something to stand or hang the container on. You will also need soap or ash for effective handwashing.

SAQ 20.5

(a) Ato Tedila cannot install a water carriage system because he does not have a piped water supply; therefore, he has to install a pit latrine of some sort. The possible choices are a single pit latrine, a pit latrine with slab, a VIP latrine with slab, a double pit latrine or one of the ecosan systems, namely an Arborloo or a Fossa Alterna.

(b) You should not recommend a pit latrine without a slab because this does not provide adequate sanitation. The VIP latrine is preferable to a simple latrine, but an ecosan system would be better because this would produce a useful product as well as protecting the health of the family and the environment. You would need to ask Tedila about his attitude to using an ecological sanitation system and whether he would be willing to make use of the composted waste material. He is a farmer so he may be able to use it on his fields and he is open-minded so this system may be attractive to him. If he was reluctant to dig out the compost you could recommend the Arborloo system because that does not require handling; the tree is planted on top of the filled pit.

(c) You should advise him to consider the location of the pit. It must be at least 15 m away from his well and preferably a greater distance. It must also be at a lower level according to the slope of the land. He should also consider the wind direction and place the latrine downwind and at a convenient distance from the house. He would need to consider the design of the squat hole to ensure it is safe for his children and comfortable for his elderly mother. You could advise him about possible materials to be used for the superstructure and recommend what is available locally. You should also advise him to install a handwashing facility next to the latrine.

Study Session 21

SAQ 21.1

Improving latrine utilisation requires *behaviour change* by the people in the community. Some people may need to be persuaded that *total sanitation* and *ODF status* are valuable aims that will help prevent the spread of disease. There are various approaches that can be used to try to achieve *behaviour change*. Two examples of these approaches are *PHAST* and *CLTS*. Both these methods depend on involving the whole community in the process and they are grouped together as *CATS*.

SAQ 21.2

The people in this village are not aware of the importance of sanitation so you would need to find ways to educate them about the connection between hygiene and sanitation, and their health. You could ask to speak to a community meeting but this approach may not be successful if you simply stand and talk to the villagers. You could suggest a coffee ceremony or other social gathering as a means to initiate discussion about the issue and to encourage people to attend. You could consider individual house-to-house visits to have more private conversations with individuals and families about hygiene and sanitation. Individual visits may help you identify potential model households that you could also use in your campaign. With the cooperation of the community, and if you had had the appropriate training or could call on the support of others who had, you may also consider using a CLTS approach. You may have to adopt several of these approaches and be flexible according to the responses you get from the community. You should also recognise that it may take time to convince the people of the benefit of change.

SAQ 21.3

To encourage the family to become a model household you will need to explain to them the purpose and benefits of the role. You should discuss the importance of correct latrine construction and use, and the importance of handwashing with them to check they have a complete understanding. You should check the condition of their latrine and that they have handwashing facilities and use them routinely. You could explain that being a model household will bring respect and admiration from others and they can be proud of their position and achievements. You should also explain that their attitude to others needs to be supportive and encouraging, not bossy and dictatorial.

SAQ 21.4

PHAST and CLTS are both community-based approaches to achieving total sanitation. They aim to promote behaviour change in the community.

PHAST uses techniques such as mapping and community discussions to promote change. CLTS uses similar techniques but also depends on confronting the community members with questions that make them realise the impact of open defecation. By bringing these questions out into the open, the community is ‘triggered’ into action to change their behaviour.

SAQ 21.5

To assess the success of the programme you would need to survey latrine use in the community. You would also need to have done a baseline survey before the CLTS programme so that you had the data of latrine utilisation beforehand to compare with. The data you would need to collect would include the number of households with a latrine and handwashing facility, how many of them use their latrine, and whether there were any signs of open defecation anywhere in the area such as faeces visible in fields, paths, compounds, etc.

Study Session 22

SAQ 22.1

A is *false*. Recycling is a good method of waste management but reducing the amount of waste produced in the first place or reusing the waste without reprocessing is preferred.

B is true. Composting of solid waste is an aerobic decomposition process that produces compost.

C is *false*. Waste recovery means that something useful is recovered from the waste; reuse of waste simply means using the item again in the same way it was used in the first place.

D is *false*. Controlled tipping is called 'controlled' because the waste is regularly covered with soil rather than just left in the open.

SAQ 22.2

	Hazardous	*Non-hazardous*
Compostable		Manure, grass, paper bags, potato peelings
Non-compostable	Obsolete herbicides, expired drugs	Tin cans, plastic *festal*

SAQ 22.3

The functional elements of waste management are: onsite handling, storage and processing; collection; transfer and transport; resource recovery and processing; and disposal. In rural areas, waste is not normally collected or transported, so the second and third elements are not relevant. Most waste in rural areas is organic and there is plenty of space. Onsite handling, resource recovery in the form of recycling or composting and final disposal are found in rural areas.

SAQ 22.4

Compost can be made from household kitchen food waste, leaves, grass, kitchen waste, and any other organic biodegradable material. The compostable waste must be separated out so it contains no plastic or metal. The waste is put in a pit or heap at least 1 m × 1 m × 1 m. It needs a little water and it should be turned over regularly to provide air for the composting organisms. The resulting compost should be like soil and have a good earthy smell.

SAQ 22.5

There are several possible indicators that can be used to assess waste management practices. These include the number of households with a compost pit, whether there is a communal refuse pit, the number of people using a communal pit, if there is one, whether the refuse pits are fenced and managed, and others. You would assess these indicators by visiting the community, observing people's practice and discussing with them what they did with their solid waste.

Study Session 23

SAQ 23.1

A is true. Healthcare waste does contain both hazardous and non-hazardous waste,

B is *false*. Infectious waste should be stored in a yellow container.

C is *false*. Chemical disinfection does involve treatment with chlorine solution of 0.5% concentration for 10 minutes but an autoclave is a steam sterilising device that relies on temperature to disinfect.

SAQ 23.2

Placenta, body parts and blood are all pathological wastes.

SAQ 23.3

You should wash your hands thoroughly before removing the old bandage. You may also want to put on gloves. Pick up a sterilised set of instruments, such as scissors, to remove the dressing. You may find the used dressing is blood-stained. It should be handled in the same way as infectious waste because, although Gadissa may be perfectly healthy, all waste that has been in contact with body fluids should be considered to be potentially infectious. You should immediately place the used dressing in a yellow waste container or bag. Keep the container tightly closed. At the end of the day, you should dispose of the container in an incinerator, if available, or burn it in the refuse pit before you leave the Health Post.

SAQ 23.4

Hirut should not have tried to recap the needle. She should have put it in to the safety box immediately.