CHAPTER – 10

MICROBES IN HUMAN WELFARE

Microbes are diverse Protozoa, bacteria, fungi and microscopic animal and plant virus, virods are also prions that are proteinaceous infectious agents.

Microbes like bacteria and many fungi can be grown on nutritive media to form colonies that can be seen with the naked eyes, such cultures are useful in studies on microorganisms.

It is also true that microbes also cause a large number of diseases in human beings, they also cause diseases in animals and plants but this does not mean that microbes are harmful, microbes are useful to man in various ways, some of the most important contribution of microbes to humans are discussed as follows:

Microbes in household products

Lactobacillus and other microorganisms known as lactic acid bacteria (LAB) thrive in milk and generate curd. The LAB synthesises acids that coagulate and partly breakdown milk proteins. It also boosts the nutritional quality by adding more vitamin B_{12}. In our stomach, the LAB also plays an important function, it prevents the growth of disease-causing microorganisms.

Bacteria ferment the dough, which is used to make dishes like *dosa and idli*. The generation of CO_2 gas causes the puffed-up look of dough.

Baker's yeast is used to ferment the dough needed to make bread (***Saccharomyces cerevisiae*).**

'Toddy', a traditional drink of some parts of southern India is made by fermenting sap from palms.

Cheese is one of the first foods to include microorganisms. The big holes in **'Swiss cheese'** are caused by a bacteria called *Propionibacterium sharmanii* producing a huge amount of CO_2. The **'Roquefort cheese'** is made by cultivating an unique fungus on it to give it a distinct flavour.

Microbes in Industrial Production

A large number of microbes are used to synthesise various products that are important to humans being, these includes beverages, antibiotics that are produced on industrial scale and requires microbes in very large quantity, for this very large vessels are used that are called **fermenters**.

Let's have a look at all the industrial products in a bit detail:

Beverages: ***Saccharomyces cerevisiae***, sometimes known as **brewer's yeast**, is used for fermenting malted grains and fruit juices to generate drinks such as wine, beer, whiskey, and rum. Wine and beer are not distilled, but whiskey, brandy, and rum are made by distilling the fermented broth.

Antibiotics: They are molecules that are produced by bacteria that have the ability to kill or slow the development of other microorganisms. **The first discovered antibiotic**

was Penicillin. The discovery of penicillin was by chance and was made by **Alexander Fleming** when he was working on ***Staphylococcus.*** However, its full potential as an effective antibiotic was established much later by Ernest Chain and Howard Florey. This antibiotic was extensively used to treat American soldiers wounded in World War II. Fleming, Chain and Florey were awarded the Nobel Prize in 1945, for this discovery.

Antibiotics have significantly enhanced our ability to cure lethal infections such as plague, whooping cough, diphtheria, and leprosy.

Brush Up Your Understanding

Q1. Which of the following is also called as baker's yeast?
(a) Lactobacillus
(b) Saccharomyces cerevisiae
(c) *Trichoderma*
(d) None of the above

S1. (b)

Q2. Which of the following are produced by by distillation of the fermented broth?
(a) Whisky (b) Brandy
(c) Rum (d) All of the above

S2. (d)

Chemicals, Enzymes and other Bioactive molecules:

Some of the chemicals produced by microbes are:

(i) *Saccharomyces cerevisiae* – Ethanol
(ii) *Acetobacter aceti* (bacterium) – Acetic acid
(iii) *Clostridium butylicum* (bacterium) – Butyric acid
(iv) *Saccharomyces cerevisiae* – Ethanol
(v) *Aspergillus niger* (fungus) – Citric acid
(vi) *Lactobacillus* (bacterium) – Lactic acid

Enzymes and their uses:

(i) Streptokinase is produced by *Streptococcus* and is used as to remove clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.
(ii) Pectinase and protease are used in used for clearing juices.
(iii) Lipase is used in laundry detergents.

Bioactive molecules:

(i) **Cyclosporin A** is produced by *Trichoderma polysporum* a fungi and is used as during organ transplant patients.
(ii) **Statins** is produced by *Monascus purpureus* a yeast and is used as blood cholesterol lowering agents.

Microbes in Sewage Treatment

Municipal sewage comprises of a high concentration of organic materials and harmful bacteria, such a sewage is very harmful and cannot be dumped into rivers and streams.

For this sewage is treated, treatment plants are used to reduce pollution by employing **heterotrophic bacteria** found naturally in sewage. Sewage treatment is a 2 step process:

Primary Treatment: Floating debris is removed by successive filtering in first treatment. Sedimentation removes grit (dirt and tiny stones). All solids that settle form the **primary sludge**, and the supernatant forms the effluent.

Secondary Treatment: Secondary treatment is also called as biological treatment; it is a process in which primary effluents go through a huge aeration tank to aid in the development of aerobic microbes into **flocs (masses of bacteria associated with fungal filaments to form mesh like structures).** These bacteria boost organic waste consumption while decreasing effluent BOD (biological oxygen demand).

When the BOD of the sewage gets lowered, the effluent is fed into a settling tank, so that tha bacterial flocs can settle. This is called as **activated sludge** which is pumped into massive tanks known as anaerobic sludge digesters, where anaerobic bacteria consume the bacteria and fungus in the sludge to generate biogas, which is a combination of methane, hydrogen sulphide, and carbon dioxide. The secondary treatment plant's effluent is discharged into bodies of water.

Biological Oxygen Demand: BOD is the quantity of oxygen consumed if bacteria oxidised all of the organic materials in one litre of water. It determines the quantity of organic stuff in the water. If the BOD of the water is high, then it means that water is more flithy.

Brush Up Your Understanding

Q1. The BOD test measures the rate of uptake of which of the following by microorganism in a sample of water?
(a) Nitrogen (b) Carbon dioxide
(c) Carbon monoxide (d) Oxygen

S1. (d)

Q2. The particles from waste water during the primary treatment are removed by.
(a) Filtration (b) Sedimentation
(c) Both (a) and (b) (d) None of the above

S2. (c)

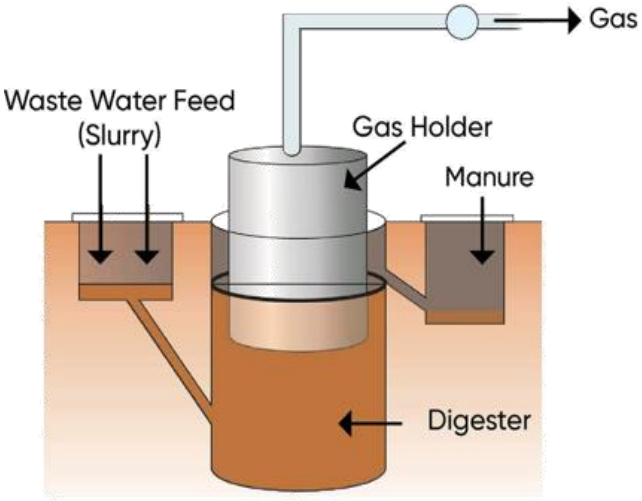
Microbes in Biogas Production

Biogas is a gas mixture created by microbial activity that may be used as a fuel. Certain anaerobic bacteria that live on cellulose material create a considerable quantity of methane, CO_2 and H_2. These microorganisms are known together as methanogens (*Methanobacterium*).

Biogas Plant: Cattle excreta (dung) is used to produce biogas as it is rich in these bacteria.

Indian Agricultural Research Institute (IARI) and the Khadi and Village Industries Commission (KVIC) worked on the technology of Biogas production.

A biogas plant is made up of a concrete tank that collects bio-wastes and feeds dung slurry. When gas is created, a floating cover is placed over the digester and travels upward. The generated gas is extracted and delivered for consumption through an output pipe. The leftover slurry is collected and utilised as fertiliser through another exit. The plants are built in rural locations since significant amounts of dung is conveniently accessible.



A biogas plant

As Biocontrol Agents

Biocontrol refers to the employment of biochemical methods to control plant disease and pests.

Biological pest and disease control is a form of pest control that relies on natural prediction rather than chemicals. In this system pests are not exterminated, but rather managed at a manageable level by a sophisticated system of check and balance inside the living and flourishing ecosystem. e.g.

(i) Ladybirds and dragonflies, are utilised to control aphids and mosquitoes.

(ii) *Bacillus thuringiensis* is used to control butterfly caterpillars on brassicas and fruit trees.

(iii) *Trichoderma* are free-living fungus found in root systems that suppress a variety of plant diseases.

(iv) The genus *Nucleopolyhedrovirus* contains the bulk of baculoviruses employed as biological control agents. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. These viruses are promising prospects for insecticidal treatments with a species-specific, limited scope.

Microbes as Biofertilisers

The organisms that improve the nutritional quality of the soil act as **Biofertilisers,** e.g. bacteria, fungi, cyanobacteria.

Rhizobium generate root nodules on the roots of leguminous plants, thus boosting soil nitrogen concentrations, which are required over many metabolic functions. *Azotobacter* and *Azospirillum* are soil-dwelling free-living bacteria that fix atmospheric nitrogen into organic forms.

Brush Up Your Understanding

Q1. Which of the following is a biocontrol agent?
(a) *Nucleopolyhedrovirus*
(b) Baculoviruses
(c) Both (a) and (b)
(d) None of the above

S1. **(c)**

Q2. In mycorrhiza, the fungal symbiont absorbs which of the following component from the soil and passes it to the plant?
(a) Calcium
(b) Magnesium
(c) Phosphorous
(d) Nitrogen

S2. **(c)**

Mycorrhiza is the symbiotic relationship of fungus with angiosperm plants that increases soil fertility. Many members of the genus Glomus form mycorrhiza. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.

Cyanobacteria (*Nostoc, Anabaena)* are autotrophic microorganisms that fix atmospheric nitrogen. This is used on paddy fields.

SUMMARY

Microbes are beneficial as well as detrimental to the welfare of human beings. Microbes are utilized in many ways. Microbes are used to synthesize different products that are useful for humans. Beverages and antibiotics are the most common product obtained from microbes. Antibiotics are chemical substances produced using microbes against any disease-causing microbe. Microbes were also used for the production of certain chemicals such as alcohols, enzymes, organic acids etc. Many microbes are of household importance also, most of them are used in setting of curd, in preparation of *idli and dosa* etc. Microbes are also very useful in the treatment of sewage water that contains human excreta. Biocontrol is defined as use of biological methods to control plant diseases and pests. Conventionally, pesticides and insecticides are being used for the control of diseases and pests. The excess use of chemicals and their harmful effect has forced the farmers to switch to organic farming. Organic farming use biofertilizers. Biofertilizers are organisms that enrich the nutrient quality of the soil. Biofertilizers contain bacteria, fungi and cyanobacteria.

IMPORTANT POINTERS

- LAB produce acids that coagulate and partially digest the milk proteins.
- Curd contains good quantity of Vitamin B_{12}.
- The puffed-up appearance of dough of idli and dosa s due to the production of CO_2 gas.
- Penicillin is a serendipitous discovery.
- Flocs are masses of bacteria associated with fungal filaments to form mesh like structures during the sewage treatment.
- The greater the BOD of waste water, more is its polluting potential.
- *Trichoderma and Baculoviruses* are biocontrol agents.
- Organic farming utilises biofertilisers.

MULTIPLE CHOICE QUESTIONS

Q1. Which of the following microbe is present in milk?
(a) Propionibacterium sharmanii
(b) Lactic acid bacteria
(c) Clostridium butylicum
(d) Trichoderma polysporum

Q2. Which of the following vitamin enhances the nutritional quality of curd when a small amount of inoculum is added to milk?
(a) Vitamin B_2 (b) Vitamin B_{12}
(c) Vitamin A (d) Vitamin C

Q3. What is the reason for the puffed up appearance of *dosa* and *idli* dough?
(a) CO2 gas gets trapped within the dough
(b) CO get trapped within the dough
(c) The microbes change the appearance of the dough
(d) All of the above

Q4 Which of the following bacteria is used for making Swiss cheese?
(a) LAB
(b) Propionibacterium sharmanii
(c) Acetobactor aceti
(d) Clostridium butylicum

Q5 Which of the following microbes is used in bread making?
(a) Saccharomyces cerevisiae
(b) Acetobactor aceti
(c) Aspergillus niger
(d) Lactobaccilus

Q6 Which of the following is not produced by distillation of the fermented broth?
(a) Brandy (b) Rum
(c) Whisky (d) Beer

Q7 Which of the following was the first discovered antibiotic?
(a) Cefexin
(b) Amoxycillin
(c) Penicillin
(d) Cephalosporin

Q8 Which of the following is also called as *gal ghotu*?
(a) Whooping cough (b) Diphtheria
(c) Leprosy (d) Plague

Q9 Which of the following is a fungus?
(a) Acetobactor aceti
(b) Lactobacillus
(c) Saccharomyces cerevisiae
(d) All of the above

Q10. Which of the following is used for commercial production of ethanol?
(a) Acetobactor aceti
(b) Aspergillus niger
(c) Saccharomyces cerevisiae
(d) LAB

Q11. Which of the following is used as an immunosuppressive agent?
(a) Penicillin
(b) Streptokinase
(c) Cyclosporin A
(d) All of the above

Q12. Which of the following forms the primary sludge in sewage treatment?
(a) Floc (b) Soil and small pebbles
(c) Microbes (d) All of the above

Q13. What is floc?
(a) They are masses of protozoa associated with fungal filaments to form mesh-like structures
(b) They are masses of bacteria associated with fungal filaments to form mesh like structures
(c) They are masses of worms associated with fungal filaments to form mesh like structures
(d) None of the above

Q14. Which of the following is the correct full form of BOD?
(a) Biological Oxygen Demand
(b) Biochemical Oxygen Demand
(c) Best Oxygen Demand
(d) Biochemical Oxygen Default

Q15. What does BOD test measures?
(a) it measures the rate of uptake of carbon monoxide by microorganisms in a sample of water
(b) it measures the rate of uptake of nitrogen by microorganisms in a sample of water
(c) it measures the rate of uptake of oxygen by microorganisms in a sample of water
(d) it measures the rate of uptake of carbon dioxide by microorganisms in a sample of water

Q16. How is the polluting potential determined by testing the BOD of waste water?
(a) Greater the BOD lesser is the polluting potential
(b) Lesser the BOD lesser is the polluting potential
(c) Lesser the BOD greater is the polluting potential
(d) Greater the BOD greater is the polluting potential

Q17. Which of the following function of mixture of gases is present in anaerobic sludge digesters?
(a) Methane, hydrogen sulphide, carbon di oxide
(b) Methane, oxygen, carbon di oxide
(c) Methane, hydrogen sulphide, hydrogen
(d) Methane, hydrogen, oxygen

Q18. Which of the following microbe produces citric acid?
(a) Acetobactor aceti (b) Clostridium butylicum
(c) Lactobascillus (d) Aspergillus niger

Q19. Which of the following is correct about antibiotics?
(a) They are medicines
(b) They are microbes
(c) They are toxic plants
(d) All of the above

Q20. Which of the following is pre-dominantly present in biogas?
(a) Oxygen
(b) Carbon di oxide
(c) Methane
(d) Carbon monoxide

Q21. Methanogens are present in.
(a) Stomach of cow (b) Rumen of cattle
(c) Intestine of cat (d) Liver of sheep

Q22. What is the function of *Methanobacterium* in the rumen of cattle?
(a) Help in breakdown of starch
(b) Help in breakdown of cellulose
(c) Help in breakdown of lactose
(d) Help in breakdown of glucose

Q23. Ladybird and dragonflies are useful to get rid of.
(a) Mosquitoes
(b) Houseflies
(c) Aphids and mosquitoes
(d) Bees

Q24. Which of the following virus are excellent candidate for species-specific narrow spectrum insecticidal applications?
(a) Cytomegalovirus
(b) Nucleopolyhedrovirus
(c) Both (a) and (b)
(d) None of the above

Q25. Which of the following is the correct full form of IPM?
(a) Internet Pest Management
(b) Integrated Pest Management
(c) Integrated Post Management
(d) Innovative Pest Management

Q26. Organic farming uses.
(a) Chemical fertilizers
(b) Bio-fertilizers
(c) Both (a) and (b)
(d) None of the above

Q27. Which the following bacteria can fix atmospheric nitrogen while living free in the soil?
(a) Rhizobium (b) Azotobacter
(c) Azospirllium (d) Both (b) and (c)

Q28. Sludge produced during wastewater treatment it is treated by.
(a) Oxidation ponds
(b) Activated sludge digesters
(c) Flocs
(d) All of the above

Q29. Bacteria growing anaerobically on cellulosic material produce large amount of which of the following gases?
(a) CO_2, H_2, CH_4 (b) CO_2, H_2O, CH_4
(c) CO, H_2, CH_4 (d) CO_2, H_2, C

Q30. The settled bacterial flocs that is allowed to sediment during sewage treatment is called.
(a) Primary sludge
(b) Secondary sludge
(c) Activated sludge
(d) Tertiary sludge

Q31. Who among the following discovered the technology of biogas production?
(a) PUSA
(b) IARI
(c) KVIC
(d) Both (b) and (c)

Q32. The fungus *Trichoderma* can be used for.
(a) Killing microbes within human body
(b) Killing several plant pathogens
(c) Killing houseflies in houses
(d) Killing mosquitoes

Q33. Which of the following bacteria forms symbiotic association with the roots of the leguminous plants?
(a) Azospirillum'
(b) Azotobacter
(c) Rhizobium
(d) Nostoc

Q34. Which of the following is used as a clot buster for removing clots from the blood vessels of patients who have undergone myocardial infarction?
(a) Cyclosporin A
(b) Streptokinase
(c) Cephalosporin
(d) Penicillin

Q35. Which of the following is correct about BOD of wastewater?
(a) It is estimated by measuring the content of CO_2
(b) It is estimated by measuring the content of CO
(c) It is estimated by measuring the content of O_2
(d) It is estimated by measuring the content of N_2

Q36. Which of the following is very effective in controlling butterfly caterpillars?
(a) Bacillus cereus
(b) Bacillus thuringiensis
(c) Bacillus pumilus
(d) Bacillus mycoides

Q37. Which of the following are main sources of biofertilizers?
(a) Cyanobacteria only
(b) Bacteria only
(c) Fungus only
(d) All of the above

Q38. Which of the following is correct about cyanobacteria?
(a) They are heterotrophic microbes
(b) They are autotrophic microbes
(c) They are saprophytes
(d) All of the above

Q39. Which of the following add organic matter to the soil and increases its fertility?
(a) Mycorrhiza (b) Rhizobium
(c) Blue Green Algae (d) Azotobacter

Q40. Which of the following is found in paddy fields and serves as an important biofertilizer?
(a) Azotobacter (b) Rhizobium
(c) Clostridium (d) Cyanobacteria

Q41. Which of the following is a symbiotic Association between a green plant and a fungus?
(a) Blue Green Algae (b) Mycorrhiza
(c) Cyanobacteria (d) Rhizobium

Q42. Which of the following mineral nutrient is absorbed by the fungal symbiont during its association with the plant?
(a) Iron (b) Calcium
(c) Phosphorus (d) Nitrogen

Q43. The primary treatment of the sewage involves.
(a) Distillation and filtration
(b) Filtration and evaporation
(c) Evaporation and distillation
(d) Filtration and sedimentation

Q44. Which of the following is called as grit in the primary treatment of sewage?
(a) Soil and large stone
(b) Large stones and mud
(c) Soil and small pebbles
(d) Pebbles and Large stones

Q45. Which of the following is used in detergent formulations and are helpful in removing oily stains from the laundry?
(a) Lactic acid (b) Lipase
(c) Citric acid (d) Ethanol

Q46. Which of the following acts as a blood cholesterol lowering agent?
(a) Trichoderma polysporum
(b) Staphylococci
(c) Penicillium
(d) Monascus purpureus

Q47. Which of the following is regarded as serendipitous discovery in science?
(a) Discovery of biogas
(b) Discovery of penicillin
(c) Discovery of Cylosporin
(d) Discovery of streptokinase

Q48. Who among the following discovered the full potential of penicillin as an effective antibiotic?
(a) Alexander Fleming (b) Ernest Chain
(c) Howard Florey (d) Both (b) and (c)

Q49. Which of the following is a biofertilizer?
(a) Urea
(b) Cyanobacteria
(c) Ammonium nitrate
(d) Ammonium sulphate

Q50. Which of the following acts as an inoculum and is pumped back into the aeration tank during sewage treatment?
(a) Grit (b) Activated sludge
(c) Primary sludge (d) All of the above

ASSERTION AND REASON

Direction: in the following questions, a statement of assertion (A) is followed by a statement of reason (R). Choose the correct option among a, b, c and d.

Q1. **Assertion (A):** The main component of biogas is CH_4.
Reason (R): Biogas plants are prepared on the foreign technology.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q2. **Assertion (A):** Wine and beer are produced by the distillation of the fermented broth.
Reason (R): Different types of alcoholic drinks are obtained only by fermentation, always followed by distillation process.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q3. **Assertion (A):** Baculovirus are species specific.
Reason (R): It is very common in root ecosystem and effective against several plant pathogens.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q4. **Assertion (A):** Cheese is one of the oldest food item in which microbes are used.
Reason (R): Different varieties of cheese are known by characteristic texture, flavour and taste.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

TRUE/FALSE

Q1. The greater the BOD of waste water, less is its polluting potential.

Q2. Biocontrol refers to the use of biological methods for controlling plant diseases and pests.

Q3. Bottled juices are clarified by the use of lipases.

Q4. The large holes in 'Swiss cheese' are due to production of a large amount of CO by a bacterium named *Propionibacterium sharmanii.*

PRACTICE QUESTIONS (MCQ)

Q1. Which of the following Microorganisms use for swiss cheese?
(a) Propionibacterium
(b) Geotrichum
(c) Penicillium
(d) Streptococcus

Q2. What are the advantage of gobar gas over conventional utilization?
(a) More efficient source of energy
(b) Used as good fertilizer
(c) Reduces the chances of spreading of pathogens
(d) All the above

Q3. Modern farmer can increase the yield of Paddy upto 50% by the use of.
(a) Cyanobacteria (b) Rhizobium
(c) Mycorrhiza (d) Farm yard manure

Q4. Which one produce gas by decomposing the gobar (Dung) in gobar gas?
(a) Fungus
(b) Virus
(c) Methanogenic bacteria
(d) Algae

Q5. Which of the following is the pair of biofertilizers?
(a) *Azolla* and BGA
(b) *Nostoc* and legume
(c) *Rhizobium* and grasses
(d) Salmonella & E. Coli

Q6. Select the correct match.
(a) *Aspergillus niger* - Acetic acid
(b) Streptokinase – Immunosuppressive
(c) Cyclosporin - A - Clot buster
(d) Statins - Cholesterol lowering agent

Q7. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are ones categorised as:
(a) Chemosynthetic autotrophs
(b) Heterotrophic bacteria
(c) Cyanobacteria
(d) Archaebacteria

Q8. Yeast is used in the production of.
(a) Bread and beer
(b) Cheese and butter
(c) Citric acid and lactic acid
(d) Lipase and pectinase

Q9. A patient brought to a hospital with myocardial infarction is normally immediately given.
(a) Cyclosporin-A
(b) Statins
(c) Penicillin
(d) Streptokinase

Q10. Which of the following statements about methanogens is not correct?
(a) They can be used to produce biogas.
(b) They are found in the rumen of cattle and their excreta
(c) They grow aerobically and breakdown cellulose-rich food.
(d) They produce methane gas.

Q11. Which of the following bacteria was associated with discovery of penicillin?
(a) Streptococus
(b) Staphylococcus
(c) Saccharomyces cerveisiae
(d) Propionobacterium

Q12. Full potential of penicillin as an effective antibiotic was established by.
(a) Alexander Flemming
(b) Ernest chain
(c) Howard florey
(d) Both (b) and (c)

Q13. *Bacillus thuringiensis* show their inhibitory effect on which part of the insect body.
(a) Gut
(b) Respiratory tract

(c) Nervous system
(d) Circulatory system

Q14. Use of biofertilizer is the part of.
(a) Inorganic farming
(b) Organic farming
(c) Energy cropping
(d) Energy plantation

Q15. LAB converts milk into curd. Choose the correct option with respect to the action of LAB on the milk proteins.
(a) It coagulates the milk protein only
(b) It digests the milk proteins only
(c) Both (a) and (b) are correct
(d) None of the above

Q16. In the human body, LAB is present in the.
(a) Liver (b) Stomach
(c) Kidney (d) All of the above

Q17. Bacteria is very helpful in making the dough of *dosa and idli*, the process that takes place in the formation of that dough is.
(a) Evaporation (b) Condensation
(c) Distillation (d) Fermentation

Q18. Toddy', a traditional drink of some parts of southern India is made by fermenting sap obtained from.
(a) Coconut
(b) Neem
(c) Palm
(d) None of the above

Q19. The microbe that have been used from time immemorial for the production of beverages like wine, beer, whisky, brandy or rum is.
(a) A virus (b) A bacteria
(c) A fungus (d) All of the above

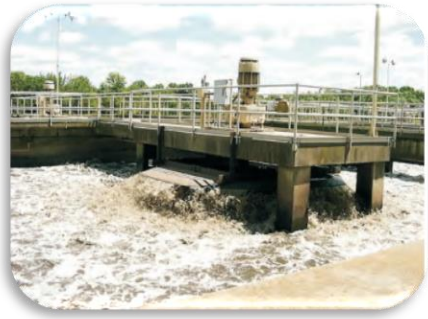
Q20. The beverages whisky, brandy and rum are produced by.
(a) Only distillation
(b) Only fermentation
(c) Both (a) and (b) are correct
(d) None of the above

Q21. (i) Partially degraded concentrate of milk, fat and casein
(ii There are several hundered of varities prepared by selected type of microbe.
Both the statements are related with.
(a) Sour cream (b) Youghrut
(c) Cheese (d) Bread

Q22. A small part of the activated sludge is pumped back into the aeration tank suring sewage treatment, this activated sludge acts as a.
(a) Digester (b) Solubiliser
(c) Inoculum (d) None of the above

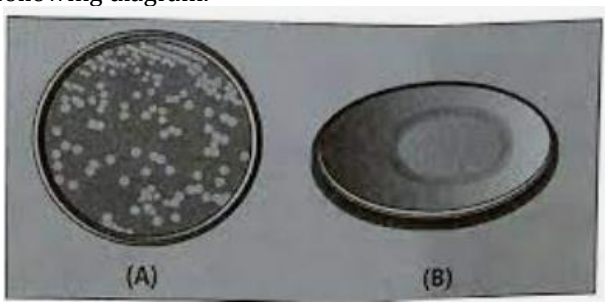
Q23. Biofertilisers enrich theQuality of.
(a) Water (b) Air
(c) Soil (d) All of the above

Q24. Identify the stage of sewage treatment shown below.



(a) Primary treatment
(b) Secondary treatment
(c) Tertiary treatment
(d) Filtration and sedimentation

Q25. Identify the colonies labelled as A and B in the following diagram.



(a) A-Fungal, B-bacterial
(b) A-bacterial, B-fungal
(c) A-algal. B-viral
(d) A-Fungal, B-Algal

Q26. Statins acts by competitively inhibiting the enzyme responsible for synthesis of.
(a) Protein (b) Cholesterol
(c) Both (a) and (b) (d) None of the above

Q27. Municipal waste water contains large amounts of.
(a) Organic matter
(b) Microbes
(c) Both (a) and (b) are correct
(d) None of the above

Q28. Treatment of waste water is done by the microbes naturally present in the sewage, these microbes are.
(a) Autotrophic (b) Saprotrophic
(c) Heterotopic (d) All of the above

Q29. *Trichoderma* species are free-living.
(a) Bacteria
(b) Fungi
(c) Virus
(d) None of the above

Q30. *Azospirillum* is a.
(a) Free living bacteria
(b) Found associated with some plants
(c) Found associated with some other microbe

(d) None of the above

ASSERTION AND REASON

Direction: in the followingQuestions, a statement of assertion (A) is followed by a statement of reason (R). Choose the correct option among a, b, c and d.

Q1. **Assertion (A):** It is seen that curd is of more nutritious value than milk.
Reason (R): LAB present in curd checks growth of disease causing organism
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q2. **Assertion (A):** Antibiotics produced by microbes are regarded as one of the most significant discoveries of the twentieth century and have greatly contributed towards the welfare of the human society.
Reason (R): Penicillin was a serendipitous discovery.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q3. **Assertion (A):** Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes.
Reason (R): *Clostridium butylicum* (a bacterium) is used for commercial production of ethanol.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q4. **Assertion (A):** Municipal waste-water is also called sewage.
Reason (R): Before disposal, sewage is treated in sewage treatment plants (STPs) to make it less polluting.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

SOLUTIONS MULTIPLE CHOICE

S1. **(b)** Lactic acid bacteria grow in milk and converts it into curd it produces acids that 7:45 and partially digested milk proteins

S2. **(b)** Small amount of curd added to fresh milk as an initiative of starter contains millions of LAB which at suitable temperature X does convert milk into curd which improve its nutritional quality by increasing the content of vitamin B12

S3. **(a)** The *idli* and *dosa* gets fermented. The fermentation process produces carbon dioxide gas which gets trapped within the dough which gives it a puffed appearance

S4. **(b)** Swiss cheese is produced by bacterium *Propionibacterium sharmanii.* It has large holes in it.

S5. **(a)** *Saccharomyces cerevisiae* also called as "bakers yeast" previously it is used for making bread at commercial levels.

S6. **(d)** Wine and beer are alcoholic drinks that are produced without distillation

S7. **(c)** Antibiotics are chemical substances which are produced by microbes and can kill or retard the growth of other microbes

S8. **(b)** The deadly disease diphtheria can be effectively treated by some of the major antibiotics

S9. **(a)** Some of the microbes are used for commercial and industrial production of certain Chemicals like organic acid enzymes and alcohol and one example is *aspergillus niger*, a fungus

S10. **(c)** *Saccharomyces cerevisiae* is used for production of Ethanol on large scale

S11. **(c)** Cyclosporine A is a bioactive molecule that is used as an immunosuppressive agent in organ transplant patients.

S12. **(b)** The grit that is the soil and small pebbles are removed by sedimentation during sewage treatment this forms the primary sludge.

S13. (b) The microbes in flocks consumed a major part of the organic matter in the effluent during sewage treatment

S14. (b) BOD is the amount of the oxygen that would be consumed if all the organic matter in one litre of water were oxidized by bacteria

S15. (c) Biological oxygen demand is a measure of the organic matter present in the water

S16. (d) Biological Oxygen Demand is a measure of the organic matter present in water, greater the value of bod of wastewater more is the polluting potential

S17. (a) The natural gases like Methane and hydrogen sulphide and carbon dioxide is produced by bacteria in the anaerobic sludge digester

S18. (d) Citric acid is produced by the fungus *Aspergillus niger*

S19. (a) Antibiotics are medicines that are very useful in killing and retarding the growth of pathogenic microorganisms

S20. (c) Biogas is a mixture of gases containing predominantly Methane produced by microbial activity that can be used as a fuel

S21. (b) *Methanobacterium* is a methanogen that produces methane gas in the rumen of cattle.

S22. (b) *Methanobacterium* help in the breakdown of cellulose in the rumen of cattle and play an important role in its nutrition

S23. (c) The use of Ladybird and Dragon Fireflies to get rid of aphids and mosquitoes is an example of biocontrol

S24. (b) *Nucleopolyhedrovirus* belong to baculoviruses that attack insects and other arthropods

S25. (b) Integrated pest management can be easily done with baculoviruses that are excellent candidates for insecticidal applications.

S26. (b) Bio-fertilizers are organism that enrich the nutrient quality of the soil

S27. (d) *Azospirillum* and *Azotobactor* are free living atmospheric fixing nitrogen bacteria that enrich the nitrogen content of the soil

S28. (a) oxidation pond effectively treats sludge that is produced during sludge treatment

S29. (a) Bacteria producing Methane carbon dioxide and hydrogen are collectively called methanogens

S30. (c) Activated sludge is treated in aerobic sludge digesters, a part of it is pumped back into the aeration tank to serve as an inoculum

S31. (d) The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute and Khadi and village Industries Commission

S32. (b) *Trichoderma* species are free living fungi that are very common in the root ecosystem, they are effective biocontrol agents of several plant pathogens

S33. (c) The nodules on the roots of the leguminous plants are formed by the symbiotic association of gram-negative bacteria *Rhizobium*

S34. (b) Streptokinase is produced by the bacterium *Streptococcus* and 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

S35. (c) Determining the BOD of wastewater is an important aspect of determining pollution present in it, greater the BOD of waste water more is its polluting potential

S36. (b) *Bacillus thuringiensis* is available in sachets of dry powdered spores, which are mixed with water and sprays on vulnerable plants

S37. (d) Biofertilizers are organisms that enrich the nutrient quality of the soil and the main sources of biofertilizers in organic farming are bacteria fungi and cyanobacteria

S38. (b) Cyanobacteria autotrophic Mai micro that are widely distributed in aquatic and terrestrial environment and many of them fix atmospheric nitrogen

S39. (c) Blue Green Algae is an important constituent of the soil that increases its fertility

S40. (d) Cyanobacteria can fix atmospheric nitrogen and are wildly distributed in terrestrial environment

S41. (b) Mycorrhiza is a mutual symbiotic association between a fungus and a plant and it plays a very important role in plant nutrition

S42. (c) The fungal symbiotic during the association absorbs the nutrient phosphorus from the soil and passes it to the plant

S43. (d) The primary treatment basically involves physical removal of particles large and the small from the sewage through filtration and sedimentation

S44. (c) The grit that is the soil and the small pebbles are removed by sedimentation during the treatment of sewage

S45. (b) lipases is very effective in detergent formulations and very useful in the removal of stains from clothes

S46. (d) Statins produced by yeast *Monascus purpureus* have been commercialized as blood cholesterol lowering agents

S47. (b) Discovery of penicillin is a serendipitous discovery. It was the first antibiotic to be discovered, the discovery was made by Alexander Fleming while he was working on *Staphylococci* bacteria

S48. (d) Ernest Chain and Howard Florey discovered the full potential of Penicillium an effective antibiotic, the antibiotic was extensively used to treat American soldiers wounded in World War 2

S49. (b) Cyanobacteria like *Anabaena* and *Nostoc* are effective biofertilizers and an effective replacements of the chemical fertilizers

S50. (b) During the sewage treatment when the BOD of the switch is reduced significantly, the effluent is passed into a settling tank where the bacteria flocs are allowed to sediment, this sediment is called activated sludge that acts and as an inoculum and is pumped back into the aeration tank during sewage treatment.

ASSERTION AND REASON

S1. (c) The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC).

S2. (d) Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

S3. (c) Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications

S4. (b)

TRUE AND FALSE

S1. (False) The greater the BOD of waste water, more is its polluting potential.

S2. (True)

S3. (False) Bottled juices are clarified by the use of pectinases and proteases.

S4. (False) The large holes in 'Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named *Propionibacterium sharmanii.*

PRACTICE SOLUTIONS

S1. (a) *Propionibacterium* is a Gram-positive, non-motile bacterium that plays an important role in the creation of Emmental cheese, and to some extent, Jarlsberg cheese, Leerdammer and Maasdam cheese.

S2. (d)

S3. (a) rice farmers sometimes, keep this plant in their paddies, because it generates valuable nitrogen via its symbiotic *Cyanobacteria*. So, modern farmers can increase the yield of paddy up to 50% by the use of *Cyanobacteria* in *Azolla pinnata*.

S4. (c) biogas is an alternate source of energy produced by anaerobic breakdown of biomass such as animals excreta and kitchen wastes with the help of methanogenic bacteria.

S5. (a) Biofertilizers are the suspension of microorganism which mainly increases the growth of the plants. These secrete the growth promoting substances.

S6. (d) Statins produced by the yeast Monascus purpureus have been commercialised as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol.

S7. (b) heterotrophic bacteria require an organic carbon source for growth that is they derive energy and carbon from organic compounds.

S8. (a) the dough, which is used for making bread, is fermented using baker's yeast

(Saccharomyces cerevisiae), they are also used for the production of beverages like wine, beer, whisky, brandy or rum.

S9. (d) Streptokinase is given to the patients with acute myocardial infarction in adults.

S10. (c) Methanogens are anaerobic chemoautotrophs. They grow in anaerobic condition and breakdown cellulose rich food.

S11. (b) In 1928, Alexander Fleming was investigating the properties of *Staphylococci*. One day, he observed that the culture of *Staphylococci* was contaminated with fungus and that colonies of the culture surrounding the fungus had been destroyed.

S12. (d)

S13. (a) The Bt toxin protein exists as an inactive toxin and is coverted into an active form due to the alkaline pH of the alimentary canal that solubilities the crystals. The activated toxin binds to the surface of midgut epithelial cells and creates pores which cause cell swelling and lysis and finally cause death of the insect.

S14. (b)

S15. (c) actobacillus and others commonly called lactic acid bacteria (LAB) grow in milk and convert it to curd. During growth, the LAB produce acids that coagulate and partially digest the milk proteins.

S16. (b) In our stomach too, the LAB play very beneficial role in checking disease-causing microbes.

S17. (d) The dough, which is used for making foods such as dosa and idli is also fermented by bacteria.

S18. (c) the sap for making 'Toddy' is obtained from palm.

S19. (c) yeast is a fungus.

S20. (c) Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth

S21. (c) it is the cheese that gets partially degraded concentrate of milk.

S22. (c) The activated sludge which are useful aerobic microbes while growing, consume the major part of the organic matter in the effluent.

S23. (c) Biofertilisers enrich the quality of soil, the main source of biofertilisers are bacteria, fungi and cyanobacteria.

S24. (b) it is the secondary treatment where the primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it.

S25. (b)

S26. (b)

S27. (c) Both organic matter and microbes are present in high quantity in sewage waste water.

S28. (c) the bacteria present in the sewage are heterotropic.

S29. (b) *Trichoderma* species are free-living fungi that are very common in the root ecosystems. They are effective biocontrol agents of several plant pathogens.

S30. (a) Some bacteria can fix atmospheric nitrogen while free-living in the soil (examples *Azospirillum and Azotobacter*), thus enriching the nitrogen content of the soil.

ASSERTION AND REASON

S1. (b)

S2. (a)

S3. (c) Yeast (*Saccharomyces cerevisiae*) is used for commercial production of ethanol.

S4. (a).