Microbes In Human Welfare

1. Lactobacillus that sets milk into curd is categorised as : (2024)

(A) Cyanobacteria

(B) Archaebacteria

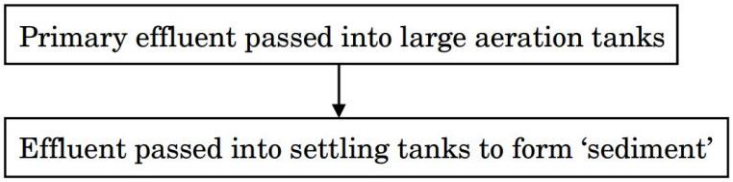
(C) Chemosynthetic bacteria

(D) Heterotrophic bacteria

Ans. (D) Heterotrophic bacteria

2. Large quantities of sewage are generated every day in cities as well as in towns and are treated in Sewage Treatment Plants (STPs) to make them less polluting. Given below is the flow diagram of stages of STP. (2024)

Study the flow diagram and answer the questions that follow :



(i) (1) Why is primary effluent passed into large aeration tanks ?

(2) What is the sediment formed, referred to as ? Mention its significance.

(3) Explain the final step in the settling tank before the treated effluent is released into water bodies.

Ans. (1) In aeration tanks there is growth of aerobic microbes and fungi (flocs) that consume major part of organic matter in effluent thus reducing BOD

(2)

• Activated sludge

• Used as inoculum in aeration tanks.

(3) Bacterial flocs are allowed to sediment. (Activated sludge)

(ii) Name any two organisms commonly used as biofertilisers, belonging to different kingdoms. Write how each one acts as a biofertiliser.

Ans.

- Rhizobium (Bacteria), live symbiotically in nodules of roots of leguminous plants and fix atmospheric nitrogen into organic form and provide nitrogen to the plant.

- Glomus (fungi), live in symbiotic association with roots of higher plants and absorb phosphorus from the soil and passes it to plants.

- Cyanobacteria (Anabaena, Nostoc, Oscillatoria), Add organic matter to the soil and increase fertility (Paddy fields)

Previous Years' CBSE Board Questions

8.1 Microbes in Household Products

MCQ

1. Large holes in "Swiss Cheese" are due to

(a) Propionibacterium shermanii (b) Saccharomyces cerevisiae

(c) Penicillium chrysogenum (d) Acetobacter aceti.
(2020)

VSA (1 mark)

2. Why do we add an inoculum of curd to milk for curdling it?
(AI 2015C)

3. How are lactic acid bacteria beneficial to us other than helping in curdling the milk? **(AI 2015C)**

SA II (3 marks)

4. Explain the changes that milk undergoes when suitable starter/inoculum is added to it. How does the end product formed prove to be beneficial for human health? **(2020)**

8.2 Microbes in Industrial Products

MCQ

5. Given below are the list of the commercially important products and their source organisms.

Select the option that gives the correct matches.

List-A		List-B	
S.No.	Bioactive Products		Microbes (Source Organism)
A.	Cyclosporin A	(i)	*Streptococcus*
B.	Statins	(ii)	*Trichoderma polysporum*
C.	Streptokinase	(iii)	*Penicillium notatum*
D.	Penicillin	(iv)	*Monascus purpureus*

Options:

(a) A-(i), B-(ii), C-(iii), D-(iv)

(b) A-(iii), B-(iv), C-(ii), D-(i)

(c) A-(iv), B-(iii), C-(ii), D-(i)

(d) A-(ii), B-(iv), C-(i), D-(iii)

(2023)

6. The bioactive molecule used as an immunosuppressive agent during organ transplant is

(a) tetracyclin

(b) cyclosporin A

(c) statin

(d) streptomycin.

(2020)

SA I (2 marks)

7. Describe the contributions of Alexander Fleming, Ernest Chain and Howard Florey in the field of microbiology.

(2020)

8. Name the microbes that help production of the following products commercially.

(a) Statin

(b) Citric acid

(c) Penicillin

(d) Butyric acid

(AI 2017)

9. Mention a product of human welfare obtained with the help of each one of the following microbes:

(a) LAB

(b) Saccharomyces cerevisiae

(c) Propionibacterium shermanii

(d) Aspergillus niger

(Delhi 2015)

10. Bottled fruit juices are clearer as compared to those made at home. Explain.

(Foreign 2015)

SA II (3 marks)

11. (a) Match the microbes listed under column-A with the products mentioned under column-B.

Column-A	Column-B
(H) Penicillium notatum	(i) Statin
(I) Trichoderma polysporum	(ii) Ethanol
(J) Monascus purpureus	(iii) Antibiotic
(K) Saccharomyces cerevisiae	(iv) Cyclosporin-A

(b) Why does 'Swiss Cheese' develop large holes?

(Delhi 2019)

12. State the medicinal value and the bioactive molecules produced by Penicillium notatum, Monascus purpureus and Trichoderma polysporum.

(AI 2019)

13. State the medicinal value and the bioactive molecules produced by Streptococcus, Monascus and Trichoderma.

(AI 2015)

14. Identify a, b, c, d, e and f in the table given below:

Scientific name of the organism	Product produced	Use in human welfare
Streptococcus	Streptokinase that was later modified	a
b	Cyclosporin A	c
Monascus purpureus	d	e
Lactobacillus	f	Sets milk into curd

(Foreign 2014)

8.3 Microbes in Sewage Treatment

VSA (1 mark)

15. What are 'flocs, formed during secondary treatment of sewage?

(NCERT Exemplar, Delhi 2019)

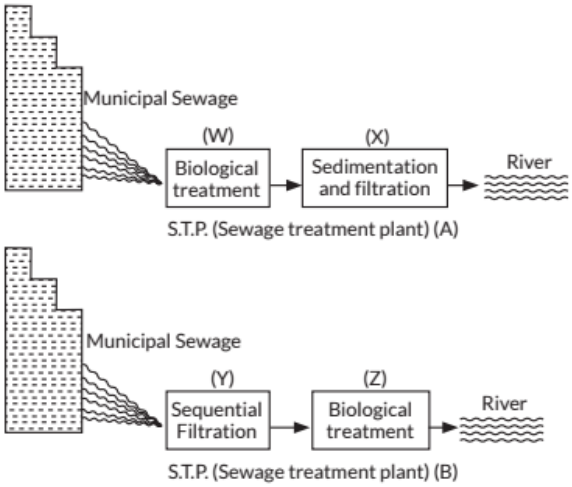
SA I (2 marks)

16. What are flocs ? State their role in biological treatment of sewage.

(Term II, 2021-22)

17. Mention the common bacterium found in the anaerobic sludge during sewage treatment and also in the rumen of cattle. How is this bacterium commercially useful? (Term II, 2021-22)

18. Study the given diagram of Sewage Treatment Plant (S.T.P.) and answer the questions that follow:



(a) Which one of the two 'S.T.P. (A) or (B) will be more effective in treating the human excreta in the municipal waste?

(b) Write the steps followed in carrying the treatment of the sewage in step (Z), once the BOD of sewage is reduced significantly till it is passed on to the "anaerobic sludge digesters".

(Term II, 2021-22)

19. List the events that reduce the Biological Oxygen Demand (BOD) of a primary effluent during sewage treatment.
(Delhi 2016)

20. Distinguish between the roles of flocs and anaerobic sludge digesters in sewage treatments.

(Delhi 2016)

21. Explain the different steps involved during primary treatment phase of sewage. (AI 2015)

22. Explain the process of secondary treatment given to the primary effluent up to the point it shows significant change in the level of biological oxygen demand (BOD) in it. **(Al 2015)**

23. Name two groups of organisms which constitute 'flocs. Write their influence on the level on BOD during biological treatment of sewage.

(Al 2014C)

SA II (3 marks)

24. Describe how do 'flocs' and 'activated sludge' help in sewage treatment.

(Delhi 2017)

25. Secondary treatment of the sewage is also called biological treatment. Justify this statement and explain the process.

(AI 2017)

LA (5 marks)

26. (a) Explain the process of sewage water treatment before it can be discharged into natural water bodies.

(b) Why is this treatment essential?

(AI 2014)

27. (a) Name the category of microbes occurring naturally in sewage and making it less polluted during the treatment.

(b) Explain the different steps involved in the secondary treatment of sewage.

(Foreign 2014)

8.4 Microbes in Production of Biogas

VSA (1 mark)

28. Write any two places where methanogens can be found.

(Delhi 2019)

SA I (2 marks)

29. Explain the role of microorganisms in the following:

(a) Reducing the sugar content in grape juice

(b) Production of a fuel

(2023)

30. Why is a slurry of cattle dung (gobar) added to bio-wastes in the tank of a gobar gas plant for generation of biogas?

(2019 C)

31. List the events that lead to biogas production from waste water whose BOD has been reduced significantly.

(Delhi 2016)

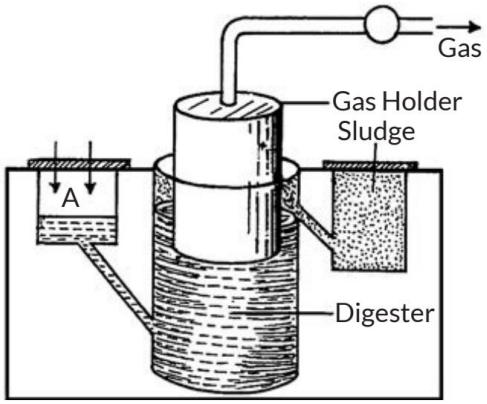
SA II (3 marks)

32. (a) Write the scientific name of methanogen bacteria. Where are these bacteria generally found? Explain their role in biogas production.

(b) Name the components of biogas.

(2020)

33. Study the picture of biogas plant given below and answer the questions that follow.



(a) Name the components gaining entry from A into the chamber.

(b) Mention the group of bacteria and the condition in which they act on the component that entered from A in the digester.

(c) Name the components that get collected in gas holder.

(2020)

34. What are methanogens? How do they help to generate biogas?

(AI 2015)

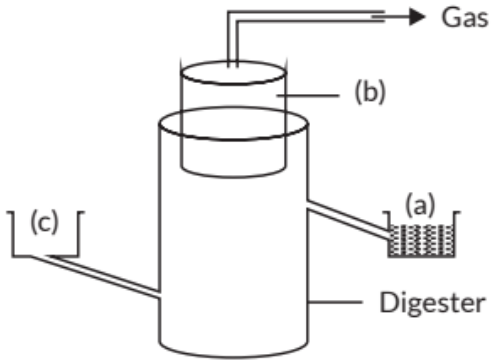
35. How can sewage be used to generate biogas? Explain. (Foreign 2015)

36. (a) What are methanogens?

(b) Name the animals in which methanogens occur and the role they play there.

(Delhi 2014)

37.



The diagram above is that of a typical biogas plant. Explain the sequence of events occurring in a biogas plant. Identify a, b and c.
(NCERT Exemplar, Delhi 2014)

8.5 Microbes as Biocontrol Agents

SA I (2 marks)

38. (i) Give an example of a genus of virus used as narrow spectrum insecticidal biocontrol agent.

(ii) How does its use serve as an aid in overall integrated pest management programme? **(2023)**

39. Name the effective biocontrol agents of several plant pathogens belonging to group of viruses. Also write the ways they support the environment.
(Term II, 2021-22)

40. Different species belonging to genus Trichoderma are useful to humans as well as to plants. Justify their roles by giving one instance of each.
(Term II, 2021-22)

41. Name the genus of baculovirus that acts as a biological control agent inspite of being a pathogen. Justify by giving three reasons that make it an excellent candidate for the job. **(2020)**

42. Why is genus Nucleopolyhedrovirus considered an excellent biocontrol agent? **(2019 C)**

43. Name a genus of baculovirus. Why are they considered good biocontrol agents? **(AI 2016)**

OR

Explain the significant role of the Genus Nucleopolyhedrovirus in an ecological sensitive area. **(Al 2014)**

SA II (3 marks)

44. Bacillus thuringiensis plays an important role in Integrated Pest Management strategy. Explain how. Name any two crops that are protected efficiently from pests. **(Term II, 2021-22)**

45. Name the genus to which baculoviruses belong. Describe their role in the integrated pest management programmes.
(AI 2019)

46. (a) Organic farmers prefer biological control of diseases and pests to the use of chemicals for the same purpose. Justify.

(b) Give an example of a bacterium, a fungus and an insect that are used as biocontrol agents. **(2018)**

47. Given below is a list of six microorganisms. State their usefulness to humans.

(a) Nucleopolyhedrovirus

(b) Saccharomyces cerevisiae

(c) Monascus purpureus

(d) Trichoderma polysporum

(e) Penicillium notatum

(f) Propionibacterium shermanii
(Delhi 2016)

48. (a) How do organic farmers control pests? Give two examples.

(b) State the difference in their approach from that of conventional pest control methods. **(Al 2016)**

49. How are baculoviruses and Bacillus thuringiensis used as biocontrol agents? Why are they preferred over readily available chemical pesticides?
(AI 2014C)

8.6 Microbes as Biofertilisers

MCQ

50. Which one of the following fixes the atmospheric nitrogen but is not an autotroph?

(a) Oscillatoria (b) Rhizobium

(c) Anabaena (d) Nostoc
(2023)

51. Some cyanobacteria in aquatic and terrestrial environment that enrich the soil by fixing atmospheric nitrogen are

(a) Rhizobium and Azotobacter

(b) Azospirillum and Glomus

(c) Anabaena and Nostoc

(d) Azospirillum and Azotobacter
(2020 C)

VSA (1 mark)

52. State one reason for adding blue-green algae to the agricultural soil.
(AI 2014C)

SA I (2 marks)

53. Farmers are often suggested to use the following organisms in their crop land so as to improve the soil fertility. Explain.

(i) Rhizobium (ii) Anabaena **(Term II, 2021-22)**

54. Some of the microbes used as biofertilisers are prokaryotes. Name the taxonomic group they come under. With the help of an example, mention how they act as biofertilisers. **(Term II, 2021-22)**

55. Many members of genus Glomus form a mycorrhizal association with plants. Elaborate how is this association beneficial to the plants.
(Term II, 2021-22)

56. Name any two autotrophic microbes and state how they serve as biofertilisers. **(2020)**

57. Name two organisms belonging to two different kingdoms that are commonly used as biofertilisers and how.
(2020)

58. Your advice is sought to improve the nitrogen content of the soil to be used for cultivation of a non-leguminous terrestrial crop.

(a) Recommend two microbes that can enrich the soil with nitrogen.

(b) Why do leguminous crops not require such enrichment of the soil?
(2018)

59. How does the application of the fungal Genus, Glomus, to the agricultural farm increase the farm output?
(Delhi 2017)

SA II (3 marks)

60. How does the activity of each one of the following helps in organic farming?

(a) Mycorrhiza

(b) Cyanobacteria

(c) Rhizobium

(Delhi 2019)

61. Choose any three microbes, from the following which are suited for organic farming which is in great demand these days for various reasons. Mention one application of each one chosen.

Mycorrhiza; Monascus; Anabaena; Rhizobium; Methanobacterium; Trichoderma.
(Delhi 2015)

LA (5 marks)

62. What are biofertilisers? Describe their role in agriculture. Why are they preferred to chemical fertilisers?
(NCERT, Foreign 2015)

CBSE Sample Questions

8.3 Microbes in Sewage Treatment

MCQ

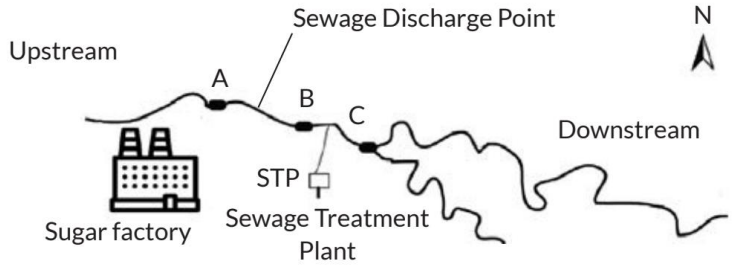
1. Which of the following water samples in the table given below, will have a higher concentration of organic matter?

	Level of pollution	Value of BOD
(a)	High	High
(b)	Low	Low
(c)	Low	High
(d)	High	Low

(2022-23)

SA I (2 marks)

2. Water samples were collected at points A, B and C in a segment of a river near a sugar factory and tested for BOD level. The BOD levels of samples A, B and C were 400 mg/L, 480 mg/L and 8 mg/L respectively. What is this indicative of? Explain why the BOD level gets reduced considerably at the collection point C?



(Term II, 2021-22)

3. Define flocs and state their importance in biological treatment of wastewater. **(2020-21)**

8.5 Microbes as Biocontrol Agents

MCQ

4. Read the following and answer any four questions from 4(i) to 4(v) given below:

Ecological Indicators

The presence of dragon flies can reveal changes in the water ecosystems more quickly than studying other animals or plants. In fact, from the nymph to the adult stage, the dragonfly has a significant, positive ecological impact. Dragonfly eggs are laid and hatched in or near water, so their lives impact both water and land ecosystems. Once hatched, dragonfly nymphs can breathe underwater which enables them to eat mosquito larvae, other aquatic insects and worms, and even small aquatic vertebrates like tadpoles and small fish and in the air. Adult dragonflies capture and eat adult mosquitoes. Community wide mosquito control programs that spray insecticides to kill adult mosquitoes also kill dragonflies.

(i) The approach to biological control includes

(a) import and release of an insect pest to a new area to provide hosts for natural enemies

(b) import and release of natural enemies from the native home of an alien insect pest that has invaded a new area

(c) preservation of natural enemies (predators and parasitoids) that are already established in an area

(d) use of insecticides to reduce alien insect pests to establish new equilibrium position.

(ii) Two diseases less likely to occur in a region with plenty of dragonflies are _____.

(a) yellow fever and amoebic dysentery

(b) malaria and yellow fever

(c) anthrax and typhoid

(d) cholera and typhoid

(iii) Dragonflies indicate positive ecological impact as

(a) the presence of dragonflies indicates polluted water

(b) dragonfly nymphs selectively eat mosquito larvae

(c) they help to decrease the probability of diseases spread by vectors

(d) dragonfly do not cause any harm to beneficial species.

(iv) The most effective stages in the life cycle of dragonfly that eradicate mosquitoes are

(a) larvae and adult

(b) caterpillar and adult

(c) nymph and adult

(d) pupa and adult.

(v) Assertion: Releasing dragonflies in areas where there is an outbreak of malarial diseases can be an environment friendly method of control.

Reason: Dragonflies are dominant species and will not allow mosquitoes to reproduce.

(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.
(2020-21)

8.6 Microbes as Biofertilisers

SA I (2 marks)

5. Explain four advantages of mycorrhizal association to plants.
(2020-21)

Detailed SOLUTIONS

Previous Years' CBSE Board Questions

1. (a): Large holes in 'Swiss Cheese' are due to CO_2 produced by bacterium called Propionibacterium shermanii during the process of fermentation.

2. The starter or inoculum used in preparation of milk products contains millions of lactic acid bacteria. Curd is prepared by inoculating cream and skimmed milk with Lactobacillus acidophilus at a temperature of about 40° C or less. Lactobacillus converts lactose sugar of milk into lactic acid which causes coagulation and partial digestion of milk protein casein and milk gets changed into curd.

3. Lactic acid bacteria (LAB) is beneficial to us in the following ways other than helping in curdling of milk:

(i) Increases nutritional quality of curd by increasing vitamin B_{12} content.

(ii) Checks the growth of disease-causing microbes in the gut.

4. The starter or inoculum used in preparation of milk products actually contains millions of lactic acid bacteria. Curd is prepared by inoculating cream and skimmed milk with Lactobacillus acidophilus at a temperature of about 40° C or less.

Lactobacillus converts lactose sugar of milk into lactic acid which causes coagulation and partial digestion of milk protein casein and milk gets changed into curd.

Lactic acid bacteria are beneficial to us in the following ways other than helping in curdling of milk:

(i) Increases nutritional quality of curd by increasing vitamin B_{12} content.

(ii) Checks the growth of disease-causing microbes in the gut.

5. (d)

6. (b): Cyclosporin A has immunosuppressive properties and inhibits T cell activation, thereby preventing rejection reactions in organ transplant.

7. Alexander Fleming (1928) discovered the first antibiotic Penicillin from fungus Penicillium notatum. He found that extract from this fungus could inhibit the growth of bacterium Staphylococcus aureus. Antibiotics were commercially extracted by efforts of Ernest Chain and Howard Florey. Fleming, Chain and Florey were awarded Nobel Prize in 1945 for their efforts and contributions.

8. (a) Statin - Monascus purpureus

(b) Citric acid - Aspergillus niger

(c) Penicillin - Penicillium notatum

(d) Butyric acid - Clostridium acetobutylicum

9. (a) LAB (Lactic acid bacteria) - Curd

(b) Saccharomyces cerevisiae - Bread

(c) Propionibacterium shermanii - Swiss Cheese

(d) Aspergillus niger - Citric acid

10. The fruit juices sold in market or bottled juices are treated with pectinases and proteases which makes them clearer than those made at home.

11. (a) (H)-(iii); (I)-(iv); (J)-(i); (K)-(ii)

(b) Large holes in 'Swiss Cheese' are due to CO_2 produced by bacterium called Propionibacterium shermanii during the process of fermentation. Concept Applied Â Anaerobic process

12. Penicillin is an antibiotic obtained from Penicillium notatum. It helps in curing rheumatic fever, tonsillitis, sore throat, gonorrhoea and some pneumonia types. Statin obtained from Monascus purpureus, inhibits cholesterol synthesis and is therefore used in lowering blood cholesterol, e.g., lovastatin, pravastatin, simvastatin. Cyclosporin A is obtained from Trichoderma polysporum. This chemical has antifungal, anti-inflammatory and immunosuppressive properties. It inhibits activation of T-cells and therefore, prevents rejection reactions in organ transplantation.

13. Streptokinase (Tissue Plasminogen Activator or TPA) is an enzyme obtained from cultures of some haemolytic bacterium Steptococcus which is modified genetically to function as clot buster. It has fibrinolytic effect hence; it helps in clearing blood clots inside the blood vessels through dissolution of intravascular fibrin. Cyclosporin A is obtained from fungus Trichoderma polysporum that is used as an immunosuppressive agent in organ transport patients. Statin is obtained from yeast Monascus purpureus have been commercialised as blood-cholesterol lowering agent.

14. a - Helps in clearing blood clots inside the blood vessels through dissolution of intravascular fibrin.

b - Trichoderma polysporum

c - Antifungal, anti-inflammatory and immunosuppressive prevents rejection reactions in organ transplantation.

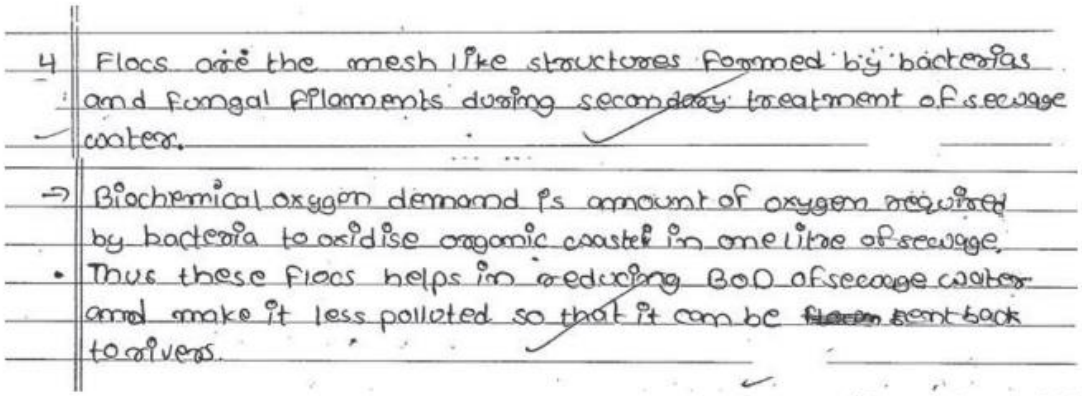
d - Statins

e - Help in lowering blood cholesterol level

f - Lactic acid

15. Flocs are masses of bacteria held together by slime and fungal filaments to form mesh-like structures. The microbes in flocs digest a lot of organic matter, converting it into microbial biomass and releasing lots of minerals.

16.



[Topper's Answer, 2022]

17. The common bacterium present in the anaerobic sludge during sewage treatment and also in the rumen of cattle is Methanobacterium, commonly called as methanogens.

In the rumen of cattle, these bacteria help in the breakdown of cellulose and play an important role in the nutrition of cattle. The cow dung rich in Methanobacterium are commercially used for the generation of biogas, commonly called gobar gas from dung and sewage. It has capability to produce methane and fuel gas inside gobar gas plant.

18. (a) STP (B) will be more effective in treating the human excreta in the municipal waste as sequential filtration is primary treatment and biological treatment is secondary treatment.

(b) Once the BOD of sewage or waste water is reduced significantly, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment, which is known as the activated sludge. A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum. The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters where other kinds of bacteria which grow anaerobically digest the bacteria and the fungi in the sludge.

19. Secondary treatment or biological treatment of sewage considerably reduces the biological oxygen demand (BOD) of primary effluent during sewage treatment. The organic matter present in the effluent is decomposed with the help of microbial flora called as sewage fungus. The effluent is constantly agitated or aerated. This causes the growth of various aerobic microorganisms and

sewage fungi. These microbes digest the organic matter thereby reducing the BOD of original sewage by 10-15%.

20. Flocs are masses of aerobic bacteria held together by slime and fungal filaments to form mesh like structures. These microbes digest a lot of organic matter converting it into microbial biomass and releasing a lot of minerals. This reduces biochemical oxygen demand or BOD.

In anaerobic sludge digesters, aerobic microbes present in the sludge get killed. Anaerobic microbes digest the organic mass as well as aerobic microbes of the sludge.

During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas which can be used as source of energy as it is inflammable. The spent sludge of anaerobic sludge digester can be used as manure or part of compost.

21. Primary treatment phase of sewage treatment removes floating and suspended solids from sewage through two processes of filtration and sedimentation. First floating matter is removed through sequential filtration. The filtrate is kept in large open settling tanks where grit settles down. Aluminium or iron sulphate is added in certain places to flocculation and settling down of solids. The sediment is called primary sludge while the supernatant is called effluent. The primary sludge traps a lot of microbes and debris. It is subjected to composting or landfill where anaerobic digestion removes the organic matter.

22. During secondary treatment, the primary effluent is taken to aeration tanks. A large number of aerobic heterotrophic microbes grow in the aeration tank. They form flocs which are masses of bacteria held together by slime and fungal filaments to form mesh like structures. The microbes digest a lot of organic matter, converting it into microbial biomass and releasing a lot of minerals. As a result, the BOD of the waste matter is reduced to 10-15% of raw sewage, it is passed into settling tank.

23. Aerobic bacteria and fungi constitute 'flocs'. Flocs are masses of aerobic bacteria held together by slime and fungal filaments to form mesh like structures. These microbes digest a lot of organic matter converting it into microbial biomass and releasing a lot of minerals. This reduces biochemical oxygen demand or BOD.

24. After the primary sewage treatment, primary effluent is taken for secondary or biological treatment into aeration tanks. A large number of aerobic heterotrophic microbes grow in the aeration tank. They form flocs which are masses of bacteria held together by slime and fungal filaments to form mesh-like structures. The microbes in flocs digest a lot of organic matter, converting it into

microbial biomass and releasing lot of minerals. This decreases the Biochemical Oxygen Demand of effluent.

Now, the effluent is passed into settling tank where the bacterial flocs are allowed to sediment. The sediment of settling tank is called activated sludge. A part of it is further used as an inoculum in aeration tank to start a new batch of secondary sewage treatment and the remaining is passed into a large tank called anaerobic sludge digesters. Here, the aerobic microbes get killed but the anaerobic microbes produce marsh gas (biogas) which is used as a source of energy.

25. Secondary treatment of the sewage is also called biological treatment because microbes are used to digest the organic matter in the sewage water. The steps involved in the process are:

(i) Primary effluent is passed into aeration tank where liquid is constantly agitated and air is pumped into it.

(ii) Large number of aerobic heterotrophic microbes grow in aeration tank and form flocs.

(iii) Microbes digest organic matter, convert it into microbial biomass and reduce BOD.

(iv) In settling tank, the bacterial flocs are allowed to undergo sedimentation. The effluent is passed into natural waters like rivers and streams. It can also be further treated with chemicals to purify it.

(v) The sediment is called activated sludge. A part of this sludge is passed into anaerobic sludge digester where anaerobic microbes digest the organic mass as well as anaerobic microbes.

(vi) During digestion, microbes produce methane, H_2S and CO_2. These gases form biogas that can be used as source of energy.

26. (a) Sewage water can be purified by passing it through sewage treatment plants with the action of microorganisms. A sewage treatment plant separates solids from liquids by physical processes and purifies the liquid by biological processes. There are three stages of this treatment; primary, secondary and tertiary. Primary treatment is physical, secondary biological and tertiary chemical. Primary treatment phase of sewage treatment removes floating and suspended solids from sewage through two processes of filtration and sedimentation. First floating matter is removed through sequential filtration. The filtrate is kept in large open settling tanks where grit settles down. Aluminium or iron sulphate is added in certain places to flocculation and settling down of solids. The sediment is called primary sludge while the supernatant is called effluent. The primary sludge traps a lot of microbes and debris. It is subjected to composting or landfill where anaerobic digestion removes the organic matter.

During secondary treatment, the primary effluent is taken to aeration tanks. A large number of aerobic heterotrophic microbes grow in the aeration tank. They form flocs that are masses of bacteria held together by slime and fungal filaments to form mesh-like structures.

The microbes digest a lot of organic matter, converting it into microbial biomass and releasing a lot of minerals. As a result, the BOD of the waste matter is reduced to 10-15% of raw sewage, it is passed into settling tank. In settling tank, the bacterial flocs are allowed to undergo sedimentation. The effluent or supernatant is generally passed into natural water bodies and sediment of settling tank is called activated sludge.

(b) This treatment prevents water pollution and water borne diseases. So, it is essential in order to protect the natural water bodies from sewage pollution.

27. (a) Aerobic heterotrophs like bacteria and fungi occur in sewage water. They are natural decomposers and digest a lot of organic matter present in the polluted water thereby releasing minerals and reducing organic wastes. Hence, they play an important role in cleaning water and making it fit for various domestic uses.

(b) Secondary treatment of the sewage is also called biological treatment because microbes are used to digest the organic matter in the sewage water. The steps involved in the process are:

(i) Primary effluent is passed into aeration tank where liquid is constantly agitated and air is pumped into it.

(ii) Large number of aerobic heterotrophic microbes grow in aeration tank and form flocs.

(iii) Microbes digest organic matter, convert it into microbial biomass and reduce BOD.

(iv) In settling tank, the bacterial flocs are allowed to undergo sedimentation. The effluent is passed into natural waters like rivers and streams. It can also be further treated with chemicals to purify it.

(v) The sediment is called activated sludge. A part of this sludge is passed into anaerobic sludge digester where anaerobic microbes digest the organic mass as well as anaerobic microbes.

(vi) During digestion, microbes produce methane, H_2S and CO_2. These gases form biogas that can be used as source of energy.

28. Methanogens are commonly found in the anaerobic sludge during sewage treatment and in the rumen (a part of stomach) of cattle.

29. (a) Grape juice is fermented by yeast (Saccharomyces cerevisiae) to reduce its sugar content. The fermentation process converts sugars present in grape juice to ethanol and carbon dioxide. This can be explained with the following reaction:

$$\underset{\text{(Sugar)}}{C_6H_{12}O_6} \xrightarrow[\text{cerevisiae}]{\textit{Saccharomyces}} \underset{\text{(Ethanol)}}{C_2H_5OH} + \underset{\text{(Carbon dioxide)}}{CO_2}$$

(b) Methanobacterium when grow anaerobically on cellulosic material produces a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. This mixture of gases is called biogas and can be used as source of energy as it is inflammable. Biogas produced is thus used for cooking and lighting.

30. Slurry consisting of excreta (dung) of cattle, commonly called gobar, is rich in methanogen bacteria (i.e., present in the rumen of cattle). Dung is used for the generation of biogas. Methane bacterium grow anaerobically and breakdown the cellulose of dung to liberate gases like methane, carbon dioxide and hydrogen sulphide.

31. Sewage water can be purified by passing it through sewage treatment plants with the action of microorganisms. There are three stages of this treatment; primary, secondary and tertiary. Primary treatment is physical, secondary is biological and tertiary is chemical. Primary treatment phase of sewage treatment removes floating and suspended solids from sewage through two processes of filtration and matter is removed through sequential filtration. The filtrate is kept in large open settling tanks where grit settles down. The sediment is called primary sludge while the supernatant is called effluent.

During secondary treatment, the primary effluent is taken to aeration tanks. A large number of aerobic heterotrophic microbes grow in the aeration tank. They form flocs that are masses of bacteria held together by slime and fungal filaments to form mesh-like structures.

The microbes digest a lot of organic matter, converting it into microbial biomass and releasing a lot of minerals. As a result, the BOD of the waste matter is reduced to 10-15% of raw sewage and then it is passed into settling tank. Where the bacterial flocs are allowed to undergo sedimentation. The effluent or supernatant is generally passed into natural water bodies and sediment of settling tank is called activated sludge.

32. (a) The scientific names of various methanogenic bacteria are Methanococcus, Methanogenium, Methanolobus, Methanosaeta, etc.

They are found in oxygen deficient environment such as marshes, swamps, sludge and digestive systems of ruminant animals like cow, buffalo, etc.

These microorganims are present in anaerobic sludge digester where they digest organic mass as well as aerobic microbes of the sludge to produce mixture of gases containing methane, H_2S and CO_2 called biogas.

(b) Biogas is a methane rich fuel gas produced by anaerobic breakdown of biomass with the help of methanogenic bacteria. It is made up of methane (50-70%), carbon dioxide (30-40%) with traces of nitrogen, hydrogen sulphide and hydrogen.

33. (a) Dung and water enter the digester chamber from A.

(b) Methanogens are the group of bacteria and these grow anaerobically. In anaerobic sludge digester, methanogens digest the flocs of bacteria and fungi in activated sludge and produce biogas.

(c) Biogas is a methane rich fuel gas produced by anaerobic breakdown of biomass with the help of methanogenic bacteria. It is made up of methane (50-70%), carbon dioxide (30-40%) with traces of nitrogen, hydrogen sulphide and hydrogen.

34. Methanogens are a group of anaerobic bacteria which obtain their energy by reducing carbon dioxide and oxidising hydrogen with the production of methane. They are found in oxygen deficient environment such as marshes, swamps, sludge and digestive systems of ruminant animals like cow, buffalo, etc. These microorganims are present in anaerobic sludge digester where they digest organic mass as well as aerobic microbes of the sludge to produce mixture of gases containing methane, H_2S and CO_2 called biogas.

35. (i) Primary treatment phase of sewage treatment removes floating and suspended solids from sewage through two processes of filtration and sedimentation. First floating matter is removed through sequential filtration. The filtrate is kept in large open settling tanks where grit settles down. The sediment is called primary sludge while the supernatant is called effluent.

(ii) Primary effluent is passed into aeration tank where liquid is constantly agitated and air is pumped into it.

(iii) Large number of aerobic heterotrophic microbes grow in aeration tank and form flocs.

(iv) Microbes digest organic matter, convert it into microbial biomass and reduce BOD.

(v) In settling tank, the bacterial flocs are allowed to undergo sedimentation. The effluent is passed into natural waters like rivers and streams. It can also be further treated with chemicals to purify it.

(vi) The sediment is called activated sludge. A part of this sludge is passed into anaerobic sludge digester where anaerobic microbes containing methanogens digest the organic mass as well as anaerobic microbes.

(vii) During digestion, microbes produce methane, H_2S and CO_2. These gases form biogas that can be used as source of energy.

36. (a) Methanogens are a group of anaerobic bacteria which obtain their energy by reducing carbon dioxide and oxidising hydrogen with the production of methane.

(b) Methanogens are present in the rumen (a part of stomach of cattle) such as cow, buffalo. In rumen, these bacteria help in the breakdown of glucose and play an important role in the nutrition of cattle. The excreta of cattle are rich in these bacteria (methanogens) and can be used for generation of biogas.

37. In the given diagram, 'a' represents sludge, 'b' represents gas holder and 'c' represents dung and water. The biogas production is an anaerobic process and is carried out in an air tight, closed cylindrical concrete tank called a digester. The tank has a concrete inlet basin on one side for feeding fresh cattle dung. There is a concrete outlet on the outer side for removing the digested sludge. The top of the tank serves as the gas tank. It has an outlet pipe for the biogas.

Biogas generation is a three-stage anaerobic digestion of animal and other organic wastes.

In the first stage of anaerobic digestion, facultative anaerobic decomposer microbes bring about enzymatic breakdown of complex organic compounds into simpler and soluble compounds often called monomers. For this, the decomposer microbes secrete cellulases, proteases and lipases (cellulolytic, proteolytic and lipolytic enzymes).

In the second stage, the simple soluble compounds of microbial digestion or monomers are acted upon by fermentation causing microbes. The latter change the monomers into organic acids.

Organic acids, especially acetic acid, are acted upon by methanogenic bacteria in the third or final stage. The methane bacteria convert organic acids as well as carbon dioxide into methane. The biogas thus formed is conducted through the outlet pipe and used for domestic purposes. The digested sludge is removed from tank and is used as fertiliser.

38. (i) Baculoviruses belonging to the genus Nucleopolyhedrovirus are used as narrow spectrum insecticidal biocontrol agent.

(ii) Baculoviruses such as Nucleopolyhedrovirus are excellent candidates for species-specific, narrow spectrum insecticidal applications. These have been

shown to have no negative impacts on plants, mammals, birds, fishes or even on non-target insects. Beneficial insects can be conserved as they are species specific. Therefore, these viruses are important component of integrated pest management (IPM) programme and deals with ecological sensitive areas.

39. The effective biocontrol agents of several plant pathogens belonging to group of viruses are the baculoviruses that belong to genus Nucleopolyhedrovirus are useful in controlling many insects and other arthropods. These viruses support the environment as they have species-specific, narrow spectrum insecticidal applications. They have been shown to have no negative impact on plants, animals, birds, mammals, fishes or evenon non-target insects. Hence, due to this, the beneficial insects are being conserved to aid in an overall integrated pest management (IPM) programme.

40. Useful role in humans: Fungus Trichoderma polysporum is used to produce a bioactive molecule, cyclosporin 'A'. It has antifungal, anti-inflammatory and immunosuppressive properties. It inhibits activation of T-cells and therefore, prevents rejection reaction in organ transplantation.

Useful role in plants: Trichoderma is used as biocontrol agent in the treatment of plant diseases. It is free living fungus, found commonly in root ecosystem, exerts biocontrol over several plant pathogens.

41. Nucleopolyhedrovirus, a genus of baculovirus that act as a biological control agent inspite of being a pathogen.

(i) They are species specific.

(ii) They are narrow spectrum bioinsecticides.

(iii) There is no side effect on plants, mammals, birds/fish and non-targent insects. Beneficial insects are conserved.

42. Nucleopolyhedrovirus, a genus of baculoviruses is useful in controlling many insects and other arthropods. They are species specific narrow spectrum bioinsecticides with no side effects on plants, mammals, birds, fish and non-target insects. Therefore, they serve as an important component of integrated pest management programme in dealing with ecological sensitive areas. These properties are useful in organic farming.

43. Refer to answer 42.

44. Bacillus thuringiensis is used as biocontrol agent. It is available as dried spores which are mixed with water and sprayed onto vulnerable plants, where they are eaten by insect larvae. Bt forms a protein crystal which contain a toxic insecticidal protein. These Bt toxin protein exist as inactive prototoxins but once caterpillar ingest the inactive toxin, it is converted into an active form of toxin due

to the alkaline pH of the gut which solubilise the crystal. The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect. The Bt toxin is coded by cry gene.

The two crops that are protected efficiently from pests are Bt cotton and Bt corn plant.

45. Baculoviruses belong mostly to the Genus Nucleopolyhedrovirus. They are useful in controlling many insects and other arthropods. They are species specific narrow spectrum bioinsecticides with no side effects on plants, mammals, birds, fish and non-target insects. Beneficial insects are conserved.

Baculoviruses are, therefore, an important component of integrated pest management (IPM) programme and are dealing with ecological sensitive areas.

46. (a) Chemical pesticides used in agricultural fields are toxic and they kill even useful organisms along with harmful ones, harm human beings and animals, pollute soil, water and crop plants. It is estimated that despite the use of chemical pesticides, 30% of the agricultural produce is lost to pathogens and pests because these continue to develop resistance against various pesticides. Now, organic farmers prefer biological control of diseases and pests to the use of chemicals. Biopesticides are the biological agents that control the growth of weeds, insects and pathogens in an agricultural field. They have targeted actions and are harmless to the crop plants, other beneficial field animals and humans. In organic farming, pests and pathogens are not eradicated but kept at manageable levels by a system of checks and balances as operating in ecosystem. An organic farmer holds the view that eradicating pests is undesirable because without them the beneficial predatory and parasitic organisms which depend upon them for food would also be annihilated.

(b) Bacterium as a biocontrol agent: Bacillus thuringiensis is effective against the cabbage looper. Fungi as a biocontrol agent: Trichoderma found in root ecosystem exerts biocontrol over several plant pathogens. Insect as a biocontrol agent: Lady bird beetle and dragonflies feeds on aphids and prey upon mosquitoes, respectively.

47. (a) Nucleopolyhedrovirus: It is a baculovirus which is an effective biocontrol agent as it is useful in controlling many insects and other arthropods. It serves as species specific narrow spectrum bioinsecticide.

(b) Saccharomyces cerevisiae: It is used to ferment dough, in order to make bread. It is also used for the preparation of ethanol.

(c) Monascus purpureus: Its fermentation activity produces statins which inhibits cholesterol synthesis and is therefore used in lowering blood cholesterol.

(d) Trichoderma polysporum: It is a fungus that produces cyclosporin-A, which is used as immunosuppressive agent in organ-transplantation.

(e) Pencillium notatum : It secretes the antibiotic Penicillin.

(f) Propionibacterium shermanii : It is used in processing of 'Swiss Cheese'. The large holes in Swiss Cheese are due to production of a large amount of CO_2 by this bacterium.

48. (a) Organic farming involves the use of biopesticides, i.e., biocontrol agents to control weeds, insects and pathogen. These biocontrol agents include viruses, bacteria, protozoa, fungi and mites. For e.g., Baculovirus heliothis can control cotton bollworm (Helicoverpa zea) whereas Bacillus thuringeinsis is effective against cabbage looper (Trichoplusia).

(b) Conventional pest control involves the use of chemical pesticides to control pests in crop-field. Pesticides are toxic and harmful to crop plants, other crop field animals and humans. On the other hand, organic farmers use biopesticides to control field pests. This approach is environment friendly, exercises specific control over pests and is harmless to humans and other beneficial field animals.

49. Nucleopolyhedrovirus, a genus of baculoviruses is useful in controlling many insects and other arthropods. They are species specific narrow spectrum bioinsecticides with no side effects on plants, mammals, birds, fish and non-target insects. Bacillus thuringiensis is a soil bacterium. The spores of this bacterium possess insecticidal cry protein, hence, kill larvae of certain insects. This bacterium was first biopesticide to be used on commercial scale. The commercial preparations of B. thuringiensis contain a mixture of spores, cry protein and inert carrier.

Chemical pesticides used in agricultural fields are toxic and biocides. They kill even useful organisms along with harmful ones, harm human beings and animals, pollute soil and water and crop plants. It is estimated that despite the use of chemical pesticides 30% of the agricultural produces is lost to pathogens and pests because these continue to develop resistance against various pesticides.

On the other hand, biopesticides are the biological agents that control the growth of weeds, insects and pathogens in an agricultural field. They have targeted actions and are harmless to the crop plants, other beneficial field animals and humans. Therefore, nowadays biopesticides are preferred over chemical pesticides.

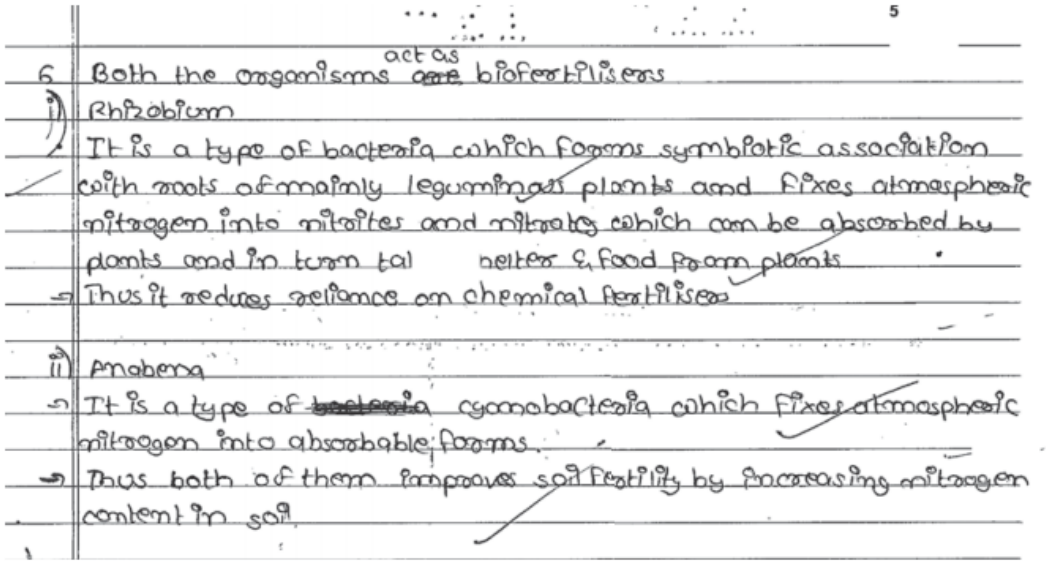
50. (b) : Rhizobium is a heterotrophic bacteria. Rhizobium bacteria is found in the nodules on the roots of leguminous plants showing symbiotic association. These bacteria fix atmospheric nitrogen into organic form, which is used by the

plants as nutrient. Anabaena, Nostoc and Oscillatoria are autotrophic cyanobacteria.

51. (c) : Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environments many of which can fix atmospheric nitrogen and enrich the soil, e.g., Anabaena, Nostoc, Oscillatoria.

52. A number of free living and symbiotic blue-green algae or cyanobacteria have the property of nitrogen fixation and are photosynthetic. Therefore, they add organic matter as well as extra nitrogen to the soil. Hence, blue green algae serve as biofertilisers and are added to agricultural fields such as cotton, maize, Mowar, rice, etc. Example of Cyanobacteria – Anabaena, Nostoc, Oscillatoria.

53.



5

6 Both the organisms act as biofertilisers

i) Rhizobium

It is a type of bacteria which forms symbiotic association with roots of mainly leguminous plants and fixes atmospheric nitrogen into nitrites and nitrates which can be absorbed by plants and in turn tal helter & food from plants

→ Thus it reduces reliance on chemical fertilisers

ii) Anabena

→ It is a type of ~~bacteria~~ cyanobacteria which fixes atmospheric nitrogen into absorbable forms.

→ Thus both of them improves soil fertility by increasing nitrogen content in soil.

[Topper's Answer, 2022]

54. Prokaryotic microbes used as biofertilisers comes under taxonomic group monera. These microbes enrich the nutrient quality of soil. The bacteria Rhizobium lives in symbiotic association with the roots of leguminous plants. These bacteria fix atmospheric nitrogen into organic forms which is used by plant as nutrient.

55. Mycorrhiza is symbiotic association of fungi with plants. Many members of genus Glomus form mycorrhiza. This association is beneficial to plants as fungal symbiont absorbs phosphorus from soil and passes it to the plant. Plants having such associations also show resistance to root borne pathogens, tolerance to drought and salinity and an increase in plant growth and development.

56. Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environment many of which can fix atmospheric nitrogen, e.g., Anabaena, Nostoc, etc. Blue green algae add organic matter to the soil and increase its fertility.

57. Rhizobium (Kingdom Monera) and Glomus (Kingdom Fungi) are commonly used as biofertilisers. Rhizobium forms symbiotic association with root nodules of leguminous plants. They fix nitrogen in the nodule which becomes available to the plant and to the soil. Glomus forms mycorrhizal association with roots of higher plants which is mutually beneficial to both the partners. The fungus performs functions like:

(i) absorption of water

(ii) solubilisation of organic matter of soil humus

(iii) direct absorption of minerals from the soil

(iv) secretion of anti-microbial substances that protect the plant root from pathogenic attack.

In return, it gets sugar and other food ingredients from the plant.

58. (a) Azotobacter and Azospirillum

(b) Leguminous crops have symbiotic nitrogen fixing bacteria such as Rhizobium that live in the root nodules of these plants. These bacteria obtain food and shelter from the plant and in return they trap nitrogen directly from the atmosphere which they provide to the plant.

59. Many members of the Genus Glomus form symbiotic associations with plants to form mycorrhiza. Glomus helps to absorb phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought and an overall increase in plant growth and development. Therefore, Glomus increases the farm yield.

60. (a) Mycorrhiza is a mutually beneficial or symbiotic association of a fungus with the root of a higher plant. The most common fungal partners of mycorrhiza are Glomus species. Mycorrhizal roots show a sparse or dense wooly growth of fungal hyphae on their surface. They perform several functions for the plant - (i) Absorption of water, (ii) Solubilisation of organic matter of the soil humus, release of inorganic nutrients, absorption and their transfer to root. (iii) Direct absorption of minerals from the soil over a large area and handing over the same to the root. Plants with ectomycorrhiza are known to absorb 2-3 times more of nitrogen, phosphorus, potassium and calcium. (iv) The fungus secretes anti-microbial substances which protect the young roots from attack of pathogens.

(b) A number of free living and symbiotic blue green algae or cyanobacteria have the property of nitrogen fixation and are photosynthetic. Therefore, they add organic matter as well as extra nitrogen to the soil. Hence, blue green algae serve

as biofertilisers and are added to agricultural fields such as cotton, maize, jowar, rice, etc.

(c) Rhizobium, is a soil bacterium which either lives freely in soil or lives in symbiotic association with roots of leguminous plants. The bacterium forms nodules or roots of leguminous plants where it lies in groups. When it occurs freely in soil, it cannot fix nitrogen.

Nitrogen fixing ability develops only when it is present inside root nodules. Hence, Rhizobium is categorised as symbiotic bacterium. It acts as a biofertiliser as it helps plants in obtaining their nitrogen nutrition.

61. Among the given microbes, the ones which are in great demand for organic farming are:

Mycorrhiza, Anabaena and Rhizobium. Mycorrhiza is a mutually beneficial or symbiotic association of a fungus with the roots of a higher plant. Mycorrhizal roots show a sparse or dense wooly growth of fungal hyphae on their surface. Plants having mycorrhizal associations show resistance to root-borne pathogens. Anabaena is free living and symbiotic nitrogen fixing cyanobacteria. Cyanobacteria are photosynthetic and have the property of nitrogen fixation. They add organic matter as well as extra nitrogen to the soil. Cyanobacteria are an extremely low cost biofertilisers.

Rhizobium is symbiotic nitrogen fixing bacteria. They form a mutually beneficial association with the plants. The bacteria obtain food and shelter from plants. In return, they give a part of their fixed nitrogen to the plants, thus enhancing the availability of nutrient to crops. It forms nodules on the roots of legume plants. They develop the ability to fix nitrogen only when they are present inside the root nodules.

62. Biofertilisers are microorganisms which bring about nutrient enrichment of soil by enhancing the availability of nutrients like nitrogen (N) and phosphorus (P) to crops. Biofertilisers includes-nitrogen fixing bacteria, nitrogen fixing cyanobacteria and mycorrhiza. Azotobacter occurring in fields of cotton, maize, jowar and rice, not only increases yield but also saves nitrogen fertiliser upto 10-25 kg/ha.

A number of free-living cyanobacteria or blue-green algae have the property of nitrogen fixation, e.g., Anabaena, Nostoc, Oscillatoria, etc. Cyanobacteria are extremely low cost biofertilisers.

The most important of the symbiotic nitrogen fixing bacteria is Rhizobium. It forms nodules on the roots of legume plants.

Nitrogen fixing cyanobacteria (blue-green algae) form symbiotic association with several plants, e.g., cycad roots, lichens, liverworts, Azolla (fern). Azolla-

Anabaena association is of great importance to agriculture. Azolla pinnata is a free-floating fresh water fern which multiplies rapidly, doubling every 5-7 days. The fern can co-exist with rice plants because it does not interfere with their growth. Chemical fertilisers cause pollution of water bodies as well as groundwater, besides getting stored in crop plants. Therefore, farmers are pressing for switch over to organic farming which includes the use of manures biofertilisers, biopesticides.

Biofertilisers are microorganisms which bring about nutrient enrichment of soil by enhancing the availability of nutrients to crops. The microorganisms which act as biofertilisers are bacteria, cyanobacteria (blue green algae) and mycorrhizal fungi. Bacteria and cyanobacteria have the property of nitrogen fixation while mycorrhizal fungi preferentially withdraw minerals from organic matter for the plant with which they are associated. Phosphate is also solubilised by some bacteria and by some fungi that form association with plant roots.

CBSE Sample Questions

1. (a): BOD is measure of organic matter present in water. The greater the BOD of wastewater, more is its polluting potential.

2. At collection points A and B, the BOD level is high due to high organic pollution caused by sugar factory and sewage discharge.

At the collection point C, the water was released after secondary treatment/ biological treatment where vigorous growth of useful aerobic microbes into flocs consume the major part of the organic matter present in the river water or effluent due to sugar factory and sewage discharge.

3. Flocs are masses of semidecayed organic matter along with decomposed microbes which are surrounded by slime.

They separate the organic matter from waste water. Flocs settle down in secondary tanks and take part in the formation of sludge. They can be used as an inoculum in biological treatment of wastewater as well as source of biogas and manure.

4. (i) (a)

(ii) (b) Pathogens of malaria and yellow fever are Plasmodium and Flavi virus respectively. Malaria and yellow fever are transmitted by mosquito's female Anopheles and Aedes aegypti respectively. Dragonflies eat larva as well as adult mosquitoes, so, malaria and yellow fever are less likely to occur in region with plenty of dragonflies.

(iii) (c): Dragonflies help to decrease the probability of diseases spread by vector such as mosquitoes, houseflies, etc. as they feed upon the larvae and adult mosquitoes.

(iv) (c)

(v) (c)

5. The four advantages of mycorrhizal associations are:

(i) absorbs phosphorus from soil and passes it to the plant.

(ii) provides resistance to root-borne pathogens.

(iii) enhances tolerance to salinity and drought.

(iv) induces an overall increase in plant growth and development.