# 5. Microbes in Human Welfare



## 5.0 : Introduction

**Q.1. What are microbes ?**

**Ans:** Microbes are microscopic living organisms. They include small algae, fungi, bacteria, protozoans, mycoplasmas and related organisms.

**Q.2. Define Microbiology.**

**Ans:** The branch of biology which deals with the study of microbes is called as microbiology.

**Q.3. Name some applied branches of microbiology.**

**Ans:** Food microbiology, Medical microbiology, Industrial microbiology are some applied branches of microbiology.

## 5.1 : Microbes in Household Production

**Q.4. What makes idlies puffy ?**

**Ans:** The bubbles of $CO_2$ trapped in glutein make idlies puffy.

**Q.5. Why does bread show fluffy appearance ?**

**Ans:** During kneeding of dough, glucose is hydrolysed by yeast (Saccharomyces cerevisiaei releasing $CO_2$ which makes the bread fluffy.

**Q.6. Give reason -'Buttermilk is used in the dough of dhokla.'** **[Mar 2013]**

**Ans:** The Lactobacilli present in butter milk bring about the fermentation process.

**Q.7. Name some traditional Indian foods made of wheat, rice and Bengal gram (or their products) which involve use of microbes.**

**Ans:** i) Wheat $\rightarrow$ Bread, Jalebi, Nan.
ii) Rice $\rightarrow$ Idli, Dosa.
iii) Bengal gram $\rightarrow$ Khaman, Dhokla.

**Q.8. Many microbes are used at home during preparation of food items. Comment on such useful ones with examples.**

**Ans:** i) Many household preparations involve the use of microbes. e.g. idli, dhokla, jalebi, etc.
ii) Microbes help in fermentation process.
iii) Lactobacilli bring about the fermentation of mixture of gram flour and buttermilk in the preparation of dhokla.
iv) Lactobacilli also helps in the preparation of jalebi and nan.
v) Yeast and' bacteria helps in the preparation of idli and dosas. Micro-organisms like species of Bacillus, Candida and Saccharomyces make the idlies puffy.

**Q.9. Write a note on Single cell protein.**

**Ans:** i) Single cell protein means dead and dried cells of microbes like bacteria, algae, molds and yeasts. They are obtained by growing microbes of various groups on different substrates.
ii) SCP contains about 45-55% proteins. So, SCP is a protein-rich powder and an ideal supplement to conventional food supply.
iii) It can be used to solve the problem of protein deficiency in the children of developing countries.
iv) Most commonly employed strains to produce SCP are bacteria like Bacillus subtilis and fungi like species of Candida and Saccharomyces cerevisiae, algae such as Chlorella, etc.

**Q.10. Write a note on fungi as a source of food.**

**Ans:** i) Mushrooms and truffles are used as a food. (They belong to 'Basidiomycetes' fungi)
ii) They produce large fleshy fruiting bodies' which are edible.
iii) They are low calorie, sugar-free, fat-free but rich in proteins, vitamins, minerals and amino acids.
iv) Some common examples of edible mushrooms are White button mushroom (*Agaricus bisporus*), Paddy straw mushroom (*Volvariella volvacea*), Oyster mushroom (*Pleurotus florida*).

**Q.11.**Name any 'two' edible varieties of mushrooms. Give nutritional values of these mushrooms. **[Mar 2014]**

**Ans:**The edible varieties of mushrooms are:

i) White button mushroom (*Agaricus bisporus*)

ii) Paddy straw mushroom (*Volvariella volvacea*)

These mushrooms are low calorie, sugar-free, fat-free but rich in proteins, vitamins, minerals and amino acids.

## 5.2 : Microbes in Industrial Production

**Q.12.Name the alcoholic beverages produced by use of microbes.**

**Ans:** Production of beverages like wine, beer, whisky, brandy or rum include use of microbes.

**Q.13. Name the steps involved in beer production.**

**Ans:** The steps involved in beer production are Malting, mashing and fermentation.

**Q.14. How are fermented (alcoholic) beverages produced?**

**Ans:**i) Alcoholic beverages are the products of alcoholic fermentation of specific substrates.

ii) Alcoholic beverages include liquors like wine, beer and whisky.

iii) Industrial production of wine involves the use of a number of strains of the yeast, Saccharomyces cerevisiae var ellipsoideus.

iv) Different flavours of wine are obtained by using different fruit juices:

v) Beer is obtained from fermented grains, mostly barley. Suitable strains of S. cerevisiae are used for fermentation.

vi) Production of beer involves :

Malting
↓
Mashing
↓
Fermentation
↓
Standing
↓
Clarification
↓
Carboxylation
↓
Filling in bottles
↓
Packaging
↓
Marketing

vii) Wine and beer are produced without fermentation.

viii) Whisky is obtained by fermenting mixed grains of com, wheat, barley, etc. The fermentation product is then distilled.

**Q.15. Name the fat soluble vitamins.**

**Ans:** Vitamin A, D, E and K are fat soluble vitamins.

**Q.16.What is the microbial source of vitamin C ?**

**Ans:** The microbial source of Vitamin C is *Aspergillus niger.*

**Q.17. Write a note on microbes in industrial vitamin production.**

**Ans:**i) Vitamins are complex organic compounds required in very small quantities for the normal growth.

ii) Vitamins include A, B, C, D, E and K.

iii) All vitamins are not produced in the human body. They can be supplemented through food or tablets.

iv) Following are some of the examples of vitamins and microbes used as source :

| Name of the Vitamin | Microbial source |
|---|---|
| a. Vitamin $B_2$ | *Neurospora gossypli*<br>*Eremothecium ashbyli* |
| b Vitamin $B_{12}$ | *Pseudomonas denitrificans* |
| c. Vitamin C | *Aspergillus niger* |

**Q.18.Who discovered antibiotics? On which bacteria was he working at that time ?**

**Ans:** Dr. Alexander Fleming, a British Physician discovered antibiotics in 1929. He was working on *Staphylococcus aureus* bacteria.

**Q.19.Define antibiotics.**

**Ans:** Antibiotics are peptides or derived proteins which are produced in small amounts by some microbes and can kill or retard the growth of other (disease causing) microbes.

**Q.20.Name some human diseases that can be controlled by using antibiotics.**

**Ans:** Human diseases like plague, whooping cough, diphtheria and leprosy can be controlled by using antibiotics.

**Q.21. Name any two antibiotics and their microbial source.**

**Ans:**

| No. | Antibiotic | Microbial source |
|---|---|---|
| i) | Chloromycetin | *Streptomyces venezuelae* |
| ii) | Erythromycin | *Streptomyces erythreus* |

**Q.22. List some microbes that are used in the production of organic acids.**

**Ans:**

| | Organic acid | Microbes used |
|---|---|---|
| i) | Citric acid | *Aspergillus niger* |
| ii) | Gluconic acid | *Aspergillus niger* |
| iii) | Fumaric acid | *Rhizopus arrhizus* |
| iv) | Acetic acid (Vinegar) | *Acetobacter aceti* |

**Q.23.From which microorganism is vinegar obtained ?** **[Oct 2014]**

**Ans:** Vinegar is obtained from *Acetobacter aceti.*

**Q.24. Enlist the uses of antibiotics.**

**Ans:** i) Medicinal uses: Antibiotics are used to control infectious diseases in human beings like diphtheria, syphilis, etc. Antibiotics are also being used to control bacterial disease in plants.

ii) As supplement: Antibiotics as supplement feed improves growth of animals.

iii) As food preservative: Antibiotics are used in preservation of food. e.g. fresh meat, fish, etc.

**Q.25.In which way microbes have played a major role in controlling diseases caused by harmful bacteria ?**

**Ans:** Antibiotics are the chemical substances which are derived from certain useful microbes and are employed to kill or retard the growth of disease-causing microbes. So, antibiotics are being used in controlling a number of bacterial diseases like cholera, pneumonia, typhoid, syphilis, whooping cough, diphtheria etc.

**Q.26.Name any two species offungus, which are used in the production of the antibiotics.**

**Ans:** *Penicillium notatum* produces antibiotic Penicillin and *Penicillium* griseofulvin produces antibiotic Griseofulvin.

**Q.27. Expand the term LAB.**

**Ans:** The term 'LAB' stands for Lactic acid bacteria

**Q.28.What are gibberellins? State its uses.**

**Ans:** Gibberellins are a group of growth hormones produced by fungi and higher plants.

**Uses :**

i) Promote growth of plant by stem elongation.

ii) Induce parthenocarpy in apple, pear, etc.
iii) Breaking dormancy
iv) Induce flowering

**Q.29.Who isolated Gibberellin for the first time? What was its source ?**

**Ans:** Gibberellin was isolated by Japanese scientists Yabuta and Sumiki in 1938 from rice seedlings infected with the fungus *Gibberella fujikuroi.*

**Q.30.What are enzymes ?**

**Ans:** Enzymes are biocatalysts which initiate or accelerate biochemical processes in living organisms.

**Q.31.Which micro-organisms are used for preparing curd ?**

**Ans:** Micro-organisms such as Lactobacillus and other lactic acid bacteria (LAB) ferment milk and convert it into curd.

**Q.32. How do lactic acid bacteria convert milk into curd ?**

**Ans:** i) During curdling, small amount of curd containing millions of lactic acid bacteria are added to fresh milk as inoculum or starter.
ii) During their growth, they produce acids that coagulate and partially digest the milk proteins, thus converting milk to curd.

**Q.33.In which food would you find lactic acid bacteria? Mention some of their useful applications.**

**Ans:** i) Lactic acid bacteria (LAB) are commonly found in milk under suitable conditions.
ii) LAB multiply and produce acids which coagulate and partially digest the milk proteins and change milk into curd.
iii) LAB are also found in the human stomach. They prevent the growth of certain disease-causing microbes.

**Q.34.**

**Ans:**

| No. | Enzyme | Microbial Source |
|---|---|---|
| i) | Invertase | *Saccharomyces cerevisiae* |
| ii) | Pectinase | *Sclerotiana libertine* |
| iii) | Lipase | *Rhizopus sps.* |
| iv) | Cellulase | *Trichoderma konigi* |

**Q.35.From which microbial source can pectinase be obtained ?**

**Ans:** Microbial source of pectinase is *Sclerotiana libertine.* **[Mar 2014 ]**

## 5.3 : Microbes in Sewage Treatment

**Q.36. What is sewage?What does it contain ?**

**Ans:** i) Large quantity of waste water generated in cities and towns is called sewage.
ii) Sewage contains high levels of organic matter, human excreta, domestic wastes and microbes.

**Q.37. Why does sewage require treatment before it is discharged into natural water bodies ?**

**Ans:** i) Sewage water contains large amount of organic matter and microbes, many of which are pathogenic.
ii) If such sewage water is discharged into natural water bodies, it will cause pollution and affect all forms of life in some way. Hence, sewage needs to be treated before discharging it into natural water bodies.

**Q.38.Explain the steps involved in sewage treatment.**

**Ans:** The sewage treatment is carried out in the following stages :

**i) Primary Treatment/ Physical process :**
a) Primary treatment employs only physical processes to separate the small and large particles (debris .
b) In primary treatment, large pieces of floating debris, oily substances are removed through filtration and sedimentation.
c) All the solids that sediment constitute the primary sludge and the supernatant forms the primary effluent.

**ii) Secondary Treatment/ Biochemical process :**

a) This is also called biological treatment, as it employs living organisms, i.e. the heterotrophic microbes naturally present in the sewage.

b) The primary effluent is passed into large but shallow aeration tanks (also known as oxidation or stabilization tanks), where the effluent is constantly agitated mechanically and air is pumped into it.

c) The microscopic algae growing as scum on the upper surface of the waste water also provides oxygen to the other microbes.

d) The aerobic microbes grow vigorously and form 'floes'. Floes are masses of bacteria associated with fungal filaments forming a mesh-like structure. The aerobic microbes consume a major part of the organic matter in the effluent. Consequently, the biochemicallbiological oxygen demand (BOD) is reduced significantly.

**iii) Tertiary Treatment/ Physico-chemical process :**

a) Once the BOD of waste water is reduced, it is passed into a settling tank where bacterial floes are allowed to settle. This sediment is called activated sludge.

b) The 'remaining part of the activated sludge is pumped into large tanks called anaerobic sludge digesters (They are also referred to as upflow anaerobic sludge blanket (UASB). In this, the anaerobic micro-organisms digest the organic matter and also the floes.

c) During this process, there is production of a mixture of gases like carbon dioxide, methane, and hydrogen sulphide.

d) Effluents from these plants are released in natural water bodies.

**Q.39. What are floes ?**

**Ans:** Floes are masses of bacteria associated with fungal filaments to form a mesh-like structure.

**Q.40. What is primary sludge ?**

**Ans:** All the solids that sediment after primary treatment of sewage form primary sludge.

**Q.41. What is activated sludge ?**

**Ans:** The sediment formed after secondary treatment of sewage is called activated sludge.

**Q.42. Why is sewage water treated till BOD is reduced ?**

**Ans:** i) BOD test is used to measure the rate of uptake of oxygen by micro-organisms in a water sample

ii) Thus, it gives a measure of organic matter present in water.

iii) More BOD indicates more polluted water, hence sewage water is treated till its BOD is reduced.

**Q.43. What is the key difference between primary and secondary sewage treatment ?**

**Ans :**

| No. | Primary treatment | Secondary treatment |
|---|---|---|
| i) | BOD before treatment is higher | Bod before treatment is lesser |
| ii) | Physical processes like screeing | Biological processes of aerobic micro |
| | and sedimentation are involved | organisms are involved. |
| iii) | Undissolved solid like polythene bags, sand, silt and small pebbles are removed | Decomposed organic wastes are removed |

**Q.44.Write a note on microbes in sewage treatment.**

**Ans:** Microbes playa significant role during secondary and tertiary sewage treatment.

i) During secondary treatment, primary effluent is continuously agitated in a large tank due to which vigorous growth of useful aerobic microbes into floes takes place. These microbes consume major part of the organic matter in the effluent as they grow. Due to this, BOD of the effluent is significantly reduced.

ii) During tertiary treatment, bacterial floes are allowed to sediment. Small part of it is passed back into the aeration tank and a large part is pumped into large tanks called anaerobic sludge digesters. These anaerobic bacteria digest the bacteria and fungi in sludge.

iii) Thus, use of microbes in sewage treatment helps to remove organic matter from waste water before it is discharged in water bodies like rivers.

## 5.4 : Microbes in Biogas Production

**Q.45.**What is biogas ?
**Ans:** Biogas is the non-conventional and renewable source of energy obtained by microbial fermentation.

**Q.46.Give the chemical composition of biogas.**
**Ans:** Biogas contains 50-80% methane, 15-45% carbon dioxide and other gases in traces.

**Q.47.Which microbes are used in biogas production ?**
**Ans:** Methanobacterium, Cellulomonas, Clostridium, Pseudomonas are used in biogas production.

**Q.48. Why are biogas plants set up in rural areas?**
**Ans:**Cattle dung is easily available in rural areas which is used as feed in biogas plant. Hence, biogas plants are generally set up in rural areas.

**Q.49. Enlist the advantages of biogas.**
**Ans:** Following are the advantages ofbiogas:
i) Biogas is a cheap, safe and renewable source of energy.
ii) Biogas can be burnt in gas stoves to provide heat.
iii) It can be used for cooking,domestic lighting, street lighting.
iv) It burns with a blue flame and without smoke.
v) It is eco-friendly and does not cause pollution.
vi) It can be used for driving engines.
vii) It helps to improve sanitation of the surrounding.
viii) It can be easily generated, stored and transported.
ix) The residue left after biogas production can be used as manure.

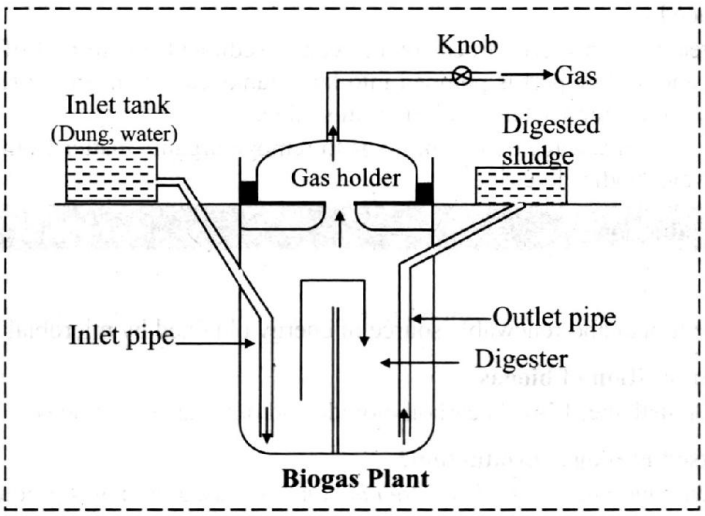
**Q.50. What is biogas? Write in brief about the production process.**
**Ans:**Biogas is the non-conventional and renewable source of energy obtained by microbial fermentation.
**Following reactions takes place in biogas plant :**
**i. Hydrolysis or anaerobic digestion :**
In this step, cellulose is hydrolyzed to simple compounds. Complex insoluble polymers are converted to simple soluble monomers with the help of bacterial hydrolytic enzymes.

Polymers $\xrightarrow{\text{Anaerobic bacteria}}$ Monomers

**ii) Acetogenesis :**
In this step, monomers are converted into organic acids. Acid-producing bacteria, involved in the second step, convert the intermediates of fermenting bacteria into acetic acid (CH3COOH), hydrogen ($H_2$) and carbon dioxide ($CO_2$). Monomers $\xrightarrow{\text{Anaerobic bacteria}}$ organic acids

**iii) Methanogenic step :**
Acids such as acetic acid is converted into methane. Methane-producing bacteria, involved in the third step, decompose compounds with a low molecular weight. For example, they utilize hydrogen, carbon dioxide and acetic acid to form methane and carbon dioxide.

Organic acids $\xrightarrow{\text{Methanogenic bacteria}}$ Methane + $CO_2$ + Other gases



Biogas Plant

**Q.51. Which group of bacteria converts organic acids to methane during biogas production ?**

**Ans:** Methanogenic bacteria convert organic acids to methane during biogas production.

**Q.52.Do you think microbes can produce energy? If yes, how ?**

**Ans:**i) Yes, microbes can also be used to produce energy. A typical example of this is the production of biogas from the dung of cattle in the gobar gas plants by the microbes called methanogens.

ii) A special category of bacteria, called methanogens, are most commonly involved in the production of biogas.

iii) These are obligatory anaerobes and cause the decomposition of cellulosic materials present abundantly in the dung of animals (especially cattle) to produce biogas.

iv) As cattle dung is abundantly available in rural areas, the gobar gas plants are more common in rural areas.

v) Most common methanogens are Methanobacillus and Methanococcus.

**Q.53.Give examples to prove that microbes release gases during metabolism.**

**Ans:**i) During making of dosa, idli or bread, puffing up of dough is due to liberation of $CO_2$ gas produced during the fermentation process.

ii) During fermentation by the bacterium *Propionibacterium sherman* large holes appear in "Swiss Cheese" due to $CO_2$ production.

iii) In secondary treatment, in sewage treatment plants, a number of gases like methane, H2S and $CO_2$ are produced during microbial digestion of organic compounds. .

iv) Methanogens (e.g. *Methanobacterium*) are being used in biogas plants to produce biogas as an energy source.

## 5.5 : Microbes as Bio- control agents

**Q.54. What is meant by biocontrol ?**

**Ans:** Biocontrol refers to the use of biological methods or micro-organisms to control plant diseases and pests.

**Q.55. Name the four groups of biocontrol agents.**

**Ans:** The four groups of biocontrol agents are bacteria, fungi, protozoans and viruses.

**Q.56. Define 'Herbicides'.**

**Ans:** Herbicides are defined as chemicals that are used to destroy herb-weeds.

**Q.57. Mention two undesirable effects of chemical pesticides.**

**Ans:**i) Chemical pesticides cause environmental pollution and it enters into the food chain.

ii) Chemical pesticides harms the beneficial organisms because they are not species specific.

iii) Improper use of chemical pesticides may damage the crop and useful flora and fauna of the area.

**Q.58. Define Biopesticides.**

**Ans:**Biopesticides are the biological agents (organisms) which can be used to kill or check the proliferation of disease causing agents.

**Q.59.List the advantages of biopesticides.**

**Ans:** Following are the advantages ofbiopesticides:

i) They reduce the application of chemicals used for controlling pests, insects.

ii) They do not cause pollution.

iii) Biopesticides are non-toxic and biodegradable.

IV) Biopesticides control the pests but keep them at a manageable level in the food chain, so it maintains biodiversity and ecosystem.

**Q.60. How can viruses be useful as biocontrol agents?**

**Ans:** i) Pathogenic viruses infect and kill many insect pests and other arthropod pests.

ii) They are useful as biocontrol agents as they kill pests.

iii) They are species specific.

iv) Viruses are used to control pests like aphids, potato beetles, etc.

v) Nucleopolyhedrovirus or NPV virus is used to control the Gypsy moth and caterpillar larvae.

**Q.61. Give two examples of microbial pesticide.**

**Ans:** i) Beauveria bassiana controlling the aphids.

ii) Nosema locustae controlling the grasshoppers, caterpillars.

**Q.62. How can insect resistant varieties of plants be developed ?**

**Ans:** With the help of genetic engineering, a gene which is responsible to produce toxic substances is isolated from Bacillus thuringiensis and inserted in the target plant. Due to this, the plant becomes toxic to insect pests.

**Q.63.Microbes can be used to decrease the use of chemical fertilizers and pesticides. Explain how this can be accomplished ?**

**Ans:**Biocontrol or biological control is the method of controlling pathogenic organisms and plant pests with the help of certain living organisms. It is based on the principle of natural predation e.g.

i) Beauveria bassiana are the natural predators of aphids, mealy bugs, mites, white flies, etc.

ii) Nosema locustae are used to control grasshoppers, caterpillars.

iii) Nucleopolyhedrovirus is used to control the gypsy moth and caterpillar larvae.

iv) Bt-cotton has the genes of Bacillus thuringiensis bacteria having insecticidal properties, so is resistant to attack by the insect pests. In this way, biocontrol agents decrease the use of chemical insecticides which generally cause environmental pollution and eco-degradation. Similarly, certain symbiotic bacteria like Rhizobium; certain free-living bacteria like Azotobacter, Clostridium, etc; certain cyanobacteria like Nostoc, Anabaena, etc. and mycorrhizae can be employed as nitrogen fixers to improve the soil fertility and decrease the use of chemical fertilizers.

v) Modern organic farmer tries to understand the food chains and web of interactions between the organisms and uses suitable biopesticides. He has the knowledge oflife cycle, habitat and feeding of organisms.

**Q.64. What are biocontrol agents? Mention any two groups of biocontrol agents and their hosts.**
**[Mar 2013]**

**Ans: Biocontrol agents :**

The micro-organisms which are used for controlling plant diseases and pests are called Biocontrol agents. The groups ofBiocontrol agents are bacteria, fungi, protozoans and viruses.

e.g.

i) Bacteria: *Bacillus thuringiensis*
Host : Caterpillars (larvae of moths and butterflies), wax moths, etc.

ii) Fungi : Beauveria bassiana
Host : Aphids, mealy bugs, mites, etc.

iii) Protozoa: Nosema locustae
Host: Grasshoppers, caterpillars, crickets and some corn-borers.

iv) Virus: Nucleopolyhedrovirus (NPV)

**Q.65. What is a weedicide? Give two examples.**

**Ans:**i) Many dicot plants grow in the field of cereals. They are weeds.

ii) The substance which kills the weed is called weedicide. Some bacteria and fungi can act as weedicide.

iii) Some of them are:

a) Phytophthora

b) Fusarium

c) Pseudomonas

d) Xanthomonas

**Q.66. Classify Biocontrol agents.**

**Ans:**Biocontrol agents are classified as :

i) Microbial pesticides

ii) Microbial weedicides / herbicides

**i) Microbial Pesticides**

| Pathogen | Host Range |
|---|---|
| **Bacteria** | |
| *Bacillus thuringiensis* (Bt) | Caterpillars (larvae of moths and butter), larve of *Aedes*, black flies, some adult beetles, wax moths, etc |
| **Fungi** | |
| *Beauveria bassiana* | Aphids, meal bugs, mites, white flies, etc. |
| **Protozoans** | |
| *Nosema locustae* | *Grasshoppers, caterpillars, some corn-borers and crickets* |
| **Viruses** | |
| Nucleopolyhedrovirus or NPV (125 types known) | Gypsy moths and caterpillars. |

**ii. Microbial Herbicides / Weedicides**

1. Pathogenic fungi as mycoherbicides:
   a) *Phytophthora palmivora*
   b) *Alternaria crassa*
   c) *Fusarium sps.*
2. Bacterial pathogens as herbicides:
   a) *Pseudomonas sps.*
   b) *Xanthomonas sps.*
   c) *Agrobacterium sps.*

## 5.6 : Microbes as Biofertilizers

**Q.67.Which bacterium fixes nitrogen in the root nodules of leguminous plants ?**
**Ans:** *Rhizobium* sps.

**Q.68.Name any two bacterial fertilizers.**
**Ans:** *Rhizobium, Azotobacter* are bacterial fertilizers.

**Q.69. Name one biofertilizer and mention its function.**
**Ans:** Rhizobium is a biofertilizer. It fixes atmospheric nitrogen into the organic form for plants.

**Q.70. Give two examples of free-living nitrogen f1xing bacteria.**
**Ans:** *Azospirillum* and *Azotobacter* are free-living nitrogen fixing bacteria.

**Q.71. Name two free-living bacteria used as biofertilizers. Why are they used ?**
**Ans:**The free-living bacteria used as biofertilizers are: Azotobacter, Clostridium, Bacillus polymyxa and *Azospirillium*. These bacteria can fix atmospheric nitrogen and enrich the nitrogen content of the soil.

**Q.72. Distinguish between Chemical fertilizers and Biofertilizers.**
**Ans :**

| No. | Chemical Fertilizers | Biofertilizers |
|---|---|---|
| i) | Fertilizers which are prepared synthetically in factories are called as chemical fertilizers | Fertilizers which occur in nature and increase productivity of soil are called as biofertilizers |
| ii) | They cause pollution | They do not cause pollution |
| iii) | They are expensive | They are not expensive. |
| iv) | e.g. Urea | e.g. Cyanobacteria |

**Q.73. Give the uses of biofertilizers.**
**Ans:** The uses ofbiofertilizers are :

i) They are cheap and economical sources of fertilizers.
ii) They increase the soil fertility, thereby increasing crop yield.
iii) They do not cause environmental pollution and also do not harm the soil micro-organisms.
iv) They are renewable sources of fertilizers.
v) They help to improve the physical status of the soil.
vi) They can be used as supplements to chemical fertilizers.
vii) They do not require energy source on a large scale for manufacturing process.
viii) They fix about 70% of the total nitrogen available to plants.

**Q.74. Write a Dote on Rhizobia as a biofertilizer.**

Ans: i) Rhizobium is a symbiotic, non-motile, non-spore forming, gram-negative aerobic bacterium.
ii) It harbours inside the roots of leguminous plants forming symbiotic association.
iii) The bacterium provides fixed nitrogen to the host plant, in return the host plant provides food and water to the bacterium.
iv) They fix atmospheric nitrogen into organic forms which can be used by plants as nutrients.
v) It adds nitrogen to the soil and increases the fertility.
Vi) The bacterium absorbs molecular nitrogen from the soil and transforms it into nitrites and nitrates.
vii) The process is called nitrogen fixation.
viii) There are many species of *Rhizobium* each specific for a particular species of leguminous plant. e.g. *R.leguminosarum* is specific to pea. *R. phaseoli* is specific to beans.

**Q.75. Describe the role of blue green algae. as a biofertilizer.**

i) Blue green algae are autotrophic prokaryotic organisms.
ii) Due to prokaryotic nucleus, they are presently called cyanobacteria.
iii) These organisms are unicellular, colonial or free-living and occur in filamentous forms, mostly found in moist soil of paddy fields.
iv) Cultures of BGA are mainly used in rice fields to increase soil fertility and crop yield.
v) The common examples of BGA biofertilizers are *Aulosira*, *Anabaena*, *Nostoc*, *Tolypothrix*.
vi) They possess special type of cells called heterocysts.
vii) Heterocyst is the site of nitrogen fixation in many cyanobacteria (BGA).
viii) The nitrogenase enzyme, present in the heterocyst fixes atmospheric nitrogen which increases the soil fertility.
ix) Cyanobacteria (BGA) also provides organic matter and other substances for plant growth.
x) Along with nitrates, they also release Vitamin B12, Vitamin C and auxins which helps in better growth and development of plants.

**Q.76. Give the role of heterocyst.** **[Oct 2013]**

**Ans :** Heterocyst is the site of nitrogen fixation in many cyanobacteria.

**Q.77. Write a short note on the heterocyst.**

**Ans:** i) Heterocyst is a large, thick walled, pale yellow coloured special cell present in some filamentous cyanobacteria.
ii) It may be intercalary or terminal in position.
iii) Heterocyst is the site of nitrogen fixation in many cyanobacteria.
iv) The nitrogenase enzyme, present in the heterocyst fixes atmospheric nitrogen which increases the soil fertility.
v) Heterocysts are impermeable to oxygen, hence maintain environment for nitrogenase enzyme.
Vi) In addition, heterocysts also release vitamin B\2, auxins and other substances in the soil which induce growth of higher plants.

**Q.78. Give the importance of heterocyst in cyanobacteria.** **[Mar 2014]**

**Ans:** In cyanobacteria, heterocyst are some specialized and colourless cells and are the site for nitrogen fixation.

**Q.79. Describe A nabaena-A zolla as biofertilizer.** **[Sept 2009]**

**Ans:** i) Anabaena is a cyanobacterium which forms symbiotic relationship with the leaves of Azolla.
ii) Azolla is a small, free-floating aquatic fern.
iii) Each leaf of Azolla has a dorsal and ventral lobe.
iv) The dorsal fleshy lobe has air cavities which are occupied by Anabaena.
v) It resides and multiplies in the air cavities of Azolla leaf.
vi. Filaments of Anabaena bear heterocysts. It fixes the atmospheric nitrogen and releases the nitrogenous compounds into the Azolla leaf.
vii) Azolla leaf after its decay, serves as an excellent biofertilizer especially for rice (paddy) crops.
viii) It also serves as a green manure.

**Q.80.Give reason "Growing leguminous crop alternately with other crops is beneficial".**

**Ans:** Growing leguminous crop alternately with other crops is beneficial because:
i) When leguminous crop is grown alternately with the other crops, the nitrogen fixed by the leguminous crop will be available to the non-leguminous crops

ii) The yield of non-leguminous crops such as wheat, rice, etc. grown in the same field is increased considerably. This is due to residual nitrates left in the soil after the removal ofleguminous crops.

**Q.81. What are two advantages that mycorrhizal association provides to the plant ?**

**Ans:** Plant having mycorrhizal association represents the following advantages :

i) Ectomycorrhizae increases surface area of roots and accelerates water and nutrient uptake.
ii) Plants having VAM grow luxuriently in less irrigated fields.

**Q.82. How are biofertilizers more beneficial than chemical fertilizers ?**

**Ans:**i) Biofertilizers increase the productivity of the soil naturally.
ii) Biofertilizers do not have any side effects, whereas chemical fertilizers cause pollution.
iii) Production of biofertilizers is inexpensive.
iv) Hence, biofertilizers are more beneficial than chemical fertilizers.

**Q.83. What are mycorrhizae? What are its types? How do they enrich the soil ?**

**Ans:** Mycorrhizae is a symbiotic association between fungus and the roots of a vascular plant. In mycorrhizal association, fungus colonizes roots of the host plants either intracellularly or extracellularly. There are basically two types of mycorrhizae.

i) Endomycorrhizae ii) Ectomycorrhizae

**i) Endomycorrhizae :**

Mycorrhizae whose hyphae enter into the plant cells and produces balloon like structure are called endomycorrhizae. Endomycorrhizae are observed in orchids and woody plants. Some of them penetrate the cells form vesicles and some finely branched hyphal coils called arbuscles. Such association is called Vesicular Arbuscular Mycorrhizae (VAM).

**ii) Ectomycorrhizae :**

In this, fungal mycelia forms a mantle on the root surface. From the mantle, fungal hyphae penetrates into the cortex of root as well as in the soil. This leads to increase in surface area for absorption of water and minerals. Ectomycorrhizae are found in oaks, pines, *Eucalyptus*.

**Q.84. What is VAM ?**

**Ans:** VAM is Vesicular Arbuscular Mycorrhizae. In this, the hyphae live in the intercellular spaces of root cortex and send projections into the root cortical cells. These branches (inside the cell) may be swollen to form vesicles or become a finely branched mass, called arbuscles.

**Q.85. How do biofertilizers enrich the fertility of the soil ?**

**Ans:**i) *Rhizobium leguminosarum* and *Azospirillum* fix atmospheric nitrogen into nitrites and nitrates.
ii) Anabaena azollae and many other species of blue green algae are important N2 fixers of rice fields.
iii) *Rhizobium leguminosarum* (found as endosymbiont in the root nodules of leguminous plants) and *Azospirillum* (found in loose association with the roots of grasses, rice, sorghum, maize, etc.) fix atmospheric nitrogen as nitrites and nitrates.
iv) Certain fungi are found as symbionts with the roots of the higher plants. e.g. Oak, *Eucalyptus*, etc. The fungal hyphae increase the surface area for absorption of water and minerals by the roots of higher plants. These also solubilize some insoluble organic compounds to make them available to the higher plants. These help in the conversion of unproductive soil into productive soil.

## Additional Information

**Q.86.Bacteria cannot be seen with the naked eyes, but can be seen with the help of a microscope. If you have to carry a sample from your home to your biology laboratory to demonstrate the presence of microbes under a microscope, which sample would you carry and why ?**

**Ans:**Bacteria can be grown and multiplied on nutritive culture media in aseptic conditions to form colonies which can be transported from home to biology laboratory where these can be demonstrated under a microscope. It is so as bacteria have very high rate of growth and reproduction in suitable conditions which are available to them either in their natural habitats or in culture media.

**Q.87.Three water samples namely river water, untreated sewage water and secondary effluent discharged from a sewage treatment plant were subjected to BOD test. The samples were labelled A, Band C;but the laboratory attendant did not note which was which. The BOD values of the three samples A, Band C were recorded as 20mg/L, Smg/L, and 400mg/L, respectively. Which sample of the water is most polluted? Can you assign the correct label to each assuming the river water is relatively clean ?**

**Ans:** BOD values indicate the amount of organic wastes present in water. The greater the BOD of waste water, more is its polluting potential. On the basis of this criterion, we can conclude :

i) The sample labelled as C is of untreated sewage water because sewage water has high quantities of organic matter; so has highest BOD value (i.e. 400 mg/L).

ii) The sample labelled as A is of water of secondary effluent chamber of STP because it comes after the primary treatment and contains less organic matter than untreated sewage water; so has less BOD (i.e. 20 mg/L).

iii) The sample labelled as B has minimum BOD (i.e. 8 mg/L) and it has been assumed that river water is relatively clean. So, sample B is of river water.

**Q.88. Arrange the following in the decreasing order (most important first) of their importance, for the welfare of human society. Give reasons for your answer.**

**Ans:** Following chemicals are arranged in their decreasing order of importance :

Penicillin > Biogas > Curd > Citric acid

It is so because :

**i. Penicillin :**

Commonly called wonder drug. It is a wide-spectrum antibiotic and is used to control a number of human disease like syphilis, gonorrhoea, diphtheria, lung infections, etc.

**ii) Biogas :**

Produced from dung of cattle by the methanogens, is an alternative source of energy especially in the rural areas. Its production also provides slurry which can be used as manure to increase the soil fertility and crop yield.

**iii) Curd :**

It is a milk product very commonly used in almost all the houses.

**iv) Citric acid :**

It is least important of all the above.



## Additional Theory Questions

**Q.1. Give any 'two' examples of edible mushrooms. [Oct 2013]** ***Refer Q.11.***

**Q.2. Production of vitamins employs not only men and machine but microbes too. Give details of such microbes.** ***Refer Q.17.***

**Q.3. What are gibberellins ? Give the applications of gibberellins. [Oct 2014]** ***Refer Q.28.***

**Q.4. How is biogas useful to human beings?** ***Refer Q.49.***

**Q.5. Describe biogas production in a biogas plant.** ***Refer Q.50.***

**Q.6. Draw a neat labelled diagram of a biogas plant.** ***Refer Q.50.***

**Q.7. Which bacteria convert organic acids into methane? [Oct 2014]** ***Refer Q.51.***

**Q.8. Write a note on biocontrol agents.** ***Refer Q.64.***

**Q.9. What are the advantages ofbiofertilizers?** ***Refer Q.73.***

**Q.10. Give the economic importance ofbiofertilizers.** ***Refer Q.73.***

**Q.11. Explain in brief the process of nitrogen fixation by *Rhizobium*. [Mar 2008]** *Refer Q. 74.*

**Q.12. Write a short note on 'Cyanobacteria' as a bio-fertilizer. [Mar 2009]** *Refer Q. 75.*

**Q.13. Explain blue green algae as a bio-fertilizer. [Mar 2010]** *Refer Q.75.*

**Q.14. Write a note on mycorrhizae.** ***Refer Q.83***

## Quick Review

| | Chemical Fertilizers | Biofertilizers |
|---|---|---|
| i) | Citric acid | *Aspergillus niger* |
| ii) | Gluconic acid | *Aspergillus niger* |
| iii) | Fumaric acid | *Rhizopus arrhizus* |
| iv) | Acetic acid (Vinegar) | *Acetobacter aceti* |

| | Antibiotic produced | Microbial source |
|---|---|---|
| i) | Chloromycetin | *Streptomyces venezuelae* |
| ii) | Erythromycin | *Streptomyces erythreus* |
| iii) | Penicillin | *Penicillium chrysogenum* |
| iv) | Streptomycin | *Streptomyces griseus* |

| | Name of the enzyme | Microbial source |
|---|---|---|
| i) | Invertase | *Streptomyces cerevisiae* |
| ii) | Pectinase | *Sclerotiana libertine* |
| iii) | Lipase | *Rhizopus sps* |
| iv) | Cellulase | *Trichoderma konigi* |

- **Scientists and their contribution**

| Scientist | Contribution | Year |
|---|---|---|
| Dr. Alexander Fleming | Accidently discovered 1st antibiotic while working with pathogenic bacterium Staphylococcus aureus | 1929 |
| Yabuta and Sumiki | 1st isolated Gibberellin from rice seedlings infected with fungus Gibberella *fujikuroi* | 1938 |



**Sewage Treatment**

- Primary treatment (Physical process)
- Secondary treatment (Biological process)
- Tertiary treatment (Physico-chemical process)

**Biogas production**

- Anaerobic digestion (Hydrolysis)
- Acetogenesis (Acidogenesis)
- Methanogenesis

**Microbial Pesticides**

- Bacteria eg. *Bacillus thuringiensis*
- Fungi eg. *Beauveria bassiana*
- Protozoans eg. *Nosema locustae*
- Viruses eg. Nucleo-polyhedro virus (NPV)

**Microbial herbicides/weedicides**

- Pathogenic fungi eg. *Phytophthora palmivora*, *Alternaria crassa*, *Fusarium sp.*
- Bacterial pathogens eg. *Pseudomonas sp.*, *Xanthomonas sp.*, *Agrobacterium sp.*

**Biofertilizers**

- Bacterial eg. *Rhizobium*, *Azotobacter*, *Azospirillum*
- Cyanobacterial eg. *Nostoc*, *Aulosira*, *Anabaena azollae*, *Tolypotarix*
- Fungal eg. Mycorrhizae (Ecto and Endomycorrhizae)

## Multiple Choice Question

**1.** The has a variety of microorganisms like algae, fungi, bacteria, protozoans, etc.
a) lithosphere b) hydrosphere
c) biosphere d) atmosphere

**2.** Dead and dried cell mass of microbes having nutritive value is also known as **[Mar 2014]**
A) BGA (blue-green algae)
b) SCP (single cell protein)
c) STP (sewage treatment plant)
d) VAM (vesicular arbuscular mycorrhizae)

**3.** Large, fleshy and edible fruiting bodies are produced by
A) yeast b) bacteria
c) some fungi d) algae

**4.** Alcoholic fermentation is performed by
a) *Chlorella* b) Yeast
c) Agaricus d) *Puccinia*

**5.** B.O.D is
a) Biological oxygen deficit
b) Botanical oxygen demand
c) Biochemical oxygen deficit
d) Biochemical oxygen demand

**6.** A treated sewage water has
a) maximum B.O.D
b) moderate B.O.D
c) low B.O.D
d) least B.O.D

**7.** Antibiotic is obtained from
a) mucor b) Gelidium
c) *Ulothrix* d) *Penicillium*

**8.** Erythromycin is obtained from **[Oct 2014]**
a) *Penicillium chrysogenum*
b) *Streptomyces griseus*
c) *Gibberella fujikuroi*
d) *Streptomyces erythreus*

**9.** Primary sewage treatment is also called as
a) biological process
b) biochemical process
c) physical process
d) bacterial process

**10.** *Rhizopus arrhizus* is used for the industrial production of
a) fumaric acid b) citric acid
c) gluconic acid d) acetic acid

**11.** Which of the following vitamins are water soluble ?
a) Vit. A and B b) Vit. Band C
c) Vit. A and K d) Vit. C and D

**12.** The micro-organism used in the production of acetic acid is **[Oct 2013]**
a) Aspergillus niger
b) Rhizopus arrhizus
c) Neurospora gossypii
d) Acetobacter aceti

**13. The antibiotic chloromycetin is obtained from**
a) Streptomyces erythreus
b) Penicillium
c) Streptomyces venezuelae
d) Streptomyces griseus

**14.** Antibiotics are
a) drugs to kill viruses.
b) toxins produced by bacteria.
c) products of bacterial metabolism.
d) both b) and c)

**15.** Milk is fermented or curdled by
a) Rhizobium b) Lactobacillus
c) Azotobacter d) Clostridium

**16.** Poisonous non-edible mushroom is
a) White button
b) Toad stools
c) Paddy straw
d) Oyster mushroom

**17.** Biogas burns with
a) blue flame b) with smoke
c) with smell d) with soot

**18.** Methanogenic bacteria are
a) archaebacteria b) actinomycetes
c) cyanobacteria d) eubacteria

**19.** Which of the following micro - organisms are used in gobar gas generation?
a) Facultative anaerobic bacteria
b) Acetogenic bacteria
c) Methanogenic bacteria
d) All of these

**20.** The components of biogas are
a) $CH_4$ $SO_2$ , $H_2$ b) $CO_2$,$C_2H_5OH$
c) $CH_4$, $CO_2$, $H_2$ d) $C_2H_6$, $O_2$, $H_2$

**21.** Most commonly used substrate for industrial production of beer is
a) barley b) wheat
c) com d) sugarcane molasses

**22.** Which microbe is used in the fermentation of barley in beer production ?
a) *Saccharomyces cerevisiae*
b) *Neurospora gossypii*
c) *Rhizopus* sps.
d) *Eremothecium ashbyi*

**23.** Which of the following is not an advantage of biogas ?
a) It bums with blue flame without smoke.
b) It helps to improve sanitation of the surrounding.
c) It is highly expensive.
d) It can be used for domestic lighting.

**24.** The first step in biogas production is
a) generation of methane.
b) aerobic breakdown of polymers.
c) anaerobic breakdown of polymers.
d) conversion of monomers to organic acids.

**25.** The main component of raw material used for biogas production is
a) vegetable waste
b) dung
c) agricultural waste
d) domestic waste

**26.** Bt-cotton contains an insect resistant gene transferred to cotton from

a) fungus b) bacterium
c) protozoans d) cyanobacterium

**27.** Removal oflarge pieces offloating debris, oily substances, etc. during sewage treatment is called
a) primary treatment
b) secondary treatment
c) final treatment
d) amplification

**28.** During biogas production, species used to bring about anaerobic digestion are of
a) Saccharomyces
b) Pseudomonas
c) Rhizopus
d) Methanococcus

**29.** During biogas production, microorganism used to bring about the anaerobic digestion is **[Mar 2013]**

**30.** The micro-organism used to produce enzyme, pectinase is
a) Saccharomyces
b) Sclerotiana
c) Rhizopus
d) Trichoderma

**31.** Nucleopolyhedrovirus is a pathogen.
a) fungal b) bacterial
c) protozoan d) viral

**32.** Biopesticides include
a) bioherbicides
b) bioinsecticides
c) bioherbicides and bioinsecticides.
d) bioherbicides, bioinsecticides and biofertilizers.

**33.** Cyanobacteria are
a) autotrophs
b) prokaryotes
c) eukaryotes
d) both (A) and B)

**34.** A bacteria producing an endotoxin thurioside which is used as an insecticide for agricultural pests is
a) *Bacillus thuringiensis*
b) *Azotobacter chroococcum*
c) *Streptomyces venezuelae*
d) *Diplococcus pneumoniae*

**35.** Rhizobium phaseoli fixes atmospheric nitrogen symbiotically in **[Mar 2013]**
a) pea b) bean
c) jowar d) maize

**36.** A specialized cell found in nitrogen fixing cyanobacteria is called **[Mar 2013 Old Course]**
a) cyst b) heterocyst
c) trichocyst d) blastocyst

**37.** VAM is
a) Vesicular-arbuscular mycorrhiza
b) Variable adenine mutation
c) Variable associative mutualism
d) Vitamins and minerals

**38.** VAMis
a) bioinsecticide b) bioherbicide
c) endomycorrhizae d) ectomycorrhizae

**39.** The nitrogen fixing. symbiotic organism present in the leaves of *Azolla* is
a) *Anabaena* b) *Azospirillum*
c) *Aulosira* d) *Nostoc*

**40.** The enzyme which helps in nitrogen fixation is
a) aldolase b) nitrate reductase
e) nitrogenase d) transaminase

**41.** Biofertilizers include
a) nitrogen fixing bacteria
b) nitrogen fixing cyanobacteria
c) both bacteria and cyanobacteria
d) bacteria, cyanobacteria and mycorrhizal fungi

**42.** Mycorrhiza is a symbiotic association between
a) bacteria and fungi
b) algae and fungi
c) fungi and roots of higher plants
d) blue green algae and roots of higher plants.

**43.** Which one of the following is free living bacterial biofertilizer ?
a) *Azotobacter*
b) *Rhizobium*
c) *Nostoc*
d) *Bacillus thuringiensis*



## Answer Keys

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | c) | **2.** | b) | **3.** | c) | **4.** | b) | **5.** | d) | **6.** | d) | **7.** | d) | **8.** | d) | **9.** | c) | **10.** | a) |
| **11.** | b) | **12.** | d) | **13.** | e) | **14.** | d) | **15** | b) | **16.** | b) | **17.** | a) | **18.** | a) | **19.** | d) | **20.** | c) |
| **21.** | a) | **22.** | a) | **23.** | c) | **24.** | c) | **25.** | b) | **26.** | b) | **27.** | a) | **28.** | b) | **29.** | a) | **30.** | b) |
| **31.** | d) | **32.** | c) | **33.** | d) | **34.** | a) | **35.** | b) | **36.** | b) | **37.** | a) | **38.** | c) | **39.** | a) | **40.** | c) |
| **41.** | d) | **42.** | e) | **43.** | a) | | | | | | | | | | | | | | |