Health Extension service

Level-III

Learning Guide-18

Unit of Competence	**Promote and Implement Hygiene and Environmental health**
Module Title:	**Promoting and Implementing Hygiene and Environmental health**
LG Code:	**HLTHES3 M05 LO3-LG-18**
TTLM Code	**HLTHES3 MO5 TTLM 0919v1**

LO3:- Provide environmental health services

Instruction Sheet	Learning Guide 18

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Promoting Solid and liquid waste management
- Promoting Healthcare Waste Management
- Promoting Latrine Construction
- Educating Latrine Utilization Changing Attitudes and Behavior
- Educating Public Health Importance of Vectors
- Introducing Water supply Safety
- Introducing Water associated diseases
- Promoting Treatment of Drinking Water at Household and Community level
- Promoting Community Drinking Water Source Protection
- Introducing Water pollution and its Control

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Promote Solid and liquid waste management
- Promote Healthcare Waste Management
- Promote Latrine Construction
- Educate Latrine Utilization Changing Attitudes and Behavior
- Educate Public Health Importance of Vectors
- Introduce Water supply Safety
- Introduce Water associated diseases
- Promote Treatment of Drinking Water at Household and Community level
- Promote Community Drinking Water Source Protection
- Introduce Water pollution and its Control

Learning Instructions:

1) Read the specific objectives of this Learning Guide.
2) Follow the instructions described below 3 to 6.
3) Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.
4) Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” **in page -6, 9, 12 and 14** respectively.
5) If you Learned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ” **in page -15.**
6) Do the “LAP test” **in page – 16** (if you are ready).

Information Sheet-1	Promoting Solid and liquid waste management

3.1 Solid and liquid waste management

3.1.1. Definition of terms

- **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.

✓ 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 categorized as liquid waste or solid waste depending on its physical state. It can also be categorized as hazardous or non-hazardous.

- **Waste: -** is generally refers to any unwanted substance that excreted in to the human environment either in liquid form or in solid form from different sources.
- Those excreted in liquid form you can consider as liquid waste even though they have a number of different identification characteristics from each anthers while those excreted in solid form can be considered as solid waste
- **Sullage (Grey water):-** is the waste water that don‘t contain human waste, And it usually arises from domestic activities such as waste water arises from washing in the bathing room, kitchens during food preparation and dishwashing
- **Sewage (black water):-** is the liquid waste that contains a mixture of waste water with human waste, And it can be called as the liquid waste that follow through the sewer
- **Human waste:-** is the waste that excreted from human body either in the urine or faeces forms
- **Runoff**:- is the liquid waste that created by rain fall collection on the ground,
- **Effluent**:- is refers to the out flow of liquid waste from the source it generated
- **Influent**:- refers to the is inflow of liquid waste
- **Sewerage :**-refers to the network of pipes for collecting or connecting from one station to anther station
- **Sludge: -** is the digested waste matter.
- **Biodegradable: -** is a biological digestion process by which microorganisms, particularly bacteria, decompose the organic matter.
- **Anaerobic bacteria**: - is the decomposing bacteria not require oxygen.

- **Liquid waste management**: - refers to the activities that carried out in order to make a liquid waste safe to the human environment through providing proper facilities and services for a safe disposable of waste.

3.1.2 Principles and Concepts of Waste Management

- **Public health importance of waste**

- Affect the health and comfort of individuals in rural Ethiopia where municipal, or onsite, facilities do not exist or are not functional.
- Lead to environmental pollution.
- Encourage the breeding of disease-vector, animal scavengers and rodents.
- Result in a range of diseases through different routes of exposure such as faeco-oral and soil transmitted mechanisms.
- 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 favorable conditions for disease vector breeding sites.
- Fire hazards.
- Psychological health hazards

3.1.3 Liquid wastes Management

- **Source**

I. The liquid waste classification based on its content

a) **Hazardous liquid waste:-** is the type of liquid waste that contains a disease causing pathogen [e.g. bacteria, viruse] or chemicals that cause adverse health effect

b) **Non hazardous liquid waste**:- is the liquid waste that don‘t contains disease causing pathogens

II. Liquid waste classification based on its source

a) Residential [domestic] liquid waste:- is the liquid waste that generated from households. It mostly considered as non hazardous liquid waste e.g. kitchen

b) Commercial liquid waste:- are the liquid wastes that generated from commercially established area of food and drinking established area, and from commercial area

c) Industrial liquid waste: - is the liquid waste that generated from industrial factories, it vary depending on the type of industries of which the materials used [inputs] and the process taken.

- ✓ It may be toxic, and hazardous in nature or can be contains Non hazardous substances. There for, it is unlike to anther liquid waste , it requires special treatment before discharging from area generated[industry]

d) Institutional liquid waste: - is the liquid waste that generated from public, private, governmental and Nan governmental institution, offices, health facility, schools, universities, religious institutions.

- **Methods liquid waste disposal**

  - **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 5 years to be cost-effective

1 Human waste management

- ✓ The sanitation technologies that are used for human waste management are:-

a) 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 2.1:- A traditional pit latrine. **Figure 2.2:-** Ventilated improved pit (VIP) latrine.

b) W.C.s 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.

Figure 2.3:- Pour-flush latrine

Figure 2.4:- Water closet (W.C.) toilet.

2. Runoff management

- Runoff or storm water is the liquid waste that created by rain fall collection on the ground, it needs to be properly managed to ensure it even though it does not have a damaging impact on property or health, but may cause physical hazard to the community of rural.
- In rural area preplanning to effectively prevent run off from entering households and public buildings for effective runoff management.

3. Sullage management

- The Sullage has been 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.
- 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 as source of drinking water.

4. Industrial wastewater management

- 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 it but if you have any concerns, you should request inspection by experts such as and environmental health officers in the district or higher administrative bodies.
- In your role as a community health worker, 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.

5. **Collection, storage and treatment of liquid waste**

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. They have inlet and outlet pipes. Fiber glass, 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.
- 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.
- The process of removing sludge from the septic tanks is called **desludging.**
- **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.
- **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.

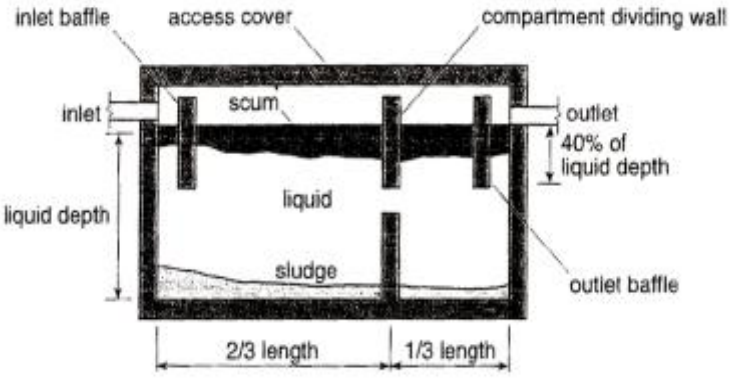

Figure 2.5:- Diagram showing the typical internal structure of a septic tank.

2. Seepage pit

- Septic tanks are a storage and treatment unit to complement such facilities as W.C.s (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.
- A seepage pit is lined with open-jointed or porous material such as bricks or stone without mortar that 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.

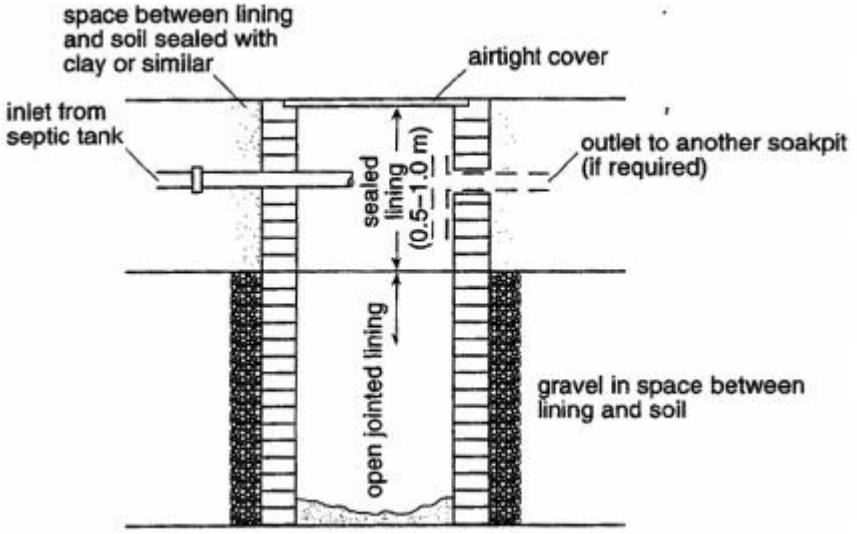

Figure 2.6:- Diagram of a seepage pit.

3. 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 fertilizer 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.
- 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.
- Neighborhoods' 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.

Figure 19.6:- An anaerobic digester under construction

6. Centralized wastewater treatment systems

- This system of liquid waste management can be functional in larger towns and cities, in the centralized waste water treatment the liquid waste may be conveyed via a sewerage network to a centralized wastewater treatment plant, for example, Addis Ababa.
- 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.

3.1.4 Solid wastes Management

- **Sources and types of solid wastes**

a) The solid waste classification by source

1) Residential solid waste is the waste that generated from residential house e.g. domestic solid waste
2) Agricultural solid waste is the waste that generated from agricultural origin.
3) Commercial solid waste is the waste that generated from commercial area.
4) Institutional solid waste is the waste that generated from institution which is governmental [private] institutions e.g. the waste that generated from the school, food and drinking establishment.
5) Health care solid waste is the waste that generated health care facilities e.g. the solid waste that generated from hospitals.

b) The solid waste classification by its content

- Infectious solid waste is the solid waste that contains a disease causing pathogens e.g. bacteria, viruses (about 10% of the total waste).
- Non infectious solid waste is the solid waste that doesn‘t contains a disease causing pathogens (about 90% of the total waste).

c) **The solid waste classification by its putrescibility**

- Putriscible solid waste is the solid waste that easily decomposed or biodegradable

- Generated by growing, handling, preparation, cooking and consumption of food. These wastes tend to be more abundant during the summer (rainy) season.
- Non- putriscible solid waste is a solid waste that don't decompose easily or non biodegradable Wastes do not decompose easily; they may or may not be combustible. The plastics bags can also be easily swallowed by animals and may block their digestive system and kill them

Figure 3.1:- Discarded plastic bags are a health hazard for grazing animals.

❖ **Hazardous wastes are defined as wastes that have one or more of the following properties:**

- **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

▪ **Functional Elements of Solid Waste Management**

- Functional elements of solid waste management are:-

1) Onsite handling,
2) Storage and processing
3) Collection
4) Transfer and transport
5) Resource recovery and processing
6) Disposal.

1) Onsite handling, storage and processing

- **Onsite handling** means the functional element that concerned with the managing of solid waste at the place where the waste is generated. For residential this means at home in the household Onsite handling is the first step in the solid waste management. It involves individual family members, households and communities who need to know how to handle waste properly at this level.

- **Handling means** the separation of wastes into their different types so that they can be dealt with in the most appropriate way, for example, separating putriscible 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 container
- 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.

Figure 3.2:- Waste basket provided local guides association at Lake Tana monasary

2) Collection, transfer and transport of solid waste

- In most of the time, in urban centers, collection is a function element 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.

3) Disposal of solid waste

- Even after recycling and resource recovery there will almost certainly be some residual waste that needs final disposal.

- Dumping Open field 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.

- **Integrated solid waste management**
  - Practically, different solid waste management's were applied in the community set up without considering the basic concepts, principles, and scientific rule of safety consideration.
- **In scientific ways the solid waste can be managed in the following ways:-**

❖ **Integrated solid waste management**

- ✓ The concept of **integrated solid waste management (ISWM**) mostly applied to municipal solid waste management in urban centers. However, the principles can be applied to some extent in rural and pre-urban solid waste management.
- ✓ In most of the time, ISWM approach means considering not only the appropriate disposal of solid waste but integrating this with other management options such as minimizing waste production, recycling, composting and other waste recovery options.
- ✓ The 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 3.3: waste management hierarchy options from most desirable at the top to least desirable at the bottom

1) **Reduction strategies**
   - **Reductions strategies** are the ways that a household or community may use to reduce or minimize 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.
2) **Reuse strategies**
   - **Reuse** refers to the act of using an item more than once, either for the same or similar purpose

- **For example,** 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 3.4: Plastic containers are frequently reused.

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 recycling.
  - ✓ 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 saves money so there is an economic, as well as an environmental, incentive to recycle.

Figure 3.5: Waste metal can be recycled by using it to make new and different products.

- **Composting of organic solid wastes**
  - **Non-hazardous** or putriscible 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. In this solid waste management, the waste is converted in to a stabilized material that can be used as fertilizes.
  - **Composting** is an environmentally-friendly way of recovering value from organic waste. 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.
  - **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 meter deep and at least 1m breadth and 1m length. However, the size can vary with the amount of waste generated.
  - The pit depth should be slightly less, about 90 cm, on one side 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 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 practiced 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**

- Incineration is another waste management method, which means that it is something is to burn. 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.

Figure 3.6:- An incinerator used for healthcare waste.

- **Final disposal of solid waste**
  - **Sanitary landfill**
    - 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 minimize any negative environmental impact.
  - **Controlled tipping or controlled burial**
    - 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'**.
  - **A refuse pit**
    - 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.
    - Care must be taken to avoid creating places that could harbor 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.

Figure 3.7:- Refuse pit with a fence to prevent people or animals from accidentally falling in.

- **Burning of waste**
  - Is another 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 fertilizer or, if mixed with mud, can be used for plastering of earth walls or floors.

Self check	Written test

Direction: - Choose the correct answer from the given alternatives

1. Separation of wastes into their different types

A) Collection **B)** Resource recovery **C)** Handling **D)** Storage

2. The least desirable waste management option

A) Reduction **B)** Disposal **C**) Reuse **D**) None

3. All are the characteristics of hazardous waste **<u>excep</u>**t

A) Corrosive **B)** Ignitable **C)** Toxic **D)** None

4. The decomposing bacteria found in pit latrines.

A) Anaerobic **B)** Aerobic **C)** Both **D)** None

5. The digested waste matter is

A) Sewage **B)** Sullage **C)** sludge **D)** All

6. The retention time of the wastewater in septic tanks should be a minimum of ----- hours

A) 48hrs **B)** 19hrs **C)** 29hrs **D)** 15hrs

Note: Satisfactory rating - 4 points unsatisfactory below-4 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____

Rating _____

Name: _____ Date: _____

Short Answer Question

1._____ 4._____

2._____ 5._____

3. _____ 6._____

Information Sheet #2	Promoting Healthcare Waste Management

3.2 Healthcare Waste Management

3.2.1 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 centers and dispensaries, obstetric and maternity clinics, outpatient clinics and the like. Other sources are dental clinics, psychiatric hospitals, cosmetic ear-piercing and tattoo parlors, and illegal drug users.

- **Healthcare waste can be put into one of two broad categories:-**
  - **Non-hazardous (general waste):- is** between 75% and 90% of the waste produced in healthcare establishments are 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:-** is 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.
    - ✓ **Noso comical infection,** also called hospital-acquired infections, is infections acquired during hospital care which is not present or incubating at admission. Infections occurring more than 48 hours after admission are usually considered nosocomial.
- **You can categories 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 recognizable 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.

- **Pressurized containers:** gas cylinders, gas cartridges and aerosol cans.
- **Radioactive waste:** containing radioactive substances from radiotherapy or laboratory research.

3.2.2 Public health importance of healthcare waste

- 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.
- 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 needle stick injuries contaminated by human blood. Needle stick injuries are piercing wounds usually caused by the point of a needle but also by other sharp objects.

3.2.3. Management of Hazardous Healthcare Wastes

- The aim of healthcare waste management is to contain infectious waste and reduce risks to public health. The steps to achieve this goal include:-

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 labeling 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.

2. Waste minimization

- Waste minimization is the first and most important step in any waste management plan. Minimizing 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 minimization, you should always bear in mind that the materials and supplies purchased should create no or minimal wastes. However, it is important to note that minimizing waste should never be carried out if it compromises patient care or creates any other risk of infection.

3. Segregation of healthcare waste

- Segregation is the process of separating different categories of waste. Healthcare waste is usually segregated into color-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 colored waste receptacles specifically for each category of waste.
- The color-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.

4. Recycling and reuse of healthcare waste

- 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 121oC for at least 30 minutes after washing to ensure complete sterilization/disinfection. 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.

5. Use of safety box

- A safety box is used only for sharps 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 needle stick

injuries to you and the community. The role of health workers and waste handlers in proper use of safety boxes, starting from assembly through to final disposal.

Figure 4.1:- Safety box in use at a Health Post.

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 stopper 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 sterilized 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 sterilized.

7. Waste storage

- 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.)
  - On the storage area door and on waste containers, the universal biological hazard symbol should be posted.

Figure 4.2:- Biological hazard symbol.

3.2.4 Prevention and Control Risks to Healthcare Workers

1. Isolation of infected patients

- The first essential measure in preventing the spread of infections is isolation of infected patients. The term isolation covers a broad domain of measures.
- The strictest form of isolation is applied in case of very infectious diseases (e.g. tuberculosis, other respiratory infections, and infectious diarrhoea). Isolation implementation should therefore be adapted to the severity of the disease and to the causative agent.
- Disease-specific precautions should include details of all the measures (private sleeping room, separation of eating utensils and water drinking materials, etc.) to be taken in the case of a specific disease caused by a defined organism.

2 .Universal precautions

- Standard precautions is applied essentially protect healthcare workers from blood borne infections caused by human Immune deficiency virus (HIV) and hepatitis B and C viruses. it should be used in the care of all patients:

❖ **Hand washing**

- ✓ Wash hands after touching blood, secretions, excretions and contaminated items, whether or not gloves are worn. Wash hands immediately after gloves are removed, between patient contacts.
- ✓ Use a plain soap for routine hand washing.
- ✓ Use an antimicrobial agent for specific circumstances.

❖ **Gloves**

- ✓ Wear gloves when touching blood, body fluids, secretions, excretions, and contaminated items. Put on clean gloves just before touching mucous membranes and non-intact skin.

❖ **Mask, eye protection, face shield**

- ✓ Wear a mask and eye protection or a face shield during procedures and patient care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, and excretions.

❖ **Gown**

- ✓ Wear a gown during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions.

❖ **Patient-care equipment**

- ✓ Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and reprocessed appropriately.

❖ **Environmental control**

- ✓ Ensure that the hospital has adequate procedures for the routine care, cleaning, and disinfection of environmental surfaces.

❖ **Linen**

- ✓ Handle used linen, soiled with blood, body fluids, secretions, and excretions in a manner that prevents skin and mucous membrane exposures, and that avoids transfer of microorganisms to other patients and environments.

❖ **Occupational health and blood borne pathogens**

- ✓ Take care to prevent injuries when using needles, scalpels, and other sharp instruments or devices.
- ✓ Use ventilation devices as an alternative to mouth-to-mouth resuscitation methods.

❖ **Place of care of the patient**

- ✓ Place a patient who contaminates the environment or who does not assist in maintaining appropriate hygiene in an isolated (or separate) room.

3. Cleaning

- ✓ One of the most basic measures for the maintenance of hygiene, and one that is particularly important in the hospital environment, is cleaning. The principal aim of cleaning is to remove visible dirt. It is essentially a mechanical process: the dirt is dissolved by water, diluted until it is no longer visible, and rinsed off. Soaps and detergents act as solubility promoting agents.
- ✓ The microbiological effect of cleaning is also essentially mechanical: bacteria and other microorganisms are suspended in the cleaning fluid and removed from the surface.
- ✓ The efficacy of the cleaning process depends completely on this mechanical action, since neither soap nor detergents possess any antimicrobial activity. Thorough cleaning will remove more than 90% of microorganisms. However, careless and superficial cleaning is much less effective; it is even possible that it has a negative effect, by dispersing the microorganisms over a greater surface and increasing the chance that they may contaminate other objects.
- ✓ Cleaning has therefore to be carried out in a standardized manner or, better, by automated means that will guarantee an adequate level of cleanliness.
- ✓ Diluting and removing the dirt also removes the breeding-ground or culture medium for bacteria and fungi. Most non-spore former bacteria and viruses survive only when they are protected by dirt or a film of organic matter; otherwise they dry out and die. Non-speculating bacteria are unlikely to survive on clean surfaces. The effectiveness of disinfection and sterilization is increased by prior or simultaneous cleaning.

4. Sterilization

- ✓ Object should be sterile, i.e. free of microorganisms, after sterilization. However, sterilization is never absolute; by definition, it effects a reduction in the number of microorganisms by a factor of more than 106 (i.e. more than 99.9999% are killed).
- ✓ Physical methods are based on the action of heat (autoclaving, dry thermal or wet thermal sterilization), on irradiation, or on mechanical separation by filtration.
- ✓ Chemical method means include gas sterilization with ethylene oxide or other gases, and immersion in a disinfectant solution with sterilizing properties (e.g. glutaraldehyde) and based on the situation you can use locally available sterilization methods like boiling.

Figure 5.1:- Autoclave in a Health Post.

5. **Disinfection**

- There are three level of disinfection.
  1. **High-level disinfection**: can be expected to destroy all microorganisms, with the exception of large numbers of bacterial spores.
  2. **Intermediate disinfection**: inactivates Mycobacterium tuberculosis, vegetative bacteria, most viruses, and most fungi; does not necessarily kill bacterial spores.
  3. **Low-level disinfection**: can kill most bacteria, some viruses, and some fungi; cannot be relied on to kill resistant microorganisms such as tubercle bacilli or bacterial spores.
  - ➢ A disinfectant solution is considered appropriate when the compromise between the antimicrobial activity and the toxicity of the product is satisfactory for the given application. Another consideration may well be the cost.
  - ➢ The more active disinfectants are automatically the more toxic ones; potentially toxic products can be applied to inanimate objects or surfaces, whereas for disinfection of human tissues only the less toxic disinfectants can be considered. For antisepsis, different disinfectants are used for application to the intact skin (e.g. alcoholic solutions) and to mucous membranes or wounds (only aqueous solutions of non-toxic substances).
  - ➢ Cost is a less important consideration for an antiseptic than for a disinfectant.
  - ➢ The principal requirements for a good antiseptic are absence of toxicity and rapid and adequate activity on both the natural flora and, especially, pathogenic bacteria and other microorganisms after a very short exposure time.
  - ➢ Essential requirements for a disinfectant are somewhat different: there must be adequate activity against bacteria, fungi, and viruses that may be present in large numbers and protected by dirt or organic matter. In addition, since disinfectants are applied in large quantities, they should be of low contamination.

- In general, use of the chosen disinfectant, at the appropriate concentration and for the appropriate time, should kill pathogenic microorganisms, rendering an object safe for use in a patient, or human tissue free of pathogens to exclude cross-contamination.

6. Hand hygiene

- As the hands of healthcare workers are the most frequent vehicle of nosocomial infections, hand hygiene including both hand washing and hand disinfection is the primary preventive measure. Thorough hand washing with adequate quantities of water and soap removes more than 90% of the transient, i.e. superficial, flora including all or most contaminants. An antimicrobial soap will further reduce the transient flora, but only if used for several minutes.
- Hand washing with (non-medicated) soap is essential when hands are dirty and should be routine after physical contact with a patient. Killing all transient floras with all contaminants within a short time (a few seconds) necessitates hygienic hand disinfection: only alcohol or alcoholic preparations act sufficiently fast. Hands should be disinfected with alcohol when an infected tissue or body fluid is touched without gloves.
- During a surgical intervention, a high proportion of gloves become perforated. Hands should therefore be disinfected with a long-acting disinfectant before gloves are put on. This will not only kill all transient floras, but will also prevent the microorganisms of the resident flora from taking the place of the transient flora during the intervention.

3.2.5 Methods of Healthcare Waste Treatment and Disposal

1 .Incinerator

- Incineration is a high-temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight.
- If the incinerator is properly designed, maintained and operated, it serves the purpose of destroying infectious microorganisms in the waste.
- It is 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.
  - 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 metal drum or barrel:-**
  - 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, sprinkle them with a small amount of kerosene .
  - Put paper under the drum, between the bricks, and set light to it so the flames rise through the metal screen.

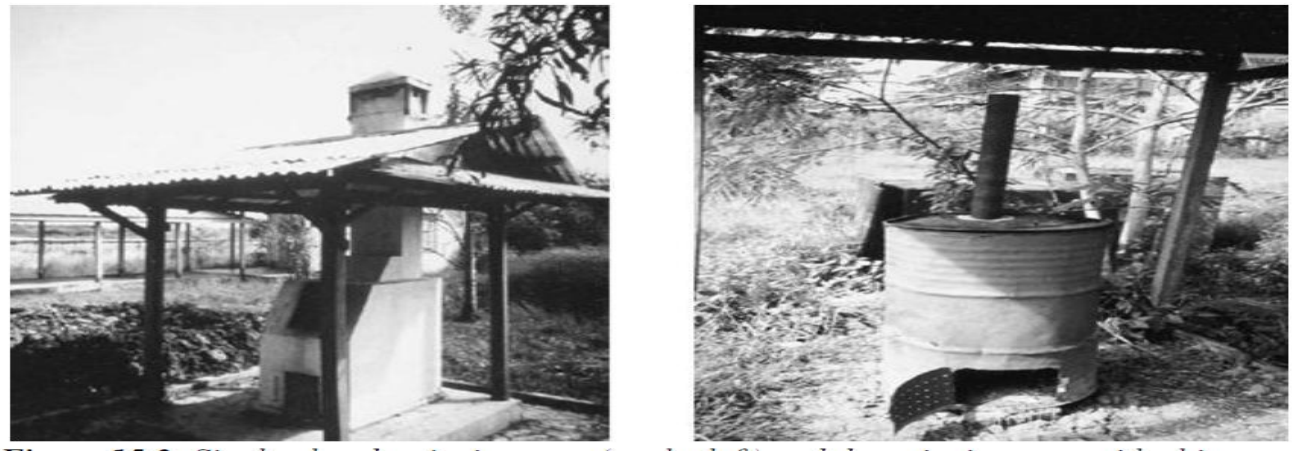

Figure 5.2: Single-chamber incinerator (on the left) and drum incinerator with chimney (on the right)

2. Open pit burning

- If there are no incinerators, then open pit burning is also possible, and frequently used in rural Health Posts.
- 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 5.3:- Open pit burning of healthcare waste.

3. Encapsulation

- Disposal of healthcare waste in municipal landfills is less advisable if it is untreated than if it is pretreated.
- One option for pretreatment is encapsulation, which involves filling containers with waste, adding an immobilizing material, and sealing the containers.
- The process uses either cubic boxes made of high-density polyethylene or metallic drums, which are three-quarters filled with sharps and chemical or pharmaceutical residues.
- The containers or boxes are then filled up with a medium such as plastic foam, bituminous sand, cement mortar, or clay material.
- After the medium has dried, the containers are sealed and disposed of in landfill sites. This process is relatively cheap, safe, and particularly appropriate for establishments that practice **minimal programs** for the disposal of sharps and chemical or pharmaceutical residues.

- Encapsulation alone is not recommended for non-sharp infectious waste, but may be used in combination with burning of such waste.
- The main advantage of the process is that it is very effective in reducing the risk of scavengers gaining access to the hazardous healthcare waste.

4. 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 sterilize 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.

5. Safe burial on health post premises

- 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.
- The bottom of the pit should be at least 1.5 metres 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

- **Certain basic rules/criteria should be followed:-**
  - Access to the disposal site should be restricted to authorized personnel only.
  - The burial site should be lined with a material of low permeability, such as clay, if available, to prevent pollution of any shallow groundwater that may subsequently reach nearby wells.
  - Only hazardous healthcare waste should be buried. If general hospital waste were also buried on the premises, available space would be quickly filled up.
  - Large quantities (>1kg) of chemical wastes should not be buried at one time. Burying smaller quantities avoids serious problems of environmental pollution.
  - The burial site should be managed as a landfill, with each layer of waste being covered with a layer of earth to prevent odors, as well as to prevent rodents and insects proliferating.

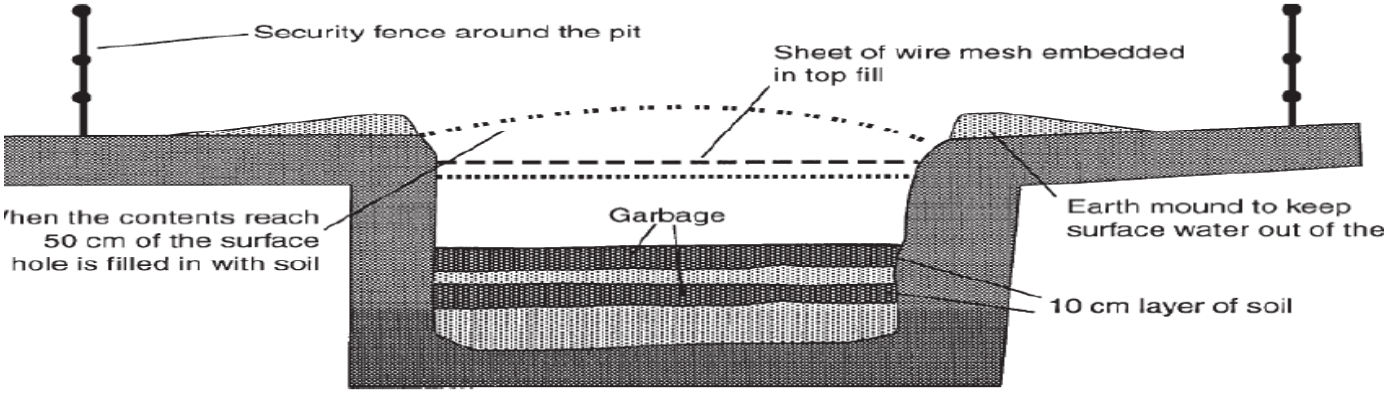

Figure 5.4: Example of a small burial pit for healthcare waste

Self check #2	Written test

Direction: - say “True” or “False”

1. Healthcare waste contains hazardous and non-hazardous waste.
2. Infectious healthcare waste is kept in red containers.
3. Chemical disinfection involves treating waste with 0.5% chlorine solution for 10 minutes by immersing in an autoclave.

Note: Satisfactory rating 3 points unsatisfactory below 3 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____
Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

3. _____

3.3 Latrine Construction

3.3.1 Concepts and Principles of Latrine Construction

- Safe human excreta disposal is crucial for preventing the spread of infectious diseases. Communities and planners need to realize that safe human excreta disposal brings about huge health benefits. The control and management of wastes are an essential.
- In rural areas, the users themselves are largely involved in preventive maintenance activities for wastewater and solid waste disposal. Awareness campaigns, and involving the community in sanitation problems, can both help to change behavior in communities, and improve basic sanitation systems.

❖ **Factors to consider when choosing a sanitation system for excreta disposal include:**

- The initial cost of the technology.
- Demand and use (what is the population density, and will the system be used in homes, schools, market places.
- Climate (temperature, humidity and rainfall).
- Soil and topography (infiltration properties of the soil, and what is the direction of the groundwater flow).
- Water availability (for waterborne systems).
- Cultural beliefs, values and practices on sanitation.
- The availability of technical skills (are there local craftsmen or technicians with the necessary skills to install and/or carry out the system).
- Agriculture (what are the characteristics of the local agriculture and home gardening).

3.3.2 Types of 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:-**

1. In places where water is more easily available, typical methods are drop-flushand-discharge systems, also known as water carriage systems, such as the pour-flush latrine or a water closet (W.C.)
2. 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:-**
  - ✓ Simple pit latrine
  - ✓ VIP latrine
  - ✓ Ecology sanitation

▪ **Classification based on improvement:-**

❖ **Improved sanitation services or methods include:**

- W.C. 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 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).
- Bucket latrine

3.3.3 Role of the Health Extension Worker in Latrine Construction

- Promote latrine construction by giving advice and encouragement to people in your community to install or improve sanitation systems.
- 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 who 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

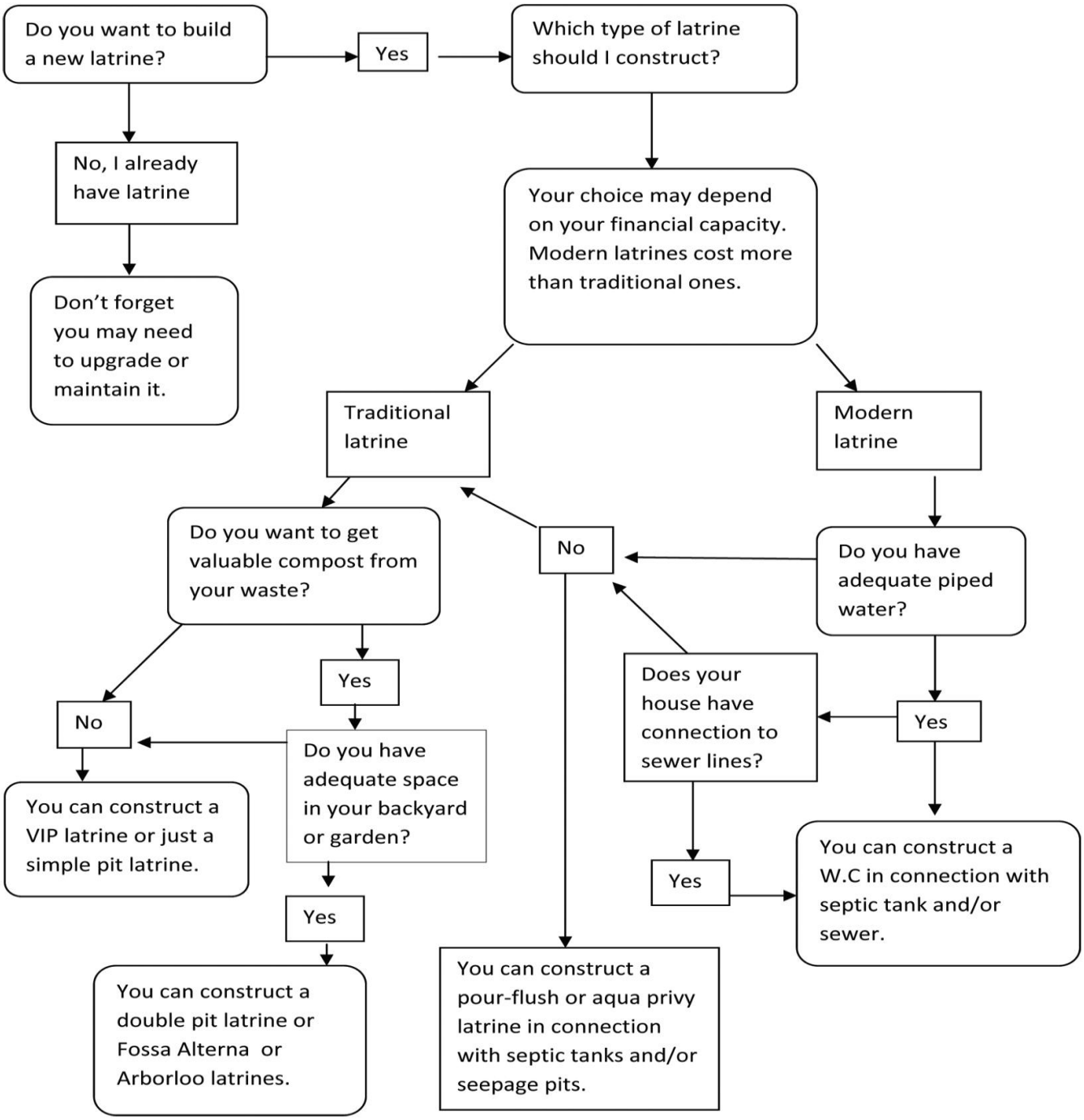

Figure3.3: Decision tree for latrine options

Self check #3	Written test

Direction: - Choose the correct answer from the given alternatives

1. Improved sanitation services

   A. Bucket latrine B. Pour-flush latrine. C. Open latrines. D. All

2. Pit latrine simple drop and- store systems in which the liquid waste collects in a pit below.

   A. Pour-flush latrine B. water closet C. Ecology sanitation D. All

Note: Satisfactory rating 3 points unsatisfactory below 3 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____

Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

Information sheet #4	Educating Latrine Utilization Changing Attitudes and Behavior

3.4 Latrine Utilization Changing Attitudes and Behavior

3.4.1 Factors affecting the Use of Latrines and Hand Washing Facilities

- The possession of an improved latrine, on its own, will not halt 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 hand washing facilities effectively.

❖ F**actors that affects the use of latrine** in the community.

- Behavioral, demographic, geographic, climatic, social, cultural and economic, the bad smell of a latrine, lack of privacy if the shelter is inadequate, childhood habits that are hard to break and many more 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 behaviors‘.
- 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 is also an anther factors which affects the use of latrines are inappropriate materials for latrine construction, the collapse of latrines, rain during rainy season etc, so that you need to identify the factors affecting the use of latrines relevant way with in your community is mandatory in order to improve the utilization of latrine within the community and farther more for health promotion by conducting an open discussion with that community.

❖ F**actors affecting Hand washing practices**

- Some family members in rural households may not **practice proper hand washing** due to poor attitude to hand washing and affordability to buy soap and utensils/equipments.
- Therefore you should focus on individual and communal communication to change the attitude of people towards the direct (health) and the indirect (economic) benefits of hand washing.
- You can recommend the use of locally available materials such as ash for detergent purposes, and tin cans or jerrycans‖ as hand washing devices and check that the hand washing facility is conveniently placed near latrines and that the water is clean to avoid further contamination.

3.4.2 Benefits of Hygiene and Sanitation Behavior Change

- Proper hygiene, adequate sanitation and safe drinking water have significant benefits for human health. You have also learned about the need to practice positive behaviors. Any change from bad habits to good practice is described as behavior change.

❖ **Critical times for hand washing are after visiting the latrine** :-

- ✓ After visiting latrine
- ✓ After cleaning a child's bottom
- ✓ Before preparing food and before eating meals or feeding children.

- Promotion of hygiene and proper sanitation is the single most important way to improve the health of your community.
- The right approaches need to be used to change behavior 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 4.1:- Adults and children should always wash their hands after using the latrine.

3.4.3 Motivating people to change their behavior

- 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 behavior change. Because human behavior 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 culturally suitable, and comfortable, for your community .If you are trying to **change behavior** by targeting individuals you need to consider not only their prior experience but also their learned behaviors. These are the habits gained by **social learning channels or socialization** 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 behavior, 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 behavior and you can use different motivational techniques‘ to get good effect
- **Your role** would be to ensure that 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 recognized and rewarded by the community leaders, both traditional and formal, and acknowledged by community members, friends and neighbors‘ in order to sustain the existing achievements and encourage others to progress well. In order to have an impact on health, any change in health practice needs to be adopted by many individuals in your community**.**
- **Shared behavior** is only achieved when the community themselves feel there is a problem, and are motivated to solve the problem by jointly taking actions that would permanently improve health conditions.

3.4.4 Monitoring and Evaluation of Latrine Utilization

- Any programme that is promoting behavior change needs to have a process for assessing how effective it is, in other words, a monitoring and evaluation process.
- Latrine utilization 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 hand washing 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 hand washing 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

Self check #4	Written test

Direction: - Choose the correct answer from the given alternatives

1. Critical times for hand washing

A. After visiting latrine B. After cleaning a child's bottom C. Before preparing food D .All

Note: satisfactory rating 1 point unsatisfactory below 1 point

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____

Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

Information sheet # 5	Educating Public Health Importance of Vectors

3.5 Public Health Importance of Vectors

3.5.1 Definition of Vector

- **Vector: -** are 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.
- 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.
- **Rodent** comprise a great number of mammals, ranging in size from the rats and mice to as large as the Porcupines and which belong to vertebrates that transmits infection from an infected person or animal to a susceptible host.

3.5.2 Vector-born Disease Transmission Mechanism

- **Generally there are two types of vector borne disease transmission mechanism.**

1. **Mechanical disease transmission:**
   - Is a type of disease transmission in which the vector is no more than a carrier that transmits pathogens without any change either on the number or form of disease pathogens
   - **Example** Flies like to rest, feed and breed 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. Example-Trachoma, diarrhea
2. **Biological disease 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 within the mosquito. When the mosquito next bites a any human for meal the saliva is injected into the skin and transfers the infection in doing so.

- **Common Vector of Borne- Diseases and their Control Methods**

1 Housefly

- The common housefly lives in close association with people all over the world. The insects feed on human foodstuffs and wastes where they can pick up and transport various disease causing agents. There are four distinct stages in the life of a fly: egg, larva or maggot, pupa and adult.
- The female fly lays 200–250 eggs at a time on organic matter such as human faeces, decaying animal and vegetable matter, fresh food or dung.
- Depending on the temperature, it takes from 6 to 42 days for the egg to develop into the adult fly. The length of life is usually 2–3 weeks but in cooler conditions it may be as long as three months.
- Flies can spread diseases because they feed freely on human food and waste matter.
- The fly picks up disease-causing organisms while crawling and feeding. Those that stick to the outside surfaces of the fly may survive for only a few hours, but those that are ingested with the food may survive in the fly's crop or gut for several days.
- Transmission takes place when the fly makes contact with people or their food.

❖ **Flies can transmit diseases**

✓ like enteric infections (such as dysentery, diarrhea, typhoid, cholera and certain helminth infections), eye infections (such as trachoma and epidemic conjunctivitis) , poliomyelitis and certain skin infections (such as cutaneous diphtheria)

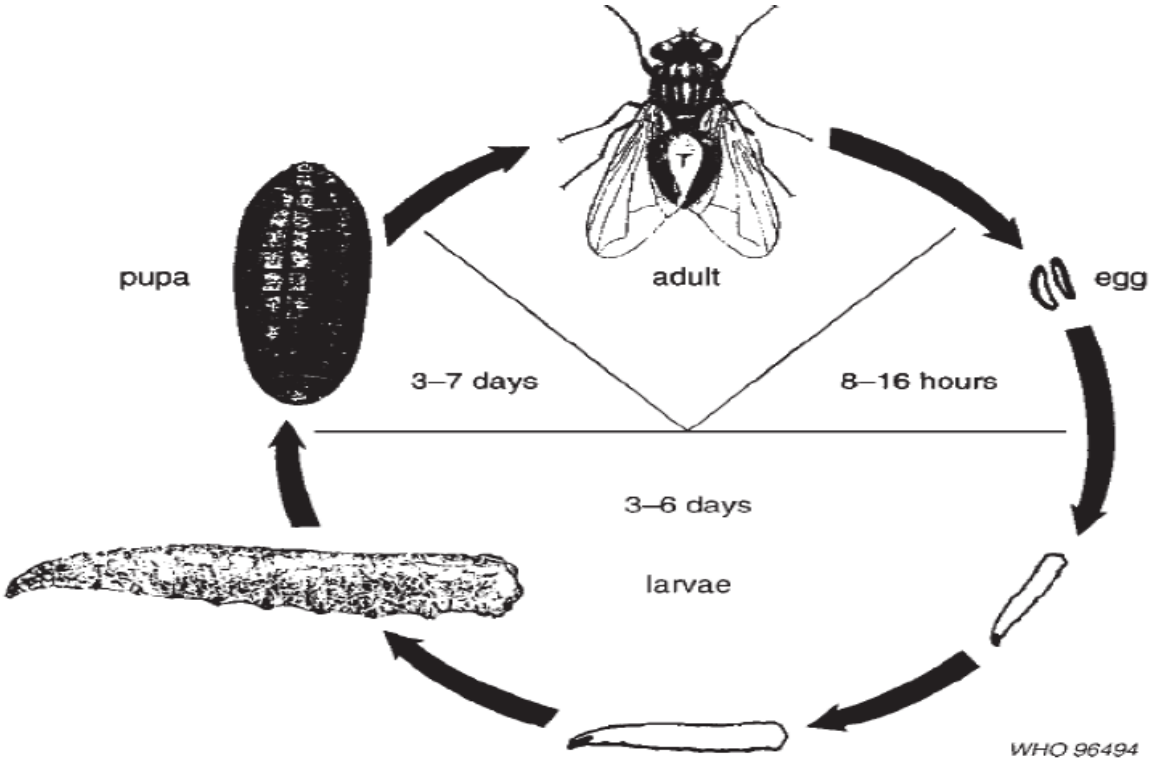

Figure 5.1: Life cycle of house fly.

2 Mosquitoes

- There are three main mosquito groups:
  - Anopheles mosquitoes breed in stagnant, relatively clean water bodies; 150–200 Eggs are laid in a group on the water surface
  - Culex breed in polluted water; 200–500 Eggs are laid in a group on the water surface
  - Aedes like relatively clean water lay egg singly
  - The laid egg 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.
  - Only female mosquitoes bite and suck blood; the males feed on the nectar of flowering plant. 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.

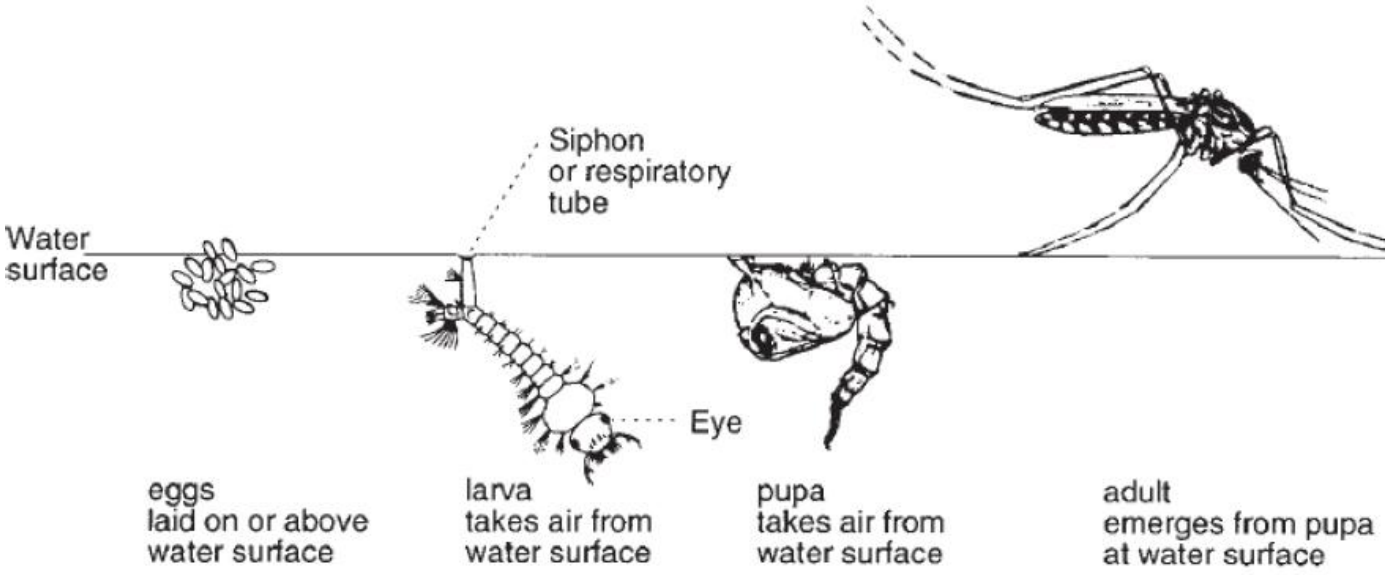

Figure 5.2: Life cycle of the mosquito

- **These species also rests at different resting position.**
  - 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

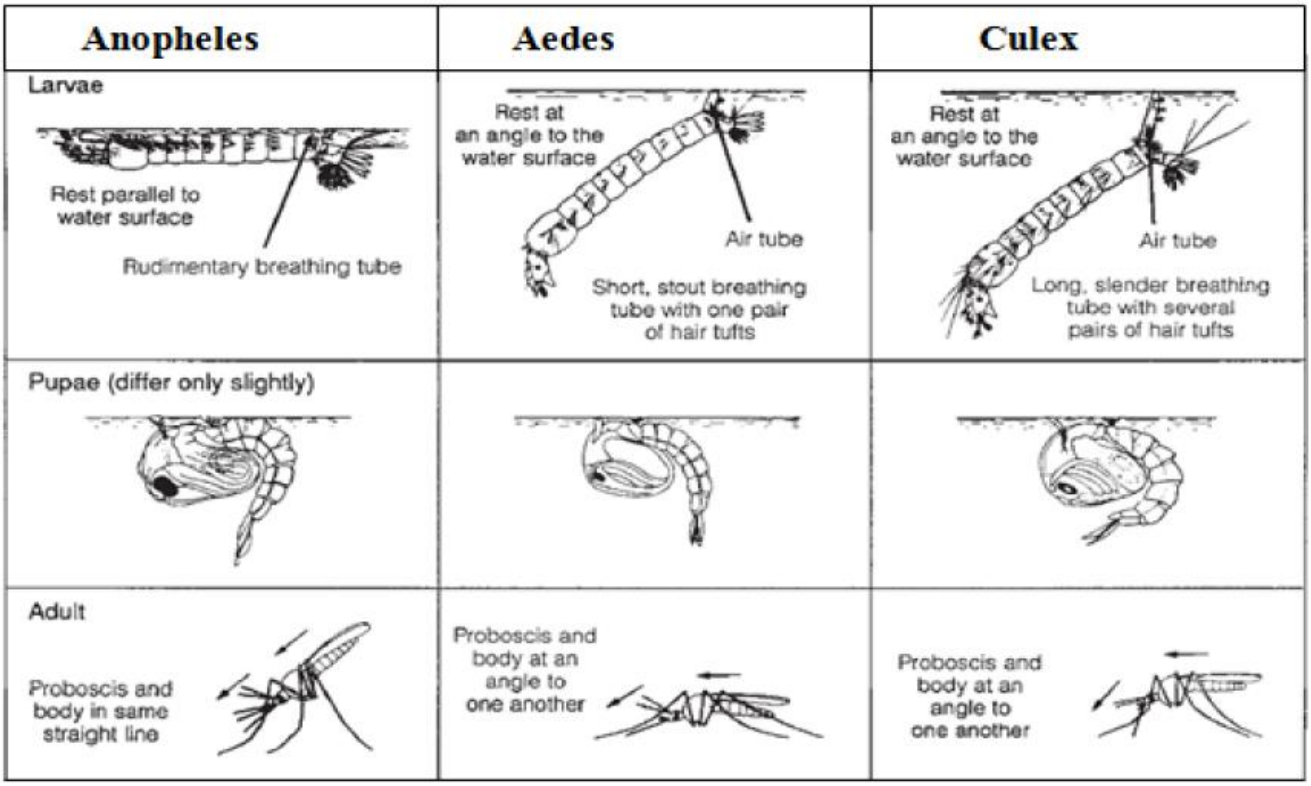

Figure 5.3: Comparison between different types of mosquito: Anopheles, Aedes and Culex

- **Different species of mosquito carry different diseases.**
  - Anophles :- transmit Malaria and filariasis
  - Culex :-transmit filariasis
  - Aedes:-transmit yellow fever and dengue fever

3. Lice

- There are three types of human louse: **the head louse, body louse and pubic louse**. All of them are wingless biting insects and live by sucking human blood. Being bitten by lice is painful, disturbing, embarrassing, and may cause an allergic reaction.
- **Head lice** eggs are laid at the base of the hair and then hatch, leaving the pale-colored egg casing, known as a nit‘on the hair. The larvae feed on blood until they reach sexual maturity. The life cycle takes about 15days with lying 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 favor the coarser body hair found in the pubic area and armpits.

- **Lice can transmit diseases** like Typhus fever, relapsing fever, dermatitis.

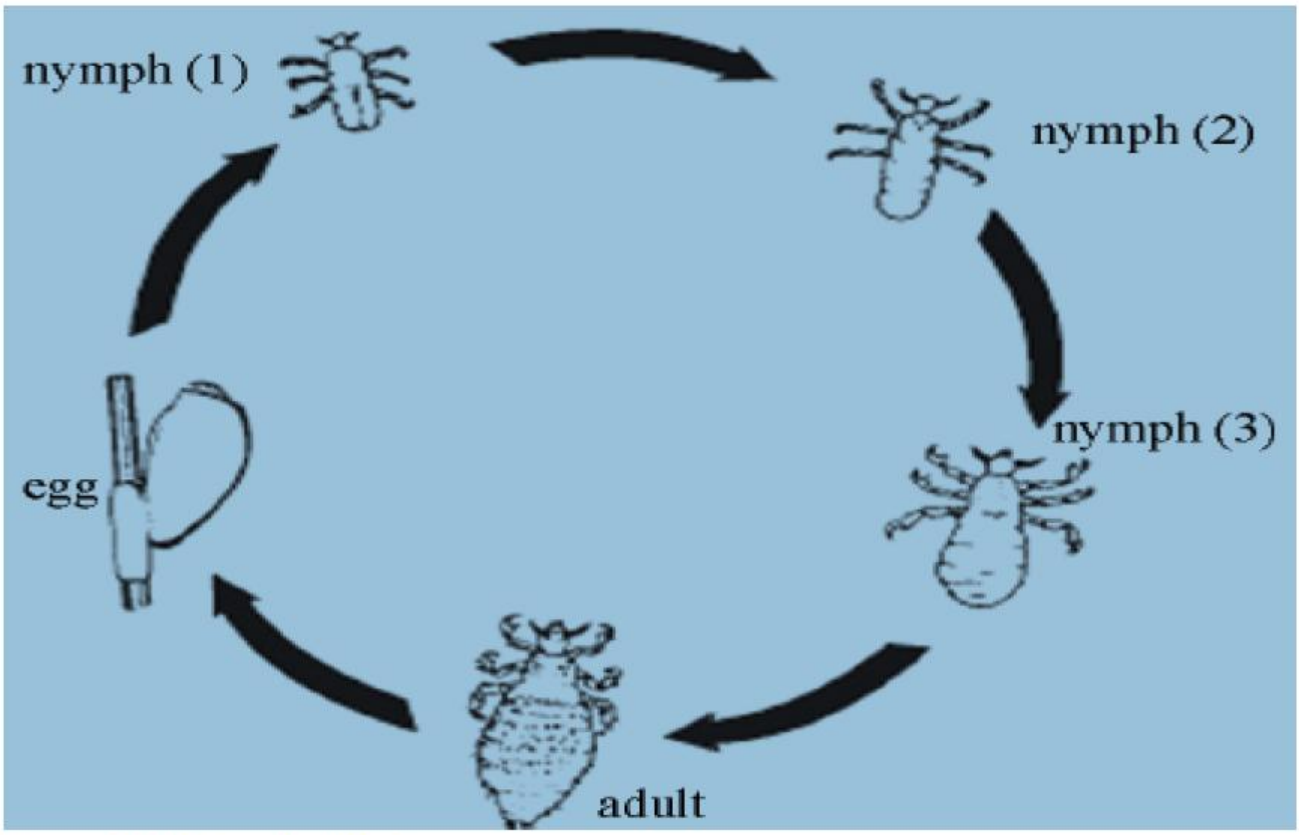

Figure 5.4: Life cycle of the louse.

4 Bedbugs

- Bedbugs are nocturnal or night-biting insects. They are typically found in houses with poor housing sanitation or in sub standard houses 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 .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.

- **Bedbugs can transmit** dermatitis and chagas disease.

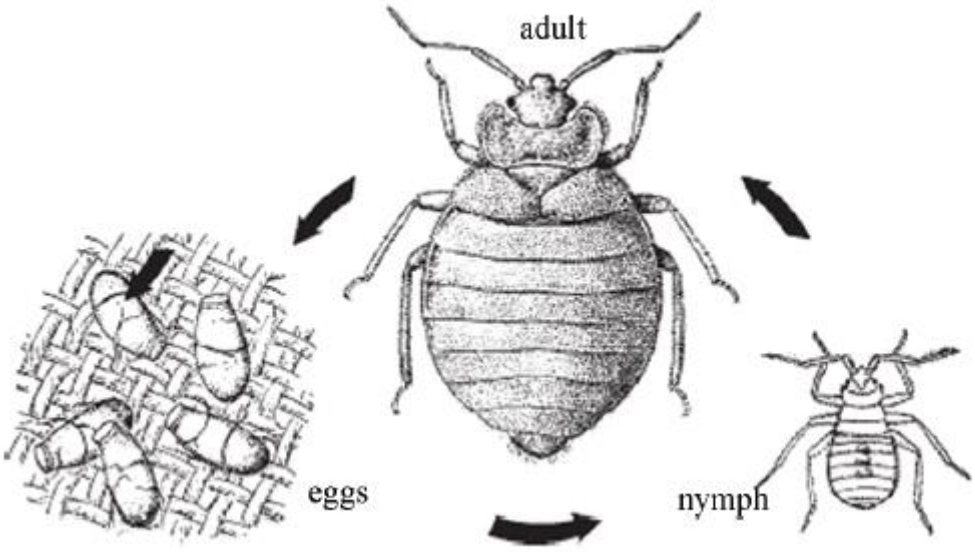

Figure 5.5: Life cycle of the bedbug.

5 Fleas

- There are different fleas like 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.
- Females require a fresh blood meal in order to produce eggs. Females lay 8–10 eggs in dark places. The eggs hatch within 2 days into larvae which feed on organic matter and develop into pupae. The life cycle takes 3–4 weeks.

- **It can be transmitted** murine typhus or endemic typhus disease.

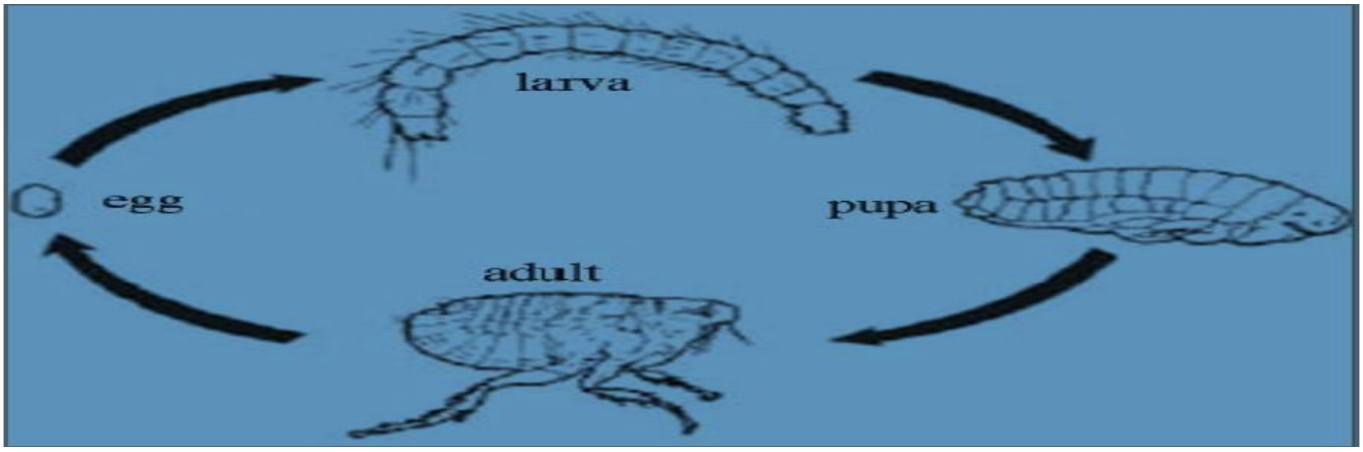

Figure 5.6: Life cycle of the flea.

6. Black Flies

- The developmental stages of black flies is the same as in mosquitoes (complete metamorphosis), demanding the existence of water for the eggs, larva and pupa.
- Eggs cling to aquatic and emergent vegetation. They are also found attached to the sides of canals in irrigation schemes, concrete dams and on aquatic animals.
- They feed on small aquatic organic matter like protozoa, bacteria, algae, fungal spores, pollen etc. Life cycle ranges from 60 days to 15 weeks or over.

- **The most important disease transmission** by black flies is **Onchocerciasis (**river blindness**).** Onchocerciasis is a dangerous disease of tropical Africa with blinding, visceral
  - ✓ Involvement and fatal effects and other disorders. Onchocerciasis is reported in south-western part of Ethiopia, around Jimma, Bonga, Shebe, Gore, Nekemte and Gardulla.

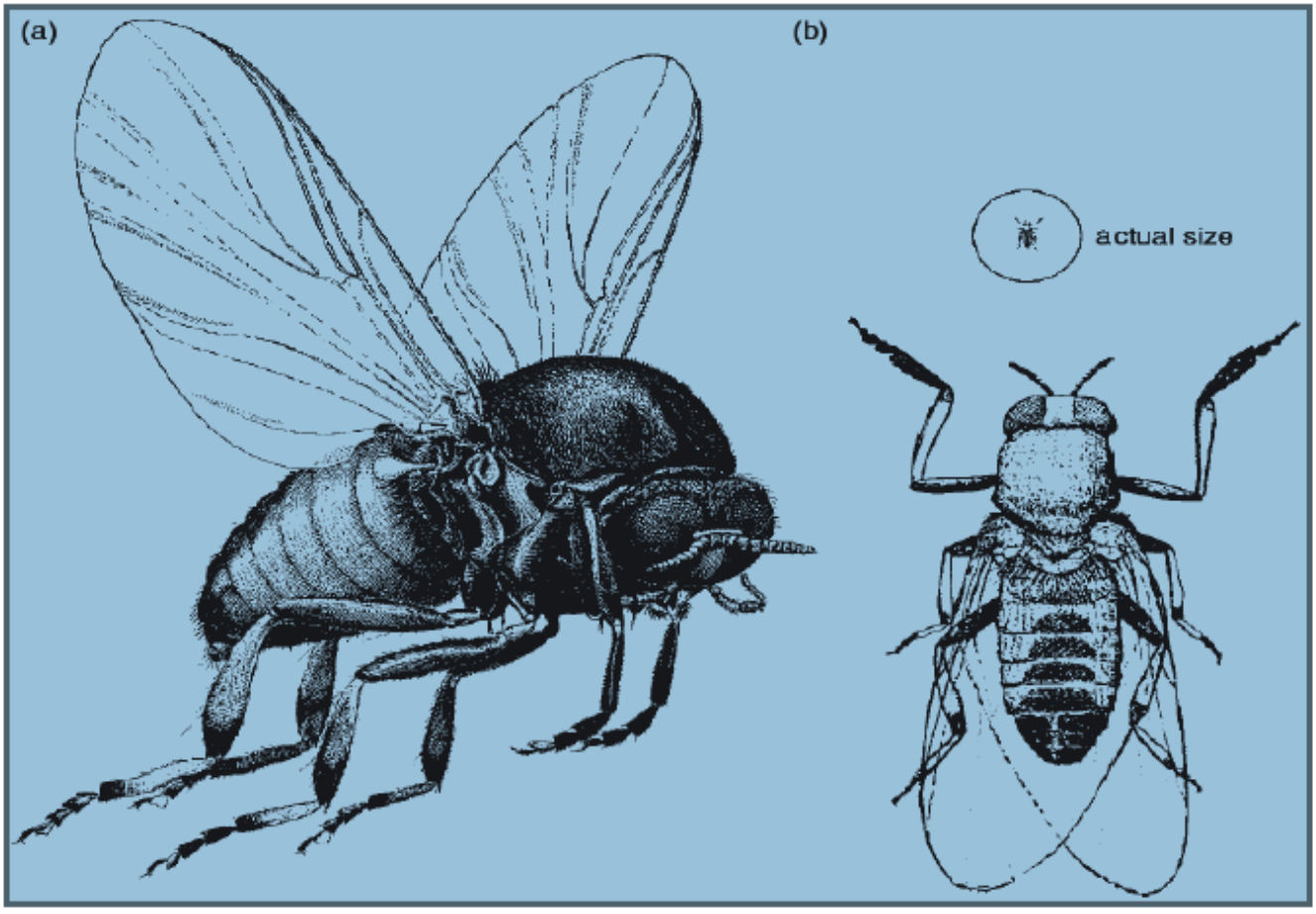

Figure 5.7: Black fly: (a) in flight and (b) at rest

7. Tsetse Flies

- The different species of tsetse flies occur in tropical Africa. They live both in dry and wet savannah regions. Their breeding sites and habitats are located close to rivers, streams and other bodies of water, mostly in trees, and bushes.
- The female tsetse fly does not lay eggs but produces larvae, one at a time. The larva develops in the uterus over a period of 10 days and is then deposited fully grown on moist soil or sand in shaded places, usually under bushes, fallen logs, large stones and buttress roots. It buries itself immediately and turns into a pupa. The fly emerges 22–60 days later, depending on the temperature.
- Females mate only once in their life and, with optimum availability of food and breeding habitats, can produce a larva every 10 days.

- **Tsetse flies transmit** the causal organisms of sleeping sickness (trypanosomiasis) to man and nagana disease to cattle.

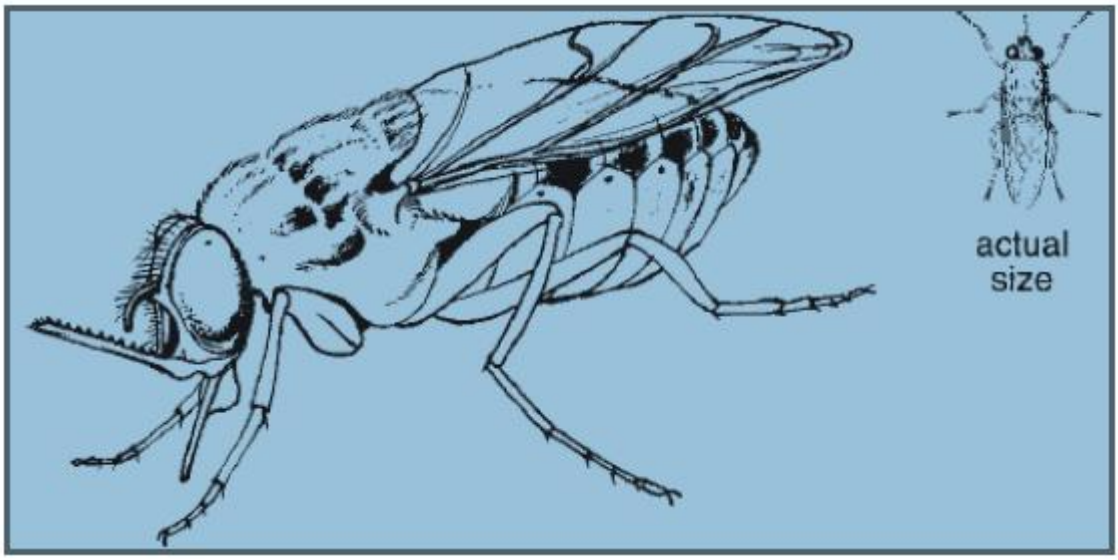

Figure 5.8: Tsetse fly; this shows a feeding fly with a swollen abdomen

8 Freshwater snails

- Many species of freshwater snail are intermediate hosts of highly infective fluke larvae of the genus Schist soma which cause schistosomiasis, also **called bilharziasis**.
- It is prevalent in areas where the snail intermediate hosts breed in waters contaminated by faeces or urine of infected persons. People acquire schistosomiasis through repeated contact with fresh water during fishing, farming (irrigating), and swimming, washing, bathing and recreational activities.
- People serve as vectors by contaminating the environment.

- Transfer of the infection requires no direct contact between snails and people. Freshwater snails are also intermediate hosts of food borne fluke infections affecting the liver, lungs and intestines of humans or animals.

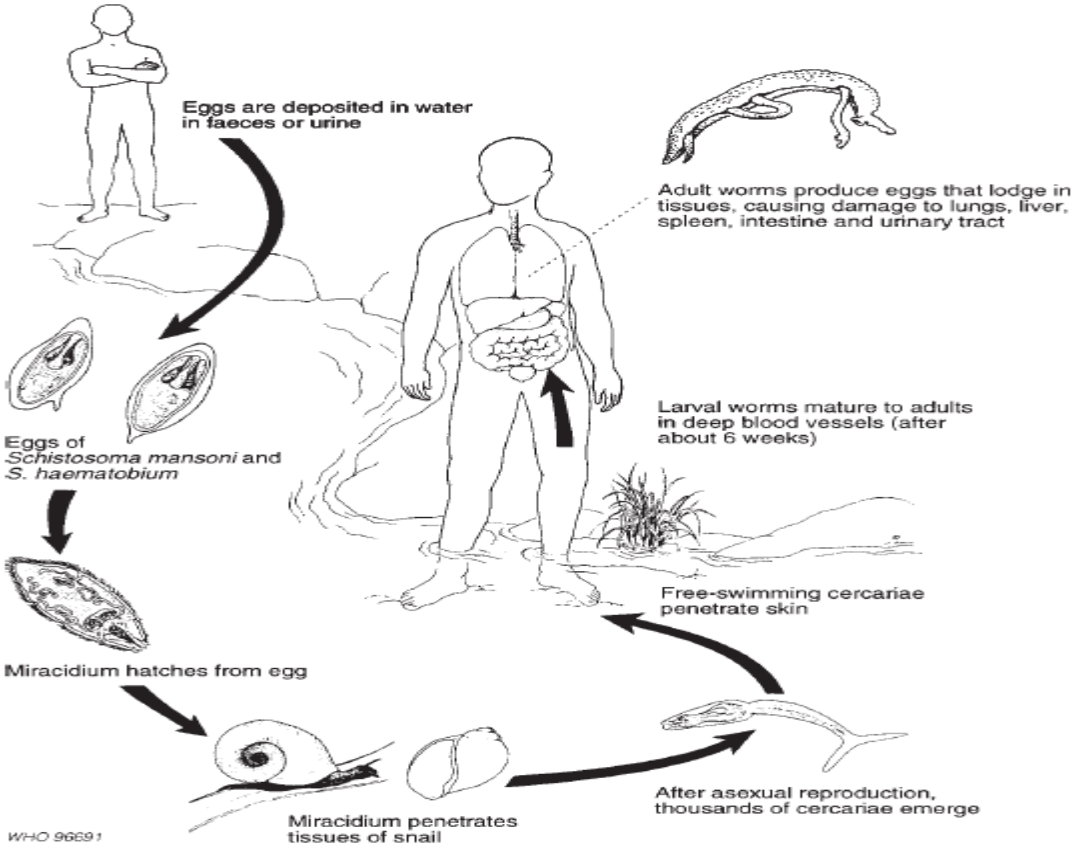

Figure 5.9: Life cycle of schistosomes

- **Prevention and control of schistosomiasis**
  - Improved detection and treatment of sick people;
  - Improvement of sanitary facilities for safe and acceptable disposal of human excreta
  - Provision of safe drinking-water;
  - Reduction of contact with contaminated water; and snail control.

3.5.3 Rodent

- Rodents are relatively small mammals with a single pair of constantly growing incisor teeth specialized 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.

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

1. 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 (4–7 times a year producing 8–12 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.

2. Roof rats (Rattus rattus)

- Also known 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 5–8 young in each litter.

3. 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 5–10 liters of about 5–6 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.

- Behavior 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, memorizing 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.

- Both species exhibit this avoidance of new objects, it is usually more pronounced in roof rats than in Norway rats.

- Public health importance of rodents
  - 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.

3.5.4 Vector Management and Control

- **Vectors can be controlled using various methods.**

1. Basic sanitation

- The approach targets the elimination or reduction of that part of the environment that facilitates breeding and harborage (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.

2. Physical measures

- 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.
- The 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
- Delousing by boiling or steaming infested clothes are physical methods for controlling lice.

Figure 5.10: Rat trapping (urban roof rat).

3 Use of chemicals

- 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.
- 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.

Figure 6.10 Insect killer chemical insecticide and fly swat.

4 Biological methods

- These include several very advanced methods that prevent the successful reproduction of pest species.
- They include the sterilization 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.

5 Integrated approaches

- 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.

3.5.5. Planning for Improving of Vector Control

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.

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.

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.

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 mobilize the people.

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.

Self Check #5	Written test

Direction: Matching

"A"	**"B"**
------**1**) Louse	**A)** Onchocerciasis
------**2**) Sand fly	**B)** trypanosomiasis
-----**3**) Black fly	**C)** Leishmaniasis
-----**4**) Tsetse fly	**D)** Typhus fever
-----**5**) Fresh water snail	**E)** Schistosomiasis
	F) Rabies

Note: Satisfactory rating 5 points unsatisfactory below 5 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____

Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

3. _____

4._____

5._____

Information sheet #6	Promoting water supply and safety measures

3.6 water supply and safety

3.6.1 Public health importance of water

- 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.
- The great majority of water related health problems are the result of bacterial, viral, protozoan and other biological agents.
- Infectious water borne diseases such as diarrhea, typhoid and cholera are leading causes of death and illness in the developing world. There are many diseases associated with water.

3.6.2 Uses of Safe Water

- Safe water is water, which is free from disease-causing agents and does not have any risk to health over a lifetime of consumption.
- **Potable water**: - means water that is safe to drink.
- **Palatable water**: - which means water that is pleasant to drink. Palatable water is at a desirable temperature, completely transparent and free from tastes, odors and colors, 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.
- 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 hand washing creates an additional water requirement and therefore an additional burden on the person responsible for collecting water.
- 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 vicious cycle of poverty.

- **Purposes of water**

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 do. 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.

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 liters of safe water per day for food preparation.

3. For hygiene and sanitation activities

- Providing safe water and encouraging people to practice 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 diarrheal diseases.
- Providing clean water for washing can prevent trachoma, which is the leading cause of preventable blindness. Hand hygiene is important for our hands can be soiled by many different contaminants, while visiting a toilet, during farming activities, cleaning children's bottoms and so on.
- Hence washing hands with soap and water is very important for reducing communicable diseases.

4. Other purposes of water are like recreation, transportation, body temperature regulation and metabolism action facilitation, aquatic life preservation etc.

3.6.3 **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 and safe water. Several criteria need to be satisfied to ensure that the people in your community have satisfactory access to water.

▪ These include:

1 Sufficient Quantity

- According to international and national guidelines, the quantity of water available in each household should be 50 to 100 liters per person per day, or an absolute minimum of 20 liters.
- The amount is largely determined by the distance of the source of water from the home.
- If the water source is outside of the home, but within around 1 kilometer (30 minutes total collection time), about 20 liters 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 liters per person per day.
- Households that do not have to travel to collect water have more time for economic activity, food preparation, childcare and education. Having access to a greater volume of water potentially encourages hand washing, general physical cleanliness and improved living conditions.

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 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 6.1:- Animals come to the river to drink at the same place as the women collect the water.

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:

A. No access: - people do not have access to safe water when:

- The distance to the water source is more than 1 kilometer or more than 30-minute round trip
- The amount of water collected is very low (often below 5 liters per capita per day)

B. **Basic access: -** people have a basic level of access to safe water when:

- The distance to the water source is within 1 kilometer/30-minute round trip.
- The amount of water to be collected on average is unlikely to exceed 20 liters per capita per day.

Figure 6.2:- Public water points an example of basic access, assuming the user lives within one-kilometer distance.

C. Intermediate access: 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 liters per capita per day

Figure 6.3:- Provision of safe water for a household with a single tap – an example of intermediate access.

D. Optimal access: - people have optimal access to safe water when:

- Supply of water is through multiple taps within the house. Approximately 100–200 liters per capita per day or more is available.
- The daily minimum water requirement was between 2 and 4.5 liters per person per day according to climate conditions.
- Because the average consumption refers to water used for all household purposes including washing, cooking and cleaning as well as drinking and eating**.**

4 Affordable

- 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 with what people can pay. For example, in most rural communities of Ethiopia the government and other organizations freely provide protected water sources.

3.6.4 Barriers to provision of Safe Water

- Capacity and finance are the main factors that prevent the effective provision of water.
- Capacity means having the ability to do something so as to get water. 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 institutionalized, meaning formal organizational 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 otherwise, the provision of safe water will be difficult.

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 favorable conditions within the community. For example, they need to identify their own problems, prioritize 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 organizations are important. The participation of women is especially important to improve the success of project outcomes.

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.
- The 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.
- The technologies need to be user-friendly and designed, so it is easy to understand how they should be effectively constructed, operated and managed.

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.

4 Insufficient Financing

- Water and sanitation continue to suffer from severe underfunding. At a local level, the potential sources of finance are government, non-governmental organizations and others. You can try to make a difference firstly by understanding that these different potential sources of funds are and then working with your colleagues and others in the community to seek financial support.

Self check #6	Written test

Direction: - Choose the correct answer from the given alternatives

1. Water that is safe to drink

A) Potable **B)** Palatable **C)** Raw water **D)** None

2. The distance to the water source is more than 1 kilometer or more than a 30-minute round trip

A) Optimal access **B)** Basic access **C)** No access **D)** None

Note: Satisfactory rating 2 points unsatisfactory below 2 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____
Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

Information sheet #7	**Introducing Water associated diseases**

3.7 Water associated diseases

- **Several terms are used to describe the types of disease associated with water**.

1**. Water-borne 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 diarrheal diseases caused by bacteria and viruses, including cholera, typhoid and bacillary dysentery. They also include diseases caused by protozoa such as giardiasis, amoebic dysentery and cryptosporidiosis.

2. **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.

3. 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 helminthes (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 when they are infected with 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.

4. 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.
- Many million individuals in Ethiopia have to get their water from unsafe sources and this makes them vulnerable to waterborne disease.

5**. Chemical contamination of water:**

- 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.

Self check # 7	Written test

Direction: - Matching

"A"	"B"
1. Waterborne diseases	**A)** Onchocerciasis
2. Water-based diseases	**B)** Trachoma
3. Water-related diseases	**C)** Bacillary dysentery
4. Water-washed diseases	**D)** Schistosomiasis

Note: Satisfactory rating 4 points unsatisfactory below 4 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____

Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

3._____

4._____

Information sheet # 8	**Promoting Treatment of Drinking Water at Household and Community level**

3.8 Treatment of Drinking Water at Household and Community level

- The purpose of **water treatment** is to reduce or remove all contaminants whether biological, physical or chemical that is 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.**
- Suspended particles, bacteria, algae, viruses, fungi, minerals such as iron and manganese, and fertilizers are among the substances that are removed during water treatment. **Suspended particles** are a tiny 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 categorized as:-**
  - Small-scale water treatment system, which includes community and household treatment methods.
  - Large-scale water treatment system that might be found in towns and cities.

1. Small-scale water treatment systems

- **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 centralized treatment system.

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.
- 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.

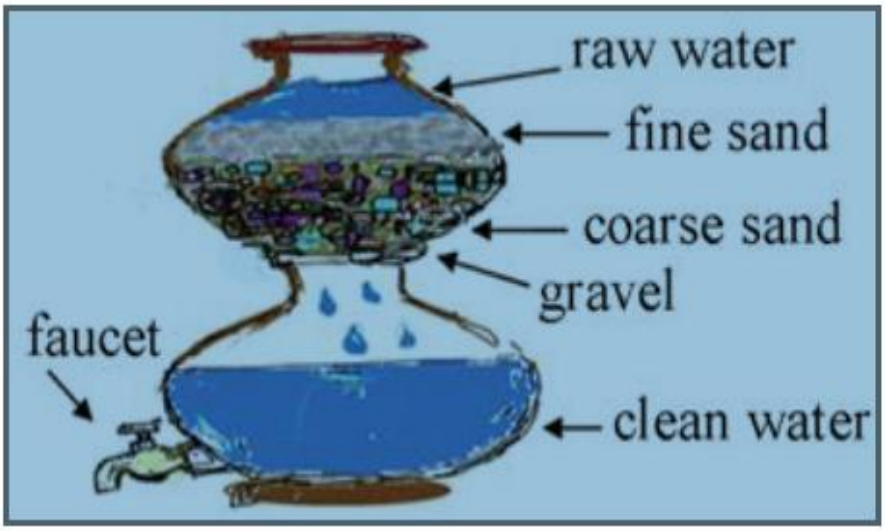

Figure 8.1: Household water filter using two clay pots placed on top of each other

2 .Cloth filtration

- Cloth filtration is a common water treatment technique that is easy to use and in expensive. Cloth filtration can be very effective against cholera, guinea worm (dracunculiasis) and other disease-causing agents.

- **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.

Figure 8.2: Cloth filtration

3 Other filtration methods

- Other filtration methods such as ceramic filters and bio sand filters are not currently widely used in Ethiopia but are also appropriate for household and community use.
- 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.
- Bio sand 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 bio sand filter is a concrete container about one meter in height and filled with sand.
- 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 bio sand 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.

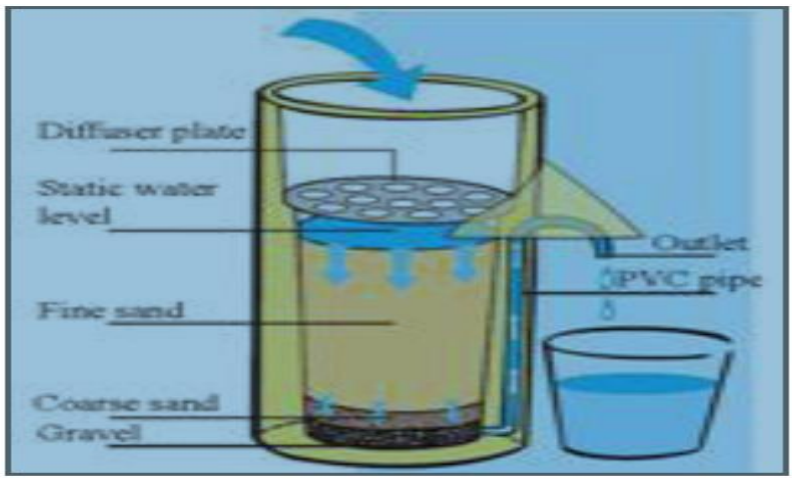

Figure 8.3:- Bio sand filter.

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.
- This simple technique requires only a few plastic bottles and sunlight. Firstly, collect several bottles (0.3 to 2.0 liters) 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). The water is now ready to drink.

❖ **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.

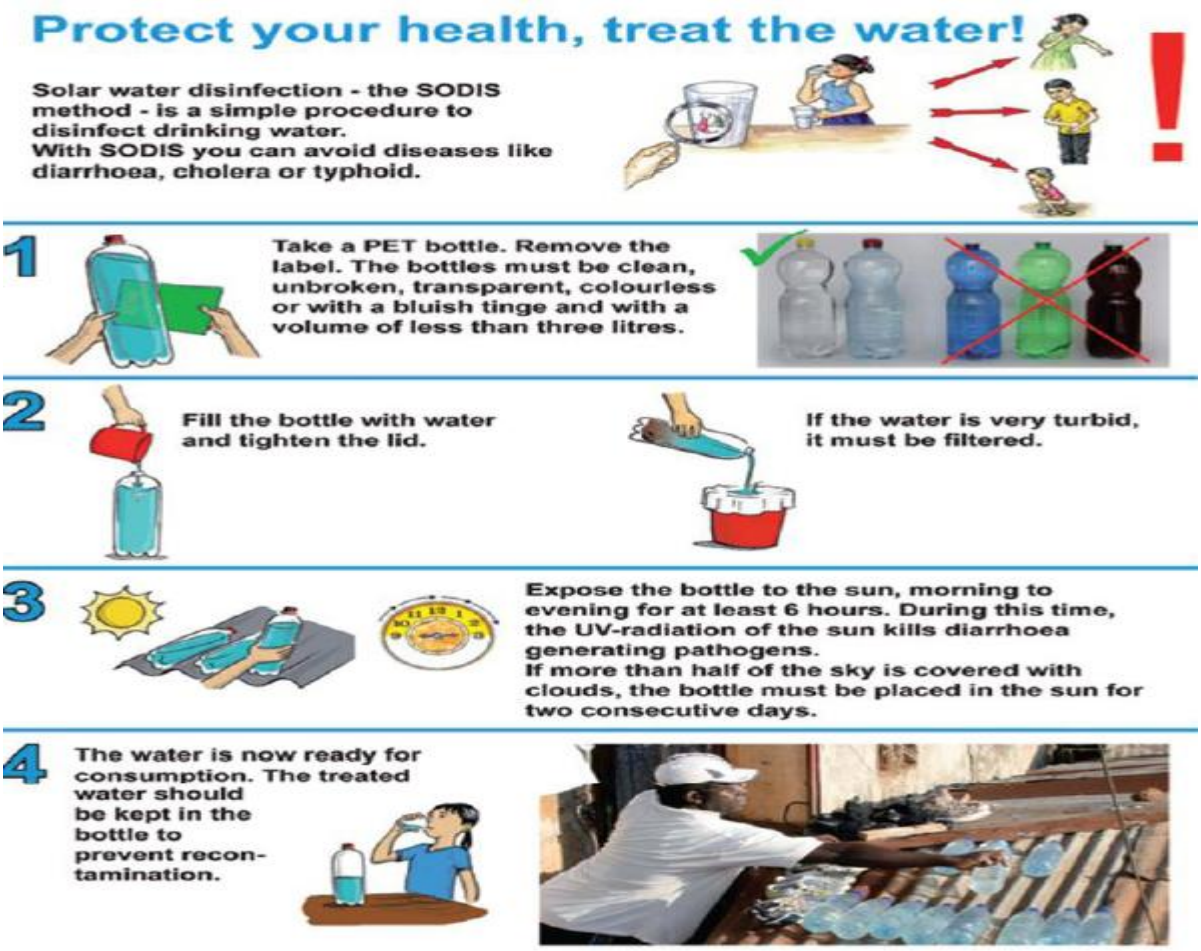

Figure 8.4: The SODIS method of water treatment.

5 Chemical disinfection methods

- There are several commercially available products designed for treating water at household level.

A. Chlorine solution

- 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.
- The procedure is to add a capful of chlorine solution to a 25 liter 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 or highly turbid.

B. Aqua tabs

- Aqua tabs are a specifically formulated and branded solid form of sodium dichloro iso cyanurate (NaDCC). NaDCC is stable in Aqua tabs form as a solid, which gives it a longer shelf life and makes storage, handling and transport much easier than with liquid bleach.
- One Aqua tab contains 67 mg of NaDCC and treats 20 litres of clear water. For visibly turbid water, two tablets per 20 liters are needed. It is very important to mix well and leave for 30 minutes contact time before consumption.

C. PUR

- PUR Purifier of Water'is the brand name of a combined flocculants and disinfectant product produced by Procter and Gamble. 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 8.5: Aqua tabs tablets for household Water treatment

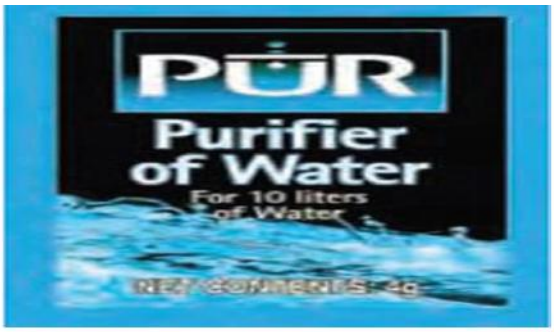

Figure 8.6: PUR Purifier of water.

D. "Wuha Agar"

- Wuha Agar is a chlorine-based water treatment solution that is used in Ethiopia . The procedure is very similar to other chemical treatment methods. For a 20 liters jerrycan, add one capful of Wuha Agar, cover and shake. After 30 minutes contact time, you can use it.

Figure 8.7: Wuha Agar for household water treatment

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.
- 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 decontaminated once it has cooled.

7. Safe Storage

- The 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.
- It is important to recognize 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.

Figure 6.8: Safe storage containers.

II. Large-scale Water Treatment System

- 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.

- **Large scale 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.

- **The main stages are usually**

1. Aeration

- 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.

2. Coagulation:

- Is the formation of particles in a liquid by adding chemicals? Its meaning is similar to flocculation.

- The flocculants 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.

3. 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.
- 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.)

4. 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.

5. 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.

6. 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.

Figure 6.9: Sedimentation tank at a municipal water treatment works.

- **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 liter (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 color will appear.
- The intensity of the color 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 objection to taste and odour
  - Some people have concerns about the potential long-term carcinogenic effects of chlorination byproducts.

Self check #8	Written test

Direction: - Choose the correct answer from the given alternatives

1. The water treatment chemical allows flocculation to take place.

A) Wuha Agar **B)** PUR **C)** Aqua tabs **D)** Chlorine solution

2. One of the following is the drawbacks of solar disinfection.

A) Requires relatively clear water. **C)** Limited volume of water can be treated.

B) The length of time required to treat it. **D)** All

Note: Satisfactory rating 2 points unsatisfactory below 2 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____
Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

Information sheet #9	**Promoting Community Drinking Water Source Protection**

3.9 Community Drinking Water Source Protection

3.9.1 Sources of Drinking Water

- The sources of drinking water that are practicable for public and domestic purposes are:-
  1. Rainwater
  2. Surface water (such as lakes, rivers, streams and ponds)
  3. Groundwater (e.g. springs wells and boreholes.)

1. Rain water

- Rainwater is reasonably clean and safe for drinking if properly collected from clean catchment (roof) surfaces.
- Rainwater is the main source of water domestic purposes in arid and semi arid areas like Somalia, afar, some areas of Wello and Borana where there are no alternative sources of water.
- Rainwater harvesting is simply means collecting, or harvesting, rainwater as it runs off from hard surfaces such as rooftops and storing it in a tank or cistern.
- Rainwater can be harvested in storage tanks (roof catchment), dams and ponds by surface catchment.
- The mean annual rainfall amount in mm, the catchment surface area, the water consumption amount, and the seasonal pattern of rainfall is necessary to design the required catchment and amount of water needed for the dry season when there is no rainfall.
- 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 9.1:- Rainwater is collected from the roof of this health centre and stored in a covered, Water tight.

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.

- It's likely to be polluted by industrial & municipal effluents affecting the water physical, biological and chemical characteristics. Contamination is most likely to be with microbiological pathogens from human and animal excreta.

- **Surface Water Sources of contaminants/pollutants**
  - 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.

Figure 9.2: A surface water source that is likely to be polluted.

3. Groundwater

- Ground water is that portion of the rainfall water which has percolated into the earth until it reaches an impermeable stratum‖. Therefore, Groundwater is water found beneath the ground surface held in the spaces within porous soil and 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 helminthes are filtered from the water as it passes through the layers of soil and rock into the groundwater.
- Ground water is likely to free from contamination and pollution; does not need treatment plants if properly protected (a protected well, spring); can be accessed for individuals where it is abundant Groundwater sources are therefore preferable to surface water sources.
- Groundwater can contain chemical contaminants, such as arsenic, fluorides and nitrates.

A. 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 percolate (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.
- A spring may vary in volume and contamination levels according to the amount of rainfall.
- 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.
- 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.

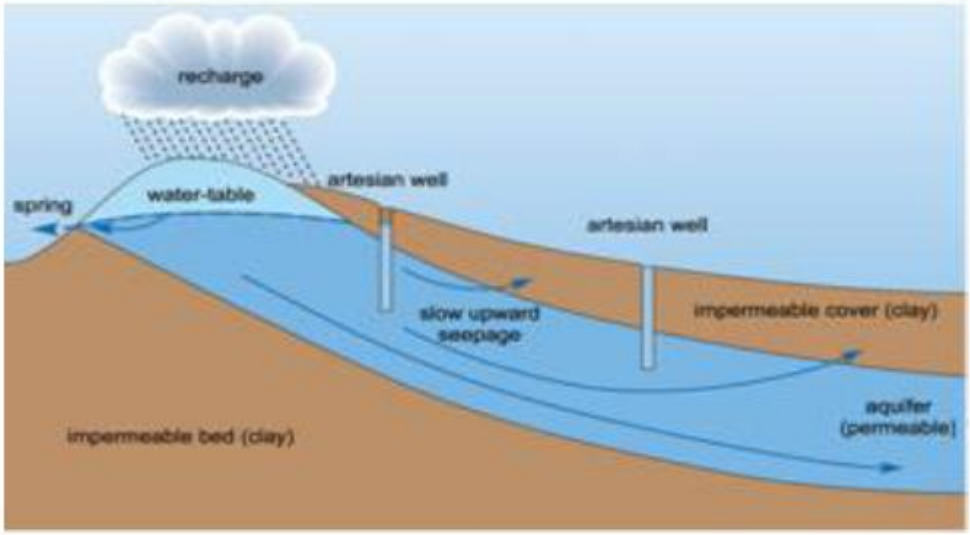

Figure 9.3: Diagram of groundwater formation with spring and artesian wells.

B. 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. It is less possibilities of contamination when we contrast with surface water sources. However it should be protected from external floods, use sanitary ropes and buckets and always fenced or covered with barrel covers

- **Wells are classified based on the depths of the water-bearing layers as follows:**

1. **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.

2. **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.

3. 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.
- 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.

- **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.
    - ✓ Waste water 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 colored, 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

3.9.2 Protection of Wells

- Before and during water source development care should be taken to minimize 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 meters and a distance of 30–50 m is recommended. However, for limestone and some other soil formations this distance need 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 meters.
- 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.
- 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 The area surrounding the well should be graded off i.e. should be sloped away from the well, in order to prevent the flow of storm water into the well.

Figure 9.4: Two wells with concrete protection.

3.9.3 Spring Water 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.
- 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. 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.
  - The surrounding area should be fenced to protect it from animals

Figure 9.5:- A protected spring, Note the concrete retention wall with two delivery pipes and the surrounding fence.

Self check # 9	**Written test**

Direction: - Choose the correct answer from the given alternatives

1. From the following which one are the key measures to control spring pollution

A) Dig a diversion ditch above the spring **C)** Build a fence to keep animals away from the spring.

B) Design and build a protection box **D)** All

2. Water found beneath the ground surface held in the spaces within porous soil and rock.

A) Groundwater **B)** Surface water **C)** Rainwater **D)** lakes

Note: Satisfactory rating 2 points unsatisfactory below 2 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____
Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

2._____

Information sheet # 10	**Introducing Water pollution and its Control**

3.10. Water pollution and its Control

3.10.1 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. 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, fertilizer 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 10.1:- Washing Lorries and cars in rivers is a source of water pollution.

3.10.2 Types of Water Pollutants

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.
- 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
- This can lead to anaerobic conditions which may create unsightly conditions and cause unpleasant odours.

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 fertilizer.
- Nitrogen and phosphorus are plant nutrients required by plants to grow. They are spread on farmland in the form of fertilizers.
- 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.

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 minimize 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 coli form 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 who 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.
- **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.

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 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.

- **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 fertilizers.
  - Animal wastes require oxygen to be broken down in water bodies and can also harbor pathogenic organisms.
  - The extensive use of fertilizers and pesticides in agricultural regions means that both surface and groundwater are affected by these pollutants.

3.10.3. Public Health Importance 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.

3.10.4 Indicators of water pollution

- The physical, chemical and biological characteristics of water are changed when the water is contaminated with different pollutants.
- Water is colorless, odorless and tasteless, as you know, but when it is polluted with physical and chemical pollutants the water may have color, odor and taste.
- To know whether water is polluted with specific bacterial contaminants; samples should be taken and sent to a laboratory for analysis.
- 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 essential is to get from 'bad' quality (more than 1,000 faecal coliforms per 100 ml) to 'moderate' quality (less than 10 faecal coli forms per 100 ml). 'Good' quality is classed as zero faecal coli forms per 100ml.

3.10.5 Prevention and 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 fertilizers. Farmers may need guidance on good agricultural practices that will help reduce water pollution from agriculture.
- For example, the amount of fertilizer used and the timing of its application can make a significant difference.
- 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.
- 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.

❖ **Key preventive measures that will help to ensure that spring water is of a consistently high quality?**

- 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.
- 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.

▪ **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 sterilized. Bottles should be clearly labeled 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.

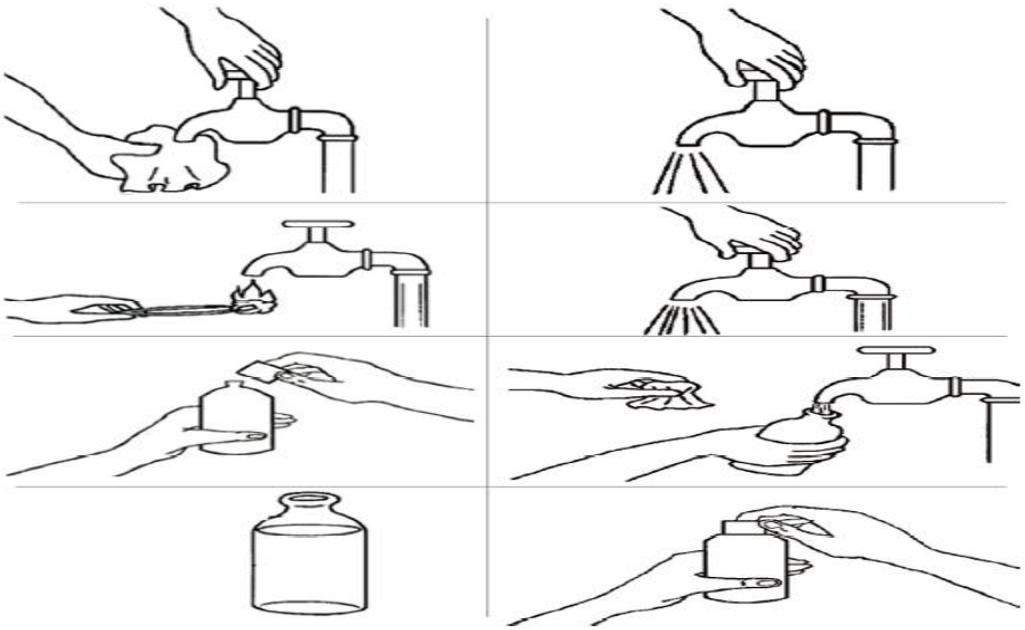

Figure 10.2: Procedures for sampling water from a tap.

Self check #10	Written test

Direction: say “True” or “False”

1. Take water samples & sent to the laboratory for bacteriological analysis.

Note: satisfactory rating 1 point unsatisfactory below 1 point

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score _____

Rating _____

Name: _____ Date: _____

Short Answer Question

1._____

Operation Sheet #1	Performing hand washing

Steps for water sampling

1. Clean the tap/outlet using a clean cloth to remove any dirt.
2. Open the tap and turn on at maximum flow and let the water run for 1 to 2 minutes; then turn it off.
3. Sterilize the tap for a minute with the flame from a cigarette lighter, or an ignited alcohol-soaked cotton-wool swab.
4. Open the tap again and allow the water to flow for 1 to 2 minutes at medium flow rate.
5. Open a sterilized bottle by carefully unscrewing the cap or pulling out the stopper.
6. Immediately hold the bottle under the water jet and fill.
7. While filling the bottle, hold the cap face downwards to prevent entry of dust, which may contaminate the sample.
8. Place the stopper in the bottle or screw on the cap. A small air space should be left to make shaking before analysis easier.

LAP Test	Practical Demonstration

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 5min.

Task 1: Perform water sampling

Reference

1. Ryan, B.A. and Mara, D.D. Pit Latrine Ventilation: Field Investigation Methodology. TAG Technical Note No. 4, UNDP and World Bank contribution to the International Drinking Water Supply and Sanitation Decade, Washington, 1983.
2. Ryan, B.A. and Mara, D D. Ventilated Improved Pit Latrines: Vent Pipe Design Guidelines. TAG Technical Note No. 6, UNDP and World Bank contribution to the International Drinking Water Supply and Sanitation Decade, Washington, 1983