

CHAPTER 10 MICROBES IN HUMAN WELFARE

Syllabus

- *Microbes in Human Welfare : In household food processing, industrial production, sewage treatment, energy generation and as biocontrol agents and biofertilizers. Antibiotics; production and judicious use.*

Chapter Analysis

| List of Topics | 2016 | | 2017 | | 2018 |
|----------------------------------|--------------|--------------|--------------|--------------|--------------|
| | D | OD | D | OD | D/OD |
| Microbes in Household Products | 1 Q (3 M) | | | 1 Q (2 M) | |
| Microbes in Industrial Products | | | | | |
| Microbes on Sewage treatment | | | 1 Q (3 M) | | 1 Q (3 M) |
| Microbes in production of Biogas | | | | | |
| Microbes as Biocontrol agents | | 1 Q (3 M) | | | 1 Q (3 M) |
| Microbes as Biofertilisers | | 1 Q (2 M) | 1 Q (2 M) | | 1 Q (2 M) |

- On the basis of above analysis, it can be concluded that a 3 marks or 2 marks Question on names of microbes/their importance/their use/their products are usually asked from this chapter. So, learn the biological names of microbes, and their product with correct spellings.



TOPIC-1

Microbes-in Household Products, Industrial Products and in Sewage Treatment and Biogas

Revision Notes

- Microbes are the major components of biological system on the earth.
- They are very minute organism which can not be seen with the naked eyes but are viewed under the microscope.
- Microbes are present everywhere such as in soil, water, air, inside our body and bodies of animals and plants.
- They are also present where no other life-form could possibly exist such as deep inside the geysers (thermal vents) where the temperature may be as high as 100°C, deep in the soil, under the layers of snow several metres thick and in highly acidic environments.
- Microbes are diverse—protozoa, bacteria, fungi and microscopic plants.
- Viruses, viroids and also prions are not considered as living entities, even though, they are considered as infectious agents.

TOPIC - 1

Microbes-in Household Products, Industrial Products and in Sewage Treatment and Biogas P. 258

TOPIC - 2

Microbes as Biocontrol Agents and Bio-Fertilisers P. 271

- Microbes like bacteria and many fungi can be grown on nutritive media to form colonies that can be seen with the naked eyes. Such cultures are useful in studies on micro-organisms.
- Some microbes are harmful to the mankind, causing a number of infectious diseases but some are important in many ways for human welfare.

Microbes in household products.

- **Lactobacillus or Lactic Acid Bacteria (LAB)**
 - It converts milk into curd.
 - It produces lactic acid that coagulates and partially digests the milk protein casein.
 - A small amount of curd containing LAB converts fresh milk into curd.
 - It also increases vitamin B₁₂.
 - In stomach, it inhibits growth of pathogens.
- **Bacterial Fermentation (Anaerobic Respiration)**
 - The dough which is formed by fermentative activity of bacteria is used to make foods such as dosa, idli etc.
 - The puffed up appearance of dough is due to the production of CO₂ gas.
 - Toddy is an alcoholic drink, made by fermenting flower sap from palms by bacteria.
 - Microbes are used to ferment fish, soyabean and bamboo-shoots to make foods.
 - Microbes are used to produce cheeses differing in flavour, taste and texture e.g. Large holes in 'Swiss cheese' are due to production of large amount of CO₂ by *Propionibacterium shermanii* (a bacterium).
 - 'Roquefort cheese' is ripened by growing a specific fungus (*Penicillium roqueforti*) on them that gives them a particular flavour.
- **Baker's Yeast (*Saccharomyces cerevisiae*) :**
 - It is used to make bread by fermenting dough.

Microbes in Industrial Products

- The large scale production of beverages, antibiotics etc. on an industrial scale, requires growing microbes in very large vessels called fermentors or bioreactors.
- **Fermented Beverages**
 - *Saccharomyces cerevisiae* (Brewer's yeast) is used in the production of beverages by fermenting malted cereals and fruit juices to produce ethanol.
 - Wine and Beer are produced without distillation.
 - Whisky, Brandy and Rum are produced by distillation of fermented broth.
- **Antibiotics**
 - The chemical substances produced by some microbes that can kill or inhibit the growth of other disease-causing microbes.
 - They are used to treat plague, whooping cough, diphtheria, leprosy and many other infectious diseases.
- **Penicillin**
 - First antibiotic discovered by Alexander Fleming in 1929.
 - He observed that a mould (*Penicillium notatum*) growing in unwashed culture plates around which *Staphylococci* could not grow.
 - He extracted penicillin from it.
 - Ernst Chain and Howard Florey established its full potential as an effective antibiotic.
 - Fleming, Chain and Florey were awarded Nobel Prize (1945).

Chemicals, enzymes and other bioactive molecules

1. Organic Acids : e.g.

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

2. Alcohol :

- Yeast (*Saccharomyces cerevisiae*) is used to produce ethanol.

3. Enzymes :

- **Lipases** : Used in detergent formulations. Help to remove oily stains from the laundry.
- **Pectinases and Proteases** : To clarify bottled juices.
- **Streptokinase** : Produced by *Streptococcus*. Used as a 'clot buster' to remove clots from the blood vessels of patients who have myocardial infection.

4. Cyclosporin A :

- It is produced by *Trichoderma polysporum* (fungus).
- It is used as an immunosuppressive agent in organ transplant patients.

5. Statins :

- It is produced by *Monascus purpureus* (a yeast).
- It is used as blood-cholesterol lowering agent.
- It inhibits the enzymes responsible for synthesis of cholesterol.

Microbes in Sewage Treatment

- Sewage (municipal waste-water) contains large amount of human excreta, organic matter and microbes.
- Sewage is treated in Sewage Treatment Plants to make it less polluting. It includes stages namely primary treatment and secondary treatment.

(a) Primary Treatment

- It is a physical treatment.
- It is the physical removal of large and small particles from sewage. It includes :
 - Removal of floating debris by sequential filtration.
 - Removal of the grit (soil and pebbles) by sedimentation.
 - All solids that settle forms the primary sludge and the supernatant forms the primary effluent.
 - The effluent is taken for secondary treatments.

(b) Secondary treatment (Biological treatment)

- Primary effluent is passed into large aeration tanks and constantly agitated.
- This allows vigorous growth of useful aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh-like structures).
- These microbes consume the major part of the organic matter in the effluent.
- This reduces the BOD (Biochemical Oxygen Demand) of the effluent.
- The effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called '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.
- Here, some anaerobic bacteria digest the bacteria and fungi in the sludge by producing gases like CH_4 , H_2S and CO_2 . These gases form the biogas.
- The effluent from secondary treatment plant is released into natural water bodies like rivers and streams.
- The Ministry of Environment and Forests has initiated Ganga Action Plan and Yamuna Action Plan to save rivers from water pollution.

Biological Oxygen Demand (BOD)

- BOD represents the amount of dissolved oxygen required for the complete oxidation of all the organic matter present in one litre of water by bacteria at 20°C .
- BOD measures the amount of organic matter present in water by measuring the rate of O_2 taken up by microbes.
- Higher BOD indicates that the water is highly polluted by organic matter. Lower value of BOD means the water is less polluted or normal.

Microbes in the Production of Biogas

- Biogas is a mixture of inflammable gases (mainly CH_4) produced by the microbial activity.
- Biogas is used for cooking and lighting.
- Methanogens grow anaerobically on cellulosic material and produce CH_4 e.g. *Methanobacterium*.
- *Methanobacterium* is found in the anaerobic sludge and rumen of cattle (for cellulose digestion).
- The dung of cattle (gobar) is rich in these bacteria.
- Dung can be used for generation of biogas (Gobar gas).
- **A Biogas plant consists of**
 - (a) A concrete tank
 - (b) Floating cover
 - (c) An outlet
- The concrete tank (10-15 feet deep) collects bio-wastes and slurry of dung.

- A floating cover is placed over the slurry, which keeps on rising as the biogas is produced.
 - An outlet which is connected to a pipe to supply biogas.
 - An outlet to remove spent slurry (used as fertilizer).
- Indian Agricultural Research Institute (IARI), Khadi and Village Industries Commission (KVIC) developed technology of biogas production in India.

IMPORTANT DIAGRAMS:

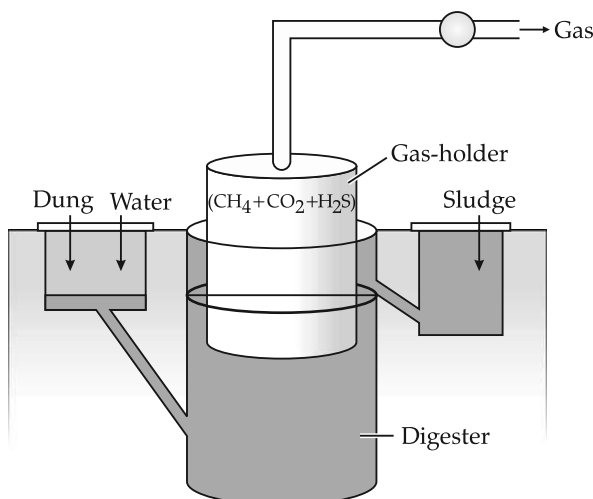


Fig 10.1: A Biogas plant



Very Short Answer Type Questions

(1 mark each)

Q. 1. Why do we add an inoculum of curd to milk for curdling it ?

[U] [Outside Delhi Set-II, Comptt. 2015]

Ans. Inoculum contains *Lactobacilli* which curdles milk into curd with lactic acid. *Lactobacillus* converts lactose sugar of milk into lactic acid which causes coagulation and partial digestion of milk protein casein. As a result, milk gets changed into curd. 1

Commonly Made Error

- Students often forget to write the name of the bacterium, *Lactobacillus*.

Q. 2. How is lactic acid bacteria beneficial to us other than helping in curdling the milk ?

[R] [Outside Delhi Set-III, Comptt. 2015]

OR

Name the nutrient that gets enhanced while curdling of milk by *Lactobacillus*.

[R] [Delhi Set-II, Comptt. 2013]

Ans. Lactic acid bacteria improves the nutritional quality by increasing Vitamin B₁₂. 1

OR

Vitamin B₁₂

Q. 3. Give the scientific name of the source organism from which the first antibiotic was produced.

[R] [CBSE SQP, 2018, Foreign Set-III, 2014]

Ans. *Penicillium notatum*. 1

[CBSE Marking Scheme, 2018]

Answering Tip

- Learn the scientific names of organism with correct spellings.

[AI] Q. 4. Name the gas released and the process responsible for puffing up of the bread dough when *Saccharomyces cerevisiae* is added to it.

[R] [Delhi Set-III, Comptt. 2013]

Ans. Gas – Carbon dioxide

Process – Fermentation

1

Commonly Made Error

- Students write the name of the gas released but forget to mention the name of the process responsible. Read the question properly and then answer.

Q. 5. Name the metabolic pathway associated with the rising of dough in making bread. What makes the dough rise ?

[R] [Delhi Set-I, Comptt. 2012]

Ans. Metabolic pathway : Alcoholic fermentation by yeast. CO₂ produced in this process is responsible for rising of dough. 1

Q. 6. Write the scientific name of the microbe used for fermenting malted cereals and fruit juices.

[R] [Outside Delhi Set-I, 2011]

Ans. *Saccharomyces cerevisiae*. 1
[CBSE Marking Scheme, 2011]

Answering Tip

- Repeated tests will help the students to remember the scientific names.

Q. 7. Milk start to coagulate when lactic acid bacteria are added to warm milk as a starter. Mention any other two benefits LAB provide.

[U] [Outside Delhi 2009]

Ans. Besides curdling of milk the lactic acid bacteria are beneficial to us in following ways :

- They improve the nutritional quality of curd by producing Vitamin B₁₂.
- They help in inhibiting the development of disease causing microorganism in the gut.

1

Q. 8. Which of the following in the baker's yeast is used in fermentation : *Saccharum barberi*, *Saccharomyces cerevisiae* [K] [Outside Delhi 2009]

Ans. *Saccharomyces cerevisiae*. 1

Q. 9. Name the group of organisms and the substrate that act to produce biogas. [R] [Delhi 2009]

Ans. Name of the group of organisms-*Methanogens*
Substrate-Cellulosic material, cow dung and agricultural waste. 1

Q. 10. Bottled fruit juices are clearer as compared to those made at home. Explain. [U] [Foreign 2015]

Ans. Bottled fruit juices are clearer as compared to those prepared at home because they are treated with enzyme pectinase and protease. This enzymes acts on juices and make them clearer. 1



Short Answer Type Questions-I

(2 marks each)

Q. 1. List the events that reduce the Biological Oxygen Demand (BOD) of a primary effluent during sewage treatment. [U] [Delhi Set-II, 2016]

Ans. Effluent from the primary settling tank passed into aeration tank, agitated mechanically and air is pumped into it, vigorous growth of aerobic microbes into flocs, microbes consume major part of the organic matter in effluent.

[CBSE Marking Scheme, 2016] 2

Detailed Answer :

The primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into flocs. While growing, these microbes (flocs) decompose the major part of the organic matter in the effluent. This decreases the biological oxygen demand (BOD) of the effluent. Sewage is treated till the BOD is significantly reduced.

Q. 2. List the events that lead to biogas production from waste water whose BOD has been reduced significantly. [U] [Delhi Set-II, 2016]

Ans. Sedimentation of flocs to form activated sludge, sludge pumped to anaerobic sludge digester, growth of anaerobic bacteria, digestion of sludge by bacteria to release biogas.

[CBSE Marking Scheme, 2016] 2

Detailed Answer :

Events that lead to biogas production from waste water with reduced BOD are:

- Once the BOD of waste water is significantly reduced, the effluent is passed into a settling tank for sedimentation.
- From settling tank, the major part of sedimented material called activated sludge (bacterial flocs) is pumped into large tanks called anaerobic

sludge digester and a small part is pumped back into aeration tank to serve as inoculum.

(iii) In these tanks, the sludge is anaerobically digested by bacteria and fungi, biogas is produced which is a mixture of methane, hydrogen sulphide and CO₂. The biogas can be used as a source of energy as it is inflammable.

Q. 3. Mention a product of human welfare obtained with the help of each one of the following microbes :

[R] [Delhi Set-I, III, 2015]

- LAB
- Saccharomyces cerevisiae*
- Propionibacterium shermanii*
- Aspergillus niger*

Ans. (i) Milk to curd ½
(ii) Bread / ethanol / alcoholic drinks / whiskey / brandy / beer/ rum ½
(iii) Swiss cheese ½
(iv) Citric acid ½

[CBSE Marking Scheme, 2015]

Answering Tip

- Use charts to learn the names of the microbes and their product as per the syllabus.

Q. 4. Explain the different steps involved during primary treatment phase of sewage.

[U] [Outside Delhi Set-I, 2015]

Ans. Physical removal of particles (large and small), by filtration and sedimentation, forming primary sludge / sedimented solids, forming effluent (supernatant) for secondary treatment.

[CBSE Marking Scheme, 2015] ½ × 4 = 2

Detailed Answer :

Primary treatment : The primary phase of sewage treatment involves physical removal of particles by filtration and sedimentation. **Different steps involved during the primary treatment are as follows :**

Initially, floating debris of sewage water is removed by sequential filtration through many screens.

Then, grit (soil + small pebbles) is removed by sedimentation in large settling tanks. The remaining solid particles, which have settled down form the sludge while the supernatant forms the effluent. Effluent is then taken for secondary treatment. 2

Q. 5. 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.

[U] [Outside Delhi Set-II, 2015]

Ans. Supernatant from the primary treatment is passed into large aeration tanks during secondary treatment. In these tanks, the effluent is agitated mechanically and air is pumped into it. This causes vigorous growth of bacteria that lead to the formation of floc, which consists of bacteria and fungal filaments in a mesh like structure. While growing, these microbes consume the major part of organic matter in the effluent, it decreases the biological oxygen demand (BOD). After a significant drop in BOD is observed, effluent is passed into the settling tank. 2

Q. 6. Explain the function of "anaerobic sludge digester" in a sewage treatment plant.

[R] [Outside Delhi Set, III, 2015]

Ans. In anaerobic sludge digester, the anaerobic bacteria-the methanogen digest the flocs of bacteria and fungi in activated sludge and produce methane along with H_2S and CO_2 i.e. biogas which is a source of energy as it is inflammable. 2

Q. 7. Name two groups of organisms which constitute 'flocs'. Write their influence on the level of BOD during biological treatment of sewage.

[R] [Outside Delhi Set-I, 2014]

Ans. The bacteria and fungal mycelium constitute flocs. These microorganisms bring about the decomposition aerobically of the major part of organic matter in primary effluent and thus helps in lowering the BOD (Biological Oxygen Demand) of the effluent. 2

Q. 8. Distinguish between the roles of flocs and anaerobic sludge digesters in sewage treatments.

[U] [Delhi Set-III, 2016]

Ans.

| S. No. | Flocs | Anaerobic Sludge Digester |
|--------|---|---|
| (i) | Breakdown organic matter aerobically. | Breakdown organic matter anaerobically. |
| (ii) | Breaks down organic matter present in primary effluent. | Breaks down organic matter present in secondary effluent. |
| (iii) | They do not produce biogas. | They produce biogas (mixture of methane, H_2S and CO_2). |

[CBSE Marking Scheme, 2016] 2

Detailed Answer :

Flocs are the mixtures of heterotrophic aerobic microbes that grow in aeration tank during secondary treatment of effluent. They consume a major part of the organic matter of the effluent.

In anaerobic sludge digesters, anaerobic bacteria grow and digest the rest of the organic compounds and produce biogas.

Answering Tip

- Learn the differences between the flocs and anaerobic sludge digester in tabular form for better retention and understanding.

Q. 9. Name the bacterium responsible for the large holes seen in 'Swiss cheese'. What are these holes due to ? [R] [Outside Delhi Set-I, II, III, 2013]

Ans. The large holes in 'Swiss cheese' are due to the production of a large amount of CO_2 by a bacterium named *Propionibacterium shermanii*. 2

Q. 10. Name the source of cyclosporin-A. How does this bioactive molecules function in our body ? [R] [Delhi Set-II, 2012]

Ans. Cyclosporin-A is produced by the fungus *Trichoderma polysporum*. Cyclosporin-A is antifungal, anti-inflammatory and used as an immunosuppressant. It is able to suppress the immune system enough so that organs and tissues, not original to the body, can be transplanted. 2

Answering Tips

- Make a list of bioactive molecules, their source and function in our body and learn them carefully.
- Emphasize on writing biological names with correct spellings according to the rules of binomial nomenclature.

Q. 11. Mention the importance of lactic acid bacteria to humans other than setting milk into curd.

[U] [NCERT] [Delhi Set-III, 2012]

Ans. (i) While converting milk into curd, lactic acid bacteria (LAB) improve its nutritional quality by increasing vitamin B_{12} .
(ii) In our stomach, LAB play beneficial role in preventing growth of disease-causing microbes. 2

Q. 12. State the use of :

- (i) *Trichoderma* with respect to organ transplant and
 (ii) *Nucleopolyhedrovirus* with respect to pest management. [R] [CBSE SQP, 2012]

Ans. (i) *Trichoderma* : It produces a bioactive molecule called cyclosporin A, which is used as an immunosuppressive agent in organ transplant.

(ii) *Nucleopolyhedrovirus* : Belongs to the family baculoviruses which are used as biocontrol agents. These viruses attack insects and they are excellent for species-specific, narrow-spectrum insecticidal applications. They are quite specific and therefore do not have any negative impact on non target organisms, thus making them useful in overall integrated pest management programme. 1 + 1
 [CBSE Marking Scheme, 2016]

Q. 13. Name the enzyme produced by *Streptococcus* bacterium. Explain its importance in medical sciences. [R] [Delhi Set-I, 2011]

Ans. Streptokinase. 1
 It is used as a 'clot buster' for removing clots from

Q. 15. Write the binomials of two fungi and mention the products/bioactive molecules they help to produce.

Ans. *Trichoderma polysporum*, cyclosporin A
Aspergillus niger, citric acid
Monascus purpureus, statin
Saccharomyces cerevisiae, ethanol / alcohol
Penicillium notatum, Penicillin

1 + 1

(Any two)

[CBSE Marking Scheme, 2017]

OR

8. A yeast, *Monascus purpureus*, helps in the production of the bioactive molecule statin, used to reduce blood cholesterol level.

Another fungi, *Trichoderma polysporum* aids in the production of cyclosporin A, an immunosuppressant.

[Topper's Answer, 2017]

Q. 16. Name the first antibiotic discovered and by whom. [R] [Outside Delhi Comptt., Set - II, 2017]

Ans. Penicillin, Alexander Fleming. 1 + 1
 [CBSE Marking Scheme, 2017]

Q. 17. During the production of curd, a small amount of curd is added as a starter to the fresh milk at a suitable temperature. Explain the changes the milk undergoes when it sets into curd.

[R] [KVS] [Delhi Set-I, II, III, 2011, 2010, 2009]

OR

Why is 'starter' added to set the milk into curd ?
 Explain [U] [Delhi Set-I, comp. 2014]

the blood vessels of patients who have undergone myocardial infarction leading to heart attack. It helps in clearing blood clots inside the blood vessels through dissolution of intravascular fibrin. 1

Q. 14. Why are some molecules called bioactive molecules ? Give two examples of such molecules. [R] [Outside Delhi Set-I, II, III, 2011]

OR

Give the scientific name of microbes from which cyclosporin-A and statin are obtained. Write one medical use of each one of these drugs.

[Foreign 2011]

Ans. Some molecules are produced by certain living organism and have ability to perform functions and modify metabolism in body of other living organisms are known as bioactive molecule.

Examples of bioactive molecules are :

(i) **Cyclosporin-A** : It is used as an immunosuppressive agent in organ-transplant patients. It is produced by *Trichoderma polysporum*.

(ii) **Statins** : Statins are produced by the yeast *Monascus purpureus* and have been commercialized as cholesterol-lowering agents. 1 + ½ + ½ = 2

Ans. When a small amount of curd is added as a starter to the fresh milk at a suitable temperature, micro-organism *Lactobacillus* and lactic acid bacteria grows in milk in millions. These bacteria convert the lactose sugar of milk into lactic acid which coagulates and partially digests milk protein casein. This causes curdling of milk and converts milk into curd. 1 + 1

Q. 18. (i) A patient who had an organ transplant was given cyclosporin - A. Mention the microbial source and state the reason for administration of this bioactive molecule.

- (ii) Bottled fruit juices bought from the market are clearer as compared to those made at home. Give reason. [A] [SQP 2017-18]

Ans. (i) Source – *Trichoderma polysporum*.
Reason – Immuno suppressive agent. $\frac{1}{2} + \frac{1}{2}$
(ii) They are clarified by pectinases and proteases. $\frac{1}{2} + \frac{1}{2}$
[CBSE Marking Scheme, 2017]

- Q. 19. Name a bioactive molecule, its source organism and the purpose for which it is given to organ transplant patients. [A] [Foreign - 2017, Set - III]

Ans. Cyclosporin A.
Source – *Trichoderma polysporum*.
Purpose – Immuno suppressive agent.
 $1 + \frac{1}{2} + \frac{1}{2} = 2$
[CBSE Marking Scheme, 2017]

- [AI] Q. 20. Name the microbes that help the production of the following products commercially :

- (i) Statin
(ii) Citric acid
(iii) Penicillin
(iv) Butyric acid [R] [Outside Dehli - 2017, Set - I]

Ans. (i) *Monascus purpureus*
(ii) *Aspergillus niger*
(iii) *Penicillium notatum*
(iv) *Clostridium butyricum* $\frac{1}{2} \times 4 = 2$
[CBSE Marking Scheme, 2017]

- Q. 21. Name the source of statin and state its action on human body. [R] [Foreign 2012]

Ans. Statin is produced by a yeast called *Monascus purpureus*. It's use lowers the blood cholesterol level in the body. It acts by inhibiting the activity of the enzyme which brings about the synthesis of cholesterol. 2



Short Answer Type Questions-II

(3 marks each)

- Q. 1. Cow dung and water is mixed and this slurry is fed into the biogas plant for digestion by microbes. The person performing the process shares that there is no need to provide inoculum for it, why? What is the role of microbes at the source? Under which condition will they be most active and effective ? [A] [SQP 2016-17]

Ans. Methanogens are present in cow dung.
Breakdown of cellulose.
Anaerobic condition. 3
[CBSE Marking Scheme, 2016]

Detailed Answer :

If the slurry of cow dung and water is fed into the biogas plant, there is no need to provide inoculum as the cow dung or excreta of cattle in itself contain

a large number of anaerobic methanogenic bacteria. Therefore, the slurry (cow dung and water) can be used for generation of biogas.

These bacteria breakdown the cellulosic material present in the rumen of cattle anaerobically and produce large amount of methane along with CO₂ and H₂S.

- [AI] Q. 2. What are methanogens ? How do they help to generate biogas. [R] [Outside Delhi Set-I, 2015]

Ans. Micro-organisms that produce methane along with CO₂ and H₂ gases under anaerobic conditions are called methanogens. Example, *Methanobacterium*. These are the bacteria found in cattle dung (gobar) and in anaerobic sludge during sewage treatment. They grow anaerobically on cellulosic material and produce a large amount of methane (main constituent of biogas) along with CO₂ and H₂. Thus, methanogens are used in biogas production. 3

- Q. 3. Explain the changes that can be observed in the characteristics of river water when sewage is discharged into it and a few weeks after the discharge with respect to :

- (i) level of dissolved oxygen
(ii) population of fresh water organisms.

[A] [Delhi Set-III, Comptt. 2015]

Ans.

| Criteria / Time of Sewage discharged | When sewage is discharged | Few weeks after discharge |
|--|---|--|
| (i) Level of dissolved oxygen | Microorganisms involved in bio-degradation of organic matter consume a lot of oxygen, resulting in sharp decline in dissolved oxygen. | Level of dissolved oxygen increases as sewage decreases. |
| (ii) Population of fresh water organisms | Decline in dissolved oxygen causes mortality of fresh water organisms. | Reappearance of population fresh water organisms. |

[CBSE Marking Scheme, 2015] $\frac{1}{2} \times 6 = 3$

Answering Tip

- Carefully learn the concept of BOD. Relate BOD with level of pollution in river.

AI Q. 4. "Determination of Biological Oxygen Demand (BOD) can help in suggesting the quality of a water body." Explain. [Delhi Set-III, 2015]

Ans. High BOD in a water body indicates more number of micro-organisms in water, resulting in bad quality of water / death of aquatic creatures, more polluting potential.

Lower BOD of water body indicates less number of micro-organisms in water, good quality of water / aquatic life flourishes / less polluting potential. 3

[CBSE Marking Scheme, 2015]

Commonly Made Error

- Several candidates do not have clear concept of how BOD indicates the level of pollution in a water body.

Answering Tip

- Discuss thoroughly, the significance of BOD in an aquatic ecosystem. Also, connect water pollution to algal bloom.

Q. 5. State the medicinal value and the bioactive molecules produced by *Streptococcus*, *Monascus* and *Trichoderma*. [A] [Outside Delhi Set-I, 2015]

Ans. *Streptococcus* : It produces *Streptokinase* enzyme that is used to dissolve clots formed in the blood vessels.

Monascus (Yeast) : It produces statins that help in lowering blood cholesterol levels.

Trichoderma (Fungus) : It produces cyclosporin A that is used as an immunosuppressant agent in organ transplantation. It inhibits activation of T-cells and thus prevents rejection of transplants.

1+1+1=3

[CBSE Marking Scheme, 2015]

Commonly Made Error

- Many students misspell the words. Many of them write incorrect bioactive molecules.

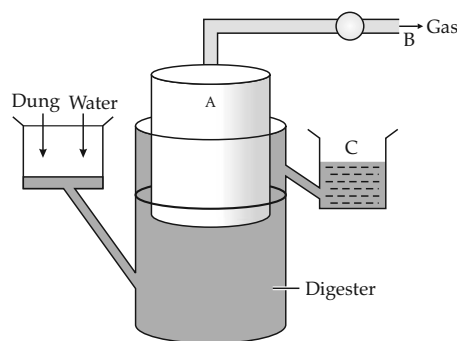
Answering Tip

- Carefully learn the scientific name, commercial product and its use.

Q. 6. Given below is a figure of a biogas plant.

(i) Identify A and justify its floating nature.

(ii) Identify the products B and C and discuss their significance. [A] [CBSE SQP, 2015]



Ans. (i) A is the floating cover which is placed over the slurry, which keeps on rising as the gas is produced in the tank due to the microbial activity.

(ii) B is the biogas which is a mixture of gases consisting of methane, hydrogen sulphide and carbon dioxide. It can be used as a source of energy to nearby houses as it is inflammable.

C is the spent slurry or sludge which is removed through another outlet and may be used as fertiliser. 1+2=3

[CBSE Marking Scheme, 2015]

Q. 7. What are Methanogens ? Name the animals they are present in and the role they play there.

[R] [Delhi Set-III, 2014]

Ans. Methanogens are the bacteria which grow anaerobically on cellulosic material and produce large amount of methane along with CO₂ and H₂S.

(i) Present in cattle (rumen) a part of stomach.

(ii) They help in

(a) Breaking down of cellulose present in food of cattle.

(b) Nutrition of animal for digestion of cellulose.

The excreta of cattle is rich in these bacteria (methanogens) and therefore can be used for generation of biogas. 1+1+1

Q. 8. Identify a, b, c, d, e and f in the table given below :

| Scientific Name of the Organism | Product produced | Use in human welfare |
|---------------------------------|---------------------------------------|----------------------|
| <i>Streptococcus</i> | Streptokinase that was later modified | a |
| b | Cyclosporin A | c |
| <i>Monascus purpureus</i> | d | e |
| <i>Lactobacillus</i> | f | Sets milk into curd |

[Foreign 2014]

- Ans. (a) Clot buster for removing clots from blood vessels.
 (b) *Trichoderma polysporum*.
 (c) Antifungal, anti-inflammatory and immuno-suppressive agent in organ transplant, prevents reactions in organ transplantation.
 (d) Statins.
 (e) Blood cholesterol lowering agent.
 (f) Lactic acid. $\frac{1}{2} \times 6$

Q. 9. Identify a, b, c, d, e and f in the following table :

[R] [Outside Delhi Comptt. 2017, Set - I, II]

| Name of Enzyme/ Bioactive Molecule | Source | Function |
|--|----------------------|---|
| (i) a | <i>Streptococcus</i> | b |
| (ii) c | d | Immuno-suppressive agent in organ transplant patients |
| (iii) Statins | e | f |

- Ans. (i) (a) Streptokinase.
 (b) 'Clot buster' for removing clots from the blood vessels (of patients who have undergone myocardial infarction leading to heart attack) / clot buster enzyme.
 (ii) (c) Cyclosporin.
 (d) *Trichoderma polysporum*.
 (iii) (e) *Monascus purpureus* (yeast).
 (f) Blood cholesterol lowering agent.

3

[CBSE Marking Scheme, 2017]

Commonly Made Error

- Many students mis-spell the bioactive molecule Streptokinase.
- Some are unable to write the use of Streptokinase or mention that it is used in dairy products instead of in curd, in bakeries, in production of antibiotics for clotting instead of clot dissolving.
- Many of them mis-spelled Cyclosporin and its source *Trichoderma polysporum*.
- Some of them forget to mention the commercial product of *Monascus purpureus* or wrote cyclosporin-A as the product of *Monascus purpureus*.
- Many of them forget to write the use of *Monascus purpureus*.

[AI] Q. 10. Explain the different steps involved in the secondary treatment of sewage.

[R] [CBSE SQP, 2018]

- Ans. (a) Primary effluent is passed into large aeration tanks with constant mechanical agitation and air supply. Useful aerobic microbes grow rapidly and form flocs. 1
 (b) Flocs while growing consume organic matter and thus reduce the biochemical oxygen demand (BOD), the effluent is passed into settling tank. 1
 (c) The bacterial flocs settle at the bottom of the tank and it forms activated sludge, a small part this is used as an inoculum in the aeration tank and the remaining part is passed into large tanks called anaerobic sludge digesters. 1

[CBSE Marking Scheme, 2018]

Answering Tip

- Keywords should be highlighted in the answers.

Q. 11. Secondary treatment of the sewage is also called Biological treatment. Justify this statement and explain the process.

[A] [Delhi - 2017, Set - I, II, III, (KVS), DDE]

Ans. It involves biological organism such as aerobic microbes / bacteria and fungi to digest / consume organic waste. 1

Primary effluent is passed into aeration tank where vigorous growth of aerobic microbes (flocs) take place, BOD reduced (microbes consume major part of organic matter), effluent is passed to settling tank where flocs sediment to produce activated sludge, sludge is pumped to anaerobic sludge digester to digest bacteria and fungi. $\frac{1}{2} \times 4$

[CBSE Marking Scheme, 2017]

OR

Secondary treatment is applied to the sewage which has undergone physical treatment. There are 2 steps in secondary treatment - ~~ana~~ aerobic digestion and anaerobic digestion. Both involve the action of microbes. Due to the involvement of living organisms, it is referred to as biological treatment. In the first step, the sewage is taken in an aerobic digestion tank and agitated strongly. ~~This~~ This enables the growth of aerobic microbes present in it - resulting in the formation of flocs - which are mucilaginous threads.

of microbial association with fungi. The flocs greatly reduce the Biochemical Oxygen Demand by digesting the ~~major~~ organic matter present in it. BOD indicates the amount of pollutants in the sewage. Sufficient lowering of BOD indicates lowered organic content of the sewage. The sludge that separates out now is called activated sludge since microbes are present in it. The supernatant fluid can be released into any water body or taken for chemical treatment. Activated sludge is taken for anaerobic digestion by heterotrophic microbes like methanogens - *Methylobacter*, *Methylophilus*, which can live anaerobically. This results in the production of biogas. The slurry that remains can be used as landfill or other purposes. Thus the active participation of microbes make secondary treatment of sewage a biological treatment.

[Topper's Answer, 2017]

Q. 12. Describe how do 'flocs' and 'activated sludge' help in Sewage Treatment. [U] [Delhi - 2017, Set - I]

Ans. **Flocs :** Aerobic microbes consume the major part of the organic matter in the effluent, significantly reduces BOD.

Activated sludge : Small part of activated sludge is used as inoculum and pumped back to aeration tank / pumped into anaerobic sludge digesters where microbes or bacteria grow anaerobically to produce CH_4 or H_2S or CO_2 or biogas. 2 + 1

[CBSE Marking Scheme, 2017]

Q. 13. The three microbes are listed below. Name the product produced by each one of them and mention their use.

- Aspergillus niger*
- Trichoderma polysporum*
- Monascus purpureus*

[R] [Delhi/Outside Delhi, Comptt, Set 1, 2018]

Ans. (a) *Aspergillus niger* - Citric Acid, natural preservative / flavouring agent. $\frac{1}{2} + \frac{1}{2}$
 (b) *Trichoderma polysporum* - Cyclosporin A, immunosuppressive agent. $\frac{1}{2} + \frac{1}{2}$
 (c) *Monascus purpureus* - Statin, blood cholesterol lowering agent. $\frac{1}{2} + \frac{1}{2}$

[CBSE Marking Scheme, 2018]

Q. 14. Describe how biogas is generated from activated sludge. List the components of biogas.

[U] [Outside Delhi Set-I, 2013]

Ans. After the significant decline of BOD of the sewage, the effluent is passed into the settling tank. In these tanks, the bacterial flocs sediment forming the activated sludge. A small part of activated sludge is pumped back into aeration tanks to serve as the inoculum. The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters. Other kinds of bacteria, that grow anaerobically, digest the bacteria and fungi in the sludge. During this digestion, bacteria produce a mixture of gases called biogas.

The components of biogas are :

- Methane (CH_4)
- Hydrogen sulphide (H_2S)

(iii) Carbon dioxide (CO_2)

2 + 1 = 3

Q. 15. Microbes play a dual role when used for sewage treatment as they not only help to retrieve usable water but also generate fuel. Write how this happens? [A] [CBSE SQP 2013, 2010]

Ans. Heterotrophic microbes naturally present in sewage are used. Vigorous growth of aerobic microbes as flocs uses organic matter in effluent and reduce BOD of waste water. Other kinds of bacteria grow in it anaerobically and digest the bacteria and fungi called flocs (masses of bacteria associated with fungal filaments). As they digest flocs, a mixture of CH_4 , H_2S , and CO_2 or biogas is evolved, which can be used as a fuel. 3

[CBSE Marking Scheme, 2018]

Q. 16. (i) Why are the fruit juices bought from market clearer as compared to those made at home?

(ii) Name the bioactive molecules produced by *Trichoderma polysporum* and *Monascus purpureus*.

[A] [Delhi, Set-I, III, 2013]

Ans. (i) The fruit juices prepared at home are turbid due to the presence of fibers and pectin in it whereas those purchased from the market are clearer because of the use of enzymes like proteases and pectinases which remove turbidity.

(ii)

| Sr. No. | Source | Bioactive molecule produced |
|---------|-------------------------------|-----------------------------|
| (a) | <i>Trichoderma polysporum</i> | Cyclosporin A. |
| (b) | <i>Monascus purpureus</i> | Statin. |

3

Q. 17. Name the two different categories of aerobic microbes naturally occurring in sewage water. Explain their role in cleaning sewage water into usable water. [R] [Delhi Set-I, 2012]

Ans. The two different categories of aerobic microbes naturally occurring in sewage water are bacteria and fungi. The two together forms flocs a mesh like structure.

The following three treatments are carried out for purifying sewage water:

(i) **Primary treatment :**

- (a) Separation of large debris.
- (b) Sedimentation in tanks.

(ii) **Secondary treatment :**

- (a) Waste water is pumped in shallow stabilization or oxidation ponds, where microbes oxidize its organic matter.
- (b) The process results in release of CO_2 and formation of sludge.
- (c) Sludge is continuously aerated further for its oxidation.

(iii) **Tertiary treatment :**

- (a) Removal of turbidity in waste water caused by the presence of nutrients (N_2 , P, etc.) in dissolved organic matter, metals or pathogens.
- (b) It involves chemical oxidation by strong oxidising agents such as chlorine gas, perchlorate salts, ozone gas, UV radiations.

3

Q. 18. (i) How is activated sludge formed during sewage treatment ?

(ii) This sludge can be used as an inoculum or as a source of biogas. Explain.

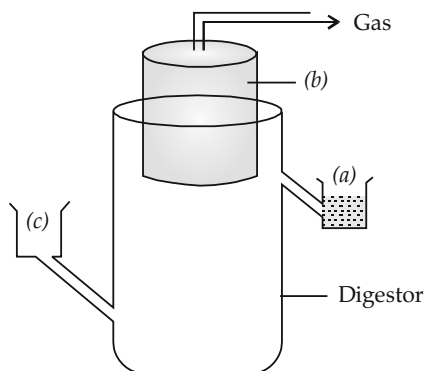
[R] [Outside Delhi Comptt. 2011, 2009]

Ans. (i) When the BOD of sewage or waste is reduced significantly, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called activated sludge.

(ii) A small part of the activated sludge is pumped back into aeration tanks to serve as the inoculum. The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters. Other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as a source of energy as it is inflammable.

 $1 + 2 = 3$

Q. 19.



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.

[A] [Delhi Set-I, 2011]

Ans. Bio wastes are collected and a slurry of dung is fed. A floating cover having gas outlet is placed over slurry which keeps on rising as the gas is produced in the tank, the spent slurry is removed through another outlet and may be used as fertilizer.

 $\frac{1}{2} \times 3 = 1\frac{1}{2}$

(a) sludge loader.

(b) gas holder / CH_4 and CO_2 .

(c) dung and water.

 $\frac{1}{2} \times 3 = 1\frac{1}{2}$

Q. 20. Identify a, b, c, d, e and f in the table given below :

| S. No. | Organism | Bioactive molecule | Use |
|--------|-----------------------------------|--------------------|------------|
| 1. | <i>Monascus purpureus</i> (yeast) | a | b |
| 2. | c | d | antibiotic |
| 3. | e | Cyclosporin A | f |

[R] [Delhi Set-I, 2010]

Ans. a – Statins.

 $\frac{1}{2}$

b – Blood cholesterol lowering agent.

 $\frac{1}{2}$

c – *Penicillium notatum*.

 $\frac{1}{2}$

d – Penicillin.

 $\frac{1}{2}$

e – *Trichoderma polysporum*.

 $\frac{1}{2}$

f – Immuno-suppressive agent in organ transplant patients.

 $\frac{1}{2}$

Q. 21. Mention the product and its use produced by each of the microbes listed below :

(i) Streptococcus

(ii) Lactobacillus

(iii) Saccharomyces cerevisiae

[A] [Outside Delhi Set-I, 2010]

Ans. (i) Streptokinase, clot buster / dissolves clot from blood vessels.

 $\frac{1}{2} + \frac{1}{2}$

(ii) Lactic acid, coagulates milk / partial digestion of milk proteins casein.

 $\frac{1}{2} + \frac{1}{2}$

(iii) Ethyl alcohol + CO_2 , ferments dough to make bread / idli.

 $\frac{1}{2} + \frac{1}{2}$

Answering Tip

- While learning the names of the microbes, lay stress on their products and their use.

Q. 22. Make a list of three household products along with the names of the micro-organism producing them.

[A] [Outside Delhi Set-III, Comptt., 2016]

Ans. Lactic acid bacteria ; curd

Saccharomyces cerevisiae ; bread

Propionibacterium shermanii ; swiss cheese

 $6 \times \frac{1}{2} = 3$

? Long Answer Type Questions

(5 marks each)

Q. 1. Describe the process of waste-water treatment under the following heads :

- (i) Primary treatment.
- (ii) Secondary treatment.

[R] [Foreign Set-I, 2016, NCERT]

OR

Explain the process of sewage water treatment before it can be discharged into natural water bodies. Why is this treatment essential ?

[Outside Delhi Set-III, 2014]

Ans. (i) Primary treatment

(a) Physical removal of particles like debris, soil, sand or silt through filtration, sedimentation in stages. $\frac{1}{2} + \frac{1}{2}$

(b) Solids settle to form primary sludge, the supernatants form the primary effluent. $\frac{1}{2} + \frac{1}{2}$

(ii) Secondary Treatment : It is the biological treatment.

(a) Effluent passed into aeration tanks. $\frac{1}{2}$

(b) Vigorous growth of useful aerobic microbes into flocs. $\frac{1}{2}$

(c) Significant reduction of BOD due to use of organic matter by microorganisms. $\frac{1}{2}$

(d) After fall in the level of BOD, the effluent is passed on to settling tanks where bacterial flocs settle to form activated sludge. $\frac{1}{2}$

(e) Activated sludge is passed on to anaerobic sludge digester, where bacteria and fungi are anaerobically digested. $\frac{1}{2} + \frac{1}{2}$

[CBSE Marking Scheme, 2016]

Detailed Answer :

Sewage water can be purified by passing it through sewage treatment plants with the help of the action of microorganisms. In this plant, the solids are separated from liquid by physical processes and the liquids are purified by biological processes. There are three stages of this treatment i.e. primary, secondary and tertiary. The primary treatment is physical, secondary treatment is biological while the tertiary treatment is chemical.

Sewage Treatment (In STP's Binary Treatment Plants):

(i) **Primary Treatment :**

Physical particles like debris and soil, sand, silt etc. are removed by : (i) sequential filtration. (ii) sedimentation.

The substances that settle down forms primary sludge and the effluent is primary effluent.

(ii) **Secondary Treatment :**

Biological treatment in which primary effluent is passed to large aeration tanks and is constantly agitated and supplied with air/O₂. This causes creation of flocs or association of useful aerobic bacteria and fungal filaments into a mesh-like structure.

In this process, the microbes use up organic matter in the polluted water and hence reduce the BOD (Biological Oxygen Demand).

Once the BOD is sufficiently reduced, it is allowed to pass to a settling tank where flocs are allowed to settle down – activated sludge.

A little sludge is pumped back to the aeration tank to serve as inoculums but most is passed to the anaerobic sludge digester where it is degraded by useful anaerobic bacteria (e.g., methanogens) releasing a mixture of gases like CH₄, CO₂, H₂, H₂S, etc. (biogas). 2

The water coming out after this treatment is hence purified and can be discharged into water bodies.

This treatment is essential to :

(i) Avoid pollution of the natural water bodies by excessive accumulation of harmful chemicals, organic matter and nutrients which may lead to eutrophication. 2

(ii) Prevent the spread of infectious water borne diseases caused due to the deadly pathogens in polluted water. 1

Q. 2. Draw labelled sketch of a typical biogas plant.

[R] [Outside Delhi Set, Comptt., 2014]

Ans. Refer Topic 1/ Revision Notes/ Important Diagrams/ Fig 10.1 5

[AI] Q. 3. (i) Name the category of microbes occurring naturally in sewage and making it less polluted during the treatment.

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

[R] [Delhi Set-II, III, 2014]

Ans. (i) Aerobic microbes. $\frac{1}{2}$

(ii) The primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh like structures). While growing, these microbes consume the major part of the organic matter in the effluent. This significantly reduces the BOD (biochemical oxygen demand) of the effluent. The sewage water is treated till the BOD is reduced. 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. This sediment is called 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. Here, other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge.

During this digestion bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as source of energy as it is inflammable. The effluent from

the secondary treatment plant is generally released into natural water bodies like rivers and streams.

$$\frac{1}{2} \times 9 = 4\frac{1}{2}$$

[CBSE Marking Scheme, 2014]



TOPIC-2

Microbes as Biocontrol Agents and Bio-fertilisers

Revision Notes

➤ Biocontrol

- It is the use of biological methods for controlling plant diseases and pests.

➤ Chemical Pesticides and Insecticides

- These are toxic and harmful to all organisms including human beings and cause pollution.
- Chemical pesticide kills both useful and harmful life forms.
- Weedicides used to eliminate weeds cause soil pollution.

➤ Microbial biocontrol agents

(a) *Bacillus thuringiensis* (Bt) :

- This is to control butterfly caterpillar. These are available in sachets as dried spores which are mixed with water and sprayed on to vulnerable plants such as brassica and fruit trees, where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released and the larvae get killed. The scientists have introduced *B. thuringiensis* toxin genes into plants *e.g.* Bt cotton.

(b) *Trichoderma sp* (Fungus) :

- These are free living species that are seen in the root ecosystems. They are effective biocontrol agents of several plant pathogens.

(c) *Baculoviruses* (Especially genus *Nucleopolyhedrovirus*) :

- It attacks insects and other arthropods. These are suitable for species-specific, narrow spectrum insecticidal applications. This is desirable in IPM program to conserve beneficial insects.

➤ Microbes as Biofertilisers

- Biofertilisers are the micro-organisms that enrich nutrient quality of the soil. *e.g.* Bacteria, fungi, cyanobacteria etc.

➤ *Rhizobium*

- It is a symbiotic bacteria found in root nodules of leguminous plants that fixes atmospheric N_2 .
- Free-living bacteria in the soil such as *Azospirillum* and *Azotobacter* enrich the nitrogen content of the soil.

➤ *Mycorrhiza*

- It is a symbiotic association of fungi (*e.g.* the genus of *Glomus*) with the roots of higher plants.
- The fungus gets food from the plant.
- The fungal symbiont help to absorb phosphorous from soil and passes it to the plant, give resistance to root-borne pathogens, tolerance to salinity and drought and also gives an overall increase in plant growth and development.

➤ *Cyanobacteria* (Blue green algae) :

- They are autotrophic microbes that fixes atmospheric nitrogen *e.g.* *Anabaena*, *Nostoc*, *Oscillatoria* etc.
- In paddy fields, *Cyanobacteria* serve as an important biofertilisers.
- It also adds organic matter to the soil and increases its fertility.



Very Short Answer Type Questions

(1 mark each)

Q. 1. State one reason for adding blue-green algae to agricultural soil.

[U] [Outside Delhi, Comptt. Set-I, 2014]

OR

Mention the role of cyanobacteria as a biofertilizer.

[A] [Outside Delhi Set-I, 2012]

Ans. Blue-green algae are cyanobacteria. They fix atmospheric free nitrogen. Therefore, they increase soil fertility and also add the organic matter to the soil. 1

Q. 2. Name the types of association that the genus *Glomus* exhibits with higher plants.

[R] [Outside Delhi Set-III, 2014]

Ans. Symbiosis / Mycorrhiza / Mutualism. 1

Q. 3. What makes *Nucleopolyhedrovirus* a desirable biological control agent ?

[R] [Outside Delhi Comptt. Set-III, 2013]

Ans. *Nucleopolyhedrovirus* is the genus of baculoviruses. They are quite effective biocontrol agent. Its specificity makes it a desirable biocontrol agent. They selectively attack insect and other arthropods. They are suitable for species specific, narrow spectrum insecticidal application. They do not harm non-target organisms. They are also desirable in IPM programme to conserve beneficial insects. 1

Q. 4. Write the significance of *nucleopolyhedrovirus* in pest management.

[R] [Outside Delhi Set-I, Comptt., 2012]

Ans. *Nucleopolyhedroviruses* are the effective biocontrol agent. They are species specific and have narrow spectrum insecticidal application having no negative impact on non target beneficial organisms. They play significant role in pest management. 1

Q. 5. Mention two advantages of adding blue-green algae to paddy fields.

[A] [Outside Delhi Comptt. 2011]

Ans. In paddy fields, cyanobacteria (blue-green algae) add organic matter to the soil and increases its fertility. $\frac{1}{2} + \frac{1}{2}$

[AI] Q. 6. Name any one symbiont which serves as a biofertilizer. Mention its specific role.

[U] [Outside Delhi Set, Comptt., 2010]

Ans. *Rhizobium*, a root nodule bacterium of legumes is a symbiont. It fixes nitrogen symbiotically and thus help the plants in obtaining their nitrogen nutrition and therefore serve as a biofertilizer. 1

Q. 7. Which of the following is a cyanobacterium that can fix atmospheric nitrogen. *Azospirillum*, *Oscillatoria*, *Spirulina*. [R] [Outside Delhi, Set, 2009]

Ans. *Oscillatoria*. 1

Q. 8. Name any two free living nitrogen fixing bacteria.

[R] [Imp.]

Ans. *Azotobacter* and *Azospirillum*. $\frac{1}{2} + \frac{1}{2} = 1$



Short Answer Type Questions-I

(2 marks each)

Q. 1. Name a genus of baculovirus. Why are they considered good biocontrol agents ?

[R] [Outside Delhi Set-I, 2016]

OR

Name the genus to which baculoviruses belong. Describe their role in the integrated pest management programmes. [Delhi Set-I, 2016]

Ans. *Nucleopolyhedrovirus*

Species specific, narrow spectrum insecticidal application, no negative impact on non-target organisms. [CBSE Marking Scheme, 2016] 2

OR

Detailed Answer :

Nucleopolyhedrovirus is a genus of baculoviruses. They are useful as they are good biocontrol agents. They are species specific, narrow spectrum bioinsecticides. They control only species specific pest, do not affect non target organisms / beneficial insects are conserved / they aid in IPM problems / no negative impact on plants or other animals. Therefore, they are considered as an important component of integrated pest management programme. 1+1

(16) *Nucleopolyhedrovirus* is a genus of baculoviruses -
They are good biocontrol agents -
• They are extremely species specific, narrow spectrum bio control agents
• They don't have any harmful effects on mammals, plants, birds and even on non-target insects
• They are especially useful in IPM (Integrated Pest Management) programme.
• They are useful when an ecologically sensitive area is being treated.

[Topper's Answer, 2016]

Q. 2. Name a free-living symbiotic bacterium that serve as bio-fertilizer. Why are they so called?

[R] [Outside Delhi Set-III, 2016]

Ans. *Azospirillum/Azotobacter, Rhizobium.*

They enrich soil nutrient/nitrogen fixation.

(Any other correct example)

[CBSE Marking Scheme, 2016] 2

Detailed Answer :

Rhizobium leguminosarum is a symbiotic bacterium found in the root nodules of leguminous plants that has the ability to fix atmospheric nitrogen.

Azospirillum and *Azotobacter* are free-living bacteria found in the soil. They enrich soil with the nitrogen contents.

[AI] Q. 3. Explain the significant role of the genus *Nucleopolyhedrovirus* in an ecological sensitive area. [R] [Outside Delhi Set-III, 2014]

Ans. The genus *Nucleopolyhedrovirus* include baculoviruses which are insecticidal and therefore used as biocontrol agents. They have narrow spectrum, insecticidal application (IPM). They have no negative impact on plants / mammals / birds / fish / even non target insects. They are desirable in integrated pest management programme.

$\frac{1}{2} \times 4 = 2$

[CBSE Marking Scheme, 2014]

Q. 4. Why is *Rhizobium* categorized as a 'symbiotic bacterium' ? How does it act as a biofertiliser ?

[R] [Delhi Set-I, 2012]

Ans. *Rhizobium* is a symbiotic bacterium living in the root nodule of leguminous plants, it fixes atmospheric nitrogen into organic forms to be used by plants as nutrient and in turn bacteria get carbohydrate food and shelter from the plant.

$\frac{1}{2} + \frac{1}{2} = 1$

It is a biofertiliser as it is a living organism that enriches nutrient content of the plant / soil.

1

[CBSE Marking Scheme, 2012]

Q. 5. What is the pathogenic property of baculovirus, used as a biological agents ? Name the genus of these organisms.

[R] [Outside Delhi Comptt. 2017, Set - I, III]

Ans. Attacks insect and other arthropods. $\frac{1}{2} \times 2$
Nucleopolyhedrovirus. 1

[CBSE Marking Scheme, 2017]

Detailed Answer :

Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents belongs to the genus *nucleopolyhedrovirus*.

Q. 6. How does the application of the fungal genus, *Glomus*, to the agricultural farm increase the farm output ? [A] [Delhi, Set - I, II 2017]

Ans. *Glomus* forms mycorrhizal association, absorbs phosphorus, provide resistance to root borne pathogens, enhanced to tolerate salinity / drought.

$\frac{1}{2} \times 4 = 2$

[CBSE Marking Scheme, 2017]

Q. 7. How do mycorrhizae help the plants to grow better? [R] [Delhi, Set - II, 2017]

OR

How do mycorrhiza act as biofertilizers ? Explain. Name a genus of fungi that forms a mycorrhizal association with plants.

[Delhi Set-II, 2012]

Ans. Mycorrhiza refers to symbiotic association between the fungus and the root of higher plants. These fungi in these associations absorb water, phosphorus, nitrogen, potassium, calcium from soil and pass it to the plant. The fungus brings about the solubilization of organic matter of soil humus, release of inorganic nutrients absorption and their transfer to roots. The genus *Glomus* forms a mycorrhizal association with plants.

2

Q. 8. 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?

[R] [Outside Delhi/ Delhi, 2018]

Ans. (a) *Azospirillum/ Azotobacter/ Anabaena/ Nostoc / Oscillatoria / Frankia* (Any two correct names of microbes).

$\frac{1}{2} + \frac{1}{2}$

(If cyanobacteria mentioned = $\frac{1}{2}$, but if along with cyanobacteria-Anabaena / Nostoc / Oscillatoria mentioned then No mark on cyanobacteria).

(b) They can fix atmospheric nitrogen, due to presence of *Rhizobium*/ N_2 fixing bacteria in their root nodules.

$\frac{1}{2} + \frac{1}{2}$

[CBSE Marking Scheme, 2018]



Short Answer Type Questions-II

(3 marks each)

Q. 1. (i) How do organic farmers control pests ? Give two examples.

(ii) State the difference in their approach from that of conventional pest control methods.

[U] [Outside Delhi Set-I, 2016]

Ans. (i) Natural predation / biological control. 1

Examples - lady bird used to kill aphids / dragon flies used to kill mosquitoes / *Bacillus thuringiensis* used to kill cotton bollworm / caterpillar / butterfly caterpillar.

(Any two)

$\frac{1}{2} + \frac{1}{2} = 1$

| (ii) | Sr. No. | Conventional Pest Control | Organic farming based pest control |
|------|---------|--|--------------------------------------|
| | (a) | Use of chemical insecticides and pesticides. | No chemical used. |
| | (b) | Harmful to non target organisms. | Not harmful to non target organisms. |
| | (c) | Cause environmental pollution. | No adverse impact on environment. |

(Any two) $\frac{1}{2} \times 2 = 1$

[CBSE Marking Scheme, 2016]

Detailed Answer :

- (i) Organic farmers control pests by utilising natural predation instead of introducing or applying chemicals. Microbial biocontrol agents are the species – specific pesticides.

The examples include :

- (a) *Bacillus thuringiensis* : This is a bacterium which produces a toxin that specifically kills

OR

insect larvae of cotton bollworm such as lepidopterans, coleopterans and dipterans leaving aside all other non-targeted organisms.

- (b) *Trichoderma* sp. which is free living fungus and works as a bio-control agent against several plants pathogens.

- (ii) Conventional pest control methods use chemicals. They are non specific, cause harm to non target beneficial organisms and pose problems like environmental pollution and biological magnification, where as organic farmers control pest by biocontrol agents. They are specific, do not harm non target organism and do not cause pollution. Moreover, as compared to conventional pest control methods, organic farmers do not try to completely get rid of pests but keep them at manageable levels. They believe that complete eradication of pests is not beneficial and has certain adverse effects. It leads to death of those beneficial creatures that are dependent on them for food.

(a) Organic farmers control pests by using biocontrol methods which rely on natural predation and parasitism rather than chemicals. Examples of biocontrol methods are ladybird beetle and dragonfly can be used for getting rid of aphids and mosquitoes respectively.

Using *Bacillus thuringiensis* (Bt) spores and spraying them over vulnerable plants to control caterpillars.

Baculoviruses are used as arthropod (insects specially) control agents.

(b) Organic farmer's biocontrol method believes that complete eradication of pests is not only impossible but also undesirable. Instead pests can be managed at suitable levels by using complex system of checks and balances.

While conventional pest control methods believes in using chemicals in completely eradicating both harmful and beneficial organisms, which is detrimental to the environment.

[Topper's Answer, 2016]

Q. 2. Given below is a list of six micro-organisms. State their usefulness to humans.

- (i) *Nucleopolyhedroviruses*
 (ii) *Saccharomyces cerevisiae*
 (iii) *Monascus purpureus*

- (iv) *Trichoderma polysporum*
 (v) *Penicillium notatum*
 (vi) *Propionibacterium sharmanii*

[R] [Delhi Set-I, 2016]

- Ans.** (i) *Nucleopolyhedrovirus* : It is a biological control agent and is a species-specific insecticide.
 (ii) *Saccharomyces cerevisiae* : It is used to ferment bread dough and used in the preparation of ethanol.
 (iii) *Monascus purpureus* : It is commercialised as blood cholesterol lowering agent.
 (iv) *Trichoderma polysporum* : It produces cyclosporin A, which act as an immunosuppressive agent in organ transplant patients.
 (v) *Penicillium notatum* : It is a source of penicillin, an antibiotic.
 (vi) *Propionibacterium shermanii* : It is used in the preparation of cheese for texture, flavour and taste.

 $\frac{1}{2} \times 6 = 3$

[CBSE Marking Scheme, 2016]

AI Q. 3. 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*.

[E & A] [Delhi Set-III, 2015]

- Ans.** *Mycorrhiza* : Fungal symbiont of the association. absorb phosphorus from soil.
Anabaena : Fix atmospheric nitrogen / Adds organic matter to the soil.
Rhizobium : It is a symbiotic root nodule bacterium which fixes atmospheric nitrogen (in leguminous plants) in organic form which is used by plant as nutrient.
Methanobacterium : They digest cellulosic material and the product / spent slurry can be used as fertilizer.
Trichoderma : Biocontrol agent for several plant pathogens.

(Any 3 microbes = $\frac{1}{2} \times 3 = 1\frac{1}{2}$)(Any 3 Corresponding roles = $\frac{1}{2} \times 3 = 1\frac{1}{2}$)

[CBSE Marking Scheme, 2015]

Q. 4. Explain the role of *Baculoviruses* as biological control agents. Mention their importance in organic farming.

OR

Explain the significant role of the genus *Nucleopolyhedrovirus* in an ecological sensitive area.

[R] [Outside Delhi Set-I, 2014]

Ans. The role of *Baculoviruses* :

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 species-specific, biocontrol agents have narrow spectrum insecticidal applications. They have been shown to have no negative impacts on plants, mammals, birds, fish or even on non-target insects.

Importance in organic farming :

- (i) *Baculoviruses* are known to control pests like potato beetles, aphids and corn borers.

- (ii) Entomopox virus is another *baculovirus* which adversely affects the rate of development of grasshopper and the amount of food it eats.

1+2=3

Q. 5. How are *Baculoviruses* and *Bacillus thuringiensis* used as bio-control agents? Why are they preferred over readily available chemical pesticides.

[R] [Outside Delhi Set-I, Comptt., 2014]

Ans. *Baculoviruses* belong to *Nucleopolyhedroviruses*. They are used as biocontrol agents and preferred over readily available chemical pesticides because they are species specific and have narrow spectrum insecticidal application. They do not harm the non target organisms.

Bacillus thuringiensis is a bacterium and is a biocontrol agent against cotton bollworm insects. They produce a toxin that specifically kill the insect larvae when the toxin is released in their gut. It is also preferred over chemical pesticides because it is specific and does not have any negative role over non target organisms. Moreover, the biopesticides are inexpensive and do not cause environmental pollution.

3

Q. 6. (i) Why do farmers prefer biofertilizers to chemical fertilizers these days ? Explain.

(ii) How do *Anabaena* and *Mycorrhiza* act as biofertilisers ?

[A] [Delhi Set-I, II, III, 2011]

Ans. (i) Farmers prefer biofertilisers to chemical fertilizers because :

- They help to get high yield of crops by making the soil rich with nutrients and useful microorganisms necessary for the growth of the plants.
 - Chemical fertilizers make the environment polluted by releasing harmful chemicals and show biological magnification.
 - Biofertilisers destroy only those harmful components from the soil that cause diseases in the plants.
 - Biofertilisers are environment friendly and protect the environment against pollutants.
- (ii) Fungi are known to form symbiotic association with plants called mycorrhiza. Many members of the genus *Glomus* forms mycorrhiza. The fungal symbiont in this association absorbs phosphorus from soil. Arbuscular mycorrhizal fungi play a vital role as a phosphatic biofertilizer.

Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environments, many of which can fix atmospheric nitrogen e.g. *Anabaena*, *Nostoc*, *Oscillatoria* etc.

1½ + 1½ = 3

Commonly Made Error

- Students gets confused between bio fertilizers and bio pesticides. They write more about chemical fertilizers instead of advantages of bio fertilizers.

Answering Tip

- Bio fertilizers and bio pesticides should be compared and contrasted in a tabular form.

Q. 7. What are biopesticides ? Give the scientific name and use of the first commercially used biopesticide in the world. [R] [Delhi 2008]

Ans. The biological agent which are used to control weeds, insects and pathogen are called biopesticides. The micro-organisms that are used as biopesticides are some viruses, bacteria, fungi and their products. The bacterium *Bacillus thuringiensis* was the first biopesticide to be used on commercial scale. 3

Q. 8. (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.

[R] [Outside Delhi/ Delhi, 2018]

- Ans.** (a) (i) Reduces dependence on toxic chemicals.
 (ii) Protects our ecosystem or environment.
 (iii) Protects and conserves non-target organisms / they are species – specific.
 (iv) These chemicals being non-biodegradable may pollute the environment permanently.
 (v) These chemicals being non-biodegradable may cause biomagnification.

(Any three) = $\frac{1}{2} \times 3$

(b) Bacteria : *Bacillus thuringiensis*. $\frac{1}{2}$

Fungus : *Trichoderma*. $\frac{1}{2}$

Insect : Ladybird / Dragonfly / Moth or any other correct example. $\frac{1}{2}$

[CBSE Marking Scheme, 2018]

Q. 9. Some microbes act as biofertilisers. Explain with the help of three suitable examples.

[U] [Delhi 2017, Set - I, II, III]

- Ans.** (i) *Rhizobium* : Symbiotically fix atmospheric nitrogen into organic forms which can be used by the plant as nutrients.
 (ii) *Azospirillum* / *Azotobacter* : Free living bacteria fix atmospheric nitrogen.
 (iii) *Glomus* / *Fungi* : Symbiotic with plants absorbs phosphorus from soil and passes it to plant.
 (iv) *Cyanobacteria* / *Anabaena* / *Nostoc* / *Oscillatoria*: Fix atmospheric nitrogen in aquatic and terrestrial environment.

(v) Blue green algae : Add organic matter to soil and increase soil fertility.

(Any three) 1×3

[CBSE Marking Scheme, 2017]

Q. 10 Baculoviruses are good example of biocontrol agents. Justify giving three reasons.

[U] [Delhi/Outside Delhi, Comptt, Set 1, 2018]

- Ans.** i. Species specific / narrow spectrum insecticidal application. 1
 ii. They have no negative impact on plants / mammals / birds / fish / non target insects. 1
 iii. They are beneficial for IPM (Integrated Pest Management) / Pest Management Programme. 1

[CBSE Marking Scheme, 2018]

[AI] Q. 11. Microbes can be used to decrease the use of chemical fertilizers. Explain how this can be accomplished. [A] [CBSE SQP, 2018]

- Ans.** (a) *Rhizobium* bacteria present in the root nodules of leguminous plants forms a symbiotic association and fixes atmospheric nitrogen into organic forms, which is used by the plant as nutrient.
 (b) Free-living bacteria in the soil *Azospirillum* and *Azotobacter* can fix atmospheric nitrogen, thus enriching the nitrogen content of the soil.
 (c) Many members of the genus *Glomus* (Fungi) form mycorrhizal symbiotic associations with higher plants, in these the fungal symbiont absorbs phosphorus from soil and passes it to the plant.
 (d) Cyanobacteria like *Anabaena*, *Nostoc*, *Oscillatoria* are autotrophic microbes widely distributed in aquatic and terrestrial environments, which can fix atmospheric nitrogen, also add organic matter to the soil and increase its fertility.

1×3 (Any three)

[CBSE Marking Scheme, 2018]

Q. 12. An organic farmer relies on natural predation for controlling plant pests and diseases. Justify giving reasons why this is considered to be holistic approach. [E & A] [Foreign 2010]

Ans. Organic farming is holistic approach for controlling plant pest because it seeks to develop an understanding of the interactions amongst the organisms in the ecosystem.

Organic farmers do not try to completely eradicate the pest but keep them at manageable levels. A complete eradication of the pest is not beneficial and also not desirable because many beneficial predatory and parasitic insects can not survive without them. 3

? Long Answer Type Question

(5 marks)

AI Q. 1. (i) How does *Bacillus thuringiensis* act as a biocontrol agent for protecting *Brassica* and fruit trees ? Explain. [Foreign Set - I, II, 2017]

(ii) (a) List the components of biogas.

(b) What makes methanogens a suitable source for biogas production ?

Ans. (i) Bacterium *Bacillus thuringiensis* (Bt) are available in sachets as dried spores, mixed with water and sprayed onto vulnerable

plants, these are eaten up by the insect larvae, the toxins are released in the gut and larva gets killed. $\frac{1}{2} \times 4 = 2$

(ii) Methane, H_2S , CO_2 , H_2



Any two = $\frac{1}{2}$, Any three = 1

(iii) Methanogens grow anaerobically on cellulosic material, produce large amount of methane, alongwith CO_2 & H_2 . $\frac{1}{2} \times 4 = 2$

[CBSE Marking Scheme, 2017]

Know the Terms

- **BOD** : Biochemical oxygen Demand
- **KVIC** : Khadi and Village Industries Commission
- **GAP** : Ganga Action Plan
- **LAB** : Lactic acid Bacteria
- **YAP** : Yamuna Action Plan
- **STPs** : Sewage Treatment Plants
- **IPM** : Integrated Pest Management
- **Primary sewage treatment** : It is a mechanical process involving the removal of coarse solid materials.
- **Secondary sewage treatment** : It is a biological process involving the action of microbes.
- **Tertiary sewage treatment** : The treatment removes remaining inorganic compounds and substances, such as the nitrogen and phosphorous.
- **Flocs** : They are masses of bacteria associated with fungal filaments to form mesh-like structures include, tertiary sewage treatment.
- **Biological Oxygen Demand (BOD)** : It is the method of determining the amount of oxygen required by microorganisms to decompose the waste present in the water supply.
- **Biocontrol** : It refers to the use of biological methods for controlling plant diseases and pests.
- **Biopesticides** : The biological agent which are used to control weeds, insects and pathogen are called biopesticides.
- **Methanogens** : Micro-organisms that produce methane along with CO_2 and H_2 under anaerobic conditions are called methanogens.

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