BIOLOGY

Chapter 8: Microbes in Human Welfare

Microbes In Human Welfare

Microbes in Human Welfare:

Apart from the harmful and Infectious disease-causing pathogens, there are several useful microorganisms which are beneficial to humans in various ways. Some of the most important contributions of microbes to human welfare are discussed below.

In Household Products:

- Fermentation of milk to prepare yogurt.
- Curdling of milk to prepare curd, cheese, and paneer.
- Fermentation of dough, which is used for making bread, idli, and dosa.

In Industrial Products:

- Production Beverages like wine, beer, whiskey, brandy or rum.
- Production antibiotics like Penicillin and other chemical substances to kill or retard the growth of disease-causing microbes.
- Few Chemicals, Enzymes and other Bioactive Molecules are also produced by these microbes for various human uses.

Antibiotics:

Antibiotics are chemical substances produced using microbes against any disease-causing microbe. Penicillin, the first antibiotic discovered was obtained from mold is referred to as Penicillium notatum. For the treatment of different diseases like Whooping cough, leprosy, diphtheria, plague, etc antibiotics are required.

For the production of certain chemicals like alcohols, enzymes, organic acids, etc, microbes are used. For example, Acetobacter aceti is used to produce acetic acid, Aspergillus niger is used to produce citric acid and Lactobacillus is used to produce lactic acid. Lipase enzymes can also be prepared using microbes. Streptokinase is produced by the bacterium Streptococcus which is very useful in removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack, thus acting as a 'clot buster'. An immunosuppressive agent known as cyclosporin A is obtained from the fungus known as Trichoderma polysporum is used during organ transplant.

Chemicals, Enzymes and other Bioactive Molecule:

Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes.

Examples of acid producers are Chemicals:

- Aspergillus niger (fungus): Citric acid
- Acetobacter aceti (bacterium): Acetic acid
- Clostridium butylicum (bacterium): Butyric acid
- Lactobacillus (bacterium): Lactic acid
- Saccharomyces cerevisiae: Ethanol

Enzymes:

- Lipase: Used in laundry detergents.
- Pectinase and protease: Used in bottled juices.
- **Streptokinase (Streptococcus bacterium):** Used as clot buster (to remove clots) from the blood vessels of patients who have undergone myocardial infraction leading to heart attack.

Bioactive molecules:

- **Cyclosporin A (Trichoderma polysporum fungi):** Used as immunosuppressive agent (for organ transplant patients).
- **Statins (Monascus purpureus yeast):** Used as blood cholesterol lowering agents.

Microbes in Sewage Treatment:

Municipal wastewater (sewage) contains large amount of organic matter and microbes which are pathogenic and cannot be discharged into natural water bodies like rivers and

streams.

Sewage is treated in sewage treatment plant to make it less polluting by using heterotrophic microbes naturally present in sewage. Sewage treatment is done in two stages:

Primary treatment: In primary treatment, floating debris is removed by sequential filtration. Grit (soil and small pebbles) are removed by sedimentation.

Secondary treatment: Secondary treatment or biological treatment involves passing of primary effluents in large aeration tank to help the growth of aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh like structures). These microbes increase the consumption of organic wastes and decrease the BOD (biological oxygen demand) of the effluents.

BOD (biochemical oxygen demand):

- BOD is the amount of oxygen that would be consumed if all the organic matter in one litre of water were oxidized by bacteria. It measures the amount of organic matter present in the water. Greater the BOD of water more it is polluted.
- Once the BOD of sewage or waste water is reduced, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called activated sludge.
- Sludge is passed into large tanks called anaerobic sludge digesters in which anaerobic bacteria digest the bacteria and fungi in the sludge and produce mixture of gas called biogas, which is a mixture of methane, hydrogen sulphide and carbon dioxide.
- The effluents from the secondary treatment plant are released into water bodies.

Microbes in Production of Biogas:

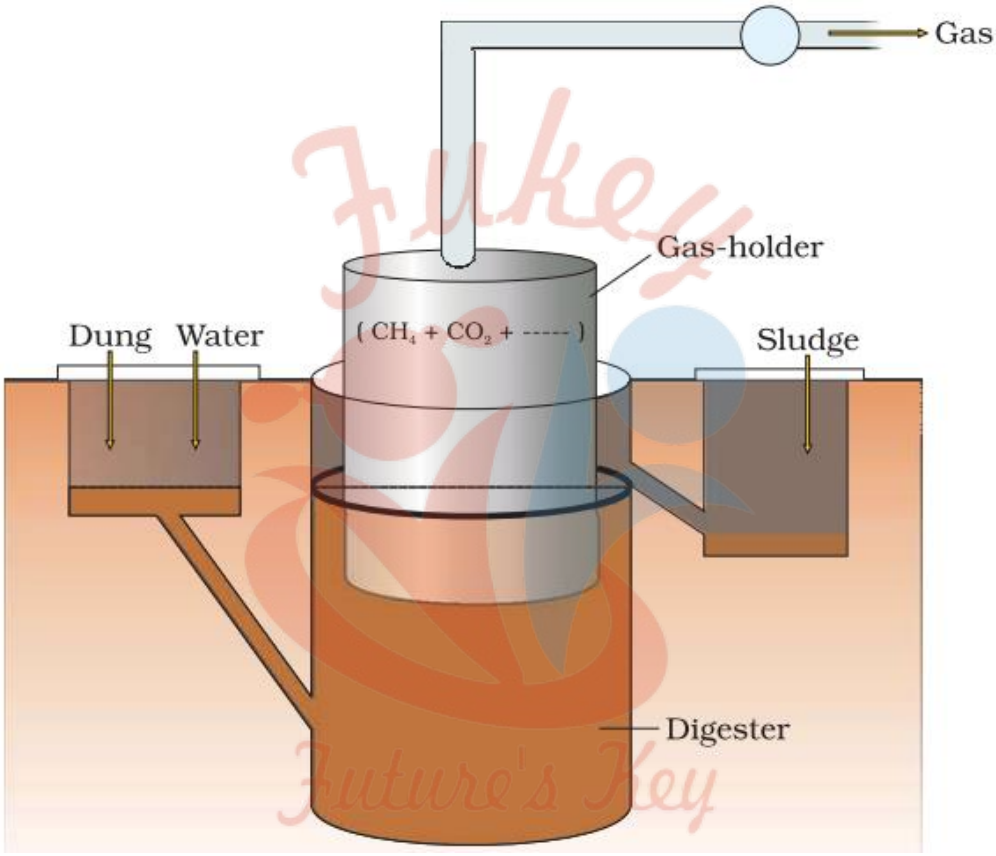
Biogas is a mixture of gases produced by the microbial activity that can be used as fuel. Certain bacteria that grow anaerobically on cellulosic material produce large amount of methane along with CO_2 and H_2. These bacteria are collectively called methanogens (Methanobacterium).

Biogas Plant:

- The excreta of cattle (gobar) is rich in methanogens bacteria and is used for generation of biogas also called as gobar gas.
- The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC).
- Biogas plant consists of a concrete tank in which bio-wastes are collected and slurry

of dung is fed.

- A floating cover is placed over digester that moves upward when gas is produced. The gas produced is removed and supplied through an outlet pipe for consumption.
- The spent slurry is removed through another outlet and used as fertilisers. Biogas plant is more often build in rural areas as large amount of cattle dug is available easily.



Microbes as Biocontrol agent:

Biocontrol means use of biochemical method for controlling plant disease and pests. The chemical used as pesticides and insecticides are harmful to human beings and animals.

Biological control of pests and disease is a method of controlling pest on natural prediction rather than chemicals. The organic farmer creates a system where the pests are not eradicated but kept at manageable level by complex system of check and balance within the living and vibrant ecosystem. For example, the Ladybird and Dragonflies are used to get rid of aphids and mosquitoes respectively. On brassicas and fruit tree, to control butterfly caterpillars bacteria Bacillus thuringiensis is used.

Biological control developed for use in the treatment of plant disease is the fungus Trichoderma. Trichoderma are free-living fungi that are very common in the root systems that control several plant pathogens.

Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications.

Microbes as Bio fertilizers:

Bio fertilizers are organisms that enrich the nutrient quality of the soil. The main sources include bacteria, fungi and cyanobacteria.

The root nodule formed by Rhizobium bacteria on root of leguminous plants increase the nitrogen level of soil, necessary for various metabolic processes. Azotobacter and Azospirillum are free living bacteria that live in soil and fix atmospheric nitrogen into organic forms.

Symbiotic association of fungi with angiosperm plants (mycorrhiza) also increase the fertility of soil. Glomus form mycorrhiza that absorbs phosphorus from the soil and passes it to the plant. These microbes also provide benefits like resistance to root-borne pathogens, tolerance to salinity and drought.

Cyanobacteria (Nostoc, Anabaena), an autotrophic microbes found in aquatic and terrestrial environment fix atmospheric nitrogen. In paddy field this acts as important bio-fertilizer. Blue green algae also add organic matter to the soil and increase its fertility.

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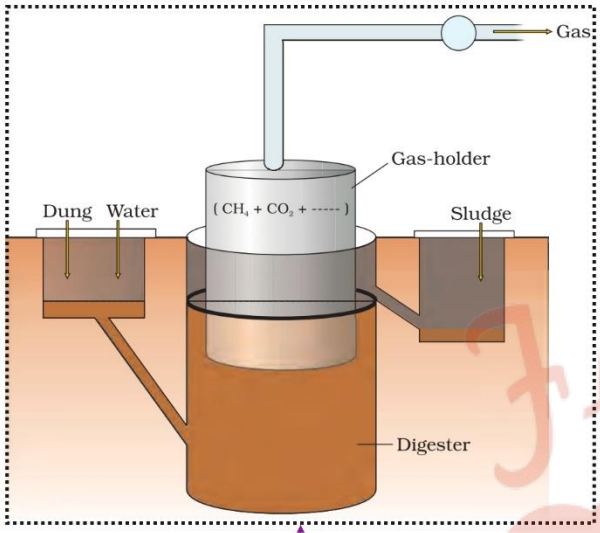


Bacteria involved is Methanobacterium

Microbes in Production of Biogas

Saccharomyces cerevisiae

Lactobacillus Or LAB

Propionibacterium sharmanii

Curd

Bread

Toddy

Swiss Cheese

Microbes in household products

- Bacillus thuringiensis: Control butterfly caterpillar
- Tichoderma sp.
- Baculoviruses (esp. genus Nucleopolyhedrovirus): Controls insect and arthropods

Microbes as biocontrol agents

Microbes in Human Welfare

Microbes as bio-fertilizers

Fungi

Cynobacteria

Bacteria

Mycorrhiza- Association of Glomus with plants

- Symbiosis: Anabaena in Azolla
- Free living: Nostoc, Oscillatoria and blue green algae

- Rhizobium (Symbiotic bacteria)
- Azospirillum and Azotobacter (free living bacteria)

Microbes in Sewage Treatment

Secondary Sewage Treatment

Primary Sewage Treatment

Involves removal of coarse solid materials

Involves the action of microbes

Microbes in Industrial Products

Organic acids

Fermented beverages

Saccharomyces cerevisiae

Enzymes

- Lipases
- Pectinases and proteases (To clarify bottels juices)
- Streptikinase (Streptococcus- used as clot

Antibiotic Penicillin

Penicillium notatum

Bioactive molecules

Aspergillus niger Acetobacter aceti Clostridium butylicum Lactobacillus (a fungus): Citric acid (a bacterium): Acetic acid (a bacterium): Butyric acid (a bacterium): Lactic acid

- Statins- Monascus purpureus used as blood-cholesterol lowering agents
- Cyclosporine A- Trichoderma polysporum used as an immunosuppressive drugs

Important Questions

➢ Multiple Choice Questions:

1. The vitamin whose content increases following the conversion of milk into curd by lactic acid bacteria is:
   (a) Vitamin C
   (b) Vitamin D
   (c) Vitamin B12
   (d) Vitamin E.
2. Waste water treatment generates a large quantity of sludge, which can be treated by:
   (a) digesters
   (b) activated sludge
   (c) chemicals
   (d) oxidation pond.
3. Methanogenic bacteria are not found in:
   (a) rumen of cattle
   (b) gobar gas plant
   (c) bottom of water logged paddy fields
   (d) activated sludge.
4. The primary treatment of waste water involves the removal of:
   (a) dissolved impurities
   (b) stable particles
   (c) toxic substances
   (d) harmful bacteria.
5. BOD of waste water is estimated by measuring the amount of:
   (a) total organic matter
   (b) biodegradable organic matter
   (c) oxygen evolution
   (d) oxygen consumption.
6. Which one of the following alcoholic drinks is produced without distillation?
   (a) Wine
   (b) Whisky
   (c) Rum
   (d) Brandy.
7. The technology of biogas production from cow dung was developed in India largely due to

the efforts of:

(a) Gas Authority of India
(b) Oil and Natural Gas Commission
(c) Indian Agricultural Research Institute and Khadi & Village Industries Commission
(d) Indian Oil Corporation.

8. The free-living fungus Trichoderma can be used for:

(a) killing insects
(b) biological control of plant diseases
(c) controlling butterfly caterpillars
(d) producing antibiotics.

9. What would happen if oxygen availability to activated sludge floes is reduced?

(a) It will slowdown the rate of degradation of organic matter.
(b) The centre of floes will become anoxic, which would cause death of bacteria and eventually breakage of floes.
(c) Floes would increase in size as anaerobic bacteria would grow around floes.
(d) Protozoa would grow in large numbers.

10. Mycorrhiza does not help the host plant in:

(a) Enhancing its phosphorus uptake capacity
(b) Increasing its tolerance to drought
(c) Enhancing its resistance to root pathogens
(d) Increasing its resistance to insects.

11. Which one of the following is not a nitrogen-fixing organism?

(a) Anabaem
(b) Nostoc
(c) Azotobacter
(d) Pseudomonas.

12. Big holes in Swiss cheese are made by a:

(a) machine
(b) bacterium that produces methane gas
(c) bacterium producing a large amount of carbon dioxide
(d) fungus that releases a lot of gases during its metabolic activities.

13. The residue left after methane production from cattle dung is:

(a) burnt
(b) buried in land-fills
(c) used as manure

(d) used in civil construction.

14. Methanogens do not produce:

(a) oxygen
(b) methane
(c) hydrogen sulphide
(d) carbon dioxide.

15. Activated sludge should have the ability to settle quickly so that it can:

(a) be rapidly pumped back from sedimentation tank to aeration tank
(b) absorb pathogenic bacteria present in waste water while sinking to the bottom of the settling tank
(c) be discarded and anaerobically digested
(d) absorb colloidal organic matter

➢ Very Short Question:

1. How does a small amount of curd added to fresh milk convert it into curd? Mention a nutritional quality that get added to the curd.

2. Why is secondary treatment of water in sewage treatment plant called biological treatment?

3. An antibiotic called ' Wonder Drug' was used to treat the wounded soldiers of America during World War-II. Name the drug and the scientist who discovered it.

4. You have observed that fruit juice in bottles bought from the market are clearer as compared to those made at home. Give reason.

5. Alexander Fleming discovered ' Penicillin, but its full potential as an effective antibiotic was established by other scientists. Name the two scientists.

6. Name the plant whose sap is used in making 'Toddy'. Mention the process involved in it.

7. What is the medical use of cyclosporin A.

8. Name the pests that lady bird & dragon flies help to get rid off respectively?

9. Give an example to prove that microbes release gases during metabolism?

10. What are interferons?

➢ Short Questions:

1. Expand the 'LAB'. How are LABs beneficial to humans?

2. What is cyclosporin A? What is its importance?

3. How do antibiotics act?

4. Write the various steps of fermentation.

5. What are the two ways by which micro-organisms can be grown in bioreactors?
6. What is sewage? In which way can this be harmful?
7. What is the key difference between primary and secondary sewage treatment?
8. Draw a simple diagram to show an anaerobic sludge digester.

➢ Long Questions:

1. Give examples to prove that microbes release gases during metabolism.
2. What are Baculo viruses? Write their significance.
3. List the events that lead to the production of biogas from wastewater whose BOD has been reduced significantly.

➢ Assertion and Reason Questions:

1. Two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both assertion and reason are true and reason is the correct explanation of assertion.
b) Both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Assertion: Champagne gives off bubbles.

Reason: Alcoholic content is 12-16% in champagne.

2. Two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both assertion and reason are true and reason is the correct explanation of assertion.
b) Both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

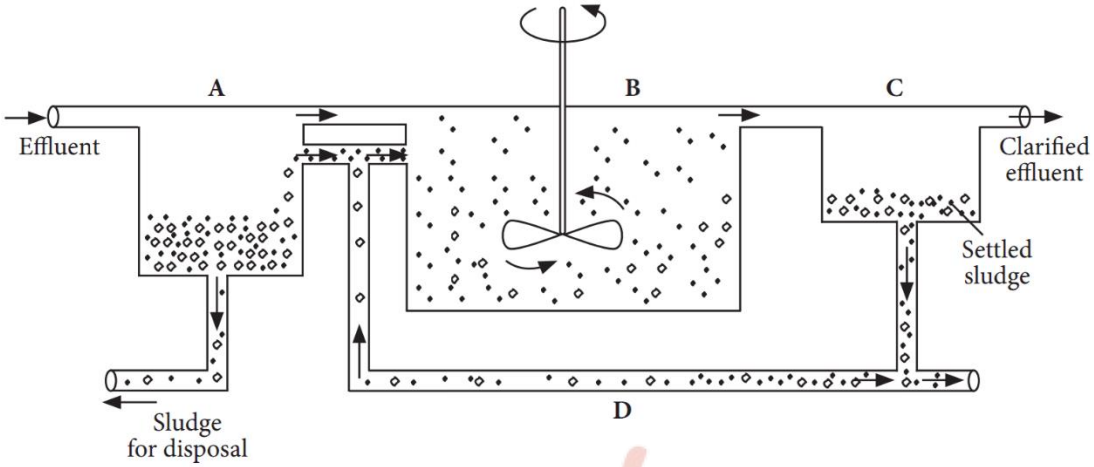
Assertion: The alcoholic content of fortified wines are high.

Reason: The fermentation is stopped before all the sugars are being converted.

➢ Case Study Questions:

1. Read the following and answer any four questions from (i) to (v) given below:

Saurin, a M.Sc student, get an assignment on sewage treatment plant (STP) to study the microbial load. After visiting such plant in his locality, he makes a simplified diagram of the STP for his project. Study the diagram given below and answer the following questions.



(i) In the diagram 'A' denotes:

a. Aeration tank.
b. Primary settling tank.
c. Secondary settling tank.
d. Sludge digester.

(ii) Which of the following is incorrect regarding the sludge released from A?

a. It is formed after primary treatment.
b. It does not require aeration.
c. It possesses floes of decomposer microbes.
d. It is used in landfills.

(iii) A large number of aerobic heterotrophic microbes grow in:

a. A
b. B
c. C
d. Both (a) and (b).

(iv) What is denoted by 'D' in the given diagram?

a. Primary sludge.
b. Primary effluent.
c. Activated sludge.
d. Secondary effluent.

(v) Assertion**:** The colloided and finely suspended matter of sewage form aggregates which are called floes.

Reason: Floes contain masses of bacteria, slime and fungal filaments.

a. Both assertion and reason are true and reason is the correct explanation of assertion.
b. Both assertion and reason are true but reason is not the correct explanation of assertion.
c. Assertion is true but reason is false.
d. Both assertion and reason are false.

2. Read the following and answer any four questions from (i) to (v) given below:

Green manuring is the fanning practice where a leguminous plant which has derived enough benefits from its association with appropriate species of Rhizobium, is ploughed into the field soil and then a non-legume is sown and allowed to get benefitted from the already present nitrogen fixer. Some legumes, such as, Crotolaria juncea, Sesbania rostrata, Lencaena leucocephala, etc. are used as green manure. Rhizobia, that fix atmospheric nitrogen in the form of nitrate, live in the roots ofleguminous plants. These nutrients are used by non-leguminous plants through the practice of green manuring.

(i) Green manures mainly provide nutrient enriched in:

a. Magnesium.
b. Sulphur.
c. Nitrogen.
d. Both (a) and (b).

(ii) Which of the following plants is used as green manure in crop fields?

a. Saccharum.
b. Dichanthium.
c. Phyllonthus.
d. Crotolaria.

(iii) Green manure plants belong to the Family:

a. Lamiaceae.
b. Papilionaceae.
c. Liliaceae.
d. Poaceae.

(iv) Due to excess use of chemical fertilisers rich in nitrate, _____ disease occurred in children.

a. Jaundice.
b. Septicemia.
c. Methemoglobinemia.
d. Botulism.

(v) A green manure is:

a. Rice.
b. Maize.
c. Sorghum.
d. Sesbania.

✓ **Answer Key-**

➢ Multiple Choice Answers:

1. (c) Vitamin B12
2. (d) oxidation pond.
3. (d) activated sludge.
4. (b) stable particles
5. (d) oxygen consumption.
6. (a) Wine
7. (c) Indian Agricultural Research Institute and Khadi & Village Industries Commission
8. (b) biological control of plant diseases
9. (b) The centre of floes will become anoxic, which would cause death of bacteria and eventually breakage of floes.
10. (d) Increasing its resistance to insects.
11. (d) Pseudomonas.
12. (c) bacterium producing a large amount of carbon dioxide
13. (c) used as manure
14. (a) oxygen
15. (a) be rapidly pumped back from sedimentation tank to aeration tank

➢ Very Short Answers:

1. A large number of lactic acid bacteria are found in small amount of curd which multiply and convert the milk into curd by producing the lactic acid. The nutritional quality improves by increasing Vitamin B12.
2. In this treatment Organic wastes of sewage water are decomposed bycertain microorganisms in presence of water.
3. Penicillin, Alexander Fleming.
4. Bottle juices are clarified by the use of pectinase and proteases.
5. Ernest chain and Howard Florey.
6. Palm tree, by fermentation.
7. Cyclosporin A is used as an immunosuppressive drug during organ transplantation.
8. Lady bird beetle is useful to get rid off aphids & dragon – flies control mosquitoes.
9. The best example of microbes release gases during metabolism are the puffed dough & bread.
10. Proteins released by cells in response to viral infection which they help to combat are

called interferons.

➢ Short Answer:

1. LAB-Lactic Acid Bacteria Benefits:

- Found in curd. They improve the nutritional quality of food.
- Yogurt is prepared from milk by Lactobacillus Bulgaricus.

2. Cyclosporin A. It is an eleven-membered cyclic oligopeptide obtained through the fermentative activity of fungus Trichoderma Polysporum.

Importance. It has antifungal, anti-inflammatory, and immunosuppressive properties. It inhibits the activation of T-cells and therefore, prevents rejection reactions in organ transplantation.

3. Antibiotics do not have identical effects on all harmful microbes. All of them inhibit growth or destroy bacteria, viruses, and fungi. Actually, antibiotic molecules should disrupt a vital link in the microbe's metabolism and this link is their target or point of impact.

4. The major steps of fermentation are:

i. Sterilization of the fermenter and medium in steam. It is carried out under pressure and high temperature.

ii. Inoculation of a selected strain of the yeast.

iii. Recovery of the product.

5. Micro-organisms can be grown in the bioreactors in two ways:

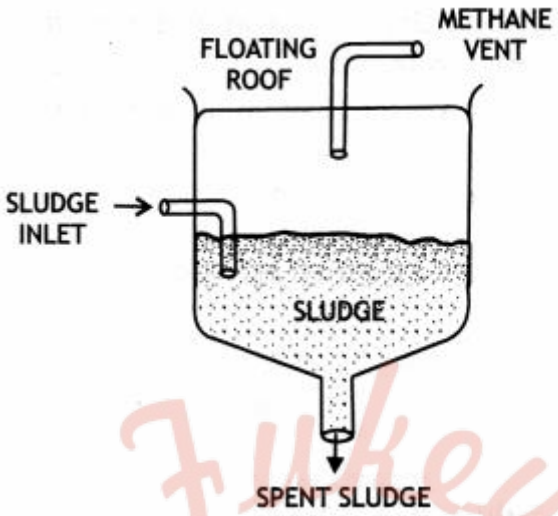
i. As a layer or film on the surface of the nutrient medium. It is known as a support growth system.

ii. By suspending cells or mycelia in a liquid medium contained in the growth vessel. It is known as a suspended growth system.

6. Sewage is used and wastewater consisting of human excreta, wash waters, industrial and agricultural wastes that enter the sewage system. In general, sewage contains 95.5% water and 0.1 to 0.5% organic and inorganic matter. They are very harmful to us due to the presence of a variety of micro¬organisms in them, most of which are highly pathogenic. Sewage has a high BOD value, which develops anaerobic conditions in water resulting in the death of water animals and emitting foul smell due to incomplete oxidation of organic materials in the sewage.

7. Primary treatment of wastes is the screening and removal of insoluble particulate materials, by addition of alum and other coagulants. It is the physical removal of 20-30% of organic materials present in sewage in particulate form. Secondary treatment of waste is the biological removal of dissolved organic matter through trickling filters, activated sludge, lagoons, extended aeration systems, and anaerobic digestors.

8. Answer:



Anaerobic sludge digester.

➢ Long Answer:

1.

i. Large holes in 'Swiss Cheese' are due to the production of a large amount of CO_2 by a bacterium named Propionibacterium shamanic.

ii. The puffed-up appearance of dough is due to the production of CO_2 gas by yeast, Saccharomyces cerevisiae.

iii. Methane, H_2S, and CO_2 are produced during microbial digestion of organic compounds in the case of secondary treatment of sewage.

iv. The dung of the cattle produces methane gas in the biogas pLants.

2. Baculoviruses are those viruses, which attack insects and other arthropods, e.g. Nuclepolyhedrovirus.

Significance:

- Baculoviruses are species-specific and narrow-spectrum insecticides.
- They have no negative impacts on plants, birds, mammals, or even other non-target insects.
- The desirable aspect In conservation of beneficial insects in overall integrated pest management (IPM) program as in an ecologically sensitive area.

3.

i. During secondary treatment of wastewater, sewage fungus forms focus.

ii. BOD decreases. As it decreases to 10-15% of originaL sewage, the wastewater Is taken to a Large settling tank where the focus of sewage fungus settles down.

iii. The supernatant can be passed into water bodies or treated further.

iv. The organic sediment is passed into an anaerobic sludge digester where anaerobic microbes methanogens decompose organic matter.

v. It is accompanied by the production of blogs and the formation of manure or compost.

➢ Assertion and Reason Answers:

1. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Solution:

Champagne wines are bottled before fermentation is complete. These wines give off bubbles of gas. Alcohol content is 12-16%.

2. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Solution:

In fortified wines, the fermentation is stopped before all the sugar is being converted and at least l percent is still present. The still wines have a higher alcoholic content due to the addition of wine, brandy or alcohol.

➢ Case Study Answers:

1.

(i) (b) Primary settling tank.

Explanation:

In the given diagram, A-primary settling tank, B-aeration tank, C-secondary settling tank.

(ii) (c) It possesses floes of decomposer microbes.

Explanation:

Primary sludge does not possess floes of decomposer microbes. These are formed during secondary treatment.

(iii) (b) B

Explanation:

A large number of aerobic heterotrophic microbes grow in the aeration tank (B).

(iv) (c) Activated sludge.

(v) (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

2.

(i) (c) Nitrogen.

(ii) (d) Crotolaria.

Explanation:

Some legumes such as Crotolaria juncea, Sesbania rostrata, Lencaena leucocephala, etc. are used as green manure.

(iii) (b) Papilionaceae.

(iv) (c) Methemoglobinemia.

Explanation:

Drinking water with high nitrate can cause a potentially fatal disorder called methemoglobinemia.

(v) (d) Sesbania.