CHAPTER / 11

Microbes in Human Welfare

Topics Covered

Microbes in Household Food Processing, Industrial Products and Sewage Treatment • Microbes in Household Products

Microbes in Industrial Products

Microbes in Sewage Treatment
 Microbes in Energy Generation as
 Biocontrol and Biofertilisers
 Energy Generation

Microbes in Biogas Production

- Microbes as Biocontrol Agents
- Microbes as Biofertilisers

TOPIC ~01

Microbes in Household Food Processing, Industrial products and Sewage Treatment

Microbes are the major components of biological systems on the earth. They are present everywhere, i.e. in soil, water, air, inside our body and even on other animals and plants. They are also found deep in extreme habitats such as thermal vents, deep in soil, under the layer of snow and in highly acidic and saline water bodies, etc., where no other life forms can exist.

- Microbes are so minute that they cannot be seen by naked eyes.
- Prokaryotes and primitive eukaryotes together constitute the world of microbes. Various types of microbes are, i.e. Protozoa, bacteria, majority of algae, fungi, virus, viroids and prions.



Unicellular eukaryotic microbe, Protozoa (a) Amoeba (b) Paramecium

Microbes are more commonly known for their harmful effects, however they have also become an essential part of many household and industrial process, etc., which are discussed below

Household Food Processing

Microbes and their metabolic processes are used in preparation of everyday food items like production of curd, formation of dough, cheese, ghee, buttermilk, cream, yogurt, etc.

Production of Curd

Microorganisms like *Lactobacillus* and other bacteria commonly called Lactic Acid Bacteria (LAB) grow in milk and convert it into curd. For preparation of curd, a starter is added to milk which turns it into curd. This starter is known as **inoculum** which contains millions of LAB. During their growth, LAB converts lactose sugar of milk into lactic acid that coagulates and partially digests the milk protein **casein** thus, converting milk into curd. LAB also improve nutritional quality by increasing vitamin-B₁₂ content of the curd.

These bacteria also play a very beneficial role in checking the growth of disease causing microbes in our stomach.

NOTE Milk or milk products are easily spoiled by bacteria. Pasteurisation is a process used to prevent the immediate growth of microbes on milk. In this method, milk is heated at particular temperature for a fixed period of time and then allowed to cool. During this process, the fermenting microbes can be inactivated for a certain period of time and used in food product preparation.

Fermentation by Microbes

Fermentation is a type of respiration in microbes occurring in the absence of oxygen. A number of fermented food items are prepared by the use of certain microbes. These are as follows:

- (i) Dough It is used in making food items such as dosa and idli employing the process of fermentation performed by bacteria.
 The puffed up appearance of dough is due to the production of CO₂. In bread making, dough is fermented using baker's yeast, i.e. Saccharomyces cerevisiae.
- (ii) Toddy It is a traditional drink in some parts of Southern India. It is made by fermenting sap from palm trees, coconut, etc.
- (iii) Cheese It is known to be the oldest food item in which microbes are used. It is formed by partial degradation of milk, fat and casein manufactured by the activity of different microorganisms. Different varieties of cheese are known by their texture, flavour and taste.

- (a) Swiss cheese It is produced by *Propionibacterium shermanii* with large holes. Holes are created due to the production of large amount of CO₂ produced by this bacterium.
- (b) **Roquefort cheese** It is ripened by growing a specific fungus *Penicillium roqueforti* on it which gives it a particular flavour.

Microbes in Industrial Products

Microbes are of immense importance in industries. The main industrial products obtained from microbes are fermented beverages, antibiotics, organic acids, alcohol, enzymes, bioactive molecules, etc.

Production of these products on an industrial scale needs growing microbes in very large vessels called fermentors. A microbe should possess desirable traits like it should be non-pathogenic and the ability to rapidly grow in a nutrient medium. Some of the fermented industrial products include:

(i) **Antibiotics** (*Anti*-against; *bio*-life) These are chemical substances produced by some microbes that can kill or retard the growth of other disease causing microbes.

Penicillin obtained from the mould *Penicillium notatum* was the first antibiotic discovered by Alexander Fleming in 1928. *Penicillium* was extensively used in treating American soldiers wounded in worldwar ll.

The second antibiotic which was extracted from a bacterial culture was **streptomycin**.

Antibiotics are used to cure deadly diseases such as plague, whooping cough, diphtheria and leprosy.

List of some microbes in

Microbe	Antibiotic	
Penicillium sp.	Penicillin	
Streptomyces griseus	Streptomycin	
S. aureofaciens	Tetracycline	
S. venezuelae	Chloramphenicol	
S. nouresi	Nystatin	

 (ii) Alcoholic beverages These include wine, beer, whisky, brandy and rum obtained by fermenting malted cereals and fruit juices with microbes like S.carlsbergensis, Candida brassicae, Zymomonas mobilis, etc., a strain of Saccharomyces cerevisiae (or brewer's yeast) to produce ethanol. The process of alcohol production is called brewing.

The variety of alcoholic drinks produced depends on the type of raw material used and the type of processing. For example, from the strach of barley grains the alcoholic bevarage, beer is obtained. Likewise, grapes are the raw material for wine production.

Wine and beer are produced without distillation. Whisky, brandy and rum are produced by the distillation of the fermented broth.

 (iii) Organic acids These are produced by the microbial metabolic actions. Most acids are used as preservatives, flavour enhances, etc.

Important organic acids producing organisms are listed below

- (a) Citric acid Aspergillus niger (fungi)
- (b) Acetic acid Acetobacter aceti (bacteria)
- (c) Butyric acid *Clostridium butylicum* (bacteria)
- (d) Lactic acid Lactobacillus (bacteria)
- (e) Gluconic acid Aspergillus niger, Penicillium chrysogenum
- (f) Fumaric acid Penicillium sp
- (iv) **Enzymes** These are used in various fields and also produced by microbes as given below:
 - (a) **Lipase** produced by *Rhizopus* sp. is used in detergent formulations and helps in removing oily stains from the laundry.
 - (b) Pectinase produced by Aspergillus sp and protease produced by A. niger and Bacillus subtilis are used for clearing of bottled juices.
 - (c) **Amylase** produced by *Aspergillus* sp. is used in digestive preparation of glucose syrup.
 - (d) **Cellulase** produced by *Trichoderma viridie* and used for the degradation of cellulose.

Microbes in Sewage Treatment

In sewage treatment, microbes play a major role in digesting organic matter.

Sewage is the municipal waste water containing mainly human excreta. It also contains a large quantity of organic matter, pathogenic microbes including aerobic and anaerobic bacteria. Therefore, before discharging into natural water bodies, sewage needs to be treated so that it is less polluting.

Sewage treatment is carried out in Sewage Treatment Plants (STPs) in the following steps:

1. Primary Treatment of Sewage

- (a) This step is also known as physical treatment as it involves physical removal of large and small particles from sewage through filtration and sedimentation.
- (b) Floating debris are removed using sequential filtration by passing through wire mesh screens.

- (c) After this, the grit (soil and small pebbles) is removed by sedimentation in settling tanks. The sediment is called **primary sludge** and the supernatant forms the **primary effluent**.
- (d) The effluent is taken for secondary treatment.

2. Secondary Treatment of Sewage

It is done with primary effluent. This treatment is also known as biological treatment as it involves the use of microbes for sewage treatment.

- (a) Primary effluent is passed into large aeration tanks with constant mechanical agitation and air supply.
- (b) This allows vigorous growth of useful aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh-like structures).
- (c) These microbes consume a major part of organic matter in the effluent while undergoing growth and cellular development. This reduces the Biochemical Oxygen Demand (BOD) of the effluent.
- (d) When BOD of sewage gets reduced, it is passed into settling tank.
- (e) The bacterial flocs settle in tank and the sediment is now called **activated sludge**.
- (f) A small amount of activated sludge is pumped back into the aeration tank to serve as inoculum.
- (g) The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge digesters**.
- (h) In sludge digesters, other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge.

During this process, bacteria produce a mixture of gases, such as methane, hydrogen sulphide and carbon dioxide which form biogas (can be used as source of energy).

The effluent from secondary treatment is generally released into natural water bodies.

3. Tertiary Treatment

It is a physico-chemical process. It involves disinfecting the water, if it is to be used for domestic purpose. It is done by various methods such as reverse osmosis, treating with chlorine, ozone gas or perchlorate salts.

PRACTICE QUESTIONS

Exams', Textbook's Other Imp. Questions

1 MARK Questions

Exams' Questions

- Fill the blanks selecting the appropriate terms given under the bit
- **Q.1** Fermentation of milk sugar, is done by Lactobacillus. [CHSE 2019] (a) glucose (b) fructose (c) sucrose (d) lactose
- Ans (d) lactose
- Q.2 In secondary treatment of sewage in open bioreactors, the microorganisms grow and multiply to form [CHSE 2018] (a) manure (b) compost (c) sludge (d) sediment
- Ans (c) sludge
- Q.3 In curd making, is useful in coagulation of milk protein. [2017] (a) Penicillium (b) Lactobacillus (c) Saccharomyces (d) Aspergillus
- Ans (b) Lactobacillus
- Q.4 Yeast and Acetobacter are both involved in the production of from carbohydrates. [2016] (a) penicillin (b) cirate (c) methane (d) vinegar
- Ans (d) vinegar
- Correct the statement of each bit if necessary, by changing the underlined word only
- Q.5 In ethyl alcohol production, the unicellular fungus, *Penicillium* is used. [2015]
- Ans In ethyl alcohol production, the unicellular fungus Saccharomyces cerevisiae is used.

Important Questions

• Choose the correct option

Q.6 Citric acid is produced when fermentation is caused by (Lactobacillus, Aspergillus sp, *Penicillium* sp., *Acetobacter* sp.) [Textbook]

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Ans Aspergillus sp.
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Q.7 Lipase enzyme is produced by the activity of

[Textbook]

- (a) Trichoderma viridie
- (b) Rhizopus sp.
- (c) Aspergillus sp.
- (d) None of the above
- Ans (b) Rhizopus sp.
- **Q.8** Antibiotic streptomycin is obtained from [Textbook]
 - (a) Streptomyces griseus
 - (b) Streptomyces aureofaciens
 - (c) Streptomyces nouresi
 - (d) Streptomyces notatum
- Ans (a) Streptomyces griseus
- Fill in the blanks
- **Q.9** Acetobacter converts to vinegar by aerobic fermentation of legumes. [Textbook]
- Ans (a) ethyl alcohol
- Q.10 Ethanol obtained by fermentation is used in industry.
- Ans microbial
- Q.11 The from secondary treatment of sewage is generally released into water bodies.
- Ans effluent; natural
- Correct the statement, if required, by changing the underlined word
- Q.12 Antibiotic tetracycline is obtained from Penicillium notatum. [Textbook]
- Ans Streptomyces aureofaciens
- **0.13** The first antibiotic to be extracted from bacterial culture was nystatin. [Textbook]
- Ans streptomycin
- **Q.14** Industrial production of organic acids through microbial cultures is due to the oxidation process by bacteria. [Textbook]
- Ans. fermentation

21/2 MARK Questions

Exams' Questions

- Write short notes on the following
- Q.15 Alcoholic beverages [2018]
- or Alcoholic fermentation [2017]
- Ans Fermented beverages include wine, beer, whisky, brandy and rum which are obtained by fermenting malted cereals and fruit juices with Saccharomyces cerevisiae or brewer's yeast to produce ethanol. This process is known as alcoholic fermentation.

The variety of alcoholic drinks produced, depends on the type of raw material used and the type of processing. Wine and beer are produced without distillation. Whisky, brandy and rum are produced by the distillation of the fermented broth.

Q.16Secondary treatement of sewage.[2015]AnsRefer to text on page no. 177.

Important Questions

• Write short notes on the following

Q.17 Microbes in industry. [Textbook]

- Ans Industrial use of microbes includes the production of beverages, antibiotics, etc., that are useful for the human. The large scale production of these products is carried out in bioreactors using the appropriate microbes, e.g. butyric acid is derived from *Clostridium* and terramycin is derived from *Streptomyces rimosus*.
- Q.18 Anaerobic sludge digesters.
- Ans. Sludge is the remaining part of organic matter after secondary treatment of sewage.

In sludge digesters, other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge.

During this process, bacteria produce a mixture of gases, such as methane, hydrogen sulphide and carbon dioxide which form biogas that can be used as source of energy.

31/2 MARK Questions

Important Questions

Q.19 Differentiate between bakery and brewery.

Ans Differences between baker's and brewer's yeast are:

[Textbook]

Bakery	Brewery	
Baker's yeast is Saccharomyces cerevisiae. It is used in fermentation to prepare dough that is used to make bread, idli, dosa, etc.	Brewer's yeast is also Saccharomyces cerevisiae but a different strain. It is used to produce various alcoholic drinks by fermenting malted cereals and fruit juices.	
In this, CO_2 released during the process of fermentation gives the fluffy appearance.	In this, CO_2 released gives a bubbled up appearance of drinks.	

- **Q.20** Differentiate between primary and secondary sewage treatment.
- Ans Differences between primary and secondary sewage treatment are:

Primary sewage treatment	Secondary sewage treatment
It is a mechanical process.	It is a biological process.
It involves physical removal of solid material.	It involves the action of microbes.
The settled solid in this is called the primary sludge.	The sediment produced in this is called activated sludge.

7 MARK Questions

Exams' Questions

Q.21 Discuss how waste water treatment can be done. Ans Refer to text on page no. 177. [2019]

Important Questions

- **Q.22** Give a detailed account of industrial application of microbes.
- Ans Refer to text on page no. 176 and 177.

TOPIC TEST 1

• Choose the correct option

1. Milk protein that coagulates during curd formation is

(a) protease	(b)	casein		
(c) rennin	(d)	pectinase	[Ans.	(b)]

- Correct the statement, if required, by changing the underlined word
 - **2.** Antibiotics are used to cure deadly diseases such as <u>plague</u>, whooping cough, diphtheria, etc.

[Ans. typhoid]

- Fill up the blanks
 - **3.** During the secondary treatment of primary effluents, the BOD level....... [**Ans.** decreases]

4. Commercial name of acetic acid is

[Ans. vinegar]

5. The process of involves heating and cooling of milk for inactivation of microbes.

[Ans. pasteurisation]

- **6.** enzyme produced by *Aspergillus niger* is used for clarifying bottled juices. [**Ans.** Pectinase]

- **9.** Write a note on production of curd using microbes.
- 10. Write a detailed account of sewage treatment.

TOPIC ~02 Microbes in Energy Generation, as Biocontrol Agents and Biofertilisers

Energy Generation

The present day life is completely dependent on energy available in different forms. Non-renewable sources of energy are obtained from fossil fuels like coal and crude petrol. Due to their extensive use, they are on the edge of depletion. Therefore, it is necessary to use alternate, renewable sources of energy to maintain the continuous supply. Biogas is an important source of renewable energy.

Biogas

Biogas is a mixture of gases, but the major component is methane gas (50-60%) other gases are relatively low; such as carbon dioxide (25-30%), hydrogen (1-5%), nitrogen (2-7%) and oxygen (0.01%). Biogas is produced by the microbial activity in digestion of biomass with the help of certain bacteria, i.e. methanogens. It is used as a fuel.

Microbes in Biogas Production

Methanogens produce large amount of CH_4 , CO_2 and H_2 . These are commonly added to anaerobic sludge during sewage treatment.

They are also present in rumen (a part of stomach) of cattle, where they help in breakdown of cellulosic material in the food and thus, play important role in nutrition of cattle.

Since, in rural areas, the cattle production is maximum, biogas is produced from their excreta, gobar.

Industrially, viable biogas is produced in large vessels called **bioreactors**.

The anaerobic digestion of complex organic molecules takes place in the following steps:

- (i) Cellulose, fats and proteins contained in the waste are made soluble (solubilisation).
- (ii) Products of low molecular weight are converted into organic acids, mainly acetic acid by microbial action (acidogenesis).
- (iii) Acetic acid thus produced is acted upon by methanogenic bacteria and is converted to CH_4 and CO_2 (methanogenesis).

Uses of Biogas

The biogas, thus produced is used for cooking and lighting. It is also used in internal combustion engines of electric generators.

Microbes as Biocontrol Agents

Biocontrol is the use of biological methods for controlling plant diseases and pests. It is a holistic approach that seeks to develop an understanding of the interactions between various organisms and use of this knowledge to control pests, weeds, etc.

Uses of Microbes as Biocontrol Agents

The use of microbes is being made popular because of the following reasons

- (i) Chemical pesticides and insecticides are nonbiodegradable. They persist in the environment for very long periods of time. This facilitates their accumulation in increasing concentration at different trophic levels is they pass through a food chain. This phenomenon as known as bioaccumulation or biomagnification.
- (ii) The pest organisms targeted by chemicals become increasingly resistant to the chemical treatment.
- (iii) The undesirable species targeted by these chemicals may include beneficial insects, animals or microbes, etc. disrupting the ecosystem balance.
- (iv) Microbes used for biocontrol reduce the target species population through many ecological mechanisms, including pathogenicity, competition, production of chemicals and other interactions. Also, they are biodegradable, thus non-polluting.
- (v) Bacteria, fungi and viruses can act as biocontrol agents due to the large diversity of target species high specificity and the variety of methods of action, e.g. Bacillus thuringiensis, Pseudomonas and Beauveria bassiana.

Biological Control of Pests and Diseases

Some examples of biological control agents are given as under:

(i) Gram-negative bacterium dried spores of this bacterium is mixed with water and sprayed onto vulnerable plants. When these plants are eaten by the insect larvae, the toxin gets released in its gut and kills the larvae.

The genes of *Bacillus thuringiensis* having insecticidal properties *sis* are isolated and incorporated into plants by using advanced biotechnological methods producing transgenic plants which are resistant to attack by insect pests.

- (ii) *Trichoderma* species are free-living fungi that are very common in the root ecosystems. They are effective biocontrol agents of several plant pathogens.
- (iii) Baculoviruses belonging to the genus Nucleopolyhedrovirus are rod-shaped, double-stranded DNA viruses used in biological

control of insects. These are excellent for species-specific, narrow spectrum insecticidal applications.

Insect larvae ingest the plant material contaminated with baculoviruses. The DNA of the virus is released in the alimentary canal. Viral DNA enters the epithelial cells of the host and replicates into large number of viral particle thus causing lysis and death of the pest later on. They are used in overall integrated pest management programme. They do not have any negative impact on the ecosystem.

Microbes as Biofertilisers

Nutrients in optimum amount are important for the proper growth, development and maximum productivity of plants. The most important nutrients are nitrogen and phosphorus which are constituent of essential elements in proteins, nucleic acids, co-enzymes, etc. The nutrient requirements of plants are met by chemical fertilisers. However, these chemicals are being used in increasing amounts in order to increase the output in high yielding varieties of crops.

However, due to excessive pollution caused by these chemical fertilisers, there is a pressure to shift to **organic farming**, i.e. to use biofertilisers. These are the organisms that bring about the nutrient enrichment of soil by enhancing the availability of nutrients to the crops. The scientists are thus working to develop biofertilisers with potential of

(i) nitrogen-fixation and

(ii) solubilising phosphates.

The main sources of biofertilisers are as follows :

Bacteria

Rhizobium is a symbiotic nitrogen-fixing bacterium that lives in the root nodules of legumes and fixes atmospheric nitrogen into organic compounds (biological nitrogen-fixation). *Azotobacter* and *Azospirillum* are free-living bacteria which absorb free nitrogen from the soil, air and convert it into salts of nitrogen compounds like amino acids and enrich the soil nutrients.

Fungi

They also form symbiotic association with plants called as **mycorrhiza** which absorb phosphorus from soil and pass it on to the plants. Many members of genus– *Glomus* form mycorrhiza. Plants with mycorrhizal association show other benefits also such as:

- (i) Resistance to root borne pathogens.
- (ii) Tolerance to salinity and drought.
- (iii) Increase in plant growth and development.

Cyanobacteria

These are autotrophic microbes found in aquatic and terrestrial environments. Many of them fix atmospheric nitrogen, e.g. *Anabaena, Nostoc, Oscillatoria*, etc. In paddy fields, cyanobacteria (blue-green algae) serve as important biofertilisers.

Biotechnological Approach

It is possible to manipulate the nitrogen-fixing property into non-nitrogen-fixing crop plants with the help of biotechnology. It is carried out to obtain following objectives :

- Modify either microbes or the targeted crop plant to benefit both through their association with each other.
- Modify non-nitrogen-fixing bacteria found in close association with the targeted crop to achieve nitrogen-fixation.
- Prepare genetically modified crop with ability to fix atmospheric nitrogen by transferring *nif* (nitrogenfixing) genes in them.

Thus, it can be concluded that microbes play a very important role in our life.

PRACTICE QUESTIONS

Exams', Textbook's Other Imp. Questions

[2014]

1 MARK Questions

Exams' Questions

- Correct the statement, if required, by changing the underlined word
 - **Q.1** The major component of biogas is <u>carbon dioxide</u>.

Ans Methane

Important Questions

- Fill up the blank
- Q.2 In pest control of crop plants has pesticidal properties. (baculovirus, papillomavirus, pox virus, *Rhizobium*) [Textbook]
- Ans (b) baculovirus
- Q.3 BGA used in biological nitrogen-fixation are called bacteria. [Textbook]
- Ans cyano
- Q.4 In biogas production, bacteria are used. [Textbook]Ans methanogenic
- Correct the statement, if required, by changing the underlined word
- Q.5 In biogas, methane is produced due to the activities of <u>nitrogen-fixing bacteria</u>. [Textbook]Ans methanogen bacteria

- Answer in one word only
- Q.6 What is called the accumulated microorganisms and organic matter in the treatment of sewage? [Textbook]
- Ans. Sludge
- Q.7 What is the major component of biogas?
- Ans. Methane
- **Q.8** What can be called the natural pest killing agent other than artificial chemical?
- Ans. Biopesticides
- Q.9 What is called the association between *Rhizobium* in the root system of legumes?
- Ans. Symbiotic association

21/2 MARK Questions

Exam Questions

- Write short notes on the following
- **Q.10** Bacillus thuringiensis
- Ans Bacillus thuringiensis is a soil-borne, Gram-positive bacterium. It is used to create a transgenic cotton plant having resistance to cotton bollworm. The genes having insecticidal properties in the bacterium are isolated and incorporated into transgenic Bt cotton plants by using advanced

[2014]

biotechnological methods. During sporulation, many Bt strains produce crystal proteins (proteinaceous inclusions), called δ -endotoxins, that have insecticidal activity.

Important Questions

Q.11 Biocontrol agents

Ans Biocontrol agents involve the use of biological methods for controlling plant diseases and pests. Bacteria, fungi and viruses can act as biocontrol agents due to the large diversity of target species and the variety of method of action. Microbes used for biocontrol reduce the target species population through many ecological mechanisms, including pathogenicity, competition, production of chemicals and other interactions.

Q.12 Biogas

[Textbook]

Ans Biogas is a mixture of gases, but the major component is methane gas. It is produced by the microbial activity in digestion of biomass with the help of certain bacteria, i.e. methanogens. It is used as a fuel. Methanogens produce large amount of CH_4 (50-70%), CO_2 (30-40%) and H_2 . They are commonly found in anaerobic sludge during sewage treatment.

31/2 MARK Questions

Important Questions

- Q.13 Differentiate between biofertilisers and chemical fertilisers. [Textbook]
- Ans Differences between biofertilisers and chemical fertilisers are:

Biofertilisers	Chemical fertilisers
These are the microbes which in association with plants make nutrients available to plants.	These are chemical formulations.
These are eco-friendly.	These are harmful and may pollute the environment.
Improve the soil profile for cropping.	Make soil unfit for cropping purposes.

- Q.14 Differentiate between synthetic pesticides and biopesticides. [Textbook]
- **Ans** Differences between synthetic pesticides and biopesticides are:

Synthetic pesticides	Biopesticides
These are not very specific, so harm non-targeted species.	These are highly specific, so do not harm non-targeted species.
They cause pollution.	They do not cause pollution.
Insects may become resistant, e.g. <i>Heliothis</i> , has become resistant to most insecticides.	Insects are not expected to develop resistance to biopesticides.
Harmful residues may often remain in food, fodder and fibres.	No harmful residues remain in food, fodder and fibres.

7 MARK Questions

Important Questions

- **Q.15** Give a detailed account of microbes as biocontrol agents.
- Ans Refer to text on page no. 181.
- Q.16 Explain how microbes are useful in pollution control and also in production of alternative source of energy. [Textbook]
- **Ans.** Microbes are major component of biological world on this earth. Although they are the causal agents of most of the infectious diseases, still they are of great importance to humans.

Now, scientists are developing the ways in which the use of microorganisms is solving pollution problem. This can be done by bioremediation. In this technique, microorganisms are used to neutralise pollutants from a contaminated site by their oxidation.

Pollution can be controlled by microbes in two ways

- (i) By enhancing the growth and activity of microbes already present an pollutant site.
- (ii) By adding some new microbes to the pollution site. Pollution control by the application of microbes works best when pollutants are a known mixture of organic compounds that are related to each other in structure and when there is no competition from indigenous microorganisms.

Production of Alternative Source of Energy Refer to text on page no. 180 and 181.

TOPIC TEST 2

- Choose the correct option (Ques. 1 to 3)
 - A major component of gobar gas is
 (a) ammonia
 (b) methane
 (c) ethane
 (d) butane
 - **2.** Which is a microbial pesticide?
 - (a) Bacillus thuringiensis (b) B. subtilis
 - (c) *B. polymyxa* (d) *B. laevis*
 - [Ans. 1. (b), 2. (a)]
- Answer in one word only
 - absorbs free nitrogen from the soil, air and converts it into salts of nitrogen compounds to enrich the soil nutrients. Ans. 3. Azospirillum]
- Answer in one word only
 - **4.** What is the name of natural pest killing agents used in place of the artificial chemicals?

[Ans. Biocontrol agents]

• Correct the statement, if required, by changing the underlined word

 In paddy fields, blue-green algae fix <u>phosphorus</u> to enrich the soil fertility. [Ans. nitrogen]

- Fill up the blank
 - 6. *Rhizobium* is a bacterium that serves as biofertiliser. [Ans. symbiotic]
 - 7. Write a short note on cyanobacteria as biofertiliser.
 - **8.** Write a short note on *Trichoderma* as a biocontrol agent.
 - **9.** Differentiate between symbiotic nitrogen-fixation and mycorrhizal nitrogen-fixation.
 - **10.** Write a detailed account on biopesticides with reference to *Bacillus thuringiensis*.

Chapter Test

1 MARK Questions

• Choose the correct option

- 1 Organisms called methanogens are most abundant in a
(a) polluted stream(b) hot spring(c) sulphur rock(d) rumen of cattle
- 2 Which of the following is mainly produced by the activity of anaerobic bacteria on sewage? (a) Mustard gas (b) Biogas (c) Laughing gas (d) Propane
- 3 Secondary sewage treatment is mainly a
 (a) chemical process
 (b) biological process
 (c) physical process
 (d) mechanical process
- 4 Which of the following products used in detergent industry is derived from *Rhizopus* sp?

 (a) Protease
 (b) Lipase

 (c) Cellulase
 (d) Pectinase

 [Ans. 1. (d), 2. (b), 3. (b) 4. (b)]

• Fill up the blanks

- 5 Statins are the blood cholesterol lowering agents produced by
- 6 Azospirillum and Azotobacter are bacteria.
- 7 are used as biocontrol agents to control mosquitoes.
- 8 Viable biogas is produced in large vessels called......
- Correct the statement, if required, by changing the underlined word
- 10 Baculoviruses belonging to the genus <u>Penicillin</u> are used as agents of biological control.
- 11 Mycorrniza provide <u>cobalt</u> to the roots of plants.
- 12 Bacillus thuringiensis is a Gram- negative bacteria.
- 13 Baculoviruses are <u>single-stranded RNA</u> viruses.
 [Ans. 10. Nucleopolyhedrovirus, 11. phosphorus, 12. positive 13. double-standard DNA]

21/2 MARK Questions

- Write short notes on the following
- 14 Harmful effects of chemical pesticides.
- 15 Enzymes produced by microbes.
- 16 Role of biotechnology in manipulating nitrogen-fixing property in crop plants.

31/2 MARK Questions

- Differentiate between
- 17 Biopesticides and biocontrol agents.
- 18 Primary sludge and activated sludge.

7 MARK Questions

- 19 Write a detailed account of microbes used in industry.
- 20 Write a detailed account of biogas production.