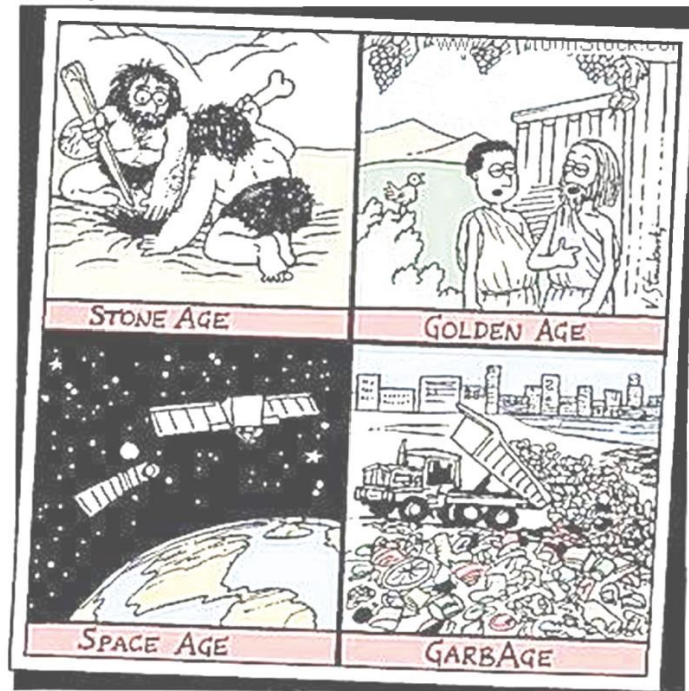


8. phosphates in wastewater
9. cause eutrophication
10. resulting in excessive growth of algae and
11. cyanobacteria
12. called algal blooms.
13. Some cyanobacteria produce toxins/poisonous substances.
14. Algal blooms cause oxygen depletion zones/ increases BOD.
15. greatly reducing populations of fish/ other aquatic species.
16. It also causes bad odour/ smell.

Any 16 X 4= 64 marks

Snapshots



<https://advanceonlineclass.com/0777211384/0779925362>

Microbiology



Unit 09 Microbiology

9.3.0 : Investigates the use of micro-organisms in industry, agriculture, environment and contribution of soil microorganisms for agriculture
 9.4.1 : Uses the microbiological concepts and principles in potable water supply and waste water management

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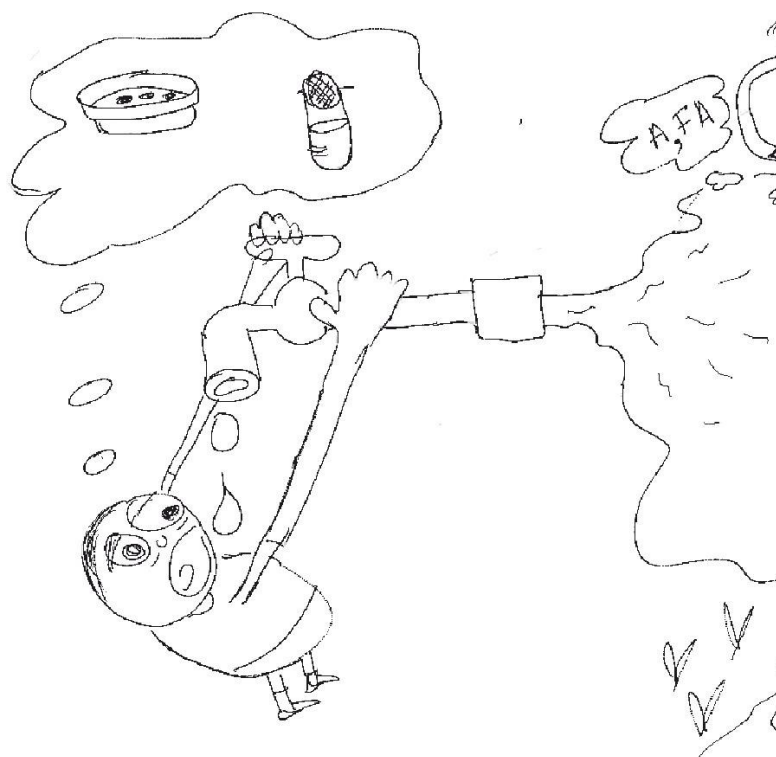
B.Sc. (Hons), M.Sc.

Number of Periods : 06

Microbiology of domestic water and waste water

Contamination routes of drinking water

Drinking water resources can be contaminated with infectious disease causing organisms or chemical pollutants. Since water undergoes a filtering of microorganisms when pass through the soil into deeper layers, generally, water from springs and deep wells are of good quality in microbial point of view. Drinking water can be contaminated by dangerous pathogens when feces enter the water supply. Many diseases are disseminated by the fecal - oral route of transmission, in which, pathogens are shed in human or animal feces, contaminate water, and ingested via drinking. Examples for diseases spread by water (water-borne diseases) are typhoid fever, cholera, diarrhea etc.



AL 2006/ Answer according to new syllabus

- (a) State the stages seen in a typical industrial waste water treatment plant and describe briefly the changes that take place in each of these stages.
- (b) What are the harmful effects of discharging untreated waste water into a natural water system?

(a) State the stages seen in a typical industrial waste water treatment plant and describe briefly the changes that take place in each of these stages.

- Primary treatment- Following steps are involved in the primary treatment.
- Large floating materials are screened out
- Removal of sand
- Removal of oil and grease
- Solid matter settles out in sedimentation tanks
- Sludge collected and removed
- No biological activity is used here
- Primary treatment removes 25-35% organic matter
- Secondary treatment- Following steps are involved in the Secondary treatment.
- The liquid flowing out of primary treatment, enters the secondary treatment stage.
- During this treatment, waste water is aerated to facilitate the growth of aerobic bacteria and rapid microbial oxidation.
- One of two systems used are, activated sludge and trickling filter.
- In activated sludge, vigorous aeration is done mechanically.
- In trickling filters, waste water is slowly sprinkled or sprayed over a bed of rocky material and allowed to trickle.
- In this process, microorganisms grow on the filter bed and oxidize organic matter.
- In secondary treatment 75-95 % of organic material is oxidized.
- The liquid flowing through these systems are then disinfected and allowed to flow into natural waters.
- Sludge remaining from both treatments is sent to an anaerobic sludge digester where anaerobic decomposition convert the organic material in the sludge, finally to methane and CO₂ (biogas).
- Digested sludge can be used as fertilizer.

(b) What are the harmful effects of discharging untreated waste water into a natural water system?

- Dissemination of pathogenic microorganisms
- Water pollution due to accumulation of biodegradable material and their decomposition products
- Decomposition which may consume large amounts of oxygen in water affecting aquatic organisms (high BOD - biological oxygen demand)
- Anaerobic decomposition leading to bad smells

2019 AL/New

2. (b) Explain the effects of discharging wastewater into natural water sources.

1. Contamination of water bodies by pathogens (through wastewater)
2. may cause typhoid fever,
3. cholera,
4. diarrhoea/ dysentery.
5. Chemical pollution of water bodies/ pollution due to chemicals in waste water.
6. Some of these chemicals are resistant to biodegradation/do not biodegrade.
7. Excessive nitrates and



3. Which of the following statements is correct regarding the culture media used to grow microbes in the laboratory?
- Agar in culture media provides the suitable pH range for the growth of microorganisms.
 - Glucose is generally used to prepare culture media to grow fungi.
 - Culture media for bacteria are prepared using potatoes.
 - Any microorganism can be cultured in a culture medium.
 - Sodium chloride is usually added to all culture media. (2019 AL/39)
4. Which of the following statements regarding drinking water treatment process is/are correct?
- Alum is added to remove suspended matter and microorganisms.
 - Ozone is used to kill microorganisms.
 - During filtration stage, microorganisms are removed by absorption into sand particles.
 - Trickling filter method is used to filter microorganisms.
 - During the primary treatment, about 90% of organic matter is removed. (2020 AL/50)
5. During the secondary treatment of wastewater,
- microorganisms pass through a trickling filter.
 - activated sludge is treated in an aerobic digester.
 - aeration is done in the activated sludge system.
 - final products of sludge digestion are methane and CO₂
 - oil and grease are removed. (2020 AL Old/50)
6. Which of the following is a step in the primary treatment of purification of industrial waste water?
- Spraying over a bed of rocky material
 - Removal of oil and grease
 - Mechanical aeration
 - Anaerobic decomposition
 - Disinfection (2021 AL/40)
7. During the secondary treatment of industrial wastewater,
- organic matter is oxidized by microorganisms in the trickling filter.
 - solid matter is allowed to settle in tanks.
 - more than 75% of the organic matter is oxidized
 - methane is produced.
 - sludge remaining after filter treatment is decomposed aerobically. (2023 AL/50)

2022 AL

1. Why is alum added during drinking water treatment?
-

Contamination of drinking water by chemical pollutants is a global issue. Industry, domestic and agriculture sectors release a large amount of chemicals that leach from the soil surface to groundwater. Most of these chemicals are resistant to biodegradation. Most freshwaters, such as tanks, often contain excessive amounts of nitrates and phosphates that come from agricultural fertilizer and household chemicals such as detergents. Accumulation of excessive amounts of such nutrients cause eutrophication, and flourish the growth of cyanobacteria and algae. They are toxic to humans. This kind of dense growth of cyanobacteria and algae, is called algal blooms. Various industries also release chemicals that are non-biodegradable. They too can contaminate drinking water supplies.



Microorganisms as indicators of water quality

Water supplies can be contaminated with pathogenic microorganisms such as *Salmonella spp.*, *Shigella sp.* and *Vibrio sp.* that causes infectious diseases such as typhoid and Cholera. Therefore, it is essential to detect the presence of such microorganisms before the consumption to prevent disease outbreak. .

However, it is not practical to test water samples to look for pathogens because, pathogens may present only in small numbers and might not be included in the test sample. On the other hand, since the testing for pathogens take time, discovery of pathogens in the laboratory takes time and, it will be too late to prevent an outbreak of the disease. Therefore, it is important to test water samples routinely for "indicator organisms, which will indicate potential contamination of water supply by pathogens.

One of the major criteria for an indicator organism is that it should be consistently present in human feces in large numbers. This ensures the, presence of indicator organism providing evidence for contamination of water supply with human feces.

2. Describes the environmental and hygienic importance of recycling solid waste

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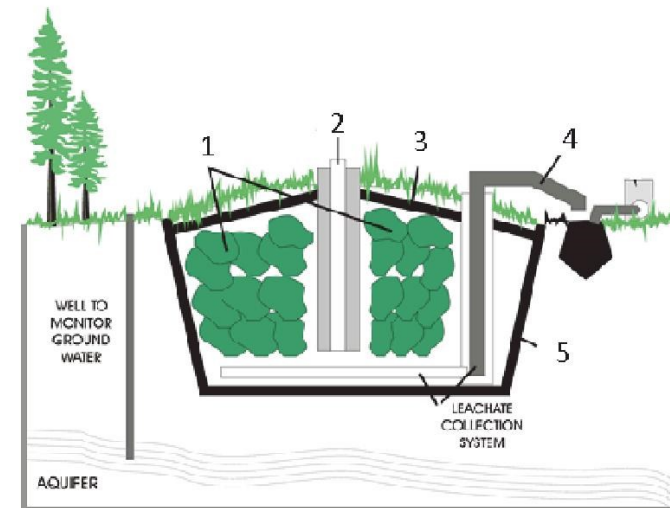
3. Describes the techniques used in managing solid waste

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4. Appreciates the value of solid waste management

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5. Following diagram shows a modern landfill. Label it.



MCQ

- Which of the following statements regarding the use of sanitary landfills is correct?
(1) It is not a good choice due to high operational costs.
(2) It involves dumping of municipal solid waste to wetland areas for land filling.
(3) It is a method of reducing the volume of solid waste.
(4) It is limited due to low ground water level in many regions.
(5) It does not involve decomposition of waste. (2018 AL/39)
- Coliform bacteria were detected in a water sample obtained from a river. Drinking untreated water from this river may not likely to cause
(1) Typhoid (2) Cholera (3) dysentery (4) paratyphoid. (5) tetanus. (2019 AL/40)

9.4.2: Explores the environmental and sanitary importance of recycling of solid wastes

1. What are constituents in solid waste.
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2. What are Environmental and hygienic importance in recycling solid waste matter
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3. Describes the techniques used in managing solid waste
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4. What is a sanitary land fill
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5. Briefly describe the factors that should consider while constructing a sanitary landfill.
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9.4.2 Explores the environmental and sanitary importance of recycling of solid wastes

Learning Outcomes:

1. Describes the nature of solid waste
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Sri Lanka, and many other countries use coliform bacteria as an indicator organism to test drinking water quality. Coliforms are Aerobic or facultative anaerobic, Gram-negative, Non-endospore forming, Rod shaped bacteria Ferment lactose to form gas within 48 hours in a lactose broth medium at 35 °c. Coliforms constitute a large portion of human intestinal microflora. They are nonpathogenic line m the intestine. Therefore, presence of coliforms in water indicates fecal contamination. However, there are some coliforms found in plant and soil samples. There are specialized test to distinguish coliforms that has fecal origin from coliforms present in plant and soil samples. Coliform test is routinely carried out by laboratories of the national water supply and drainage board to determine water quality of drinking water.

Water-borne diseases

Pathogenic organisms that are frequently transmitted through water cause infections in the intestinal tract such as typhoid, paratyphoid, cholera, gastroenteritis and dysentery.

Process of drinking water treatment

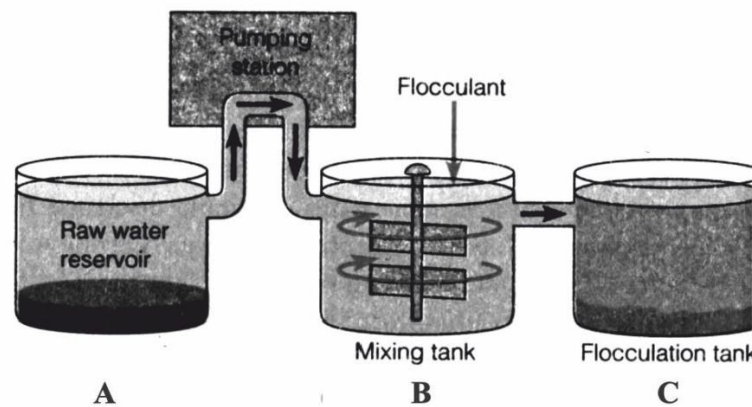
Drinking water that comes from various water supplies can be polluted at any time. Therefore, water needs to be purified before consumption for our health and safety.

The idea of water purification is not to sterilize water, but to make water free of disease-causing organisms. There are three main steps in an urban water treatment plant. They are,

- Sedimentation and coagulation,
- Filtration
- Disinfection.

1. Sedimentation & Coagulation

This is the first step. If water is turbid (cloudy), water is allowed to stand in a holding tank for a period of time to allow settling down of particles suspended in water. This occurs in large reservoirs, where water remains for a holding period during which large particulate matter settles to the bottom. Sedimentation is enhanced by adding alum (Aluminum potassium sulphate) which produces a sticky precipitate. Many microorganisms as well as finely suspended matter are removed in this manner.



C

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D

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2013 AL

(i) What are the adverse effects of discharging large amounts of waste water into natural water bodies?

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(ii) Many industrial waste water treatment plants use two stages of treatment, primary treatment and secondary treatment to purify waste water.

(a) What happens during the primary treatment stage?

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(b) Name the two methods generally employed in the secondary treatment stage.

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(c) What is the major function of the secondary treatment stage?

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(iii) Some industrial waste water treatment plants employ an anaerobic sludge digestion system.

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(iv) Name the three major techniques currently used in the management of solid waste.

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11. State 3 steps of waste water treatment.

.....

12. What is the % removal of degradable materials during primary treatment.

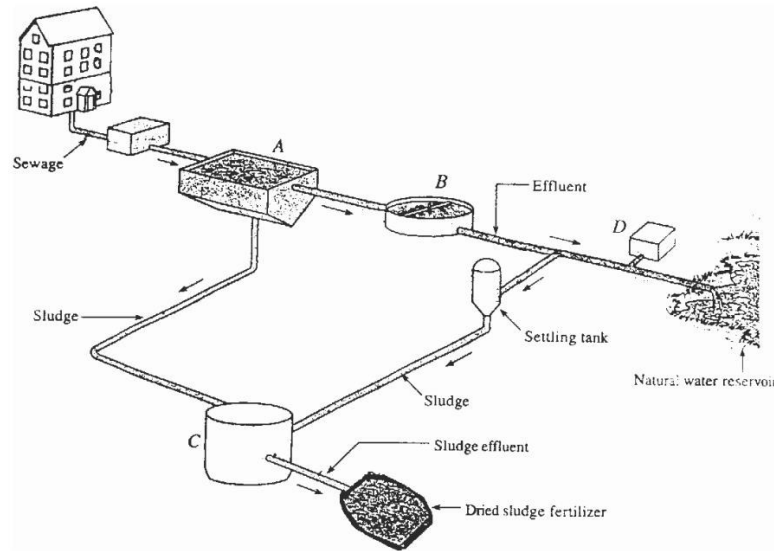
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13. What is the % removal of degradable materials during secondary treatment.

.....

2003 AL

1. Name the stages marked A, B, C and D.



A

B

C

D

(ii) State what takes place at each of these stages.

A

.....

.....

B

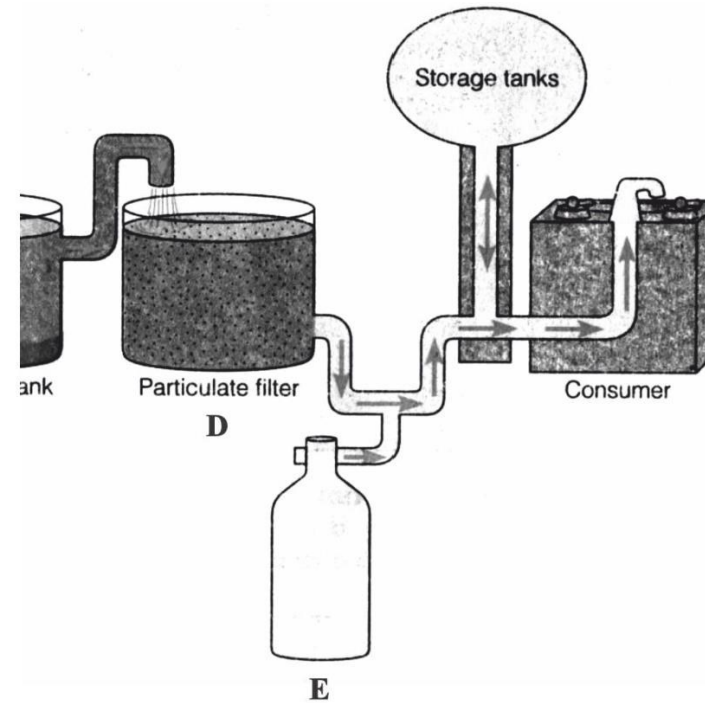
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2. Filtration

After sedimentation and coagulation, water is filtered by passing through beds of fine sand. Filtration removes protozoan cysts and other microorganism. Microorganisms are trapped by surface absorption onto the sand panicles. This removes about 99% of bacteria. Some urban treatment plants additionally use activated carbon for the removal of toxic chemicals.

3. Disinfection

The final step in water treatment is disinfection. Water can be disinfected by several methods. Chlorination is one of the most commonly used method. It kills pathogenic bacteria. Disinfection by ozone (O₃) is another method. Ozone is highly reactive. It kills microorganisms by oxidation. Ozone has become a preferred method of disinfection since it leaves no taste or odor and has little residual effect.



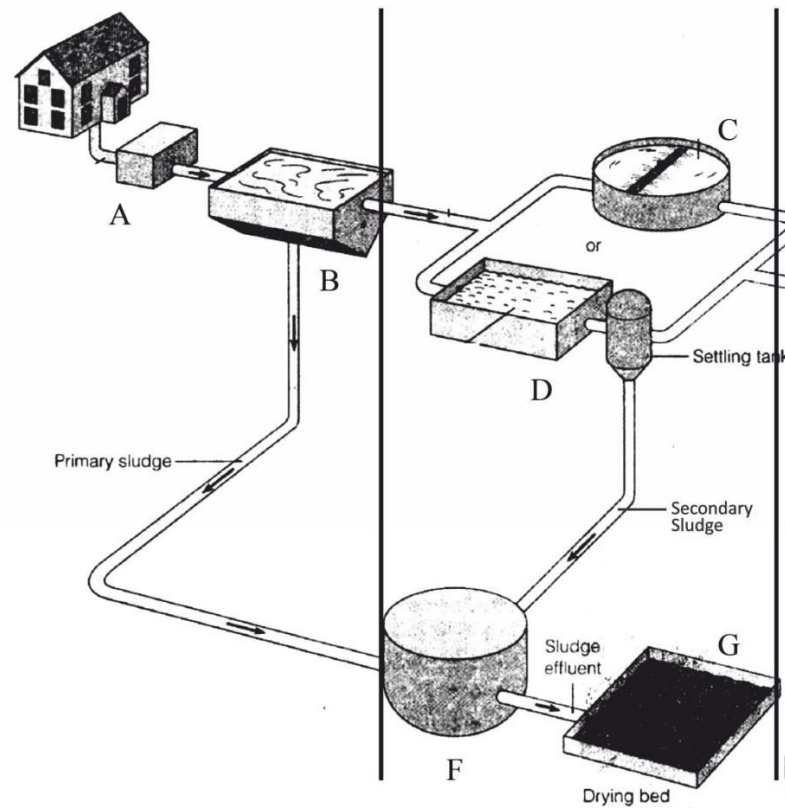
Wastewater (sewage) management

Wastewater includes water from household use such as water used for toilets and washing, water from urban drainage systems and from industry. Many developing countries and some developed countries still do not have proper wastewater treatment mechanisms.

• **Principles and main steps in purification of industrial waste water**

I. Primary treatment- Following steps are involved in the primary treatment.

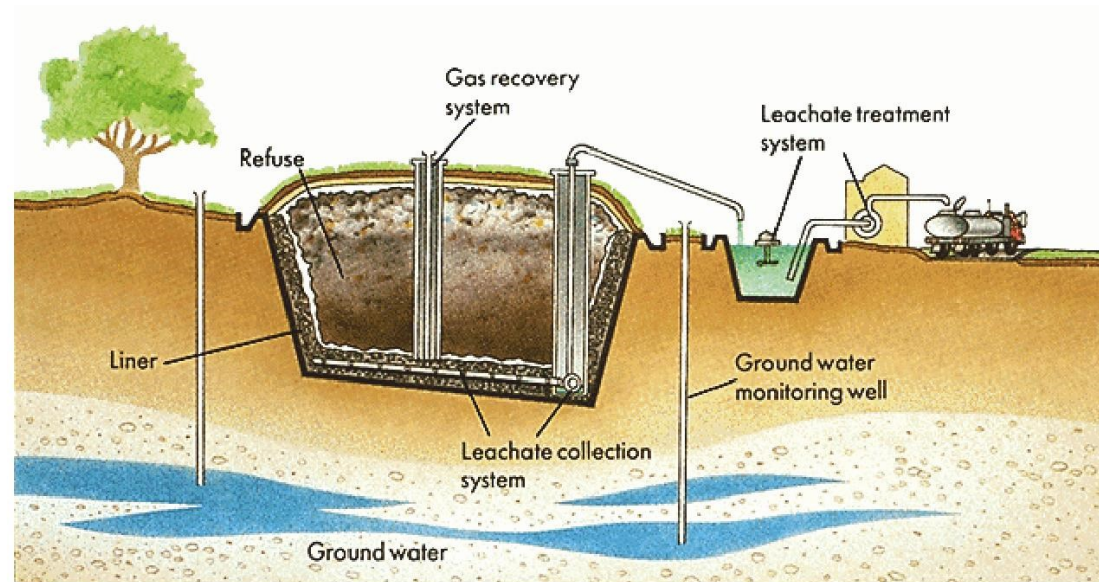
- Large floating materials are screened out
- Removal of sand
- Removal of oil and grease
- Solid matter settles out in sedimentation tanks
- Sludge collected and removed
- No biological activity is used here
- Primary treatment removes 25-35% organic matter



3. What is the test done to check the sanitary condition of water.
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4. State why this is called as an indirect test.
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5. What is the reason not to use specific tests.
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6. State 5 main properties of coliforms.
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7. Lists the diseases transmitted through water.
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.....
8. States the steps in water treatment in an urban water treatment plant.
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9. Explains the effects of discharging waste water into natural water resources.
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10. In a municipal water purification plant,
 - (a) What is the chemical that add to increase sedimentation.
 - (b) For disinfection
 - (c) What are diseases result due to non hygienic water
 - (d) What are 3 main steps of purification of water.
 - (e) There are 3 main steps state how microbial number reduce during main steps

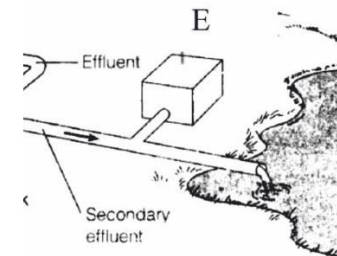
3. Sanitary land filling

Sanitary landfills are one of the most popular forms of waste disposal, primarily because, they are the least expensive way to dispose the waste. More than four-fifths of municipal solid waste is disposed in landfills. A sanitary landfill is an engineered means of disposal of waste. In a sanitary landfill, waste is spread in layers on a piece of property, usually on marginal or sub-marginal land. The objective is to spread the layers and then compact them tightly, greatly reducing the volume of the waste. The waste is then covered by soil. A landfill should not be located in areas with high ground water levels. Much of the waste in a sanitary landfill will decompose through biological and chemical processes that produce solid, liquid and gaseous products.



II. Secondary treatment- Following steps are involved in the Secondary treatment.

- The liquid flowing out of primary treatment, enters the secondary treatment stage.
- During this treatment, waste water is aerated to facilitate the growth of aerobic bacteria and rapid microbial oxidation. One of two systems used are, activated sludge and trickling filter.
- In activated sludge, vigorous aeration is done mechanically. In trickling filters, waste water is slowly sprinkled or sprayed over a bed of rocky material and allowed to trickle. In this process, microorganisms grow on the filter bed and oxidize organic matter.
- In secondary treatment 75-95 % of organic material is oxidized.
- The liquid flowing through these systems are then disinfected and allowed to flow into natural waters.
- Sludge remaining from both treatments is sent to an anaerobic sludge digester where anaerobic decomposition convert the organic material in the sludge, finally to methane and CO₂ (biogas).
- Digested sludge can be used as fertilizer.



9.4. 0: Utilizes the microbiological concepts and principles to maintain the quality of water and for solid waste management

Learning Outcomes :

1. Describes the possible contamination routes of drinking water

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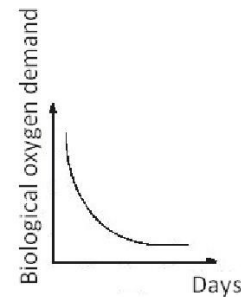
2. Describe the importance of coliforms as an indicator of fecal contamination.

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Adverse effects of discharging large amount of waste water into natural water bodies.

- Dissemination of pathogenic microorganisms
- Water pollution due to accumulation of biodegradable material and their decomposition products
- Decomposition which may consume large amounts of oxygen in water affecting aquatic organisms (high BOD — biological oxygen demand)
- Anaerobic decomposition leading to bad smells



Solid waste treatments

Nature of solid wastes

- Solid waste include materials such as plant and animal residues, food waste, paper, plastic, polythene and glass. Among these, organic wastes such as plant and animal residues and food wastes are rapidly degradable. However, synthetic materials such as plastic and polythene are not easily degraded and tend to accumulate continuously. Proper management of solid waste, ensure community health and environmental safety. Accumulation of unmanaged waste in big piles in the open environment can lead to soil, air and water pollution which is harmful for the environment and organisms in contact with the polluted environment.

Environmental and hygienic importance of recycling solid wastes

- Open dumping of waste provide breeding grounds for mosquitoes, flies, other insects and rats. These organisms serve as vectors for dangerous diseases such as dengue, chikungunya, various food borne diseases and leptospirosis.
- Contaminated water resources have the risk of spreading water borne diseases such as typhoid, paratyphoid, cholera, dysentery and gastroenteritis.
- Piles of waste at public and residential area often create social issues due to unpleasant smell generated during anaerobic digestion of waste.
- Heavy piles of waste sometimes can be dangerous due to accumulation of methane, generated during anaerobic digestion of waste. Accumulation of methane can cause explosion and fire.
- Groundwater can be polluted by the leachate of waste piles. Leachate means liquid pass through the waste, extracting the dissolved and the suspended matter from the waste.

Therefore, solid waste must be properly managed using appropriate technology which is socially accepted and environment friendly.

9.4.2 Explores the environmental and sanitary importance of recycling of solid wastes

Number of Periods : 02

1. Sorting and recycling

In many countries municipal solid waste is sorted into kitchen waste, plant material, paper, plastic, glass etc. and collected into separate containers. Sorting allows separation of waste that can be recycled such as paper, plastic and glass. Although paper is presumably biodegradable, it is not easily degraded since microorganisms cannot effectively attack papers when the waste is placed into large compacted dumping sites.



2. Degradation/decomposition of organic matter

Readily degradable organic matter such as kitchen and garden waste is subjected to natural microbial degradation by the process of composting. Resulting compost is used in agriculture and gardening. Compost generate additional income to the waste management authorities such as municipal council. Anaerobic condition in the pile of compost, promote the activity of methanogenic bacteria. The methane gas they produce can be collected to generate electricity.