

# 8

# Microbes in Human Welfare

## Fastrack Revision

- ▶ Microbes are the major components of biological systems on this earth.
- ▶ Microbes are present everywhere that is in soil, water, air, inside the body of plants and animals, inside thermal vents, deep in the soil, under the layers of snow several meters thick and in highly acidic environments.
- ▶ Microbes are diverse such that they are protozoa, bacteria, fungi and microscopic plants viruses, viroids and prions that are proteinacious infectious agents.
- ▶ Microbes like bacteria and many fungi can be grown on nutritive media to form colonies which can be seen with naked eyes.
- ▶ Microbes cause a large number of diseases in human beings, animals and plants but all microbes are not harmful instead several microbes are useful to man in diverse ways.
- ▶ **Microbes in Household Products**  
A large number of microbes or products derived from them are used everyday such as in production of curd, fermentation, production of cheese, etc.

### I. Production of Curd

- ▶ Milk is converted to curd by microorganisms such as *Lactobacillus* and others commonly called **Lactic Acid Bacteria (LAB)** which grow in milk and convert into curd.
- ▶ During growth of bacteria, the LAB produces acids that coagulate and partially digest the milk proteins.
- ▶ A small amount of curd is added to the fresh milk as inoculum or starter which at suitable temperatures multiply, thus, converting milk to curd, which also improves its nutritional quality by increasing vitamin B<sub>12</sub>.
- ▶ In our stomach, the LAB plays very beneficial role in checking disease causing microbes.

### II. Fermentation

- ▶ The dough, which is used for making foods such as dosa and Idli is also fermented by bacteria.
- ▶ The puffed-up appearance of dough is due to the production of CO<sub>2</sub>.
- ▶ The dough, which is used for making bread, is fermented using baker's yeast (*Saccharomyces cerevisiae*).
- ▶ A number of traditional drinks and foods are also made by fermentation by the microbes.
- ▶ **Toddy**, a traditional drink of some parts of southern India is made by fermenting sap from palms.
- ▶ Microbes are also used to ferment fish, soyabean and bamboo shoots to make foods.

### III. Production of Cheese

- ▶ Different varieties of cheese are known by their characteristic texture, flavour and taste, the specificity coming from the microbes used.

- ▶ The large holes in '**Swiss cheese**' are due to production of a large amount of CO<sub>2</sub> by a bacterium named *Propionibacterium shermanii*.
- ▶ The '**Roquefort cheese**' is ripened by growing specific fungi on them, which gives them a particular flavour.

## Knowledge BOOSTER

*Single Cell Protein (SCP) is the production of microbial biomass for consumption as human food or animal feed. The common SCP are Spirulina, yeast and Fusarium graminearum.*

### ▶ Microbes in Industrial Products

Production on an industrial scale, requires growing microbes in very large vessels called **fermenters**. Beverages, antibiotics, enzymes are some of the industrial products produced by microbes.

#### I. Fermented Beverages

- ▶ Microbes are used for the production of beverages like wine, beer, whisky, brandy or rum.
- ▶ *Saccharomyces cerevisiae* is used for the production of fermented beverages.
- ▶ Malted cereals and fruit juices are fermented by *S. cerevisiae* to produce ethanol.
- ▶ Wine and beer are produced without distillation.
- ▶ Whisky, brandy and rum are produced by distillation of the fermented broth.

#### II. Antibiotics

- ▶ Antibiotics are the chemical substances which are produced by some microbes and can kill or stop the growth of other microbes.
- ▶ Alexander Fleming discovered **Penicillin** obtained from *Penicillium notatum* which was the first antibiotic to be discovered.
- ▶ Alexander Fleming while working on *Staphylococci* bacteria observed a mould growing in one of his unwashed culture plates around which *Staphylococci* could not grow and he found out that it was due to a chemical produced by *Penicillium notatum*.
- ▶ Antibiotics are used against the deadly diseases like plague, whooping cough, leprosy, malaria, etc.

#### III. Chemicals, Enzymes and other Bioactive Molecules

- ▶ Microbes are used for the production of organic acids, alcohols and enzymes.

#### Examples:

- *Aspergillus niger* (a fungus) is the producer of citric acid.
- *Acetobacter aceti* (a bacterium) produces acetic acid.
- *Clostridium butylicum* (a bacterium) is the producer of butyric acid.

- *Saccharomyces cerevisiae* (an yeast) is used for commercial production of ethanol.
- *Lactobacillus* (a bacterium) is the producer of lactic acid.

► **Enzymes produced by the microbes are:**

- **Lipases:** Used in detergent formulations.
- **Pectinases and proteases** used in making bottled fruit juices clearer.
- **Streptokinase** produced by the bacterium *Streptococcus* is used as a 'clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.

► **Bioactive molecules produced by microbes are:**

- **Cyclosporin A** used as an immune suppressive agent in organ-transplant patients, is produced by the fungus *Trichoderma polysporum*.
- **Statins** produced by the yeast *Monascus purpureus*, is used as blood-cholesterol lowering agents that act by competitively inhibiting the enzyme responsible for synthesis of cholesterol.

## Knowledge BOOSTER



The first organic acid produced through microbial fermentation was lactic acid (Scheele, 1789).

► **Microbes in Sewage Treatment**

- Municipal waste-water which contains large amount of organic matter is called **sewage**.
- Before disposal, Sewage is Treated in Sewage Treatment Plants (STPs) by the heterotrophic microbes to make it less polluting.
- Sewage treatment is carried out in two stages: Primary and Secondary treatment.

► **Primary Treatment**

- Primary treatment basically involves physical removal of large and small particles.
- Initially, floating debris is removed by sequential filtration and then the grit (soil and small pebbles) are removed by sedimentation.
- All solids that settle form the primary sludge, and the supernatant forms the effluent.
- The effluent from the primary settling tank is taken for secondary treatment.

► **Secondary Treatment or Biological Treatment**

- The primary effluent is passed into large aeration tanks where it is constantly agitated. This allows vigorous growth of useful aerobic microbes into flocs.
- **Flocs** are the masses of bacteria associated with fungal filaments to form mesh-like structures.
- While growing, the microbes significantly reduce the **BOD (Biochemical Oxygen Demand)** which is the amount of oxygen required to oxidise total organic matter in the effluent.
- The BOD test measures the rate of uptake of oxygen by microorganisms. Greater the BOD of waste water, more is its polluting potential.
- The effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment and the 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** where

other kinds of bacteria grow anaerobically that digest the bacteria and the fungi in the sludge.

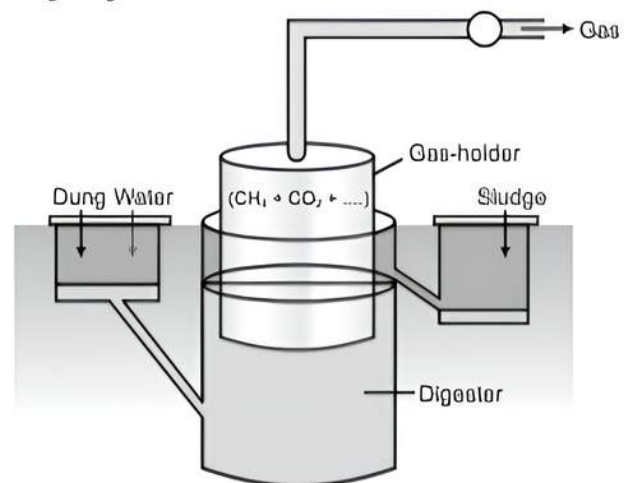
- During digestion, bacteria produce a mixture of gases such as methane, hydrogen sulfide and carbon dioxide which form biogas.
- The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.

► **Microbes in the Production of Biogas**

- Biogas is a mixture of gases (containing predominantly methane) produced by the microbial activity and which may be used as fuel.
- Certain bacteria grow anaerobically on cellulosic material and produce large amount of methane along with  $\text{CO}_2$  and  $\text{H}_2$  which are collectively called as **methanogens**.
- One common methanogen is *Methanobacterium*.
- These bacteria are commonly found in the anaerobic sludge during sewage treatment and in the rumen of cattle to digest cellulose in the food of the cattle. Thus, the excreta of cattle, commonly called gobar, can be used for generation of biogas, commonly called gobar gas.

► **Biogas Plant**

- The biogas plant consists of a concrete tank (10-15 feet deep) in which bio-wastes are collected and slurry of dung is fed.
- A floating cover is placed over the slurry, which keeps on rising as the gas is produced in the tank due to the microbial activity.
- The biogas plant has an outlet, which is connected to a pipe to supply biogas to nearby houses.
- The spent slurry is removed through another outlet and may be used as fertiliser.
- The biogas thus produced can be used for cooking and lighting.



► **Microbes as Biocontrol Agents**

- **Biocontrol** refers to the use of biological methods for controlling plant diseases and pests.
- Chemicals, insecticides and pesticides are extremely harmful to human beings and also these pollute our environment.
- The use of bio-control measures will greatly reduce our dependence on toxic chemicals and pesticides.
- Bio-control agents which are useful in controlling plant diseases and pests are:

- The ladybird, a beetle with red and black markings and dragon flies are useful to get rid of aphids and mosquitoes respectively.
- Bacteria *Bacillus thuringiensis* (Bt) is used to get rid of butterfly caterpillars where dried spores of *Bacillus thuringiensis* are mixed with water and sprayed onto vulnerable plants such as Brassicas and fruit trees. These are eaten by the insect larvae and in the gut of the larvae, the toxin is released due to which the larvae gets killed.
- *Trichoderma* species are free-living fungi found in the root ecosystem. These are effective as bio-control agents of several plant pathogens.
- *Baculoviruses* are pathogens that attack insects and other arthropods and the majority of *Baculoviruses* used as biological control agents are in the genus *Nucleopolyhedrovirus*.

► **Microbes as Biofertilisers**

- Biofertilisers are organisms that enrich the nutrient quality of the soil.
- The main sources of biofertilisers are bacteria, fungi and cyanobacteria.

► **Some microbes used as biofertilisers are:**

- *Rhizobium* form root nodules in *Leguminous* plants and fix atmospheric nitrogen into organic forms, which is used by the plant as nutrient.
- Free living bacteria like *Azospirillum* and *Azotobacter* fix atmospheric nitrogen and hence increases nitrogen content of the soil.
- Many members of the genus *Glomus* form Mycorrhiza, which is the symbiotic association of fungi with roots of the plants.
- The fungal symbiont in these associations absorbs phosphorus from the soil and passes to the plants.
- Plants having symbiotic association show resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.
- Cyanobacteria are autotrophic microbes which can fix atmospheric nitrogen: **Example:** *Anabaena*, *Nostoc*, *Oscillatoria*, etc.
- Blue-green algae also add organic matter to the soil and increase its fertility.



## Practice Exercise



### Multiple Choice Questions

Q 1. Which one of the following alcoholic drinks is produced without distillation?

- a. Wine      b. Whisky      c. Rum      d. Brandy

Q 2. The chemical substances produced by some microbes which can kill or retard the growth of other microbes are called:

- a. Antiseptics      b. Antacids  
c. Antibiotics      d. All of these

Q 3. Antibiotics are obtained from:

- a. bacteria      b. fungi  
c. actinomycetes      d. All of these

Q 4. Which of the following antibiotics was extensively used to treat American soldiers wounded in World War II?

- a. Neomycin      b. Bacitracin  
c. Chloramphenicol      d. Penicillin

Q 5. Streptomycin is obtained from:

- a. *Streptomyces griseus*      b. *S. cerevisiae*  
c. *S. venezuelae*      d. *S. rimosus*

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

- a. tetracycline      b. cyclosporin A  
c. statin      d. streptomycin

Q 7. BOD of wastewater is estimated by measuring the amount of:

- a. total organic matter  
b. biodegradable organic matter  
c. oxygen evolution  
d. oxygen consumption

Q 8. BOD is ..... in polluted water and ..... in potable water.

- a. more, less      b. less, more  
c. less in both      d. medium in both

Q 9. .... is the first step of sewage treatment.

- a. Precipitation      b. Chlorination  
c. Sedimentation      d. Aeration

Q 10. Identify the fungus that ripens the famous 'Roquefort' cheese:

(CBSE 2023)

- a. *Saccharomyces cerevisiae*  
b. *Propionibacterium shermanii*  
c. *Monascus purpureus*  
d. *Penicillium notatum*

Q 11. A microbial bio-control agent that can be used to control butterfly caterpillars is:

- a. *Trichoderma polysporum*  
b. *Bacillus thuringiensis*  
c. *Streptococcus*  
d. *Mycorrhiza*

Q 12. The free-living fungus *Trichoderma* can be used for:

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

Q 13. Organic farming includes:

- a. use of fertilisers and pesticides of biological origin.  
b. IPM (Integrated Pest Management).  
c. locally developed pest resistant varieties.  
d. All of the above

Q 14. Living organisms used to enrich the nutrient quality of the soil are called as:

- a. Bio-control agents      b. Bio-fertilisers  
c. Synthetic fertilisers      d. Natural fertilisers

- Q 15. 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	S. No.	Microbes (Source Organism)
(A)	Cyclosporin A	(i)	<i>Streptococcus</i>
(B)	Statins	(ii)	<i>Trichoderma polysporum</i>
(C)	Streptokinase	(iii)	<i>Penicillium notatum</i>
(D)	Penicillin	(iv)	<i>Monascus purpureus</i>

**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)
- Q 16. A nitrogen fixing microbe associated with the fern *Azolla* in rice fields is:  
 a. *Frankia* b. *Rhizobium*  
 c. *Spirulina* d. *Anabaena*
- Q 17. *Azolla pinnata* has been found to be an important bio-fertiliser for paddy crops. This quality is due to the presence of:  
 a.  $N_2$  fixing bacteria b.  $N_2$  fixing Cyanobacteria  
 c. *Mycorrhiza* d. All of these

 **Assertion & Reason** Type Questions 

**Directions (Q.Nos. 18-25):** Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a, b, c and d as given below.

- a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

- b. Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.  
 c. Assertion is true but Reason is false.  
 d. Assertion is false but Reason is true.

- Q 18. Assertion (A): Whisky develops colour during the ageing process.  
 Reason (R): Vodka is colourless.
- Q 19. Assertion (A): Immobilised yeasts cause less fermentation.  
 Reason (R): Brewer's yeast produces beer not wine.
- Q 20. Assertion (A): In ripening of cheese, insoluble proteins are cleaved to form soluble peptides.  
 Reason (R): Hard cheese and soft cheese, both are ripened by lactic acid bacteria.
- Q 21. Assertion (A): Enzymes application in industry is enhanced by its immobilisation.  
 Reason (R): Immobilisation provides protection to enzymes without affecting their activity.
- Q 22. Assertion (A): Acetic acid is prepared by acetic acid bacteria.  
 Reason (R): Alcoholic fermentation and the conversion of alcohol to acetic acid are aerobic processes.
- Q 23. Assertion (A): *Aspergillus niger* produces lactic acid.  
 Reason (R): *Rhizopus* produces citric acid.
- Q 24. Assertion (A): Intercropping checks the population of insects.  
 Reason (R): Plant pests can be controlled biologically by their natural parasites and pathogens.
- Q 25. Assertion (A): *Rhizobium* forms nodules on the roots of legume plants.  
 Reason (R): *Rhizobium* fixes atmospheric nitrogen into organic forms which is used by the plant as nutrients.

**Answers**

- (a) Wine  
Wine is the alcoholic drink produced without distillation whereas whisky, rum and brandy are produced by the distillation of the fermented broth. The alcoholic drinks are formed either by distillation or without distillation depending on the type of raw material used for fermentation.
- (c) Antibiotics
- (d) All of these  
Antibiotics are obtained from bacteria (like streptomycin) fungi (like *Penicillium*) and actinomycetes (like *Novoblocin*).
- (d) Penicillin
- (a) *Streptomyces griseus*
- (b) cyclosporin A
- (d) oxygen consumption  
Biological Oxygen Demand (i.e., BOD) is measured by the amount of oxygen what would be consumed when all the organic matter in one litre is oxidised by bacteria. Thus, the BOD of waste water is estimated by measuring the amount of oxygen consumption.
- (a) more, less
- (c) Sedimentation
- (b) *Propionibacterium sharmanii*
- (b) *Bacillus thuringiensis*  
An example of microbial biocontrol agent is bacteria *Bacillus thuringiensis* (Bt). It can be introduced in order to control butterfly caterpillars. These are

available in sachets as dried spores that are mixed with water and sprayed onto valuable plants such as *Brassica* and fruit trees, where these are eaten by the insect larvae.

12. (b) biological control of plant diseases
13. (d) All of the above
14. (d) Natural fertilisers
15. (d) A-(ii), B-(iv), C-(i), D-(iii)
16. (d) *Anabaena*

*Anabaena* are the nitrogen fixing bacteria which also forms colonising and establish symbiotic relationships with aquatic species such as *Azolla* that are found in rice fields.

17. (b)  $N_2$  fixing Cyanobacteria
18. (c) Assertion is true, but Reason is false.
19. (c) Assertion is true, but Reason is false.
20. (b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

21. (b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

An immobilized enzyme is physically entrapped or covalently bonded by chemical means to an inert and usually insoluble matrix, where it can act upon its natural substrate. The matrix is usually a high molecular weight polymer such as polyacrylamide, cellulose, starch, glass, beads, etc. Because of its binding with a matrix the immobilized enzyme has better stability in many cases. Efficiency of immobilized enzyme is better. The enzyme can be recovered at the end of the reaction and can be used repeatedly.

22. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Acetic acid production involves both aerobic and anaerobic processes, alcohol from glucose is aerobic process, and acetic acid production is an anaerobic process.

23. (b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

24. (b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

Intercropping keeps the population of insects at low level. In intercropping, the pest susceptible crop is grown along with other crops which are repellent to pests.

Plant pests are controlled biologically through the means of their natural parasites and pathogens. For example, *Baculovirus heliothis* can control cotton bollworm, *Bacillus thuringiensis* can control the cabbage hopper and *Entomophthora ignobilis* can control the green peach aphid of potato.

25. (b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.



## Case Study Based Questions

### Case Study 1

#### Microbes in Household Products

Microorganisms include bacteria, viruses, fungi and Protozoa. In our mind, we presume, most of the time, that microbes are always harmful. Microbes are, of course, the causal agents of many infectious diseases of plants and animals including humans but they also have lots of beneficial role. Lactic Acid Bacteria (LAB) are one of this kind of useful group. These are Gram positive, non-sporulating, either rod-shaped or spherical bacteria. They produce lactic acid in milk products as major metabolic end product of carbohydrate fermentation. LAB is considered as natural fermenters. *Lactobacillus* is a common LAB which converts lactose sugar of milk into lactic acid, that causes coagulation and partial digestion of milk protein casein. Milk is then changed into curd, yoghurt and cheese. *Lactobacillus* is also used in probiotics which have potentially beneficial effect on gut ecosystem of humans. Some other probiotic strain used belongs to the genus *Bifidobacterium*.

- Q 1. Which of the following is not considered as microorganisms?

- a. Bacteriophage
- b. *Streptococcus*
- c. *Porphyra*
- d. *Staphylococcus*

- Q 2. Select the incorrect option regarding the characteristics of lactic acid bacteria.

- a. They are rod-shaped or spherical.
- b. They are gram-positive.
- c. They take part in carbohydrate fermentation.
- d. They are acid intolerant.

- Q 3. Which of the following is not a lactic acid producing bacteria?

- a. *Streptococcus*
- b. *Lactococcus*
- c. *Saccharomyces*
- d. *Enterococcus*

- Q 4. Probiotics are:

- a. gut friendly live bacteria.
- b. acid balancing alternated bacteria.
- c. beneficial number of dead bacteria.
- d. Gram negative attenuated bacteria.

- Q 5. Assertion (A) : *Lactobacillus* bacteria do not retain crystal violet stain while staining.

Reason (R) : *Lactobacillus* has a very thin layer of peptidoglycan layer in their cell wall.

- 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.

### Answers

1. (c)
2. (d)
3. (c)
4. (a)
5. (d)

## Case Study 2

### Antibiotics

Discovery of Penicillin by Alexander Fleming in 1928 marked the beginning of the remarkable era in medical field. Penicillin was the first antibiotic extracted from *Penicillium notatum*. Antibiotics are used to treat bacterial diseases. These can be broad spectrum which can kill diverse group of disease-causing bacteria and narrow spectrum which is effective only against one group of pathogenic strain. Antibiotics can act as bactericides or bacteriostatic. Bactericidal antibiotics kill bacteria by—disruption of cell wall synthesis (e.g., penicillin, cephalosporin, etc.), inhibition of 50S ribosome function (e.g., erythromycin), inhibition of 30S ribosome function (e.g., streptomycin, neomycin), inhibition of amino acid-tRNA binding to ribosome (e.g., tetracycline), etc. Bacteriostatic antibiotics do not kill the bacteria rather they restrict the growth of bacteria. Penicillin belongs to  $\beta$ -lactum group of antibiotics, and it inhibits bacterial cell wall synthesis by binding and inactivating protein. It inhibits transpeptidation of reaction and blocks cross-linking of the cell wall. It is used to treat tonsillitis, sore throat, gonorrhoea, rheumatic fever and some pneumonia types.

- Q 1. The first antibiotic was extracted from a:**
- Lichen
  - Fungus
  - Eubacteria
  - Actinomycetes
- Q 2. Which of the following kills bacteria by interfering 50 ribosome functions?**
- Cephalosporin
  - Erythromycin
  - Streptomycin
  - Neomycin
- Q 3.  $\beta$ -lactum group of antibiotics kill the bacterial pathogen by:**
- disruption of plasma membrane.
  - inhibition of translation of mRNA
  - disruption of cell wall.
  - inhibition of transcription of mRNA.
- Q 4. Penicillin is not used to treat:**
- pneumonia
  - tonsillitis
  - rheumatic fever
  - candidiasis
- Q 5. Assertion (A):** Cephalosporins act by disruption of bacterial cell wall synthesis mechanism.
- Reason (R):** Cephalosporins are bacteriostatic antibiotics.
- Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
  - Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
  - Assertion is true, but Reason is false.
  - Assertion is false but Reason is true.

## Answers

1. (b)    2. (b)    3. (c)    4. (d)    5. (c)

## Case Study 3

### Enzymes in Bio-industry

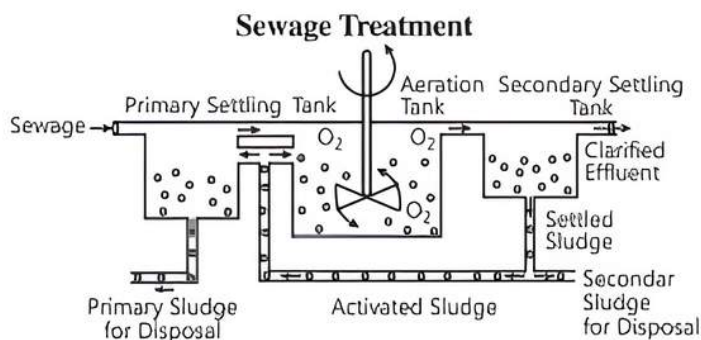
Enzymes are best known for their ability to catalyse biochemical reactions without undergoing any change. A large number of enzymes are being used in biotechnological industry. Most of them are obtained from microbes. Proteases degrade proteins and polypeptides. Most of the commercially applicable proteases are alkaline and are biosynthesised mainly by bacteria such as *Pseudomonas*, *Bacillus* and some fungi like, *Aspergillus*. These enzymes are used in clearing beer, softening of bread and meat, degumming of silk, etc. Alkaline serine proteases have the largest applications in bio-industry. Alkaline proteases have shown their capability to work under high pH, temperature and in presence of inhibitory compounds. Another important group of enzymes is amylases. Amylolytic enzymes act on starch. These are obtained from *Aspergillus*, *Rhizopus* and *Bacillus* sp. These are used in softening and sweetening of bread, production of alcoholic beverages from starchy materials, clearing of turbidity in juices caused by starch, etc.

- Q 1. Polypeptides are degraded by:**
- amylases
  - proteases
  - pectinases
  - lipases
- Q 2. Amylolytic enzymes are not obtained from:**
- Aspergillus*
  - Rhizopus*
  - Mucor*
  - Bacillus*
- Q 3. Clearing of turbidity in juices caused by starch is achieved by:**
- amylases
  - proteases
  - Both a. and b.
  - rennet
- Q 4. Select the incorrect option from the following:**
- enzymes are proteinaceous substances.
  - enzymes are substrate specific.
  - enzymes are large sized molecules.
  - microbial enzymes can work only in normal temperature and pH.
- Q 5. A farmer harvests corns and prepares corn starch. He wants to prepare some corn syrup from this. For the conversion he needs to use enzyme:**
- amylase
  - glucoamylases
  - glucosomerase
  - All of these

## Answers

1. (b)    2. (c)    3. (a)    4. (d)    5. (d)

## Case Study 4



### Activated sludge method of sewage treatment

Observe the above figure carefully and answer the following questions:

#### Q 1. What is primary treatment?

**Ans.** It is a physical process of removal of large and small particles from sewage through sequential filtration and sedimentation.

#### Q 2. What is secondary treatment?

**Ans.** It involves biological process of microbial degradation of organic matter contained in sewage effluent.

#### Q 3. What do you mean by flocs?

**Ans.** Flocs are the masses of bacteria associated with fungal filament to form mesh like structure.

OR

#### What is activated sludge?

**Ans.** In secondary settling tank, the flocs undergo sedimentation. The sediment is called activated sludge.



### Very Short Answer Type Questions

Q 1. Which one of the following is the baker's yeast used in fermentation? *Saccharum barberi*, *Saccharomyces cerevisiae*, Sonalika.

OR

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

**Ans.** *Saccharomyces cerevisiae* is used in fermentation of malted cereals and fruit juices.

Q 2. Milk starts to coagulate when Lactic Acid Bacteria (LAB) is added to warm milk as a starter. Mention any other two benefits that LAB provides.

**Ans.** The two benefits that LAB provides are:  
 (i) It increases nutritional quality of curd by increasing vitamin-B<sub>12</sub> content.  
 (ii) It checks the growth of disease-causing organisms in the gut.

Q 3. Discuss the role of LAB in producing curd.

**Ans.** *Lactobacillus lactis* and *Streptococcus lactis* bacteria produce acids which cause coagulation of milk protein called casein and changes milk into curd.

Q 4. Name the kind of cheese which possesses characteristic holes.

**Ans.** Swiss cheese process characteristic holes.

Q 5. Why are drinks like whisky and rum are more intoxicating than wine?

**Ans.** This is because wine is produced without distillation whereas whisky and rum are produced by distillation of the fermented broth.

Q 6. How is 'toddy' prepared?

**Ans.** Toddy is a traditional drink of Southern India which is prepared by the yeast fermentation of coconut water.

Q 7. Mention the three enzymes of industrial importance.

**Ans.** Three enzymes of industrial importance are proteases, pectinases and lipases.

Q 8. Name the two vitamins produced by microbial fermentation.

**Ans.** Vitamin-B<sub>12</sub> (Cobalamin) and Vitamin-B<sub>2</sub> (Riboflavin) are produced by microbial fermentation.

Q 9. Give the scientific name of the source organism from which the first antibiotic was produced.

**Ans.** The first antibiotic was produced by *Penicillium notatum*.

Q 10. Who discovered the first antibiotic? Name the antibiotic.

**Ans.** Alexander Fleming discovered the first antibiotic named penicillin.

Q 11. Why are antibiotics always sold in combination with *Lactobacillus*?

**Ans.** Antibiotics may kill even the useful bacteria present in the digestive tract. LAB is given, which will protect some microbes in the digestive tract and enhance the production of vitamin -B<sub>12</sub>.

Q 12. What is the medical use of cyclosporin A?

**Ans.** Cyclosporin A is used as an immunosuppressive agent in organ transplant patient.

Q 13. What are 'flocs', formed during secondary treatment of sewage? (CBSE 2019)

**Ans.** Flocs are masses of bacteria associated with fungal filaments and they are helpful in increasing the decomposition rate. They are put in the aeration tank while secondary sewage treatment is in process.

Q 14. Write any two places where methanogens can be found. (CBSE 2019)

**Ans.** Methanogens can be found in the guts of animals/ hydrothermal vents/ Deep layers of marine sediments / wetlands.

Q 15. Mention the information that the health workers derive by measuring BOD of a water body.

Ans. By measuring BOD of a water body, health workers find the amount of dissolved oxygen in water. The lesser the amount of dissolved oxygen, the more polluted the water body will be.

Q 16. Expand the terms.

(i) LAB (ii) BOD

Ans. (i) LAB : Lactic Acid Bacteria.  
(ii) BOD : Biochemical Oxygen Demand.

Q 17. Which of the following is a free-living bacterium that can fix nitrogen in the soil? *Spirulina*, *Azospirillum*, *Sonalika*.

Ans. *Azospirillum* is a free-living bacterium that can fix nitrogen in the soil.

Q 18. Name the group of organisms and the substrate they act on to produce biogas.

Ans. Group of organisms—Methanogens. Substrate: Cellulosic material/cow dung/agriculture waste.

Q 19. Which of the following is a cyanobacterium that can fix atmospheric nitrogen?

*Azospirillum*, *Oscillatoria*, *Spirulina*.

Ans. *Oscillatoria* can fix atmospheric nitrogen.

Q 20. How is the presence of cyanobacteria in the paddy fields beneficial to rice crop?

Ans. Cyanobacteria can fix atmospheric nitrogen. In paddy fields, the cyanobacteria act as an important biofertiliser. They also add organic matter to soil and increase its fertility.

Q 21. Mention the role of cyanobacteria as a biofertiliser.

Ans. Cyanobacteria is a biological organism that fixes atmospheric nitrogen.

### Short Answer Type Questions

Q 1. Name the microbes that help production of the following products commercially: (CBSE 2017)

- (i) Statin
- (ii) Citric acid
- (iii) Penicillin
- (iv) Butyric acid

Ans. (i) Statin: *Monascus purpureus* (fungus)  
(ii) Citric acid: *Aspergillus niger* (fungi)  
(iii) Penicillin: *Penicillium notatum* (fungi)  
(iv) Butyric acid: *Clostridium butylicum* (Bacteria)

Q 2. How does addition of a small amount of curd to fresh milk help in the formation of curd? Mention a nutritional quality that gets added to the curd.

OR

How does 'starter' added to milk help it to set into curd?

Ans. When a small amount of curd as starter is added to fresh milk, millions of Lactic Acid Bacteria (LAB)

present in the starter grow in milk and convert it to curd. During this process, acids are produced by LAB that coagulate and partially digest the milk proteins. LAB increases vitamin-B<sub>12</sub> content along with other vitamins in the curd.

Q 3. Write the names of two fungi and mention the products/bioactive molecules they help to produce.

Ans.

Fungi	Products/Bioactive molecules produced
<i>Trichoderma polysporum</i>	Cyclosporin-A
<i>Aspergillus niger</i>	Citric Acid
<i>Monascus purpureus</i>	Statin
<i>Saccharomyces cerevisiae</i>	Ethanol/Alcohol
<i>Penicillium notatum</i>	Penicillin (Any two)



### TIP

Student must learn the scientific names of the organisms and name must be free from spelling mistake.

Q 4. Name the blank spaces a, b, c and d from the table given below:

Type of microbe	Scientific name	Product	Medical application
Fungus	a	Cyclosporin	b
c	<i>Monascus purpureus</i>	Statin	d

Ans. a. *Trichoderma polysporum*  
b. Immunosuppressive agent  
c. Fungus  
d. Blood cholesterol lowering agent

Q 5. Name the source of statin and state its action on the human body.

OR

Name a microbe used for statin production. How do statin lower blood cholesterol level?

Ans. Statin is produced by the yeast, *Monascus purpureus*. (CBSE 2017)

It acts as a blood-cholesterol lowering agent, by competitively inhibiting the enzyme responsible for synthesis of cholesterol.

Q 6. Name a bioactive molecule, its source organism and the purpose for which it is given to organ transplant patients.

Ans. Cyclosporin A is a bioactive molecule given to organ transplant patients. It is obtained from a fungus *Trichoderma polysporum*. It is used as an immunosuppressive agent.

Q 7. Name the source of streptokinase. How does this bioactive molecule function in our body?

Ans. The source of streptokinase is *Streptococcus*. Streptokinase is a clot buster, i.e., it removes clot from the blood vessels of patients who had a heart attack.



Q 8. Why are some molecules called bioactive molecules? Give two examples of such molecules.

(CBSE 2017)

Ans. Some molecules are called bioactive molecules, because microbes like bacteria or fungi are used in their production.

e.g. Citric acid – Acetic acid  
Butyric acid – Lactic acid  
Ethanol – Urase  
Streptokinase – Cyclosporin A

(Any two)

### COMMON ERROR

Most of the students forget to write the examples as asked.

Q 9. How was penicillin discovered?

Ans. Penicillin was an accidental discovery. Sir Alexander Fleming observed that in unwanted culture, plates of Staphylococcus a mould of Penicillium was growing. This mould inhibited the growth of Staphylococcus around it. Later, the antibiotic penicillin was isolated from this fungus.

Q 10. (i) Write the first step the primary effluent undergoes when it enters the secondary treatment plant and state the purpose.

(ii) What is the level of B.O.D. indicative of in the secondary treatment plant? Mention its significance.

(CBSE 2023)

Ans. (i) The primary effluent is passed into large aeration tank where it is constantly agitated. This allows vigorous growth of useful aerobic microbes into flocs.

(ii) During the secondary treatment of primary effluents, the B.O.D. level decreases because useful microbes consume a major part of the organic matter. Reduction in the organic matter leads to lowering of B.O.D. It indicates the amount of organic pollution present in an aquatic ecosystem.

Q 11. List the events that lead to biogas production from waste water whose BOD has been reduced significantly.

(CBSE 2016)

Ans. The events leading to biogas production are:

(i) The effluent is passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This is called activated sludge.

(ii) The sludge is pumped into anaerobic sludge digesters where they are anaerobically digested. During this digestion, bacteria produce biogas.

Q 12. How do *Mycorrhiza* act as biofertilisers? Explain. Name a genus of fungi that forms a mycorrhizal association with plants.

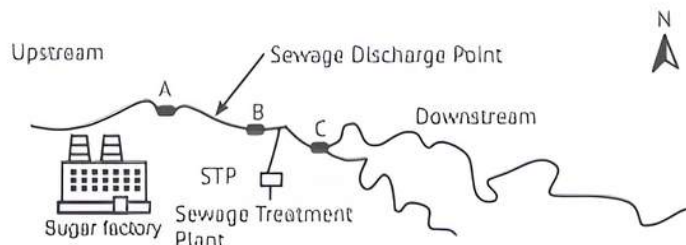
Ans. *Mycorrhiza* is a symbiotic association of a fungus with roots of higher plants. The fungus absorbs phosphate from soil and passes it to the plant. It also provides resistance to root-borne pathogen and increase the tolerance of plant to salinity and drought. In this way, they act as biofertilisers.

Genus of fungi – *Glomus*.

Q 13. 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?

(CBSE SQP 2022, Term-2)



Ans. 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).

Q 14. How did a citizen group called Friends of Arcata Marsh, Arcata, California and USA, help to improve water quality of the marshland using Integrated Waste Water Treatment? Explain in four steps.

(CBSE 2015)

Ans. The four steps are:

(i) Water is treated by conventional method/ sedimentation / filtration / chlorination.

(ii) Water flows to six connected marshes.

(iii) The water in marshes is seeded with appropriate plants / algae / fungi / bacteria.

(iv) This helps to neutralise the pollutants/ assimilate the pollutants / absorb pollutants / remove heavy metals.

Q 15. Describe how biogas is generated from activated sludge. List the components of biogas. (CBSE 2016)

Ans. The activated sludge is pumped into large tanks called anaerobic sludge digesters. Here, bacteria which grow anaerobically digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases which form biogas.

Biogas is made up of methane, hydrogen sulphide and carbon dioxide.

Q 16. What are methanogens? Name the animals they are present in and the role they play there.

(CBSE 2010)

Ans. Methanogens are bacteria which grow anaerobically on cellulosic material. They are present in the rumen of cattles.

These bacteria are responsible for the breakdown of cellulose and help in nutrition of animal.

Q 17. How do methanogens generate biogas?

Ans. Methanogens are anaerobic methane producing bacteria. They generate biogas when they act by anaerobic decomposition on cellulose rich bio-waste (anaerobically).

Q 18. What are biopesticides? Give the scientific name and use of first commercially used biopesticide in the world.

Ans. Biopesticides are living organisms which are able to kill or repel specific pests. Nowadays, biopesticides are used in place of chemical fertilisers.

*Bacillus thuringiensis* (Bt) is the first bacterial biopesticide to be used on commercial scale. It is a microbial biocontrol agent that can be introduced to control butterfly caterpillars.

Q 19. Your advice is sought to improve the nitrogen content of the soil to be used for cultivation of a non-leguminous terrestrial crop. (CBSE 2018)

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

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

Ans. (i) *Azospirillum/Azotobacter/Anabaena/Nostoc/Oscillatoria/Frankia.*



### TIP

Students write incorrect names of microbes or make mistakes in their spellings.

(ii) Leguminous crops do not require such enrichment of the soil as they can fix atmospheric nitrogen. due to presence of *Rhizobium* /  $N_2$  fixing bacteria in their root nodules.



### Long Answer Type-I Questions

Q 1. Name the group of bacteria involved in setting milk into curd. Explain the process they carry in doing so. Write another beneficial role of such bacteria. (CBSE 2019)

Ans. *Lactobacillus* and other Lactic Acid Bacteria (LAB) are responsible for the curdling of milk.

The process is:

(i) These bacteria utilise and act upon the milk sugar lactose leading to its oxidation to lactic acid.

(ii) This lactic acid produced in turn leads to partial digestion and coagulation of milk proteins to form curd.

Action by LAB leads to an increase in vitamin B12 content of the curd. On consumption of curd, these bacteria add to the healthy and beneficial gut flora outcompeting the growth of harmful gut flora.

### COMMON ERROR

Students often give incorrect explanation and many forget to answer, the sub-parts of question.

Q 2. (i) Match the microbes listed under Column A with the products mentioned under Column B.

	Column A		Column B
(A)	<i>Penicillium notatum</i>	(i)	Statin
(B)	<i>Trichoderma polysporum</i>	(ii)	ethanol
(C)	<i>Monascus purpureus</i>	(iii)	antibiotic
(D)	<i>Saccharomyces cerevisiae</i>	(iv)	Cyclosporin-A

(ii) Why does 'Swiss cheese' develop large holes?

(CBSE 2019)

Ans.

- (i) (A) *Penicillium notatum* (iii) antibiotic  
(B) *Trichoderma polysporum* (iv) Cyclosporin -A  
(C) *Monascus purpureus* (i) Statin  
(D) *Saccharomyces cerevisiae* (ii) ethanol

(ii) Swiss cheese develops large holes because of the large amount of carbon dioxide produced by the bacterium *Propionibacterium shermanii*.

Q 3. What are antibiotics? Name the classes of organisms that produce antibiotics.

Ans. Antibiotics are chemical substances primarily produced by some microorganisms which in low concentration can kill or retard the growth of other disease causing microorganisms.

Antibiotics are mainly produced from three groups of microorganisms:

- (i) *Eubacteria* (true bacteria)  
(ii) *Actinomycetes* (ramified bacteria)  
(iii) *Fungi*

Q 4. The aeration tank of a sewage treatment plant is not functioning properly. Explain in detail the impact of this on the treatment of sewage and BOD of the effluent. (CBSE SQP 2023-24)

Ans. (i) It will adversely affect the secondary treatment or biological treatment of sewage.

(ii) When the aeration tank is not functional, the air will not be pumped into it.

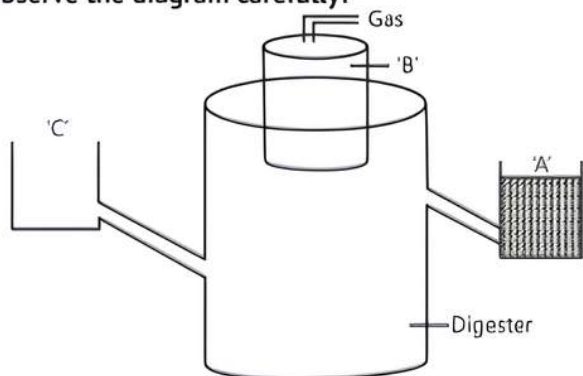
(iii) This will not allow the vigorous growth of useful aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh like structures).

(iv) Thus, the major part of the organic matter in the effluent will not be consumed by these bacteria.

(v) The BOD (Biochemical Oxygen Demand) of the effluent will not be reduced. BOD refers to the amount of the oxygen that would be consumed if all the organic matter in one liter of water were oxidised by bacteria.

- (vi) The greater the BOD of waste water, more is its polluting potential. Thus, the effluent will remain polluted with high amount of organic matter and high BOD.

Q 5. Observe the diagram carefully:



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. (CBSE 2016)

Ans. The sequence of events are:

- (i) The biogas plant tank is fed with slurry of dung. A floating cover is placed over the slurry which keeps on rising as the gas is produced in the tank due to the microbial activity of methanogens like *Methanobacterium*.
- (ii) Methanogens grow anaerobically on cellulosic material in cow dung to produce large amount of methane, CO<sub>2</sub> and H<sub>2</sub>.
- (iii) The biogas plant has an outlet, which is connected to a pipe to supply biogas. The spent slurry is removed through another outlet and is used as fertiliser.

A—Sludge tank B—Gas holder; C—Charge pit (Gobar + H<sub>2</sub>O) Inlet.

- Q 6. (i) Organic farmers prefer biological control of diseases and pests to the use of chemicals for the same purpose. Justify.  
(ii) Give an example of a bacterium, a fungus and an insect that are used as biocontrol agents.

(CBSE 2018)

- Ans. (i) Biological control helps to:
- (a) Reduce dependence on toxic chemicals.
  - (b) Protect our ecosystem or environment.
  - (c) Protects and conserves non-target organisms / they are species - specific.

On the other hand, chemicals are not preferred because:

- (a) These chemicals being non-biodegradable may pollute the environment permanently.
  - (b) These chemicals being non-biodegradable may cause bio-magnification
- (ii) Bacteria – *Bacillus thuringiensis*  
Fungus – *Trichoderma*  
Insect – Ladybird / Dragonfly / Moth or any other correct example.

Q 7. Name the genus to which *Baculoviruses* belong. Describe their role in the integrated pest management programmes.

Ans. *Baculovirus* belongs to the genus *Nucleopolyhedrovirus*.

The role of *Baculoviruses* is as follows:

- (i) *Baculoviruses* are pathogens that attack insects and other arthropods.
- (ii) These viruses are very useful for species-specific, narrow spectrum insecticidal applications.
- (iii) Also, as they show no negative impact on plants, mammals, birds, fish or even on non-target insects, they are beneficial in Integrated Pest Management (IPM) programme in which beneficial insects are conserved.

Q 8. (i) Write the scientific name of the nematode that infests the tobacco plants and the part that it infests.

(ii) How is *Agrobacterium* used to protect tobacco plant from this attack? (CBSE 2023)

Ans. (i) *Meloidogyne incognita* that is a root infecting nematode. It is also called as southern root knot nematode.

(ii) *Agrobacterium* is used to protect tobacco plants by inserting a particular gene into the plant's genome. This gene enables the plant to produce a protein that inhibits the growth of viruses that can attack the plant.

### COMMON ERROR

Often students forget to write scientific names in italics.



### Long Answer Type-II Questions

Q 1. Enumerate the role of microbes in producing some household products. (CBSE 2016, 19)

Ans. Microbes play the following role in producing Household Products:

(i) Curd

- (a) Curd is formed by adding a small amount of curd to milk, which acts as a starter.
- (b) *Lactobacillus* and Lactic Acid Bacteria (LAB) present in starter, multiply at suitable temperature and convert milk into curd.
- (c) Acids released by LAB during the growth coagulates and partially digest milk protein, casein.
- (d) Benefits of LAB:
  - Increases vitamin B<sub>12</sub> amount thus increasing nutrient quality of milk.
  - Checks disease-causing microbes in stomach.

(ii) Dough

- (a) Dough is formed by fermentation by bacteria.

- (b) Bread is made by fermentation by *Saccharomyces cerevisiae* or commonly called baker's yeast.
- (c) CO<sub>2</sub> released during the process of fermentation gives the puffy appearance to dough.
- (d) It is used to make foods like Idli, dosa, bread, etc.

**(iii) Toddy**

- (a) It is a traditional drink of Southern India.
- (b) It is made by fermentation of sap from palm trees by bacteria.

**(iv) Cheese**

- (a) Cheese is formed by partial degradation of milk by different microorganisms.
- (b) Swiss cheese is formed by the bacterium *Propionibacterium shermanii*. Its characteristic feature is formation of large holes due to production of large amount of CO<sub>2</sub>.
- (c) Roquefort cheese is formed by ripening with the fungi *Penicillium roqueforti* for a particular flavour.

**Q 2. (a) Explain Yamuna Action Plan.**

**(b) Complete the table:**

Name of the organism	Product/Enzyme/Bioactive molecule
<i>Aspergillus niger</i>	(i)
(ii)	Ethanol
(iii)	Cyclosporin-A
(iv)	Acetic acid
<i>Monascus purpureus</i>	(v)
<i>Streptococcus</i>	(vi)

**Ans. (a) Yamuna Action Plan:** In order to protect the major rivers of India from sewage pollution, the Ministry of Environment and Forests has initiated development of sewage treatment plants under the National River Conservation Authority, e.g., Ganga Action Plan and Yamuna Action Plan. Industries contribute chemical effluents to the river's pollution load and the toxicity kills aquatic animals in large sections of the river. Under these plans, a large number of sewage treatment plants were built so that only treated sewage is discharged into the rivers.

- (b)** (i) Citric acid  
 (ii) *Saccharomyces cerevisiae*  
 (iii) *Trichoderma polysporum*  
 (iv) *Acetobacter aceti* (v) Statin  
 (vi) Streptokinase

**Q 3. Describe the process of waste-water treatment under the following heads:**

- (i) Primary treatment  
 (ii) Secondary treatment

OR

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

**Ans. (i) Primary treatment or Physical treatment**

- (a) It is the physical removal of large and small particles from sewage.
- (b) First, the floating debris is removed by sequential filtration by passing through wire mesh screens.
- (c) Then, the grit (soil and small pebbles) are removed by sedimentation in settling tanks. The sediment is called primary sludge and the supernatant is the effluent.
- (d) The effluent is taken for secondary treatment.

**(ii) Secondary treatment or Biological treatment**

- (a) Primary effluent is passed into large aeration tanks with constant mechanical agitation and air supply.
- (b) Useful aerobic microbes grow rapidly and form flocs. Flocs are masses of bacteria associated with fungal filaments to form mesh-like structures.
- (c) The growing microbes consume organic matter and thus reduce the Biochemical Oxygen Demand (BOD).
- (d) When BOD of sewage has reduced, the effluent is passed into settling tank. Here, the bacterial flocs settle and the sediment is called activated sludge.
- (e) A small part of the sludge is used as an inoculum in the aeration tank and the remaining part is passed into large tanks called anaerobic sludge digesters.
- (f) In the digesters, heterotrophic microbes anaerobically digest bacteria and fungi in sludge producing mixture of gases such as methane, hydrogen sulphide and CO<sub>2</sub> which form the biogas.

The sewage treatment is essential before being released into water bodies so as to check water borne diseases or pathogenic organisms due to water pollution.



**TIP**

*Learn the process sequentially in steps under both the heads.*

**Q 4. (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.**

OR

**Secondary treatment of the sewage is also called biological treatment. Justify this statement and explain the process.** (CBSE 2017)

- Ans.** (i) Aerobic microbes occur naturally in sewage and make it less polluted during the treatment.
- (ii) The steps involved in the secondary treatment or Biological treatment of sewage are:
- (a) Primary effluent is passed into large aeration tanks with constant mechanical agitation and air supply.

- (b) Useful aerobic microbes grow rapidly and form flocs which are masses of bacteria associated with fungal filaments to form mesh-like structures.
- (c) The growing microbes consume organic matter and thus reduce the Biochemical Oxygen Demand (BOD).
- (d) When BOD of sewage has reduced, the effluent is passed into settling tank. Here, the bacterial flocs settle and the sediment is called activated sludge.
- (e) A small part of the sludge is used as an inoculum in the aeration tank and the remaining part is passed into large tanks called anaerobic sludge digesters.
- (f) In the digesters, heterotrophic microbes anaerobically digest bacteria and fungi in sludge producing mixture of gases such as methane, hydrogen sulphide and CO<sub>2</sub> which form the biogas.

**Q 5. Why should biological control of pests and pathogens be preferred to the conventional use of chemical pesticides? Explain how the following microbes act as biocontrol agents:**

- (i) *Bacillus thuringiensis*    (ii) *Nucleopolyhedrovirus*

**Ans.** Biological control of pests and pathogens is preferred because of the following reasons:

- The chemicals cause pollution of water bodies as well as ground water, besides getting stored in the plants.
  - The chemicals are toxic thus extremely harmful to human beings and other animals.
- (i) ***Bacillus thuringiensis*:** They produce toxin genes which when introduced into plant, become resistant to attack by insect pests. They are available in sachets as dried spores, which are mixed with water and sprayed onto vulnerable plants. When they are eaten by the insect larvae, the toxin is released in the gut where it becomes active and kills the larvae. Specific Bt toxin genes obtained from *B. thuringiensis* are used in several crop plants which make them resistant to insect pest.
- (ii) ***Nucleopolyhedrovirus*:** These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. This is especially desirable when beneficial insects are being conserved to aid in an overall Integrated Pest Management (IPM) programme.



## TIP

Apprehend what is being asked before answering by reading the question carefully.



## Chapter Test

### Multiple Choice Questions

**Q 1. Which of the following is widely used as a successful bio-fertiliser in Indian rice field?**

- a. *Rhizobium*                      b. *Acacia arabica*  
c. *Acalypha Indica*              d. *Azolla pinnata*

**Q 2. Which of the following options includes bio-fertilisers?**

- a. Cow dung manure and farmyard waste.  
b. A quick growing crop ploughed back into the field.  
c. *Nostoc*, *Oscillatoria*  
d. All of the above

**Q 3. *Mycorrhiza* does not help the host plant in:**

- a. enhancing its phosphorus uptake capacity.  
b. increasing its tolerance to drought.  
c. enhancing its resistance to root pathogens.  
d. increasing its resistance to insects.

### Assertion and Reason Type Questions

**Directions (Q.Nos. 4-5):** Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a, b, c and d as given below:

- a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion.  
b. Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.  
c. Assertion is true but Reason is false.  
d. Both Assertion and Reason are false.

**Q 4. Assertion (A):** An organism which acts as herbicide is called bioherbicide.

**Reason (R):** *Phytophthora palmivora* is a mycoherbicide.

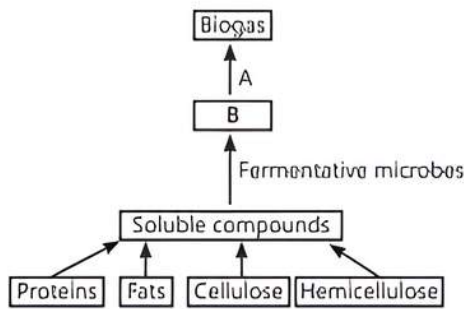
**Q 5. Assertion (A):** *Azotobacter* fixes nitrogen in symbiotic form.

**Reason (R):** *Azotobacter* form root nodules in the roots of Leguminous plants.

### Case Based Questions

#### Case Study 1

**Q 6.** Villagers in a place near Chambur started planning to make power supply for agricultural purposes from cow dung. They have started a biogas plant for the purpose. Study the flowchart for biogas production given ahead and answer the following questions.



- (i) **Biogas is composed of majorly:**
- Methane, CO<sub>2</sub> and O<sub>2</sub>
  - Methane, CO<sub>2</sub>
  - CO<sub>2</sub>, H<sub>2</sub>S and H
  - H<sub>2</sub>S, H and O<sub>2</sub>
- (ii) **In the given flowchart, 'A' denotes:**
- Aerobic bacteria
  - Methanogen bacteria
  - Cellulose degrading bacteria
  - Yeast and Protozoa
- (iii) **What is represented by 'B' in the flowchart?**
- Carbohydrates
  - Protein polymers
  - Organic acids
  - Fat globules
- (iv) **'C' in the given flowchart causes:**
- aerobic breakdown of complex organic compounds.
  - anaerobic digestion of complex organic compounds.
  - fermentation of organic compounds.
  - fermentation of monomers.

### Case Study 2

- Q 7. Biogas is a methane rich fuel produced by the degradation of biological matter by the bacterial action under anaerobic conditions. It is an ideal gas made up of 50-70% methane (CH<sub>4</sub>), 30-40% CO<sub>2</sub>, 1-5% H<sub>2</sub>, traces of O<sub>2</sub>, N<sub>2</sub> and H<sub>2</sub>S. Microbes produce different types of gaseous end-products based upon the microbes and the organic substrates

they utilise during growth and metabolism. Certain bacteria, collectively called **methanogens** which grow anaerobically on cellulosic material, produce large amount of methane along with CO<sub>2</sub> and H<sub>2</sub>, e.g., *Methanobacterium*, *Methanococcus*.

Read the given passage carefully and give the answer of the following questions:

- What is biogas?
- Give the composition of biogas.
- What are methanogens?

OR

Name any two methanogens.

### Very Short Answer Type Questions

- Q 8. Give the significance of biofertilisers.
- Q 9. What are *Nucleopolyhedroviruses* being used for nowadays?
- Q 10. Name the pests that ladybird, beetle and dragonflies help to get rid of.

### Short Answer Type Questions

- Q 11. List the events that reduce the Biological Oxygen Demand (BOD) of a primary effluent during sewage treatment.
- Q 12. Why is *Rhizobium* categorised as a 'symbiotic bacterium'? How does it act as a biofertiliser?

### Long Answer Type -I Question

- Q 13. What are the advantages of using biofertilisers in agriculture?

### Long Answer Type -II Question

- Q 14. Explain how are microbes important for humans.