Chapter 7

Environmental Sanitation

Introduction

In the past, sanitation was centred on the sanitary disposal of human excreta. Now, the term sanitation covers the whole field of controlling the environment with a view to prevent disease and promote health. Poor hygiene, inadequate quantities and quality of drinking water, and lack of sanitation facilities cause millions of the world's poorest people to die from preventable diseases each year. Women and children are the main victims.

This chapter deals with the essentials of sanitation, importance of proper disposal of human faeces, faeco-oral transmission of diseases, hygiene education, disposal of solid & liquid wastes, and disposal of biomedical waste.

Objectives

After reading this chapter you will be able to:

- Define environmental sanitation
- List the essential components of environmental sanitation
- Understand the links between sanitation and health
- Explain faeco-oral transmission of diseases
- State the importance of proper disposal of human faeces
- Mention various issues related to hygiene education
- Describe methods of disposal of solid and liquid wastes
- Explain methods of disposal of biomedical waste

7.1 Essentials of Sanitation

Sanitation is a general term which comprises all phases of programme for improving environment and health. Specifically, sanitation is intended to **prevent diseases by creating favourable conditions to promote health**.

The term "**sanitation**" can be applied to specific aspects/concepts/ locations or strategies, such as:

- **Basic sanitation** - refers to the management of human faeces at the household level.
- **On-site sanitation** - the collection and treatment of wastes is done where it is deposited. Examples are the use of pit latrines and septic tanks.
- **Food sanitation** - refers to the hygienic measures for ensuring food safety.
- **Environmental sanitation** - the control of environmental factors that form links in disease transmission. Subsets of this category are solid waste management, water and wastewater treatment, industrial waste treatment and noise and pollution control.

Definition of Sanitation

WHO and UNICEF define 'environmental sanitation' as "the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect in his physical development, health and survival".

Sanitation in fact is "the science of safeguarding health". National Sanitation Foundation of the U.S.A. says that sanitation is "a way of life". It is the quality of living that is expressed in a clean home, a clean farm, a clean business, a clean neighbourhood and a clean community. Being a way of life, it must come from within the people; it is nourished by knowledge and grows as an obligation and an ideal in human relations".

Man has controlled a number of factors in his environment, e.g., food, water, housing, clothing, sanitation. It is the control of these factors that has been responsible for considerable improvement in the health of the people in the developed countries during the twentieth century.

Essential Components of Environmental Sanitation

According to UNICEF and WHO, Environmental Sanitation includes seven elements:

(i) Handling of drinking water

(ii) Disposal of waste water

(iii) Disposal of human excreta

(iv) Disposal of solid wastes and cattle dung

(v) Home sanitation and food hygiene

(vi) Personal hygiene

(vii) Village sanitation.

The Links between Sanitation and Health

Water, sanitation and health are linked in many ways:

- Contaminated water that is consumed may result in **water-borne diseases** (viral hepatitis, typhoid, cholera, dysentery and other diseases that cause diarrhoea).
- Without adequate quantities of water for personal hygiene, **skin and eye infections** (e.g. scabies, pyoderma, conjunctivitis, trachoma etc.) spread easily.
- **Water-based diseases** and **water-related vector-borne diseases** can result from water supply projects (including dams and irrigation structures). The water projects inadvertently **provide habitat for mosquitoes** that are intermediate hosts for parasites (e.g. malaria, filariasis and Japanese encephalitis).
- Water containing **high amounts of chemicals** (e. g. fluorides, arsenic, nitrates, etc.) can cause serious disease.
- **Improvements in water quality and quantity** can reduce childhood diarrhoea by 15 to 20%. Greater reductions can be produced through **safer excreta disposal** (36%) and **hand-washing** (35-42%).
- **Poor hygiene practice**, particularly involving food and hands, may be a major cause of disease transmission, even where appropriate excreta disposal facilities are in place.

Water and Sanitation (WatSan) is one of the primary drivers of 'public health' (health of people at large). Their availability to people would prevent sickness. The disease burden on our society is very high because of lack of safe water and sanitation.

The following losses occur, consequent to sickness:

- Loss of wages due to loss of working hours/days,
- Cost of the medicines & medical services,
- Loss of opportunity during the period of illness, and
- Loss of good nutritional status, which costs lot of money to regain.

We need to **encourage people to calculate these costs**. Suffering from sanitation related diseases is not acceptable. Especially since **these disease are preventable** through very simple, inexpensive and affordable technologies.

People have money to buy tobacco. But many of them say **that they can't afford to buy soap for washing hands**. Should we believe them? By not having a latrine at home and by refusing to use soap for washing hands, they are not only neglecting their own health, but **also endangering other's health in the society**.

Once we ensure access to clean water and to adequate sanitation facilities for all people, **a huge battle against all kinds of diseases will be won**. We cannot actually defeat diseases like AIDS, tuberculosis, malaria, or other infectious diseases, until we have won the **battle for safe drinking water and sanitation**.

There are some population groups which are particularly susceptible to **Faeco Oral (F.O.) Diseases**. We should pay particular attention in preventing these diseases among these people. Such **special risk groups include**:

- **Children under five years of age** are most at risk from communicable diseases since their immune systems have not developed fully. **Malnutrition** resulting from food insecurity and chronic emergencies increases this risk further.
- **Severely malnourished children and adults** are at increased risk from diarrhoeal disease.
- **Elderly people**, especially if exhausted after travelling considerable distances.

7.2 Diseases related to Sanitation

Some of the diseases that are related to water, sanitation and hygiene are given below:

Diarrhoea:

- 1.8 million people die every year from diarrhoeal diseases; 90% are children under the age of five, mostly in developing countries.
- 88% of diarrhoeal disease is attributed to unsafe water supply, inadequate sanitation and hygiene.
- Improved water supply reduces diarrhoea morbidity by 6% to 25%, if severe outcomes are included.
- Improved sanitation reduces diarrhoea morbidity by 32%.
- Hygiene interventions (including hygiene education and promotion of hand washing) can lead to a reduction of diarrhoeal cases by up to 45%.

Malaria:

- 1.3 million people die of malaria each year, 90% of whom are children under 5.
- There are 396 million episodes of malaria every year in the world.
- Intensified irrigation, dams and other **water related projects** contribute importantly to this disease burden.
- **Better management of water resources** reduces transmission of malaria and other vector-borne diseases.

Trachoma and conjunctivitis:

- Improving access to safe water sources and better hygiene practices can reduce trachoma morbidity by 27%, which can cause blindness, if not properly treated.
- **Conjunctivitis** causes redness, itchiness, swelling of the eyelids. Many children get this painful but not serious sickness..
- These diseases spread more in the crowded places. Lack of good face washing, hand washing and hygiene also contributes to their spread.

Intestinal helminths (e.g. ascariasis, trichriasis, hook worms etc.)

- 133 million people suffer from high intensity intestinal helminths infections which often lead to severe consequences such as cognitive impairment, massive dysentery, or anaemia.
- These diseases cause around 9400 deaths every year.
- Access to safe water and sanitation facilities and better hygiene practice can reduce morbidity from ascariasis by 29% and hookworm by 4%.

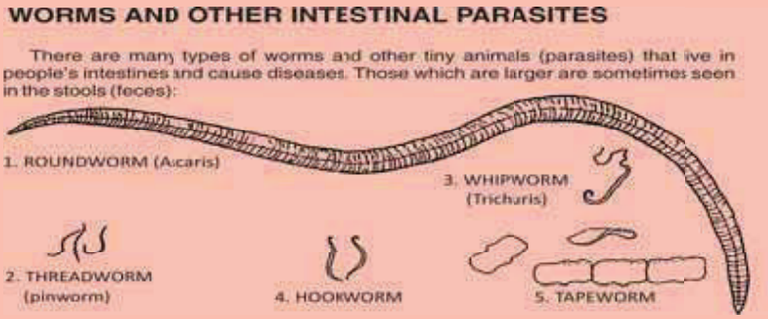

Fig: *Intestinal parasites which are spread by faecal contamination.*

Japanese encephalitis:

- 20% of clinical cases of Japanese encephalitis die, and 35% suffer permanent brain damage.
- Improved management for irrigation of water resources reduces transmission of disease.

Environmental classification of excreta related diseases is given in the box below. It divides all these diseases into seven groups.

Environmental classification of excreta related diseases

1. **Non-bacterial faeco-oral diseases** (viral and protozoal)

   (Rota virus, hepatitis virus, giardiasis, etc.)

2. **Bacterial faeco-oral diseases** amoebiasis,

   (Typhoid or salmanellosis; shiegellosis, etc.)

Helminthic (worm) diseases:

3. Geo-helminthiases (life-cycle is related to the soil)

   (Ascaris, trichuris and hookworms)

4. Taeniases (tape worm disease)

   (Beef and pork tapeworms)

5. Water-based heminthiases (these are more in Africa)

   (Schistosoma, Clonorchis and fasciolopsis).

(The above categories are excreted infections, means the disease agent is excreted in faeces by the host).

Vector diseases:

6. Excreta-related insect vector diseases

   (e.g. filaria)

7. Excreta-related rodent vector diseases (e.g. lepto-spirosis).

Some Food-Borne Micro-organisms

- **Salmonellosis** is a major problem in most countries. Salmonellosis is caused by the Salmonella bacteria. Symptoms are fever, headache, nausea, vomiting, abdominal pain and diarrhoea. Examples of foods involved in outbreaks of salmonellosis are eggs, poultry and other meats, raw milk and chocolate.

- **Campylobacteriosis** is a widespread infection. It is caused by certain species of Campylobacter bacteria. Foodborne cases are mainly caused by foods such as raw milk, raw or undercooked poultry and drinking water. Acute health effects include severe abdominal pain, fever, nausea and diarrhoea.

- Infections due to **Entero-haemorrhagic E. coli** (e.g. **E.coli-O157** and **Listeriosis**) have become important foodborne diseases. Although their incidence is relatively low, they have their severe and sometimes fatal (particularly among infants, children and the elderly).

- **Cholera** is a major public health problem in developing countries, also causing enormous economic losses. The disease is caused by the bacterium **Vibrio cholerae**. In addition to water, contaminated foods can be the vehicle of infection. Different foods (including rice, vegetables, millet gruel and various types of seafood) have been implicated in outbreaks of cholera. Symptoms, including abdominal pain, vomiting and profuse watery diarrhoea, may lead to severe dehydration and possibly death (unless fluid and salt are replaced).

The UN organisation UNICEF is working around the world to improve water supplies and sanitation facilities in schools and communities, and to promote safe hygiene practices. UNICEF uses a **human rights based approach** and works in partnership with communities – especially women and children – in planning, implementing and maintaining water and sanitation systems. UNICEF works with government and other partners to create conditions for change – or enabling environments – to ensure the effectiveness and sustainability of all **Water, Sanitation and Hygiene (WASH) Programmes**. **WASH programmes** are designed to contribute to the Millennium Development Goal (MDG) for water and sanitation: to halve, by 2015, the proportion of people without sustainable access to safe water and basic sanitation.

7.3 Human faeces: Importance of Proper Disposal

Due to availability of water, food and warmth, **micro-organisms live in our intestines** (especially in large intestine). So, a human excreta always contains large numbers of germs. Some of them may cause diarrhoea and other faeco oral (F.O.) diseases. When somebody becomes infected with faeco-oral diseases (E.g. cholera, typhoid and hepatitis A) their excreta will contain large amounts of the germs.

Excreta-related communicable diseases include cholera, typhoid, dysentery (including shigellosis), diarrhoea, hookworm, roundworms, poliomyelitis and hepatitis. The likelihood of all these diseases (especially epidemics such as cholera and hepatitis) increases significantly when a population is displaced or affected by a disaster.

Transmission of excreta-related diseases is largely faecal-oral. Hook worm disease spreads through penetration of the host's skin at his/her feet.

The disease agents (bacteria, viruses and parasites) that cause these diseases, cannot be seen, as they are too small to be seen (our eye cannot see anything less than 0.2 m.m. in size). These agents get into humans through the mouth or skin; and are passed out in excreta. They can be passed from one person to another because of unclean hygiene practices.

Unsafe disposal of human faeces can lead to the transmission of faeco-oral disease, can result in:

1. the contamination of the ground and water sources,
2. can provide breeding sites for flies (which may carry infection).
3. faeces may attract domestic animals and vermin (which spread the potential for disease).
4. create an unpleasant environment in terms of odour and sight.

7.4 Faeco-oral Transmission of Diseases (Five Fs)

There are five routes (shown in the figure below) through which disease causing biological agents **('pathogens')** are transmitted from **faeces of the infected person** to the mouths of **new hosts**. They are

1. Fluids (Water)
2. Foods (Eatables/snacks/vegetables/fruits)
3. Flies (House flies)

4. Fingers (of human beings), and

5. Fields (Soil).

This transmission has to be stopped by achieving a **"Sanitation Barrier"** between the infected person's faeces and the possible new hosts (human beings).

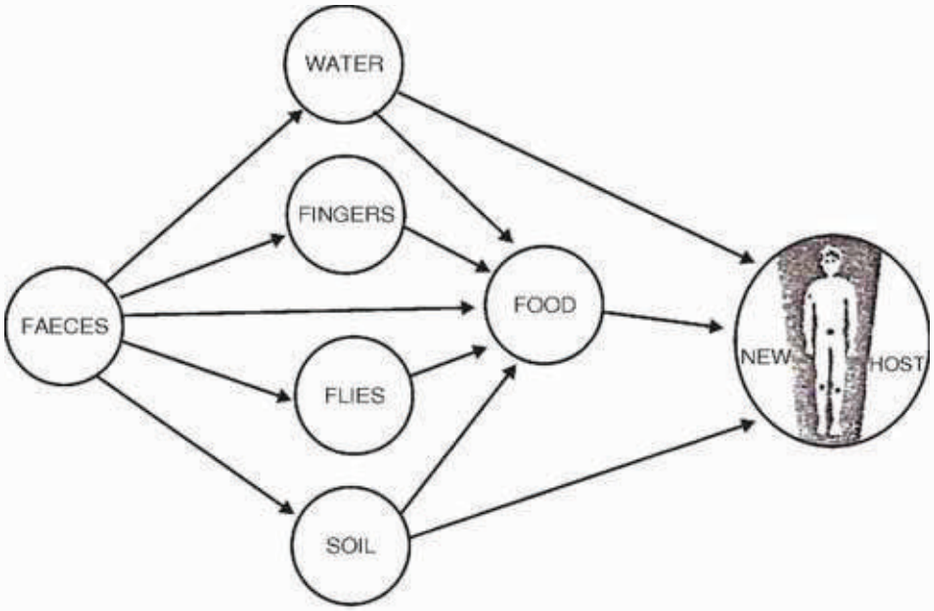

Fig: Five routes of transmission *of faeco-oral diseases.*

1. The Fluids

During the rainy season, the faeces that have been excreted by the people in open fields may be washed away by rain-water. This water can run into wells and streams. The germs in the excreta will then contaminate the water. Such water, if used by people for drinking or cooking can lead to infections.

Water gets contaminated with pathogenic microorganisms through intestinal discharges of man and animals. Furthermore, in the intestinal tract of man and animals, there exists a characteristic group of organisms designated as coliforms.

The coliform group of bacteria includes aerobic and facultatively anaerobic, gram negative, nonspore forming bacilli which ferment lactose with acid and produce gas within 48 hours at, 35°C. The most common species of this group are various strains of **Escherichia coli** and **Aerobacter aerogenes**.

E. coli is commonly found in the intestinal tract of man and animals, while **A. aerogenes** is normally found on plants and grains, and may sometimes occur in the intestinal tract of man and animals. Contamination of water with either type makes the water unsatisfactory for drinking purposes.

Faeco-oral diseases transmitted by **contaminated water** include cholera, typhoid, hepatitis-A and many diarrhoea1 diseases. These diseases may also be spread by other means. But the **quality of public water supplies** is particularly important in controlling them. So, we monitor water quality by testing for **indicators of faecal contamination** such as **thermo-tolerant (faecal) coliforms**.

2. The Fingers

A person with **unwashed hands** who touches food will make it dirty. Microbes can spread when people handle raw meat and then don't wash their hands before touching cooked food.

The untrained food handlers that make and serve us the food, do not even know that washing hands with soap is necessary (leave alone actually following it scrupulously). They pass the F-O Diseases! They may make a tasty food at very reasonable cost, but **would offer us the diseases too with it free of cost**!

3. The Foods

Many raw foods, most notably poultry, meats, eggs and unpasteurized milk, may be contaminated with disease causing organisms. Thorough cooking usually kills the pathogens.

Eating on road side can lead to food poisoning. We should be conscious that often the food we may be tempted to eat on the road side can lead to disease burden on us. It is better to avoid eating from cooked food outlets as they may not be maintaining good food hygiene; we may eat some bananas to quench our hunger; or eat some hygienically packed factory made food (e.g. biscuits). But, of course, we have to **clean our hands before eating** such safe food. Otherwise, our own dirty hands can contaminate the food we eat outside our homes!

4. The Flies

Flies often feed on human faeces. They carry faeces and microbes on their feet to wherever they next land. Just one fly crawling over a plate of food can be enough to spread diarrhoea to the people who eat the food.

When the flies touch our food, the excreta and the germs in the excreta are passed onto the food, which may later be eaten by another person. Some germs can grow on food and in a few hours their numbers can increase very quickly. Where there are germs there is always a risk of disease.

5. The Fields

Many common diseases that can give diarrhoea can spread from one person to another when people defecate in the open fields.

Fig: *Contamination of soil by open field defaecation.*

Open field defaecation leads to hookworm infestation, especially in the slums and rural areas. Many farmers have **wrong notion that human faeces is good manure**. Actually it is the human urine which has more urea that is nutritious for the plants. Human faeces hardly have any nutrients in them which are useful for the plants. Faeces actually become

manure only after **putrefaction, which can occur over 3 to 6 months**, (if the farmer passes it into the pit of a sanitary latrine). **If we defecate in agricultural field, we are actually polluting the farm land** with all the pathogens (bacteria, viruses and eggs of parasites). **Farmers should not allow people to defecate in their farms**. If they allow, they can get hook worm infection, when they work in their own farm!

We have to always keep these in mind and ensure that these five routes of transmission of faeco-oral disease are blocked to protect ourselves from these disease.

We can greatly **reduce the spread of faeco-oral diseases:**

- By disposing of human excreta safely in sanitary latrines
- By isolating excreta from flies and other insects, and
- By preventing faecal contamination of water supplies.
- **By proper personal hygiene** (particularly washing hands after defecation and before eating and cooking).

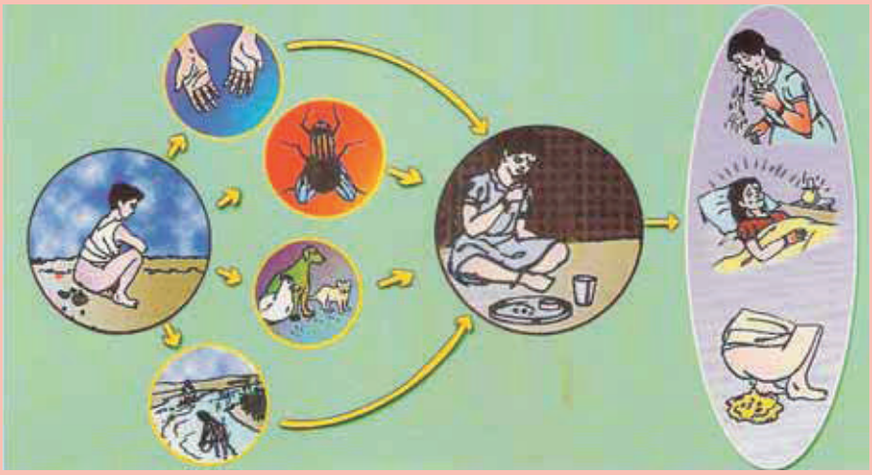

Fig: *How excreted infections spread through the five Fs.*

Excreted infections are those pathogens that are present in the excreta of the person. It causes diseases in another person. Such excreted infections include **a wide variety of:**

-Viruses -Bacteria

-Protozoa -Helminths worm

The **importance of excreta disposal** cannot be overestimated. Diseases transmitted via the faeco-oral route, such as diarrhoea, have been shown to account for **40% of all childhood deaths**.

7.5 Breaking Faeco-oral Transmission of Diseases

Pathogens from faeces can be prevented from reaching the five Fs by obtaining a **Sanitation barrier**. This barrier has to be ensured for controlling faeco-oral transmission of diseases.

Good sanitation practices bring about a sanitation barrier between one person's faeces and another person's mouth.

The main components of this sanitation barrier are:

1. Sanitary latrine, and
2. Hand-washing with soap.

If this sanitation barrier is achieved, much of India's disease burden could be reduced. This leads to tremendous socio-economic gains to individuals, families and the community.

1. **Use of Sanitary Latrines**

Only about 48 % of the rural population in India has access to toilets and sanitation services. The **Millennium Development Goal** target to reduce by half the proportion of people without access to basic sanitation, such as simple latrines, by 2015.

When people do not have basic sanitation, their children pay the price in lost lives, missed schooling, in disease, malnutrition and poverty.

Schools with decent toilet facilities enable children (especially girls reaching puberty) to remain in the educational system. Clean, safe and dignified toilet and **hand-washing facilities in schools** help ensure that girls get the education they need and deserve. When girls get an education, the whole community benefits.

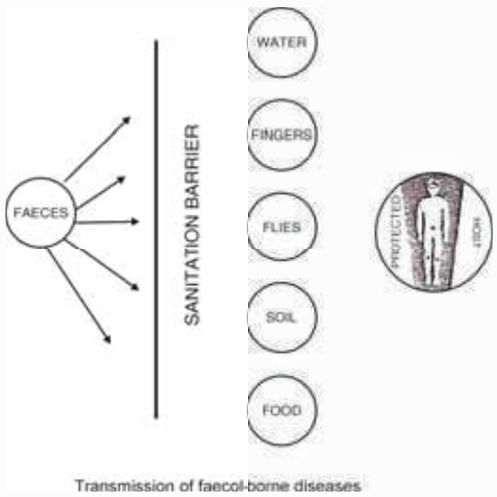

Fig: *Pathogens from faeces can be prevented from reaching the five Fs by obtaining a* ***Sanitation barrier****. This barrier can be achieved by just two things: 1) Sanitary Latrine and 2) Hand washing with soap.*

2. Hand Washing with soap

This has been covered in chapter 6 of this book.

7.6 Hygiene Education

Water taps and toilets are only as safe as the ways people use them. So, hygiene education is an integral part of WatSan (water & sanitation) projects.

If communities do not understand how water becomes polluted, their practices can easily contaminate their water. **Simply washing hands with soap and water can reduce diarrheal diseases by over 40 percent**.

Fig: *Children learning good hygiene practices through a card.*

Our messages are straightforward. But changing longstanding practices of people is a challenge. So, we have to continually use innovative approaches to alter the unsafe behaviour of the people.

It is necessary to bring about a **sanitation revolution in India** because of the following reasons:

- India has a very heavy burden of disease on the society.
- Just by increasing sanitation and hygiene, **80% of the disease burden** on the society (especially in the rural areas) can be reduced.
- It can bring down the mortality rate among children below the age of five years (U5MR).
- It would be possible to **raise the standard of living** of the people in the country.

To prevent **faeco-oral transmission of infections**, we need three safe things: **safe water, safe food and safe environment**. The above three things can be achieved through the following:

- Sanitary latrines

- Sanitary land fillings
- Soakage pits
- Hand-washing with soap on regular basis
- Abolishing open defecation
- Controlling public spitting.

Hygiene education can be imparted through public awareness campaigns, household discussions, demonstrations, radio programs, plays and puppet shows, picture books, games, posters, and videos. All these should encourage people to:

- wash their hands, faces, bodies, and clothes,
- safely dispose of faeces, refuse, and wastewater,
- prepare and store food properly,
- protect their water supply and store water safely, and
- Carefully maintain their toilet facilities.

It is not easy to change people's hygiene related behaviours. Some of the reasons for this are given below.

- **These need be done every day–** Hygiene behaviours such as cleaning children and washing hands have to be done every day. So, they will be more difficult to promote than a behaviour such as immunization that only has to be done a few times in a life time.
- They need **spending time or money–** e.g. buying soap and nail cutter, collecting enough water for repeated hand washing.
- They may not be simple to carry out and also they may require **learning new skills–** e.g. washing hands with soap properly, keeping the latrine clean.
- They may be **in conflict with existing/traditional practices–** e.g. stopping to go for open field defecation in the village, along with friends.
- Whole community does that and just some individuals – e.g. open field defecation in the village.
- They may be long standing habits, and so are not be easy to change.

Education for environmental sanitation should focus on the following:

- Women, teachers, leaders, and school children should be the **first target** for such a program. Community participation is a very effective key to the success of sanitation projects.
- Health education and sensitization are a prerequisite to people's participation. But we should recognize that it takes time to convince the communities.
- Particular attention must be given to the maintenance and cleanliness of the latrines serving community (e.g. health centres, markets.

School health programs offer a good entry point for community hygiene promotion. Local school children and college students can be involved in preparing educational posters and notices for public places.

Fig: *A hygiene promotion procession organised by school authorities.*

Sanitation in public places

Where a large number of people are using one area (e.x. a bus station/ school), especially when they are eating food from the same source, there is a greater risk of the spread of F.O. diseases. All **public places** need to have adequate sanitation and hygiene facilities.

Educate about ill-effects of public spitting:

About 4 persons in every 1,000 population of India (0.4% of the population of both urban and rural population) now is carrying tuberculosis bacilli in their sputum **('sputum carriers of TB')**. They are throwing these rod shaped bacteria in to our society. They eventually reach people's respiratory tracts through the dust. These bacilli do not die easily. Also they carry other respiratory infections.

So, we should not indiscriminately spit around openly.

Let us avoid the **"take it easy policy" on hygiene**: It is the "take it easy policy" of the ordinary Indian which is keeping us in **conditions of poor sanitation**. We should resist the people that pollute our land, air and food and **work steadily towards improving their unhygienic and insanitary habits**. We should do it at least in our own work environment, that is the hospital where we work!

Let us deal with **hygiene education issues** under the following heads:-

1. Hand hygiene
2. Latrine hygiene
3. Water hygiene
4. Food hygiene
5. Hospital hygiene

1. Hand Hygiene

Please refer to chapter 6 for hand hygiene.

2. Latrine Hygiene

There are several basic rules for **sanitation in public places**:

- There should be sufficient **toilet facilities** for the maximum number of people using the area during the day. This normally means **one toilet compartment for every 25 users**. The toilet facilities should be arranged in **separate blocks** for men and women. The men's toilet block should have **urinals and toilet compartments**; the women's block, toilet compartments only.
- **Toilet facilities** should not be connected directly to kitchens. This is in order to reduce the **number of flies entering the kitchen** and to reduce odours reaching the kitchen. It is important that people using the toilet facilities **cannot pass directly through the kitchen**.
- There must be a **hand washing basin** with clean water and soap close to the toilet facilities. There should be separate, similar facilities **near to kitchens** or where food is handled.
- There must be a **reliable water supply** for the purposes of **hand washing**, personal hygiene and flushing of toilet facilities.
- **Refuse** must be disposed of properly and not allowed to build up, as it will attract flies and vermin.

- We have to **ensure that latrines can be used at nights also**. For this to be achieved, latrines have to be **safe for women & children**. Good lighting is essential in the latrines.

Responsibilities for cleaning public facilities should be very clearly defined. Dirty facilities make it more likely that people will not use the facilities properly. Or they will not use at all. Clean facilities set a good example to users.

India's national sanitation programme, the **Total Sanitation Campaign** (TSC), is operational in most of the districts now.

Promoting adoption of sanitary latrines:

We can **promote adoption of sanitary latrines** in the community by doing the following:

- Analyse the causes behind why the people are not having latrines.
- Understand the community preferences about the latrines (e.g. Toilet attached to bed room/toilet in the backyard).
- Discuss the inconveniences they face due to lack of toilets. Discuss the problems and constraints they envisage to face, in case they decide to construct toilets.
- Discuss about the availability of services of trained mason and technological options available to them.
- Give information on different low-cost options available to them (e.g. water seal latrine/VIP latrine). Explain how they can up-grade the facilities already available with them.

Tell that sanitary latrines enhance women's dignity and safety: Lack of toilets makes women and girls vulnerable to violence (if they are forced to defecate only after nightfall and in secluded areas). Sanitary latrine enhances dignity, privacy and safety, especially for women and girls.

3. Water Hygiene

The quantity and quality of the water that we drink is directly linked to health. If the water is contaminated with **germs or chemicals**, health will be affected. **Outbreaks of diseases** transmitted by water have a major impact on human health.

Ample quantity of clean and safe water is essential in controlling WatSan related infections. We have to help **people in rural areas** dig or drill wells that tap groundwater, build gravity-

flow systems that convey water from upland streams and springs, and collect and store rainwater. In crowded cities, we also help connect **slum communities** to municipal water sources.

Fig: *Water supply of ample quality and quantity contributes to health, through improving sanitation & hygiene.*

The human right to water entitles everyone to sufficient and safe water of acceptable quality for personal and domestic uses.

Purification of water by Slow Sand Filtration Plant:

Slow Sand Filtration Plant requires considerable area because the rate of filtration of water in this is slow. A concrete floor (with drainage tiles) to collect the filtered water is constructed. The tile is covered with coarse gravel, fine gravel, coarse sand and finally 2 to 1 feet of sand at the top. Water from the top seeps through the filter slowly. It is collected by tile drain pipes at the bottom, and is pumped into a reservoir.

At best five million gallons of water per acre, per day, can be filtered. Slow sand filters are clogged by turbid water. Water to be filtered is, therefore, clarified by sedimentation with or without coagulation.

The purification of water is accomplished not by the screening action of the sand for the spaces arc much too large, but by a different principle. A **colloidal, flocculent material** (composed of bacteria, algae, and protozoa) accumulates in the surface layers of fine sand. This slimy, gelatinous film closes up the pores between the sand grains and makes the filter bed more and more effective. Since bacteria have a negative electrical charge and colloidal material on the sand grains has a. positive charge, bacteria are thus adsorbed on the particles.

Bacteria are also ingested by Protozoa. They live in the upper layer of the film. Metabolic activity of microorganisms also greatly reduces the chemical content of the water. When, the gelatinous film finally become too thick, the efficiency of the filter gradually decreases. The filter is taken out of service and the surface layer is removed.

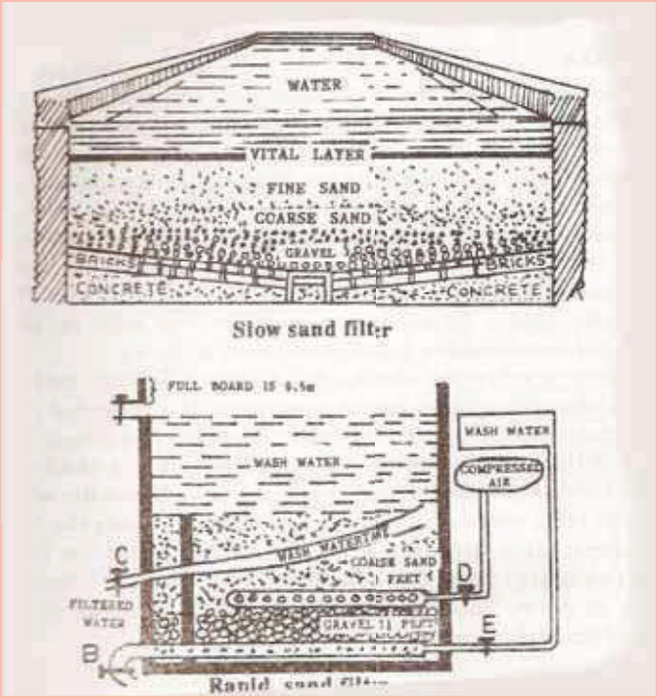

***Fig: Slow and rapid sand filters**. These sand filter plants are efficient in purification of water; and are suitable for urban areas.*

Effectiveness of water supply, sanitation and hygiene interventions:

Constructing drinking water supply facilities is necessary. But that is not enough to improve health. Sanitation and hygiene promotion must also be done. Most endemic diarrhoea is not water-borne. It is transmitted from person to person by poor **hygiene practices**.

Improved hygiene (eg: hand washing) and sanitation (eg: latrines) are more important than drinking water quality for improvement of health conditions. These can substantially reduce in diarrhoea and parasitic infections; and contribute to reduction of childhood morbidity and mortality.

If we ensure that **good quantity of water** is available to people, they can wash their hands and utensils well. Because they wash their hands and utensils well, they can maintain the hygiene of their drinking water hygiene well in the family. So, improving the **'quantity of water'** will automatically improve the **'quality of water'**!

Proper storage of water at home:

Key factors in the provision of **safe household water** include:

- the conditions and practices of water collection and storage, and
- the choice of water collection and storage containers or vessels.

Water can easily get contaminated during **household storage**. The risk is especially high where all members of a family/ community do not practice good hygiene.

Water stored in the home may become contaminated during handling if it is not stored and protected properly. So even if water is purified or collected from a clean and properly protected water source, it may become contaminated.

Quality of drinking water:

There is always a risk that water may become contaminated with pathogens (either at the source or during treatment/distribution). It is important to test water supplies regularly to make sure that the water is safe to use. Contaminated water supplies have to be quickly identified and remedial measures taken water samples may deteriorate during prolonged transport. So, it is better to carry out water quality monitoring using **on-site testing methods**.

Disinfection of water is an important step in the **control of water-borne diseases** such as cholera, typhoid, hepatitis A and many diarrhoeal diseases. **Disinfected water** is not necessarily sterile. Bacteria dangerous to health are killed by disinfection but others not dangerous to health may survive. Water may be disinfected by chemical or physical means.

Keeping water in clay pots will help keep water cool and fresh for drinking. Plastic or metal containers may be easier to use for collecting water (they are lighter to carry), but they do not keep water cool.

Use ladle to draw water

Microbes get into water when someone with unwashed hands touches the water. Anyone who has not washed hands after touching faeces, will make the water dirty. Either pour

water directly from the container or **use a ladle to scoop out water**. Do not drink directly from this but use a cup/ glass. Store the ladle in a clean place and not on the ground. **Leaving water uncovered** means that dirt or flies can fall in. Water for drinking should always be covered.

Monitoring the quality of water by "E. coli Count":

Escherichia coli is a bacterium found in the intestines of man and animals.

Coliforms are several different types of bacteria that exist in the **intestines of warm blooded animals**. They are found in human faeces and animal droppings. But it doesn't grow in water. Also it doesn't grow well in the environment. So **if it is found in water, the implication is that the water has been contaminated with faecal material**. Some strains of E. coli, such as O157:H7, cause serious disease, though most do not. The micro-organism is used as a 'Indicator of Faecal Pollution'. If E. coli is present in water, other enteric pathogens (e.g. Salmonella or Rota virus), might be present.

Coliform bacteria are described and grouped, based on their common origin or characteristics, as either **total or faecal coliforms. Total coliforms** includes:

- **faecal coliform bacteria** (such as Escherichia coli or E.coli), as well as
- **other types of coliform bacteria** that can survive in soil and vegetation.

Total coliforms do not necessarily indicate recent water contamination by faecal waste. However their presence or absence in treated water is often used to determine **whether water disinfection is working properly**.

Faecal coliforms are bacteria that are present naturally within the body waste of all warm blooded animals. Most of these species are **not capable of survival outside the body of a warm blooded animal** for an long period of time. The presence of faecal coliforms usually **indicates recent contamination of groundwater by human sewage or animal droppings**.

A laboratory test is needed to tell whether these microorganisms are present in a sample of water that we collect. **Sources of total and faecal coliforms** in groundwater can include:

- Agricultural run-off
- Effluent from septic systems or sewage discharges
- Infiltration of surface water contaminated with faecal matter from wildlife.

After testing water for faecal or total coliforms, the report is given as the **number of colony forming units per 100 millilitres** (**CFU**/100mL). A single sample may contain up to 10 total coliform CFU/100 Ml. However, **no samples should contain faecal coliform bacteria**.

Poor well site selection, poor maintenance of the well and construction of shallow wells increase the risk of microorganisms getting into the well water supply.

4. Food Hygiene

Foodborne illnesses are defined as diseases, usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food. Every person is at risk of foodborne illness. Foodborne diseases are a widespread and growing public health problem, both in developed and developing countries.

Most foodborne diseases are sporadic and often not reported. But **foodborne disease outbreaks** may happen on massive proportions. For example, in 1994, an outbreak of **salmonellosis** due to contaminated ice cream occurred in the USA. It affected an estimated 224,000 persons. In 1988, an outbreak of hepatitis A (resulting from the consumption of contaminated clams), affected some 300,000 individuals in China.

Food poisoning:

Food poisoning is usually caused by micro-organisms, including bacteria, viruses and moulds. The spread of these germs can be prevented by practising good food hygiene.

Food poisoning from bacteria can occur in two different ways.

1) Some bacteria release poisons called **'toxins'**. These **toxins**, when present in our food, lead to symptoms of food poisoning within hours after the food is eaten.

2) Other bacteria **'multiply in the body'** before causing symptoms. The delay between eating the contaminated food and developing symptoms is known as the 'incubation period'. This can be a few hours or up to a few days.

Some of the commonly occurring **food borne diseases** is listed in the table below.

Table : Food borne diseases

Disease	Causative Ogranism	Vector / Means of spread.
Bacterial Anthrax	Bacillus anthracis	Contaminated meat.
Botulism	Clostridium botulinum	Anaerobic growth of spores in inadequately processed/ Canned/bottled food/
Cholera	Vibrio cholerae	Contaminated water or food; flies.
Dysentery (bacillary) flies	Genus Shigella	Contaminated water or food;
Paratyphoid fever milk products/ shellfish; flies.	Salmonella spiecies	Contaminated food, particularly
Salmonellosis Meat/milk products.	Salmonella spp.	Contaminated food, particularly
Staphylococcal Infections.	Staphylococcus spp	Food contaminated by humans
Streptococcal Infections.	Streptococcus spp	Food contaminated by humans
Typhoid fever Particularly milk, milk products and shellfish.	Salmonella typhi	Contaminated water and food
Amebiasis	Entameba histolytica	Contaminated food, particularly Vegetables eaten raw; water
Ascariasis	Ascaris lumbricoides	Contaminated vegetables eaten
Taeniasis and	Taenia saginata	Infected beef.
Crysticercosis	Taenia solium and its larval form Crysticercus celluloses.	Infected pork.
Trichinellosis	Trichinella spiralis	Infected pork.
Trichuriasis	Trichuris trichuria	Contaminated food.

Symptoms of food poisoning include diarrhoea, stomach pain, nausea and vomiting. Depending on the specific cause and the situation of the person affected, food poisoning can lead to:

- gastroenteritis (inflammation of the stomach and intestines),
- more serious illnesses,
- organ failure and even death.

Bacteria that cause food poisoning are found in many foods, including:

- meat and meat products - in particular poultry, minced meat and patés
- seafood
- eggs and raw egg products - in particular **mayonnaise** (it is made from uncooked eggs).
- unpasteurised milk (or milk contaminated after pasteurisation)
- soft and mould - ripened cheeses
- cooked foods - especially if these haven't been cooled and stored properly.
- unwashed fruit and vegetables

Improving Food Hygiene & Personal Hygiene

Maintaining high levels of personal hygiene and kitchen hygiene are important and effective ways to stop germs from spreading.

- Wash your hands and nails with soapy and water:
  - before handling food,
  - between handling cooked and uncooked foods, and
  - after going to the toilet.
- The wet hands transfer germs more effectively from one place to another, than the dry hands. So, rinse your hands well and dry them (on a clean hand towel, a disposable paper towel, or under a hand dryer).
- Use different clothes for different jobs (e.g. washing up and cleaning surfaces).

- Wipe and disinfect surfaces and utensils regularly, using a detergent or dilute solution of bleach
- Don't handle food if you have stomach problems such as diarrhoea and vomiting, or if you're sneezing or coughing frequently.
- Cover up cuts and sores with waterproof plasters.
- If possible, remove rings, watches and bracelets before handling food. Germs can hide under these.

Appropriate temperatures for prevention of food poisoning:

The most serious types of food poisoning are caused by bacteria. Bacteria multiply best in a **moist environment between 5°C and 63°C**. Just a single bacterium on an item of food left overnight, can generate many millions of bacteria by the morning. **Storing food below 5°C** prevents bacteria from multiplying. **Cooking food at temperatures over 70°C** will kill any existing bacteria.

When eating out, consider whether the food hygiene is good at that eatery (e.g. restaurants, cafés or pubs). There are certain **warning signs of poor hygiene standards** that you can look out for:

- dirty dining areas, toilets, cutlery or crockery.
- rubbish and overflowing bins outside (these could attract pests).
- staff with dirty uniforms, dirty fingernails or with long hair not tied.
- hair or insects in food.
- raw food and ready to eat food displayed together
- hot food that isn't fully cooked in all the parts; and cold food that is served lukewarm.

Storing food safely in the refrigerator

Always check labels for guidance on where and how long to store food (especially fresh or frozen food). Store fresh or frozen food in the fridge or freezer within two hours of purchase - sooner if the weather is hot.

- Allow meal leftovers to cool to room temperature before storing them in the fridge, (within two hours of preparation). Divide leftovers into smaller portions the fridge can cool more quickly.

- Store raw food such as meat in airtight containers at the bottom of the fridge. This prevents juices or blood from dripping onto other food.
- Defrost frozen foods (this is also collect thawing) before use. Place them on a plate/container as they defrost, so that they don't drip on or contaminate other foods.
- Don't overfill the fridge (food may not cool properly).
- Keep the fridge at less than 5°C and the freezer at less than -18°C. Consider getting a thermometer and keeping it in the fridge.
- Don't store opened tins of food in the fridge (Transfer the contents to a suitable airtight container).

Cooking food safely

If food isn't cooked at a high enough temperature, bacteria can still survive. The following will help you to cook safely:

- Don't cook foods too far in advance. Keep cooked foods covered.
- Food should be piping hot (steaming) before serving.
- Take special care that pork, sausages, ham burgers and poultry are cooked through. They should not be pink in the middle. Using a clean skewer, pierce the meat. When cooked properly, the juices run clear.
- When microwaving, stir food well from time to time to ensure even cooking.
- Reheat food only once and serve piping hot.
- Eggs contain harmful bacteria. They can be dangerous to pregnant women, older people and babies. Don't serve eggs with runny yolks. Don't use egg containing foods that will not be cooked (e.g. homemade mayonnaise).

Ten Golden Rules for Safe Food Preparation:

1. **While buying foods, choose foods that are processed for safety:**

   Many foods like fruits and vegetables are best in their natural state. Other foods may not be safe unless they have been processed. For example, buy pasteurized milk as opposed to raw milk. Select fresh poultry/frozen poultry that is treated with ionizing radiation.

   Remember that food processing was invented to improve safety as well as to prolong shelf-life of the food.

2. Cook food thoroughly:

Many raw with foods, most notably poultry, meats, eggs and unpasteurized milk, may be contaminated disease causing organisms. Thorough cooking will kill the pathogens. But the temperature of all parts of the food must reach at least 70°C. Foods that are frozen in the refrigerator (e.g. frozen meat, fish & poultry) must be thoroughly thawed, before they are cooked.

3. Eat cooked foods immediately:

When cooked foods cool to room temperature, microbes begin to proliferate. The longer the wait, the greater the risk. To be on the safe side, eat cooked foods just as soon as they come off the heat.

4. Store cooked foods carefully:

If you must prepare foods in advance or want to keep leftovers, be sure to store them under either hot conditions (above 60°C) or under cool conditions (below 10°C). This rule is of vital importance if you plan to store foods for more than four or five hours.

A common error (responsible for cases of foodborne disease), is putting too large a quantity of warm food in the refrigerator. If the refrigerator is overburdened, cooked foods cannot quickly cool. When the centre of food remains warm (above 10°C) for too long, microbes proliferate. This causes food poisoning.

5. Reheat cooked foods thoroughly:

Microbes may have developed during storage (proper storage slows down microbial growth but does not kill the organisms). Thorough reheating (e.g. in a microwave oven) means that all parts of the food must reach at least 70°C.

6. Avoid contact between raw foods and cooked foods:

Safely cooked food can become contaminated through even the slightest contact with raw food. This 'cross contamination' can be direct (e.g. raw poultry meat comes into contact with cooked foods).

7. Wash hands repeatedly:

Wash hands thoroughly before you start preparing food and after every interruption (especially if you have to change the baby or have been to the toilet). After preparing raw foods such as fish, meat, or poultry, wash again before you start handling other foods.

If you have an infection on your hand (e.g. boil or infected wound), bandage it or cover it, before preparing food. Also remember that household pets (dogs, cats, birds, turtles) often harbor dangerous pathogens, which can pass from your hands into food.

8. **Keep all kitchen surfaces meticulously clean:**

Since foods are so easily contaminated, any surface used for food preparation must be kept absolutely clean. Think of every food scrap, crumb or spot as a potential reservoir of germs.

Cloths that come into contact with dishes and utensils should be changed frequently and boiled before re-use. Separate cloths for cleaning the floors also requires frequent washing.

9. **Protect foods from insects, rats, and other animals:**

Animals frequently carry pathogenic microorganisms which cause foodborne disease. Storing foods in closed containers is your best protection.

10. **Use safe water:**

Safe water is just as important for food preparation as for drinking. In case you have any doubts about the quality of water supply, boil water before adding it to food or making ice for drinks. Be especially careful with any water used to prepare an infant's meal.

5. Hospital Hygiene

We serve food in our hospitals. We have to make sure that our patients do not catch any foodborne infections in our hospital premises. So, the hospitals should have **very hygienic kitchens**. Also the food has to be served hygienically by personnel who maintain high standards of personal hygiene. **Food safety is of utmost importance in the hospital settings**.

Fig: *A modern hospital's food preparation area.*

We need to promote the following desirable personal hygiene practices among **health care personnel**:-

Practices assessed for physicians and nurses:-

- Use uniforms according to hospital policy.
- Ensuring that uniforms are clean.
- Use proper shoes (not slippers).
- Have short fingernails.
- Do not wear jewellery (rings/bracelets).
- Use needle-cutter and specific container for discarding used syringes, needles and other sharp items.
- Wash hands after each step of working.
- Wash hands after contact with patients.
- Wear gloves when needed.
- Use **protective devices** (gown, mask, gloves and goggles) when in contact infectious patients or if there is possibility of splashing blood or other body fluids.

Practices assessed for hospital cleaners:

- Use gloves for cleaning of toilets and other sites.
- Wear boots when washing the ward.
- Wear rubber aprons when washing the ward.

7.7 Disposal of Wastes

Sanitation promotes health through prevention of human contact with the hazards of wastes. Wastes that can cause health problems are human and animal faeces, solid wastes, domestic wastewater (sewage, sullage, grey-water), industrial wastes, and agricultural wastes. Let us look into how different kinds of wastes can be disposed in a sanitary manner.

Waste can be divided by their physical, chemical and biological characteristics. Wastes can also be classified by their consistency, as follows:-

- **Solid wastes** are waste materials that contain less than 70% water. They include materials like household garbage, industrial wastes and mining wastes.

- **Liquid wastes** are usually wastewaters that contain less than 1% solids. Such wastes may contain high concentrations of dissolved salts and metals.

- **Sludge** is a class of wastes between liquid and solid. They usually contain between 3% and 25% solids. Rest of the material is water dissolved.

Wastes may be hazardous or non-hazardous. Non-hazardous wastes are those that pose no immediate threat to human health and the environment. Household garbage is included into this category. Disposal of garbage is a problem that is growing with increasing socio-economic development and growth of population. Hazardous wastes are of two types:

- Those that have common hazardous properties such as ignitability (burns when comes in contact with a flame) and reactivity (chemically react when comes into contact with other materials); and

- Those that are 'Special Wastes', which contain leachable toxic components (e.g.: radioactive wastes and medical wastes). Such toxins percolate into the soil. Their disposal is regulated with specific guidelines.

Hazardous wastes pose a danger to humans or other living organisms. Management of radioactive and other hazardous wastes is subject to laws. Hazardous wastes can be pumped into deep wells. There is a strong opposition to this method because of the apparent explosions and even earthquakes that have resulted from waste injection techniques. Hazards can be physical, microbiological, biological or chemical agents of disease.

Fig: *Transportation of solid wastes (waste collection vehicle & dustbin) - A front loading garbage truck.*

Waste collection methods vary widely between different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private industry.

7.7.1 Disposal of Solid Wastes

The disposal of refuse can have a significant effect on the health of communities. If the refuse is not disposed of properly, it can lead to pollution of surface water (rain washes the refuse into rivers and streams). We have many methods of disposing of solid wastes. But there is no absolutely safe way to do this job.

Waste management is the collection, transport, processing, recycling/ disposal, and monitoring of waste materials. It is undertaken to reduce their effect on health and the environment; or to improving aesthetics. Waste management also can recover resources from it.

Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management for non-hazardous residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities. Management for non-hazardous commercial and industrial waste is the responsibility of the institution that generates the waste.

It is important that **industrial waste** is disposed of safely, as it is sometimes toxic and highly dangerous to human health.

Fig: *What goes into our dustbins? This picture shows what are the contents of solid waste bins (in percentage terms) in the developed countries.*

How long to rot	
Cotton rags	1–5 months
Paper	2–5 months
Orange peel	up to 6 months
Wool socks	1–5 years
Cigarette ends	1–12 years
Plastic-coated drink cartons	5 years
Plastic bags	10–20 years
Photo film	20–30 years
Leather shoes	25–50 years
Artificial fibre clothes (nylon, etc)	30–40 years
Tin cans	50–100 years

***Table: Biological degradation of solid wastes**. This table shows the time needed for the nature to degrade each type of solid waste.*

Landfills:

Disposing of waste in a landfill involves burying the waste, This remains a common practice in most countries. Landfills were often established in abandoned or unused quarries, mining voids or borrow pits. A properly-designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Poorly-managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid leachate.

A common by-product of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobically. This gas can create odour problems, kill surface vegetation. Also it is a greenhouse gas.

Modern landfills include methods to contain leachate such as clay or plastic lining material. Deposited waste is normally compacted to increase its density and stability. It is covered to prevent attracting vermin (such as mice or rats). Many landfills also have **landfill gas extraction systems** installed

***Fig:** A landfill compaction vehicle in action.*

to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes. The gas is burnt in a gas engine, to generate electricity.

More than 90 percent of municipal refuse is disposed by landfills. But **landfills** can contaminate drinking water in the area. It is the most cost effective method of disposal. Collection and transportation of wastes accounts for 75 percent of the total cost.

In a modern landfill, refuse is spread **thin and compacted layers**. It is covered by a layer of clean earth. Pollution of surface water and groundwater is minimized by lining and contouring the fill, compacting and planting the uppermost cover layer, diverting drainage, and selecting proper soil in sites not subject to flooding or high groundwater levels. **The best soil for a landfill is clay**. Clay is less permeable than other types of soil.

Materials disposed of in a landfill can be further secured from leakage by solidifying them in materials such as cement, fly ash (from coal based power plants), asphalt, or organic polymers.

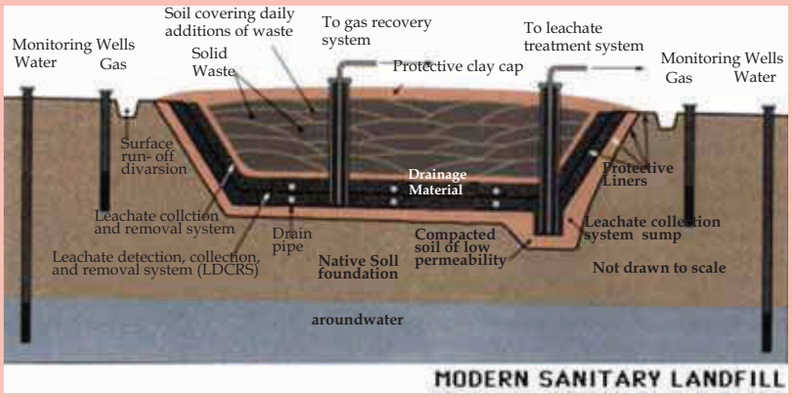

Fig: *Sketch of a modern sanitary landfill.*

The importance of 'daily cover' lies in the reduction of vector contact and spreading of pathogens. Daily cover also minimises odour emissions and reduces windblown litter.

Fig: *Landfill operation in Hawaii.*

Disposal of solid waste is most commonly conducted in **landfills**. But incineration, recycling, composting, and conversion to bio-fuels are some **other methods for solid waste disposal**.

Incinerators:

Incineration is a disposal method that involves combustion of waste material. Incineration and other high temperature waste treatment systems are sometimes described as **"thermal treatment"**. Incinerators convert waste materials into heat, gas, steam and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is **good method of disposing of biomedical waste (hospital wastes)**. Incineration is a controversial method due to issues such as emission of gaseous pollutants. Incineration is common in **places where land is more scarce**.

Refuse is burned in **incinerators**. It is more expensive but a safer method than landfills. Modern incinerators are designed to **destroy 99.9% of the organic waste material**. For incineration options, the release of air pollutants, including certain toxic components is an attendant adverse outcome. Recycling and biofuel conversion are the sustainable options that generally have superior life cycle costs, particularly when total ecological consequences are considered. Composting value will ultimately be limited by the market demand for compost product.

Micro-pollutants may be present in gaseous emissions from the incinerator. **Dioxins** which may be created within the incinerator, which may have serious environmental consequences in the local area. On the other hand, this method produces heat that can be used as energy. **'Waste-to-energy'** or **'energy-from-waste'** are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam and/or electricity.

Garbage burned in incinerators can pollute air, soil and water. Communities residing near the incinerators often object to them.

Recycling the solid wastes:

It takes time, energy, labour, and money to make new products from recycled ones. Right now it's often easier or cheaper for manufacturers to use virgin rather than recycled materials to make things. To complete the recycling loop, those cans, papers, and bottles must be remade into new products that you buy and use.

The best method of reducing waste disposals negative effect on society is simply to **prevent generation of wastes**. If the consumers of our country were to make a firm stand against the production of useless waste. The **recycling of complex products** (such as computers and electronic equipment) is more difficult. They need additional dismantling and separation.

Organic materials can be detoxified biologically. Composting and land farming, in which materials are spread out over a large land area so that microbes can decompose them, are examples of biological treatment of hazardous waste. If the materials are not detoxified before they percolate into groundwater than obvious repercussions may occur.

The practice of recycling solid waste is an old one. Metal implements were melted down and recast in prehistoric times. Today, recyclable materials are recovered from municipal refuse by a number of methods, including shredding, magnetic separation of metals, screening, and washing. Composting includes preparing refuse and breakdown of organic matter by aerobic microorganisms.

Fig: *An active compost heap.*

Biological reprocessing

Waste materials that are organic in nature (e.g. plant material, food scraps, and paper products) can be recycled using biological composting and digestion processes. The resulting organic material is then recycled as mulch or compost (for agricultural or landscaping purposes).

Biological decomposition may be of aerobic or anaerobic methods.

Fig: *Anaerobic digestion in a treatment plant of Germany.*

Waste to energy method' of disposing solid wastes is one of the best methods environmentally. **Waste gas** from the process (such as methane) can be captured and used for generating electricity. Composting and anaerobic digestion are some of the biological reprocessing methods. '

Some of the Waste management concepts:

Waste hierarchy – This refers to the **"3 Rs"; reduce, reuse and recycle;** This is the cornerstone of waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

- **Extended producer responsibility** - (EPR) is a strategy designed to promote the integration of all costs associated with products throughout their life cycle (including end-of-life disposal costs) into the market price of the product. Extended producer responsibility is meant to impose accountability over the entire lifecycle of products and packaging introduced to the market.
- **Polluter pays principle** implies that the polluting party pays for the impact caused to the environment. It means that a **waste generator** has to pay for appropriate disposal of the waste.
- **Waste minimization** is an important method of waste management is the prevention of waste material being created, also known as **'waste reduction'**. Methods of avoidance include:
    - reuse of second-hand products,
    - repairing broken items instead of buying new ones,
    - designing products to be refillable or reusable (such as cotton instead of plastic shopping bags),
    - avoiding use of disposable products (e.g. disposable cutlery),
    - removing any food/liquid remains from cans, packaging, and
    - designing products that use less material to achieve the same purpose (e.x. light weight beverage cans).

7.7.2 Disposal of Liquid Wastes

The standard sanitation technology in urban areas is:

- the collection of wastewater in sewers,
- treatment of sewage in wastewater treatment plants for reuse, or disposal in rivers, lakes or the sea.

Waste water is called by different names. They include:

1. **Sewage:** Sewage is the content of sewers. It is usually liquid in nature and contains stool, urine, liquid waste from households and factoriess

2. **Effluent**: It is liquid waste from factories or outflow from sewage, septic tank.

3. **Silage**: Liquid waste from houses is called silage. Silage is not mixed with stool or other solid waste.

It is better to have separate drainage system in the **urban areas** for collection and drainage of rain water. In such case, sewers collect only sewage water **(sanitary sewers)**. **Sewers** are either combined with storm drains or separated from them as **sanitary sewers**. **Combined sewers** are usually found in the older parts of urban areas. Heavy rainfall and inadequate maintenance can lead to combined sewer overflows (or sanitary sewer overflows). That means, diluted raw sewage gets discharged into the environment, which exposes the population to faeco-oral contamination.

In areas, households are not connected to **sewers**, they discharge their wastewater into septic tanks (it is an **'on-site sanitation'** method in which sewage is not taken away). Ground water can be contaminated by faecal material from the **'septic tanks'**. Septic tank systems might be feeding human faecal matter to the ground water. However, wells in the surrounding area, both up and downstream of the potentially contaminated site tested negative for Escherichia coli. The wells may be contaminated by human faeces from the outflow of the septic tanks.

Fig: Poor drainage systems *in our urban areas are a cause of high incidence of sanitation related diseases.*

Industries often discharge **industrial wastewater** into municipal sewers. This can complicate wastewater management (unless the industries have pre-treated their discharges).

The reuse of untreated wastewater in irrigated agriculture is common in developing countries. The reuse of treated wastewater in gardens, agriculture and for industrial use is becoming increasingly widespread. **Wastewater** is often used in agriculture as it contains water, minerals, nutrients and its disposal is often expensive. Wastewater can also be used as a fertilizer, thus minimizing the need for chemical fertilizers. This reduces costs, energy, expenditure and industrial pollution. Wastewater is also commonly used in aquaculture (fish farming).

Soakage Pit:

Soakage pit is the best method for disposal of household waste water in the **rural areas**. How a soakage pit is laid is showed in the picture below. Dig a pit two metres deep and 1.5 metres square (or 1.5 metres in diameter). Divide it vertically into three equal portions. The lowest portion should be filled with gravel or burnt bricks of 3/4 size. The middle portion should be filled with bricks of 1/2 size. Cover the uppermost portion with bricks of 1/4 size. Further, this should be covered with six inch **a layer of earth**.

The opening should be protected by a **parapet** 10 cm. high, to prevent rain water from entering the pit. The house drain should join the soakage pit through a pipe opening into the middle of the pit.

The waste water should be made to pass through a **basket filled with straw or leaves**. This serves as a filter. The content of the basket has to be removed from time to time and are replaced by fresh dry straw or leaves. During the **rainy season** the soakage pit should be disconnected by blocking the drain.

After a certain time the soakage pit becomes **"Sewage Sick"** and starts overflowing. Then the pit has to be emptied. The stones/bricks have to be washed, dried and replaced. Soakage pits cannot be used in water-logged areas.

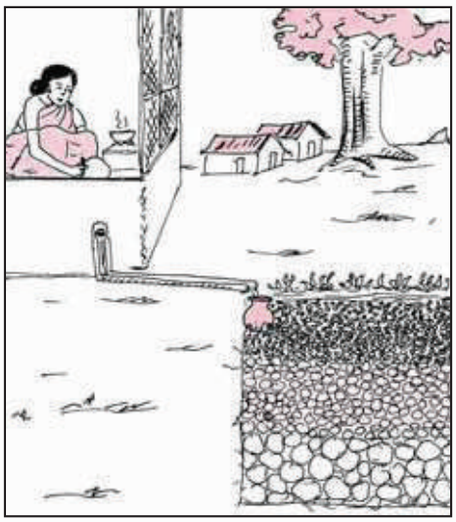

Fig: Soakage pit*: it provides water for garden; and also prevents collection of stagnant water that can breed mosquitoes.*

Treatment of municipal wastewater:

In developed countries treatment of municipal wastewater is now widespread. In developing countries, most wastewater is still discharged untreated into the environment (often into the water bodies like rivers, lakes or sea).

Fig: *Sewage treatment plant.*

7.8 Disposal of Biomedical Wastes

Healthcare waste (HCW), also called Biomedical Waste, is a by-product of healthcare. It includes sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials. Poor management of HCW exposes healthcare workers, waste handlers and the community to infections, toxic effects and injuries.

Biomedical waste differs from other types of hazardous wastes like industrial waste. The **risk comes from biological sources** as the wastes have been generated in the diagnosis, prevention or treatment of diseases. Common **producers of biomedical waste** include hospitals, health clinics, nursing homes, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care and funeral homes.

Fig: *Sorting of medical wastes in hospital.*

Biomedical Waste must be properly managed to protect the general public. Also we have to protect **healthcare and sanitation workers**, who are regularly exposed to biomedical waste (as an occupational hazard). Any **tools or equipment** that come into contact with

potentially infectious material are sterilised in an autoclave.

Sorting of medical wastes in hospital:

Where it is generated, the biomedical waste is placed in specially-labelled bags and containers for removal by transporters. Other forms of waste should not be mixed with biomedical waste, as different rules apply to the treatment of different types of waste.

Disposing of these materials with regular household garbage puts waste collectors at risk for injury and infection, especially from sharps as they can easily puncture a standard household garbage bag. Many communities have programs in place for the disposal of household biomedical waste. Some waste treatment facilities also have mail-in disposal programs. Hospitals should have the following four **disposal and collection systems**:

3. Container to collect all plastic related articles for further disposal.

4. Container to collect all kinds infected materials of hospital wards (organs or specimen from surgery, pathology and medical wards).

5. Dry or wet refuse from patients, wards and other places of hospital corridors.

6. Specific containers for toxic or dangerous items like mercury, batteries, wastes solvents and radioactive waste.

Colour Code for storage system:

Colours used in the hospitals for storage bins/bags of biomedical wastes convey the following messages:

- Red : Fire hazard and or flammables.
- White : Contact hazard and or corrosive.
- Blue : Health hazard and or toxic poisonous.
- Yellow : Reactivity hazard/oxidisers.
- Green, Gray : Moderate or slight hazard.

Safe disposal of hospital waste

1. **Waste segregation** is an important step. Papers, cardboards glass, metals can be segregated and separated for recycling in the market.

2. Separate **pathological and infected waste** from regular waste. It is to be collected in separate bags, preferably in colour red, to signify 'dangerous'.

3. **Solid non-infectious hospital waste** can be disposed of by standard composting method.

Biomedical waste is treated by the following methods:-

- incineration;
- discharge through a sewer or septic system; and
- steam, chemical, or microwave sterilisation.

Solid Hospital Waste

These are collections from dry sweeping papers, cardboards and other non-septic waste. These can be collected in different receptacles and can be disposed by **composting** at a suitable ground.

Biomedical wastes are generated often in our households also. **Household biomedical waste** usually consists of:

- needles and syringes from drugs administered at home (such as insulin), soiled wound dressings,
- disposable gloves, and
- bed sheets or other cloths that have come into contact with bodily fluids.

Biomedical waste treatment facilities are licensed by the local governing body, which implements laws related to operation of these facilities. The laws ensure that the contamination from biomedical wastes would not reach the general public (through contamination of air, soil, groundwater, or municipal water supply).

Questions

1. Define environmental sanitation.
2. Explain the importance of environmental sanitation.
3. List the essential components of sanitation.
4. Describe methods of disposal of solid waste.
5. Explain methods of disposal of liquid waste.
6. What are the advantages of using sanitary latrines?