

# MICROBES IN HUMAN WELFARE

## STUDY-NOTES

Microbes are important component of life on earth. They are omnipresent— soil, water, air, hot water springs, deep below the earth surface, and in acidic environments.

**Examples:** protozoa, bacteria, fungi, microscopic animal, plant viruses, viroids and prions (proteinacious infectious agents), which may be harmful or useful for human beings.

### MICROBES IN HOUSEHOLD PRODUCTS

- Lactic acid bacteria (LAB), e.g, *Lactobacillus* converts milk to curd, which also increase its vitamin B12 content. LAB also checks growth of disease causing microbes in stomach.
- Saccharomyces cerevisiae* ferments dough for *dosa* and *idli*.
- 'Toddy' is made by fermentation of sap from palms.
- Cheese preparation also uses microbes. Different types of cheese are due to specific microbes used in their production. For example, *Propionibacterium sharmanii* makes large holes due to production of large amount of CO<sub>2</sub> in 'Swiss cheese'. The 'Roquefort cheese' are ripened by specific fungi, which also, gives them a particular flavour.

### MICROBES IN INDUSTRIAL PRODUCTS

#### A. Fermented Beverages

- Yeasts *Saccharomyces cerevisiae* are used for production of beverages like wine, beer, whisky, brandy or rum. They ferment malted cereals and fruit juices and produce ethanol.
- Different types of alcoholic drinks are obtained depending on the type of raw material and the type of processing.
- For example, wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

#### B. Antibiotics

- Antibiotics are chemicals produced by microbes.
- Antibiotics kill or decrease the growth of other pathogens. For eg., the mould *Penicillium notatum* produces Penicillin that kills *Staphylococci* bacteria.
- Alexander Flemming discovered penicillin obtained from *Penicillium notatum* which was the first antibiotic to be discovered. While working on *Staphylococci* bacteria he observed a mould growing in one of his unwashed culture plates around which *Staphylococci* could not grow. 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.

#### C. Chemicals, Enzymes and Bioactive Molecules

Microbes are used for commercial production of organic acids, alcohols and enzymes. For example-

##### (i) Production of acids

- 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.
- Lactobacillus* (a bacterium) is the producer of lactic acid.

- (ii) **Production of Ethanol:** *Saccharomyces cerevisiae* (Yeast) is used for commercial production of ethanol.
- (iii) **Production of enzymes**
  - (a) **Lipases**, used in detergent formulations and in removing oily stains from laundry
  - (b) **Pectinases** and **proteases**, used for clarified bottled juices.
  - (c) **Streptokinases** are produced by bacterium *Streptococcus*. These are modified by genetic engineering to use as a 'clot buster'. It removes clots from the blood vessels of patients of myocardial infarction.
- (iv) **Production of bioactive molecules**
  - (a) **Cyclosporin A**, produced by fungus *Trichoderma polysporum*, and used as immunosuppressive agent in organ-transplant patients.
  - (b) **Statins** produced by yeast *Monascus purpureus*, are used as blood-cholesterol lowering agents. It competitively inhibits the enzyme responsible for cholesterol synthesis.

## MICROBES IN SEWAGE TREATMENT

- The discharge of sewage directly into water bodies or river cause water pollution. Therefore, before disposal it should be treated, which is done in sewage treatment plants (STPs).
- Waste water is treated with heterotrophic microbes which is naturally present in the sewage.
- Sewage treatment is completed in two stages:

### A. Primary treatment

- It includes physical removal of various particles from the sewage by filtration and sedimentation. This is performed in different steps:
  - (a) **Filtration:** removal of floating debris
  - (b) **Sedimentation:** removal of grits (soil and pebbles)
  - (c) Remaining solids settle and form the **primary sludge**. The supernatant is called **effluent**, which is then taken and sent for secondary treatment.

### B. Secondary treatment or Biological treatment

- In the large aeration tanks, primary effluent is mechanically constantly agitated and air is pumped into it.
- This results in vigorous growth of useful aerobic microbes into **flocs**, the mesh like structures which includes bacterial masses with fungal filaments.
- Microbes grow by consuming major part of the organic matter in the effluent. Hence, reduce the BOD of effluent.
- Treatment of sewage water occurs till significant reduction of BOD of effluents.
- After reduction of BOD, the effluent is passed into a settling tank to allow flocs to sediment. This sediment is now called **activated sludge**.
- A small part, called **inoculum**, of the activated sludge is pumped back into the aeration tank.
- The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge digesters**. Here anaerobic bacteria digest the aerobic bacteria and the fungi of the sludge.
- During this digestion, bacteria produce gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as energy source.
- The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.
- BOD (Biochemical Oxygen Demand) refers to the amount of the oxygen is consumed when all the organic matter in one litre of water is oxidised by bacteria.
- BOD test measures the rate of uptake of oxygen by microorganisms in a sample of water. Therefore, indirectly it is a measure of the organic matter present in the water.
- Greater value of BOD refers to more polluting potential of the sewage water.

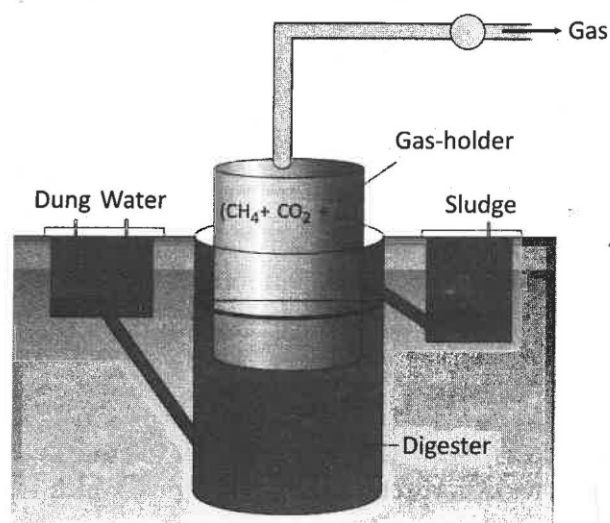
## MICROBES IN BIOGAS PRODUCTION

- Microbes produce various gaseous end-products during their growth and metabolism.

- The type of the gas produced depends upon the microbes and the organic substrates they utilise. Some anaerobic bacteria, called **methanogens**, grow on cellulosic material, and produce methane along with  $\text{CO}_2$  and  $\text{H}_2$ . For example, *Methanobacterium*.
- These are generally found in anaerobic sludge and in the rumen of cattles where they breakdown cellulose. Therefore, cattle-excreta (dung/gobar) is rich in bacteria and is used for biogas (gobar gas) generation.

### Structure of a Biogas plant

- The biogas plant consists of a 10-15 feet deep concrete tank in which bio-wastes are collected and a slurry of dung is fed.
- It is covered with a floating cover, which rises due to microbial production of gases.
- An outlet is connected to a pipe to supply biogas to nearby areas.
- The spent slurry is removed through another outlet and may be used as fertiliser.



## MICROBES AS BIOCONTROL AGENTS

- Biocontrol refers to the use of biological methods for controlling plant diseases and pests. The biocontrol agents protect plants from natural enemies like parasites, from predation, etc. They control the infestation of plant pests. For example, weeds, nematodes, insects, and mites. The biological control agents are harmful organism specific, and do not kill useful organisms of the soil.
- Insecticides and pesticides are toxic and extremely harmful to other organisms. In addition, they also cause soil and water pollution. Insecticides, pesticides and herbicides also enter the food chain through fruits, vegetables and crop plants.

### A. Biological control of pests and diseases

#### (i) Holistic approach

- The holistic approach of biological control of pests and diseases comprises intricate interactions amongst numerous organisms present in fields.
- Eradication of pests that are food or hosts of predatory and parasitic insects will also be helpful in removing these parasites. Therefore, biocontrol measures will greatly reduce our dependence on toxic chemicals and pesticides.

#### (ii) Biological farming approach

- The important part of the **biological farming approach** is to become familiar with the various life forms inhabiting the field.
- For example, predators, pests, and also their life cycles, patterns of feeding and the habitats they prefer. This aids in developing suitable means of biocontrol.

## B. Some examples of biocontrol agents

- (i) Beetle and Dragonflies are useful in eradicating aphids and mosquitoes, respectively. Butterfly caterpillars can be removed by bacteria *Bacillus thuringiensis*. Dried spores of *B. thuringiensis* are mixed with water and sprayed onto vulnerable plants. For example, brassicas and fruit trees. When eaten by larvae, toxin is released in their gut, which kills the larvae. The bacterial toxins kill the caterpillars, but other insects remain unharmed.
- (ii) *B.thuringiensis* toxin genes are introduced into plants. Such plants are resistant to attack by insect pests. For e.g., Bt-cotton.
- (iii) *Trichoderma* is free-living fungi and is very common in root ecosystems. They are used as biocontrol agents of various plant diseases.
- (iv) *Baculoviruses* attack insects and other arthropods. Most of the baculoviruses used as biological control agents belong to genus **Nucleopolyhedrovirus**. They do not have negative impacts on plants, mammals, birds, fish or non-target insects.

## MICROBES AS BIOFERTILISERS

- Excessive use of chemical fertilisers to meet demands of increasing population resulted in both soil and water pollution.
- Due to various environmental and health problems associated with overuse of chemical fertilisers, people switched to organic farming, which uses biofertilisers for crop production.
- **Biofertilisers** are organisms that improve the nutrient status of the soil.

### Sources of biofertilisers

#### (i) Bacteria

- *Rhizobium* forms nodules on the roots of leguminous plants. It is an example of symbiotic nitrogen fixation.
- The bacteria fix atmospheric nitrogen into organic forms, which is used by the plant as nutrient.
- Some free-living soil bacteria can also fix atmospheric nitrogen and increases the nitrogen content of the soil.
- For example, *Azospirillum* and *Azotobacter*. Some other bacterial biofertilisers are *Rhizobium*, *Azotobacter*, *Azospirillum*, and *Klebsiella*.

#### (ii) Fungi

- Mycorrhizae are symbiotic relationships between fungi and plants.
- In mycorrhizal association, fungi absorb phosphorus from the soil and provide to plants.
- Plants in associations possess resistance to root-borne pathogens, tolerance to salinity and drought. In general, plants show increased growth and development.

#### (iii) Cyanobacteria

- Cyanobacteria are autotrophic and extensively found in aquatic and terrestrial environments.
- Some of them fix atmospheric nitrogen, e.g. *Nostoc*, *Anabaena*, *Aulosira*, etc.
- Cyanobacteria are most important biofertiliser in paddy fields as they add organic matter to the soil and increase the fertility.
- These are used regularly in fields to replenish soil nutrients and to reduce dependence on chemical fertilisers.

## QUESTION BANK

### MULTIPLE CHOICE QUESTIONS

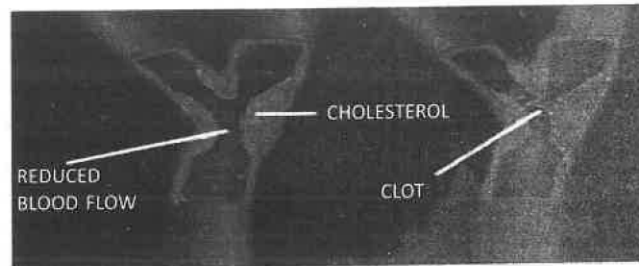
1. *Aspergillus* is a/an

- (a) Alga                                      (b) Fungus                                      (c) Bacterium                                      (d) Cyanobacterium

2. Which of the following produces blood-cholesterol lowering agents?

- (a) *Anabaena*                                      (b) *Clostridium*                                      (c) *Monascus*                                      (d) *Rhizobium*

3. A patient was admitted in ICU. He was diagnosed to suffered from myocardial infarction. The condition of his coronary artery was as shown in figure given below. Which bioactive agents can be given to him to improve his health condition?



- (a) Streptokinase produced by *Streptococcus*  
 (b) Statins produced by *Monascus purpureus*  
 (c) Cyclosporin A, produced by *Trichoderma polysporum*  
 (d) None of the above
4. Select the correct statement about heterotrophic microbes in sewage treatment plants.
- A. Heterotrophic bacteria derive energy from organic compounds.  
 B. They help in nutrient recycling.  
 C. They decompose dead and decaying plants and animal remnants and help in biodegradation.  
 D. Heterotrophic bacteria are used for making curd, antibiotics, nitrogen-fixation, etc.
- Select the correct statement:
- (a) A, B only                      (b) C, D only                      (c) A, B, C only                      (d) A, B, C, D
5. *Bacillus thuringiensis* is used for
- (a) Beer fermentation                      (b) Biopesticide  
 (c) Antibiotic                      (d) Formation of enzymes
6. Which of the following statements is correct?
- (a) Heterotrophic bacteria derive energy from organic compounds.  
 (b) Heterotrophic bacteria derive energy from inorganic compounds.  
 (c) Heterotrophic bacteria derive energy from sun.  
 (d) None of the above
7. A free-living aerobic and non-photosynthetic nitrogen fixing bacterium is
- (a) *Anabaena*                      (b) *Clostridium*                      (c) *Azotobactor*                      (d) *Rhizobium*
8. Which bacteria is used in sewage treatment plants?
- (a) *Bacillus*                      (b) *Streptococcus*                      (c) *Scytonema*                      (d) *Nostoc*
9. *Streptococcus* is used for the preparation of
- (a) Cheese                      (b) Paneer                      (c) Idli                      (d) Dosa
10. Which of the following cyanobacteria is abundantly found in paddy fields, and is helpful in atmospheric nitrogen fixation?
- (a) *Aulosira*                      (b) *Scytonema*                      (c) *Microcystis*                      (d) *Streptococcus*
11. Citric acid is metabolic product of
- (a) *Rhizopus*                      (b) *Mucor*                      (c) *Aspergillus*                      (d) *Saccharomyces*
12. Which of the following enzyme is responsible for atmospheric nitrogen fixation by *Nostoc*?
- (a) Streptokinase                      (b) Nitrogenase                      (c) Pectinases                      (d) Proteases



21. Acetic acid is produced by  
 (a) *Clostridium* (b) *Aspergillus* (c) *Acetobacter* (d) *Saccharomyces*
22. Which of the following is not correctly matched?  
 (a) *Aspergillus niger*-Fungi (b) *Nostoc*-Cyanobacteria  
 (c) *Saccharomyces*-Bacteria (d) *Trichoderma*-Fungi
23. Which of the following is a cyanobacterial nitrogen fixer?  
 (a) *Rhizobium* (b) *Clostridium* (c) *Nostoc* (d) *Azotobacter*
24. Match the following and select the correct option.

Column I	Column II
A. Dragonflies	(i) Biocontrol agents of several plants pathogens
B. <i>Bacillus thuringiensis</i>	(ii) Get rid of mosquitoes
C. <i>Glomus</i>	(iii) Narrow spectrum insecticidal
D. Baculoviruses	(iv) Biocontrol agents of lepidopteran plant pests
	(v) Absorb phosphorus from soil

- (a) A-(iii), B-(iv), C-(v), D-(i) (b) A-(i), B-(v), C-(iv), D-(ii)  
 (c) A-(iv), B-(i), C-(v), D-(iii) (d) A-(ii), B-(iv), C-(v), D-(iii)

25. Match Column I with Column II.

Column I	Column II
A. <i>Trichoderma polysporum</i>	(i) Brewer's yeast
B. <i>Monascus purpureus</i>	(ii) Cyclosporin A
C. <i>Streptococcus</i>	(iii) Statins
D. <i>Saccharomyces</i>	(iv) Clot buster

Select the correct option:

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

26. Match Column I with Column II.

Column I	Column II
A. <i>Saccharomyces cerevisiae</i>	(i) Production of immuno-suppressive agents
B. <i>Monascus purpureus</i>	(ii) Ripening of Swiss Cheese
C. <i>Trichoderma polysporum</i>	(iii) Commercial production of ethanol
D. <i>Propionibacterium shermanii</i>	(iv) Production of blood-cholesterol lowering agents

Select the correct option:

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

27. *Monascus purpureus* is a \_\_\_\_\_ and commercially used for the production of \_\_\_\_\_.  
 (a) Yeast, blood cholesterol lowering agents (b) Cyanobacteria, blood cholesterol lowering agents  
 (c) Bacteria, statins (d) Fungus, ethanol
28. A free-living anaerobic nitrogen fixing bacterium is  
 (a) *Rhizobium* (b) *Streptococcus* (c) *Azotobacter* (d) *Clostridium*

29. A biocontrol agent to be a part of an integrated pest management should be
- Species specific and symbiotic
  - Free living and broad spectrum
  - Narrow spectrum and symbiotic
  - Species specific and inactive on non-target organisms
30. Gases produced in anaerobic sludge digesters are
- Methane and carbon dioxide
  - Methane, carbon dioxide and hydrogen sulphide
  - Carbon dioxide and oxygen
  - Hydrogen sulphide and carbon dioxide
31. Biogas mostly contains
- Methane
  - Ethane
  - Carbon dioxide
  - Hydrogen sulphide
32. Select the correct statement(s).
- Whisky, brandy and rum are produced by distillation of the fermented broth.
  - Wine and beer are produced without distillation.
  - Penicillium notatum* inhibits the growth of *Staphylococci* bacteria in culture.
  - All the above are correct.
33. Which of the following statements about methanogens is not correct?
- They produce methane gas.
  - They can be used to produce biogas.
  - They are found in the rumen of cattle and excreta.
  - They grow aerobically and breakdown cellulose rich food.
34. The BOD test measures the rate of uptake of
- Oxygen
  - Carbon dioxide
  - Nitrogen
  - Hydrogen sulphide
35. Which of the following can be used as biofertilisers?
- Aspergillus* and *Rhizopus*
  - Rhizobium* and *Rhizopus*
  - Cyanobacteria and *Rhizobium*
  - Aspergillus* and Cyanobacteria
36. *B. thuringiensis* is used for the control of pests in
- Bt-croton
  - Bt-cotton
  - Bt-tomato
  - Bt-rice
37. It converts its food—sugar and starch into CO<sub>2</sub> and alcohol through fermentation. We can classify this microbe as
- eukaryotic but aerobe
  - prokaryotic but anaerobe
  - prokaryotic but aerobe
  - eukaryotic but anaerobe
38. Select the correct match.
- Lactobacillus*—LAB
  - Propionibacterium shermanii*—Swiss cheese
  - Saccharomyces cerevisiae*— Baker's yeast
  - All are correct
39. Select the incorrect statement.
- 'Toddy', is made by fermenting sap from palms.
  - Different varieties of cheese are known by their characteristic texture, flavour and taste.
  - Large holes in 'Swiss cheese' are due to large amount of O<sub>2</sub>.
  - LAB produce acids that coagulate and partially digest the milk proteins.
40. In *Anabaena*, enzyme nitrogenase is found in
- Terminal cells
  - Vegetative cells
  - Heterocysts
  - All of these



41. Which nutritional quality increases when milk is converted into curd?  
 (a) Vit D (b) Vit A (c) Vit B<sub>12</sub> (d) Vit B<sub>6</sub>
42. The sources of biofertilisers are  
 (a) Fungi (b) Bacteria (c) Cyanobacteria (d) All of these
43. Which of the following is correctly matched for the product produced by them?  
 (a) *Methanobacterium*: Lactic acid (b) *Penicillium notatum*: Acetic acid  
 (c) *Sacchromyces cerevisiae*: Ethanol (d) *Acetobacter aceti*: Antibiotics
44. Which of the following organism form root nodules with higher plants?  
 (a) *Nostoc* (b) *Anabaena* (c) *Streptococcus* (d) *Rhizobium*
45. Which of the following atmospheric gas is fixed by biological organism in its usable forms?  
 (a) CO<sub>2</sub> (b) N<sub>2</sub> (c) O<sub>2</sub> (d) H<sub>2</sub>
46. Which of the following sewage treatment removes suspended solids?  
 (a) Tertiary treatment (b) Secondary treatment (c) Primary treatment (d) Sludge treatment
47. The free living organism is/are  
 (a) *Azospirillum* (b) *Azotobacter* (c) Both (d) None of these
48. Which of the following nutrient element is absorbed by microbe and provided to plants for their growth?  
 (a) Phosphorus (b) Nitrogen (c) Carbon (d) Oxygen
49. The Ladybird, and Dragonflies are useful to get rid of many  
 (a) Aphids (b) Mosquitoes  
 (c) Both aphides and mosquitoes (d) None of these
50. Select the correct statement about clot busters.  
 (a) Streptokinase acts as a clot buster. (b) It is produced by *Streptococcus* species.  
 (c) Removes clots from the blood vessels. (d) All are correct.
51. Which of the following microbes symbiotically forms association with plants and provides nutrition to them?  
 (a) *Azotobacter* (b) *Aspergillus* (c) *Glomus* (d) *Trichoderma*
52. Which of the following gene is introduced into plants?  
 (a) *Bacillus thuringiensis* (b) *Bacillus subtilis* (c) *Bacillus sphaericus* (d) *Bacillus lentimorbus*
53. Select the correct statement from the following:  
 (a) Biogas is produced by the activity of aerobic bacteria on animal waste.  
 (b) *Methanobacterium* is an anaerobic bacterium found in rumen of cattle.  
 (c) Biogas commonly called gobar gas is a pure methane.  
 (d) Activated sludge sediment in settlement tanks of sewage treatment plant is a right source of aerobic bacteria.
54. What would happen if oxygen availability to activated sludge flocs is reduced?  
 (a) It will slow down the rate of degradation of organic matter.  
 (b) The center of flocs will become anoxic, which would cause death of bacteria and eventually breakage of flocs.  
 (c) Flocs would increase in size as anaerobic bacteria would grow around flocs.  
 (d) Protozoa will grow in large numbers.

55. Which of the following is the example of biological control agent?  
 (a) *Trichoderma* (b) *Methanogens* (c) *Saccharomyces* (d) *Glomus*
56. Yeast is used in the production of  
 (a) Citric acid and Lactic acid (b) Lipases and Streptokinase  
 (c) Bread and Beer (d) Cheese and Beer
57. Select the correct statement.  
 (a) *Aspergillus niger* produces cyclosporin A.  
 (b) Activated sludge is digested by aerobic bacteria to produce marsh gas.  
 (c) Fleming, Chain and Florey were awarded Nobel Prize for discovering penicillin.  
 (d) BOD is amount of oxygen produced by bacteria on decomposition.
58. Which of the following shows species-specific, narrow spectrum insecticidal properties?  
 (a) *Trichoderma* (b) *Methanogens*  
 (c) *Saccharomyces* (d) *Nucleopolyhedrovirus*
59. Which of the following can be effectively used in Integrated Pest Management programme?  
 (a) *Trichoderma* (b) *Methanogens*  
 (c) *Saccharomyces* (d) *Nucleopolyhedrovirus*
60. The mechanical process of removal of particles in Sewage Treatment Plant is also known as  
 (a) Physical process (b) Biological process  
 (c) Chemical process (d) None of these
61. Select the correct statement about statins.  
 (a) Statins help lower the level of low-density lipoprotein (LDL) cholesterol in the blood.  
 (b) LDL cholesterol is referred to as "bad cholesterol".  
 (c) Statins reduce the production of LDL inside the liver.  
 (d) All are correct.
62. Select the correct statement about Ganga Action Plan.  
 (a) It is initiated by The Ministry of Environment and Forests.  
 (b) This is to save these major rivers of our country from pollution.  
 (c) A large number of sewage treatment plants has to be built.  
 (d) All the above are correct.
63. The mechanical process of removal of small and large particles in STPs is/are  
 (a) Filtration (b) Sedimentation (c) Both (d) None
64. In sewage treatment plants, the solid that gets settle at the bottom is known as  
 (a) Primary sludge (b) Secondary sludge (c) Tertiary sludge (d) None
65. Which of the following is wrongly matched in the given table?
- | Microbe                           | Product       | Application                       |
|-----------------------------------|---------------|-----------------------------------|
| (a) <i>Monascus purpureus</i>     | Statins       | Lowering of blood cholesterol     |
| (b) <i>Streptococcus</i>          | Streptokinase | Removal of clot from blood vessel |
| (c) <i>Clostridium butylicum</i>  | Lipase        | Removal of oil stains             |
| (d) <i>Trichoderma polysporum</i> | Cyclosporin A | Immunosuppressive                 |
66. Which of the following microorganisms helps in the absorption of nutrients from soil?  
 (a) *Rhizobium* (b) *Anabaena* (c) *Frankia* (d) *Glomus*
67. The most common substrate used in the production of ethanol is  
 (a) Soya meals (b) Corn meals (c) Mosses (d) Molasses

68. Alexander Fleming discovered Penicillin when he was experimenting with the species of  
 (a) *Streptococcus* (b) *Staphylococcus* (c) *Staphylobacilli* (d) *Streptobacilli*
69. Fleming accidentally discovered penicillin from a mould, while working on  
 (a) Fungi (b) Bacteria (c) Cyanobacteria (d) Yeast
70. Select the incorrect statement about fermentation.  
 (a) *Propionibacterium* is used to ferment the cheese.  
 (b) The puffed appearance of dough is due to the production of carbon dioxide gas.  
 (c) Fermentation in muscles produces ethanol.  
 (d) Toddy is prepared by fermenting sap from palms.
71. The large vessels in growing microbes on large industrial scale is known as  
 (a) Digester (b) Fermentor (c) Bioreactor (d) Incubator
72. The gas responsible for puffing appearance of "dhokla" is due to the process of  
 (a) Respiration (b) Fermentation (c) Digestion (d) Distillation
73. The substance which inhibits the growth of other organism is  
 (a) Antibiotics (b) Antibody (c) Interferons (d) Prions
74. Effluents from the primary tanks is sent for further processing which involves  
 (a) Primary treatment (b) Secondary treatment (c) Biological treatment (d) Both (b) and (c)

### INPUT-TEXT BASED QUESTIONS

Read the following paragraphs and answer the following questions.

I. A major component of this waste water is human excreta. This municipal waste-water is also called sewage. It contains large amounts of organic matter and microbes. Many of which are pathogenic. Have you ever wondered where this huge quantity of sewage or urban waste water is disposed off daily? This cannot be discharged into natural water bodies like rivers and streams directly. Before disposal, hence, sewage is treated in sewage treatment plants (STPs) to make it less polluting. Treatment of waste water is done by the heterotrophic microbes naturally present in the sewage.

1. Waste water treatment is done by
  - (a) homotrophic microbes artificially made in the sewage
  - (b) heterotrophic microbes naturally present in the sewage
  - (c) symbiotic microbes artificially made in the sewage
  - (d) chemotrophic and heterotrophic microbes naturally present in the sewage
2. Two gases are produced during secondary treatment by sewage. They are
  - (a) Carbon monoxide and Methane
  - (b) Carbon dioxide and Nitrogen dioxide
  - (c) Carbon dioxide and Hydrogen sulphide
  - (d) Oxygen and Hydrogen sulphide
3. Match Column I with Column II.

Column I	Column II
A. Primary treatment	1. Activated sludge
B. Floccs	2. Aerobic microbes
C. Secondary treatment	3. Sedimentation
D. Sludge digesters	4. Anaerobic bacteria

Select the correct option:

- (a) A1, B2, C3, D4 (b) A3, B2, C1, D4 (c) A2, B1, C3, D4 (d) A3, B4, C1, D2



## EXPLANATION

2. Statins are produced by the yeast *Monascus purpureus*. It is commercially available sold as blood-cholesterol lowering agents. It competitively inhibits the enzyme responsible for synthesis of cholesterol.
3. Streptokinase is produced by the bacterium *Streptococcus*. It is modified by genetic engineering and is used as a 'clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.
5. *Bacillus thuringiensis* (Bt) is a Gram-positive, soil bacterium. It is most commonly used as biological pesticide.
8. *Bacillus* is a heterotrophic gram positive bacterium which is widely found in soil and water. It is used in sewage treatment plants.
10. *Aulosira* is a free-living nitrogen-fixing cyanobacteria. It is found in a variety of environmental niches such as soil and moist rocks.
12. Nitrogenases enzymes are found in some bacteria, such as cyanobacteria (blue-green algae) and rhizobacteria.
14. Bottled juices are clear as they are clarified by the use of pectinases and proteases.
15. Cyclosporin A produced by the fungus *Trichoderma polysporum*. It is a non-ribosomal peptide of amino acids. It is used as immunosuppressant drugs.
18. *nif* gene encodes enzymes involved in atmospheric nitrogen fixation.
23. *Nostoc* is a filamentous cyanobacterial nitrogen fixer that forms colonies composed of filaments of moniliform cells in a gelatinous sheath.
31. Biogas is a mixture of gases, primarily consisting of methane, carbon dioxide and hydrogen sulphide. This is produced from various raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste and food waste. It is a renewable energy source.
40. Heterocysts are specialised cells for nitrogen fixation in cyanobacteria.
48. Mycorrhiza provides phosphorous to plants. It is a non-disease-producing association in which the fungus invades the root to absorb nutrients.
52. *Bacillus thuringiensis* is mostly known for cry genes. The plants produce insecticidal proteins and is responsible for an effective and environmentally safe pest control.
57. The Nobel Prize in Physiology or Medicine 1945 was awarded jointly to Alexander Fleming, Boris Chain and Howard Walter Florey "for the discovery of penicillin and its curative effect in various infectious diseases."
62. The Ministry of Environment and Forests has initiated Ganga Action Plan and Yamuna Action Plan to save these major rivers of our country from pollution. Under these plans, it is proposed to build a large number of sewage treatment plants so that only treated sewage may be discharged in the rivers.
70. Fermentation by yeasts produces ethanol.
72. The gas (CO<sub>2</sub>) responsible for puffing appearance of "dhokla" is due to the process of fermentation.

### Input-Text Based Answers

I.	1. (b)	2. (c)	3. (b)	4. (c)	5. (b)
II.	1. (b)	2. (b)	3. (c)	4. (c)	5. (a)