CHAPTER > 10

Microbes in Human Welfare

NEET KEY NOTES

- **Microbes** are microscopic, single-celled, minute organisms that individually are too small to be seen with naked eyes, i.e. can be seen only under a microscope.
- Microbes constitute major groups of biological systems on the earth, which are present almost everywhere, i.e. in soil, air, water, on/in plants and animals and also even inside our body. These can be found in extreme conditions of pH (alkaline and acidic soil) and temperature (thermal vents or geysers and below the several metre thick snow layers).
- Microbes are diverse group of organisms including protozoans, bacteria, fungi, microscopic plants, viruses, viroids and prions (proteinaceous infectious agents), etc.
- Some microbes cause infections and diseases in human beings, animals and plants. But several microbes are useful to man in diverse ways.

Microbes in Household Products

- We use microbes and microbe derived products almost everyday. Curd is made by *Lactobacillus* and other bacteria commonly called **Lactic Acid Bacteria** (LAB), which grow in milk and convert it to curd.
- A small amount of curd added to the fresh milk as **inoculum** or starter contains millions of LAB, which at suitable temperature multiply and produce acids that coagulate and partially digest the milk proteins. It also increases the content of vitamin-B_{12} in curd making it more nutritious and helps in replacing disease causing microbes in the stomach.
- The **dough** used for making foods such as dosa, idli, cakes and bread is fermented by using baker's yeast (*Saccharomyces cerevisiae)*. The puffed up appearance of dough is due to the production of CO_2.
- A traditional drink of Southern India called **'toddy'** is also made by fermenting sap from palms.
- **Cheese** of different textures, flavours, etc., are also made by using different microbes, e.g. the holes in 'Swiss cheese' are due to the production of a large amount of CO_2 by a bacterium called '*Propionibacterium shermanii*'.
- The **'Roquefort cheese'** is ripened by growing a specific fungi (*Penicillium roqueforti*) on them, which gives them a particular flavour.

Microbes in Industrial Products

In industry, microbes are used to make a number of products such as beverages, enzymes and antibiotics, etc., valuable to human beings. Industrial scale production requires growing microbes in very large vessels called **fermentors**.

Fermented Beverages

- Large scale production of beer, brandy, whisky, rum, etc., is done by fermenting malted cereals and fruit juices using unicellular fungi *Saccharomyces cerevisiae* (brewer's yeast).
- Different types of alcoholic drink like wine and beer are produced without distillation. Whisky, brandy and rum are produced by distillation of the fermented broth.

Antibiotics

- These are the chemical substances which are produced by some microbes to kill or retard the growth of other disease causing microbes. **Penicillin** was the first antibiotic to be discovered by **Alexander Fleming**.
- Alexander Fleming had observed that if a mould of *Penicillium notatum* grows on a nutrient medium, it does not let a bacterium *Staphylococcus* grow around it. He isolated the chemical produced by the mould and named it penicillin. However, its full potential as an effective antibiotic was established later on by **Ernst Chain** and **Howard Florey**. For this discovery, Fleming, Chain and Florey were awarded the Nobel Prize in 1945.
- Antibiotics are widely used in treating human and animal bacterial diseases. Deadly diseases like plague, whooping cough (kali khansi), diphtheria, leprosy (kusht rog) are completely curable diseases now due to the use of antibiotics.
- One of the most productive sources of antibiotics has been the genus–*Streptomyces* from which many antibiotics have been derived. Some of them are streptomycin, tetracycline, erythromycin, terramycin, which are obtained from *Streptomyces griseus*, *S. aureofaciens*, *S. erethreus* and *S. remosus*, respectively.

Chemicals, Enzymes and Other Bioactive Molecules

- Many fungi and bacteria are used for commercial production of **organic acids** like citric acid produced by *Aspergillus niger* (a fungus), acetic acid produced by *Acetobacter aceti* (a bacterium), butyric acid produced by *Clostridium butylicum* (a bacterium) and lactic acid produced by *Lactobacillus* (a bacterium).
- Yeast (*Saccharomyces cerevisiae*) is used for the commercial production of ethanol.
- Microbes are also used for the production of **enzymes**. **Lipases** are used in detergent formulations to remove oily stains from laundry. **Pectinases** and **proteases** are used to clarify bottled juices. **Streptokinase** produced from *Streptococcus* (a bacterium) is used as a '**clot buster**' for removing blood clots from blood vessels of patients.
- In organ transplant patients, a bioactive molecule **cyclosporin-A** acts as an immunosuppressant and is produced by *Trichoderma polysporum* (fungi) and statins act as blood cholesterol lowering agent and are obtained from the yeast, *Monascus purpureus*.

Microbes in Sewage Treatment

- Sewage is the municipal wastewater generated everyday in cities and towns. It contains large amounts of organic matter and many pathogenic microbes. That is why before being disposed, in water bodies, it needs to be treated in **Sewage Treatment Plants** (STPs) to make it less polluting.
- Certain heterotrophic microbes naturally present in sewage are used in its treatment. This treatment is carried out in two stages, i.e. primary treatment and secondary treatment.
- In **primary treatment**, physical removal of particles, i.e. large and small, is done from the sewage through filtration and sedimentation. All solids that settle down, form the **primary sludge** and the supernatant forms the effluent, which is taken for secondary treatment.
- In **secondary treatment** or **biological treatment**, the primary effluent is passed into large aeration tanks where it is constantly agitated mechanically. This allows the growth of the aerobic microbes into **flocs** (masses of bacteria associated with fungal filaments to form mesh-like structures) which consume the major part of the organic matter in the effluent that significantly reduces the BOD (Biochemical Oxygen Demand) of the effluent.
- BOD is the amount of oxygen that would be consumed, if all the organic matter in one litre of water were oxidised by bacteria. The sewage water is treated till the BOD is reduced. The greater is the BOD of wastewater, more is its polluting potential.
- The effluent is then passed into a **settling tank** where the bacterial flocs are allowed to sediment. This sediment is called **activated sludge** as it contains active microbes. From here
  - A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum.
  - The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge digesters**. Here, lack of oxygen kills the aerobic bacteria which are digested along with the other biomass by anaerobic bacteria and fungi.
  - The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.
- During digestion of organic matter, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form **biogas**, which is inflammable and can be used as a fuel.
- The ministry of environment and forests has initiated the **Ganga Action Plan** and **Yamuna Action Plan** to save these major rivers of our country from pollution. These plans propose to build a large number of sewage treatment plants, so that only treated sewage may be discharged into the rivers.

Microbes in Production of Biogas

- Biogas is a mixture of gases (mainly CH_4, CO_2, H_2) produced by certain bacteria, which grow anaerobically on cellulosic material. These bacteria are collectively called **methanogens** and are found in the anaerobic sludge generated during sewage treatment and in the rumen (a part of stomach) of cattle, helping in the breakdown of cellulose. It plays an important role in the nutrition of cattle. Thus, the excreta (dung) of cattle, commonly called gobar (which is rich in methanogenic bacteria) can be used for generation of biogas, commonly called as gobar gas.
- **Biogas plant** consists of a concrete tank (10-15 feet deep) in which bio-wastes are collected and slurry of dung is fed. *Methanobacterium* in the dung acts on the biowaste to produce biogas (used for cooking and lighting).
- The biogas plant has an outlet, which is connected to a pipe to supply biogas to nearby houses. Spent slurry removed from plant can be used as **fertiliser**.
- Biogas production technology was developed in India mainly by **IARI** (Indian Agricultural Research Institute) and **KVIC** (Khadi and Village Industries Commission).

Microbes as Biocontrol Agents

- Biocontrol refers to the use of biological methods for controlling various plant diseases and pests.
- This method is employed because the long time use of chemical insecticides, pesticides and weedicides has been proved to be harmful for all living organisms and the environment (air, water, soil, etc).
- **Biological control of pests** and **diseases** The use of biocontrol measures has become more preferable since it greatly reduces our dependence on toxic chemicals. Here, pests can be controlled by making use of natural predation rather than chemicals.
- Biocontrol involves creation of a system where the insects/pests are not eradicated rather are kept at manageable levels by a system of check and balances within ecosystem. Various microbes can be used as **biocontrol agents**, e.g.
  - Aphids and mosquitoes can be controlled by ladybird beetle and dragonflies, respectively.
  - Butterfly caterpillars can be killed by using the bacteria *Bacillus thuringiensis*. *Bt* is available as dried spores which are mixed with water and sprayed on to plants such as brassicas and fruit trees, where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released and the larvae get killed. This will kill the caterpillars, but leave other insects unharmed.
  - **Fungi** (like *Trichoderma* sp., a free-living fungi, that are common in root ecosystems) are effective against several fungal plant pathogens.
  - **Viruses** (like baculoviruses belonging to genus *Nucleopolyhedrovirus*) are excellent for species specific, narrow spectrum insectivides. These do not have negative impact on non-target insects and have narrow spectrum insecticidal applications.
- **Integrated Pest Management** (IPM) is an environmentally sensitive and effective approach of pest management that uses information on life cycles of organisms and their interaction with environment. The integrated pest management is done to control insects and pests of plants, animals and humans.

Microbes as Biofertilisers

- To cut down the pollution caused by chemical fertilisers, it is important to switch to **organic farming** (raising crops through the use of components of biological origin, e.g. **biofertilisers**).
- Biofertilisers are organisms, e.g. bacteria, fungi and cyanobacteria that enrich the nutrient quality of the soil.
- The main sources of biofertilisers are as follows
  - **Bacteria** *Rhizobium* is a symbiotic bacterium living in the root nodules of legumes and fixes atmospheric nitrogen into organic compounds. *Azotobacter* and *Azospirillum* are free-living bacteria, which fix atmospheric nitrogen from the air and thus, enrich the nitrogen content of the soil.
  - **Fungi** form symbiotic association with plants (mycorrhiza), which absorb phosphorus from the 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
  - Resistance to root borne pathogens.
  - Tolerance to salinity and drought.
  - Increase in plant growth and development.
  - **Cyanobacteria** are autotrophic microbes found in aquatic and terrestrial environments. Many of them fix-nitrogen, e.g. *Anabaena*, *Nostoc*, *Oscillatoria*, etc. In paddy fields, cyanobacteria serve as important biofertiliser, it also adds organic matter to the soil, thus increasing its fertility.

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

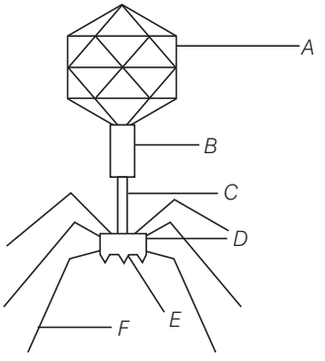
TOPIC 1 ~ *Basic Concepts and Microbes in Household Products*

1 Microorganisms or microbes are found in
(a) soil, air, water and inside the bodies of living organisms
(b) thermal vents deep in soil
(c) under snow and in highly acidic environments
(d) All of the above

2 The microscopic proteinaceous infectious agents are
(a) viroids (b) prions
(c) protozoans (d) bacteria

3 The nutritive medium for growing bacteria and many fungi in the laboratory is called
(a) culture media
(b) fermentation media
(c) baking media
(d) None of the above

4 Given below is the diagram of a bacteriophage. In which one of the option, all the six parts *A, B, C, D, E* and *F* are correct?



(a) A–Head, B–Tail, C–Collar, D–Pins, E–Plate, F–Prongs
(b) A–Head, B–Collar, C–Tail, D–Plate, E–Pins, F–Prongs
(c) A–Head, B–Tail, C–Collar, D–Plate, E–Prongs, F–Pins
(d) A–Head, B–Collar, C–Tail, D–Pins, E–Plate, F–Prongs

5 Which of the following bacteria convert milk into curd?
(a) *Propionibacterium shermanii*
(b) *Saccharomyces cerevisiae*
(c) *Lactobacillus*
(d) Thermophilic bacteria

6 Microorganisms such as *Lactobacillus* are commonly called
(a) Citric Acid Bacteria (CAB)
(b) Lactic Acid Bacteria (LAB)
(c) Tartaric Acid Bacteria (TAB)
(d) Formic Acid Bacteria (FAB)

7 The most abundant prokaryotes helpful to human in making curd from milk and in the production of antibiotics are the ones categorised as
(a) cyanobacteria ***CBSE-AIPMT 2012***
(b) archaebacteria
(c) chemosynthetic autotrophs
(d) heterotrophic bacteria

8 The starter or inoculum is added to the fresh milk in order to convert milk into curd and improves its nutritional quality by increasing
(a) vitamin-B_{12} (b) protein
(c) calcium (d) All of these

9 Study the following flowchart that shows curd formation from milk and select the correct option for *A* and *B*.

Curd is added as inoculum to the fresh milk
↓
LAB shows growth in milk
↓
Production of ..... *A* ..... starts
↓
Coagulation and digestion of milk protein
↓
Improved nutritional quality by increased ..... *B* .....

(a) A–citric acid, B–vitamin-B_{12}
(b) A–lactic acid, B–vitamin-B_{12}
(c) A–lactic acid, B–vitamin-C
(d) A–citric acid, B–vitamin-B_2

10 Which gas is released during the process of fermentation that gives the puffy appearance to dough for making bread?
(a) CO_2 (b) CO
(c) O_2 (d) H_2

11 Toddy, a traditional drink of Southern India is made by ...*A*... of sap from …*B*… tree. Here, *A* and *B* refer to
(a) A–fermentation, B–palm
(b) A–fermentation, B–bamboo
(c) A–distillation, B–palm
(d) A–distillation, B–bamboo

12 Swiss cheese is formed by the bacterium
(a) *Aspergillus niger*
(b) *Lactobacillus*
(c) *Propionibacterium shemanii*
(d) *Penicillium roqueforti*

13 Roquefort cheese is formed by ripening with ...*A*...for a particular flavour. Here *A* refers to
(a) yeast (b) fungi
(c) bacteria (d) None of these

14 Which of the following food items are produced through fermentation by the microorganisms?
I. Idli II. Dosa
III. Toddy IV. Cheese
Choose the correct option.
(a) I, II and III (b) I, III and IV
(c) II, III and IV (d) All of these

TOPIC 2 ~ *Microbes in Industrial Products*

15 Which one of the following equipments is essentially required for growing microbes on a large scale, for industrial production of enzymes?
NEET 2019
(a) Sludge digester (b) Industrial oven
(c) Bioreactor (d) BOD incubator

16 The alcoholic beverages produced by the distillation of the fermented broth are
(a) wine and beer
(b) wine, whisky and brandy
(c) whisky, brandy and rum
(d) whisky, beer and brandy

17 Which of the following organisms is used in the production of beverages like wine, beer, whisky brandy or rum?
(a) *Clostridium butylicum*
(b) *Aspergillus niger*
(c) *Saccharomyces cerevisiae*
(d) *Penicillium notatum*

18 Yeast is used in the production of
CBSE-AIPMT 2012
(a) citric acid and lactic acid
(b) lipase and pectinase
(c) bread and beer
(d) cheese and butter

19 Brewer's yeast is
(a) *Penicillium notatum*
(b) *Trichoderma polysporum*
(c) *Propionibacterium shermanii*
(d) *Saccharomyces cerevisiae*

20 Who observed a mould growing in unwashed culture plate while working on *Staphylococcus* bacterium?
(a) Ernst Chain (b) Alexander Fleming
(c) Lamarck (d) Florey

21 Which one of the following antibiotics was extensively used to treat American soldiers wounded in World War-II?
(a) Streptokinase (b) Penicillin
(c) Statins (d) Neomycin

22 Who got Nobel Prize in 1945 for the discovery of penicillin as an antibiotic?
(a) Alexander Fleming (b) Ernst Chain
(c) Howard Florey (d) All of these

23 Antibiotics are used to treat diseases like
(a) diphtheria, whooping cough
(b) plague
(c) leprosy
(d) All of the above

24 Identify the blank spaces *A, B, C* and *D* given in the following table and select the correct answer.

Types of microbes	Scientific names	Commercial products
Bacterium	*A*	Lactic acid
Fungus	*B*	Citric acid
C	*Acetobacter aceti*	Acetic acid
Fungus	*Penicillium notatum*	*D*

(a) A–*Lactobacillus*, B–*Aspergillus niger*, C–Bacterium, D–Penicillin
(b) A–*Staphylococcus*, B–*Clostridium, C*–Yeast, *D*–Penicillin
(c) A–*Lactobacillus*, B–*Microsporum*, C–Yeast, D–Penicillin
(d) A–*Staphylococcus*, B–*Microsporum*, C–*Agaricus*, D–Penicillin

25 Which one of these microbes is used in the commercial production of butyric acid?
(a) *Clostridium butylicum*
(b) *Streptococcus butylicum*
(c) *Trichoderma polysporum*
(d) *Saccharomyces cerevisiae*

26 Which of the following is correctly matched for the product produced by them? ***NEET 2019***

(a) *Acetobacter aceti* – Antibiotics
(b) *Methanobacterium* – Lactic acid
(c) *Penicillium notatum* – Acetic acid
(d) *Saccharomyces cerevisiae* – Ethanol

27 Choose the incorrect pair.

(a) Lipases – Used in detergents for removing oil stains
(b) Pectinases and proteases – Used in clarifying bottled juices
(c) Statins – Competitively inhibit the enzyme responsible for cholesterol synthesis
(d) None of the above

28 Which of the following is used as 'clot buster' for removing clots from blood vessels of patient who have undergone myocardial infarction?

(a) Ethanol (b) Statins
(c) Cyclosporin-A (d) Streptokinase

29 Identify the blank spaces *A, B, C* and *D* given in the following table and select the correct answer.

Types of microbes	Scientific names	Products	Medical applications
Fungus	*A*	Cyclosporin-A	*B*
C	*Monascus purpureus*	Statin	*D*

(a) A–*Trichoderma polysporum*, B–As an immunosuppressive agent in organ transplant patients, C–Yeast, D–As blood-cholesterol lowering agent
(b) A–*Trichoderma polysporum*, B–As blood-cholesterol lowering agent, C–Protozoa, D–As an immunosuppressive agent in organ transplant patients
(c) A–*Clostridium butylicum*, B–Used as a clot-buster, C–Yeast, D–As blood- cholesterol lowering agent
(d) A–*Clostridium butylicum*, B–As blood-cholesterol lowering agent, C–Yeast, D–Used as a clot-buster

30 *Monascus purpureus* is a yeast used commercially in the production of ***CBSE-AIPMT 2012***

(a) ethanol
(b) streptokinase for removing clots from the blood vessels
(c) citric acid
(d) blood cholesterol lowering agent, statins

31 Which of the following is a commercial blood cholesterol lowering agent? ***NEET 2019***

(a) Statin
(b) Streptokinase
(c) Lipases
(d) Cyclosporin-A

32 Which of the following is incorrectly matched in the given table? ***NEET 2016***

	Microbes	Products	Applications
(a)	*Monascus purpureus*	Statins	Lowering of blood cholesterol
(b)	*Streptococcus*	Streptokinase	Removal of clot from blood vessel
(c)	*Clostridium butylicum*	Lipase	Removal of oil stains
(d)	*Trichoderma polysporum*	Cyclosporin-A	Immunosppressive drug

33 Which industrial products are synthesised from microbes?

I. Antibiotics
II. Toddy
III. Bioactive molecules
IV. Bread

Choose the correct option.

(a) I, II, III and IV
(b) II, III and IV
(c) I and IV
(d) III and IV

TOPIC 3 ~ *Microbes in Sewage Treatment*

34 Sewage contains large amounts of …*A*… and …*B*… . Here *A* and *B* refer to

(a) A–inorganic matter, B–bacteria
(b) A–organic matter, B–pathogenic microbes
(c) A–organic matter, B–virus
(d) A–inorganic matter, B–pathogenic microbes

35 Primary treatment of wastes is the

(a) physical removal of large and small particles from sewage
(b) biological removal of large and small particles from sewage
(c) Both (a) and (b)
(d) chemical removal of large and small particles from sewage

36 In the primary treatment of sewage, the floating debris is removed by sequential ... by passing through wire mesh screens. The most appropriate word for filling the blank is

(a) filtration (b) sedimentation
(c) condensation (d) evaporation

37 In the primary treatment of sewage, the soil and small pebbles are removed by

(a) filtration
(b) sedimentation
(c) condensation
(d) evaporation

38 Which one of the following in sewage treatment removes suspended solids? ***NEET 2017***

(a) Tertiary treatment (b) Secondary treatment
(c) Primary treatment (d) Sludge treatment

39 In the biological treatment of sewage, the masses of bacteria held together by fungal filament to form mesh-like structures called as

(a) activated sludge (b) aerobic process
(c) flocs (d) anaerobic sludge

40 Choose the correct option to fill in the blanks.

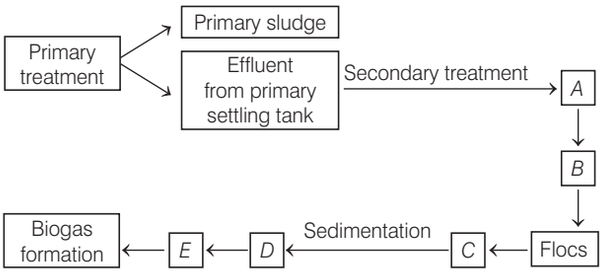
I. Primary treatment of sewage involves physical removal of small and large particles through ...*A*... and ...*B*... .
II. Microbes consume the major part of organic matter in the effluent and reduce ...*C*... of sewage.
III. ...*D*... particularly ...*E*... anaerobically breakdown cellulosic material and produce CO_2 and H_2 from anaerobic sludge during ...*F*... . treatment.
IV. When BOD of sewage has reduced, the effluent is passed into ...*G*... . Here, *A* to *G* can be

(a) A–sedimentation, B–centrifugation, C–BOD, D–Methanogen, E–*Methanobacterium*, F–water gas plant, G–settling tank
(b) A–centrifugation, B–sedimentation, C–BOD, D–Methanogen, E–*Methanococcus*, F–biogas plant, G–sludge tank
(c) A–filtration, B–centrifugation, C–BOD, D–Methanogen, E–*Methanobacillus*, F–gobar gas plant, G–filtre tank
(d) A–filtration, B–sedimentation, C–BOD, D–Methanogen, E–*Methanobacterium*, F–sewage treatment plant, G–settling tank

41 In the sewage treatment, bacterial flocs are allowed to sediment in a settling tank. This sediment is called as

(a) activated sludge (b) primary sludge
(c) anaerobic sludge (d) secondary sludge

42 Given below is the flowchart of sewage treatment. Identify *A, B, C, D* and *E* and select the correct option.



(a) A–Small aeration tank, B–Microbial digestion, C–High BOD, D–Activated sludge, E–Aerobic sludge digesters
(b) A–Large aeration tank, B–Mechanical agitation, C–Increased BOD, D–Activated sludge, E–Aerobic sludge digesters
(c) A–Small aeration tank, B–Microbial digestion, C–Low BOD, D–Activated sludge, E–Anaerobic sludge digesters
(d) A–Large aeration tank, B–Mechanical agitation, C–Reduced BOD, D–Activated sludge, E–Anaerobic sludge digesters

43 Primary sludge ***CBSE-AIPMT 2014***

(a) possesses flocs of decomposer microbes
(b) requires aeration for formation
(c) involves little decomposition
(d) forms during secondary sewage treatment

44 During sewage treatment, biogas is produced, which includes ***NEET 2013***

(a) methane, hydrogen sulphide and carbon dioxide
(b) methane, oxygen and hydrogen sulphide
(c) hydrogen sulphide, methane and sulphur dioxide
(d) hydrogen sulphide, nitrogen and methane

45 Microbes are used in

I. primary treatment of sewage.
II. secondary treatment of sewage.
III. anaerobic sludge digesters.
IV. production of biogas.

Choose the correct option.

(a) I, II and III
(b) I, III and IV
(c) II, III and IV
(d) All of the above

46 The BOD test measures the rate of uptake of oxygen by microbes in water bodies. The greater BOD of sample water, indicates that

(a) it is highly polluted
(b) it is not polluted
(c) it is moderately polluted
(d) pollution level cannot be determined

47 Which of the following plans has been initiated by the Ministry of Environment and Forests to protect rivers from water pollution?

(a) Ganga action plan
(b) Yamuna action plan
(c) Both (a) and (b)
(d) None of the above

TOPIC 4 ~ *Microbes in Production of Biogas*

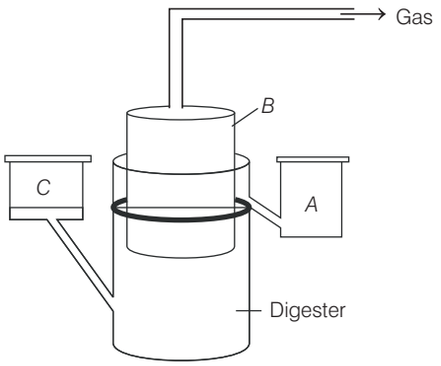
48 The most flammable gaseous component of biogas is
(a) methane, CO_2, H_2 and H_2S
(b) methane
(c) CO_2, H_2 and H_2S
(d) CO, methane and N_2

49 Methanogens are found in
I. organic acid II. rumen of cattle
III. butanal IV. anaerobic sludge
Choose the correct option.
(a) I and II (b) II and III
(c) II and IV (d) III and IV

50 Which of the following bacteria is present in the rumen of cattle?
(a) *Rhizobium* (b) *Azotobacter*
(c) *Methanobacterium* (d) *Clostridium*

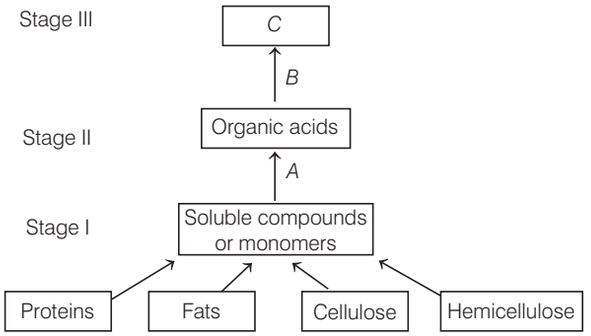
51 The primitive prokaryotes responsible for the production of biogas from the dung of ruminant animals, include the ***NEET 2016***
(a) thermoacidophiles (b) methanogens
(c) eubacteria (d) halophiles

52 The diagram given below represents a typical biogas plant. Select the correct option for *A*, *B* and *C*, respectively.



(a) A–Sludge, B–Dung + Water, C– Gas holder
(b) A–Dung + Water, B–Sludge, C–CH_4 + CO_2
(c) A–Sludge, B–Gas holder, C–Dung + Water
(d) A–CH_4 + CO_2, B–Dung + Water, C–Sludge

53 Study the following flowchart of biogas production and select the correct option for *A, B* and *C*.



(a) A–Methanogenic bacteria, B–Fermentative microbes, C–CO_2 and hydrogen (biogas)
(b) A–Anaerobic microorganisms, B–*Methanococcus*, C–CO_2 and nitrogen (biogas)
(c) A–Anaerobic microbes, B–Methanogenic bacteria, C–CO_2 and methane (biogas)
(d) A–Aerobic microorganism, B–*Methanobacter*, C–CO_2 and methane (biogas)

54 Gobar gas generation technology in India was developed by the collaboration of ...*A*... and ...*B*... . Here, *A* and *B* refer to
(a) A–Rural Bank of India, B–Khadi and Village Industries Commission
(b) A–Indian Agricultural Research Institute, B–Khadi and Village Industries Commission
(c) A–National Bank for Agriculture and Development, B–Indian Agricultural Research Institute
(d) A–National Bank for Agriculture and Development, B–Khadi and Village Industries Commission

TOPIC 5 ~ *Microbes as Biocontrol Agents and Biofertilisers*

55 *Bacillus thuringiensis* is used as
(a) biofungicide (b) biopesticide
(c) biocontrol agent (d) bioweapon

56 In *Bt* cotton, the *Bt* toxin present in plant tissue as protoxin is converted into active toxin due to
(a) alkaline pH of the insect gut ***CBSE-AIPMT 2015***
(b) acidic pH of the insect gut
(c) action of gut microorganisms
(d) the presence of conversion factors in insect gut

57 Cultivation of *Bt* cotton has been much in the news. The prefix *Bt* means
(a) 'Barium-treated' cotton seeds
(b) 'Bigger thread' variety of cotton with better tensile strength
(c) produced by 'biotechnology' using restriction enzymes and ligases
(d) carrying an endotoxin gene from *Bacillus thuringiensis*

58 *Trichoderma* species, free-living fungi, are present in root ecosystems are potentially useful as
(a) biopesticides
(b) biofertilisers
(c) methanogens
(d) vectors for genetic engineering

59 Which of the following can be used as a biocontrol agent in the treatment of plant disease? ***NEET 2019***
(a) *Chlorella* (b) *Anabaena*
(c) *Lactobacillus* (d) *Trichoderma*

60 Baculoviruses *(Nucleopolyhedrovirus)* do not show
(a) host specificity
(b) narrow spectrum applications
(c) effects on non-target insects
(d) utility in IPM programme

61 A biocontrol agent to be a part of an integrated pest management should be ***NEET (Odisha) 2019***
(a) species-specific and symbiotic
(b) free-living and broad spectrum
(c) narrow spectrum and symbiotic
(d) species-specific and inactive on non-target organisms

62 Which one of the following is an example of carrying out biological control of pests/diseases using microbes? ***CBSE-AIPMT 2012***
(a) *Trichoderma* sp., against certain plant pathogens
(b) *Nucleopolyhedrovirus* against white rust in *Brassica*
(c) *Bt* cotton to increase cotton yield
(d) Ladybird beetle against aphids in mustard

63 Select the correct group of biocontrol agents. ***NEET 2019***
(a) *Trichoderma*, Baculovirus, *Bacillus thuringiensis*
(b) *Oscillatoria*, *Rhizobium*, *Trichoderma*
(c) *Nostoc*, *Azospirillum*, *Nucleopolyhedrovirus*
(d) *Bacillus thuringiensis*, Tobacco mosaic virus, Aphids

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

65 The organisms which are used to enrich the nutrient quality of the soil are
(a) bacteria (b) cyanobacteria
(c) fungi (d) All of these

66 The most important of the symbiotic nitrogen-fixing bacteria, which forms nodules on the roots of legume plants is
(a) *Aspergillus* (b) *Rhizobium*
(c) *Penicillium* (d) *Streptococcus*

67 Among the following pairs of microbes, which pair has both the microbes that can be used as biofertilisers? ***NEET (Odisha) 2019***
(a) *Aspergillus* and *Rhizopus*
(b) *Rhizobium* and *Rhizopus*
(c) Cyanobacteria and *Rhizobium*
(d) *Aspergillus* and Cyanobacteria

68 Which of the following belongs to free-living nitrogen-fixing bacteria?
I. *Rhizobium* II. *Azospirillum*
III. *Azotobacter*
Choose the correct option.
(a) I and II (b) I and III (c) II and III (d) All of these

69 The symbiotic association of fungi with the roots of higher plants is called
(a) eubacteria (b) actinomycetes
(c) mycorrhiza (d) lichen

70 The most common fungal partner of mycorrhiza belongs to genus
(a) *Azotobacter* (b) *Glomus* (c) *Azolla* (d) *Frankia*

71 Which one of the following helps in absorption of phosphorus from soil?
(a) *Nostoc* (b) *Anabaena* (c) *Glomus* (d) Yeast

72 Which of the following are the part or example of symbiotic mutualistic association?
(a) *Rhizobium* (b) Mycorrhiza
(c) Both (a) and (b) (d) *Oscillatoria*

73 Which of the following is cyanobacteria and fix atmospheric nitrogen?
(a) *Oscillatoria* (b) *Nostoc*
(c) *Anabaena* (d) All of these

74 Which of the following is common to *Azospirillum*, *Anabaena*, *Nostoc* and *Oscillatoria*?
(a) N_2-fixer microbes (b) Prokaryotic organism
(c) Both (a) and (b) (d) Eukaryotic organism

75 Which of the following serves as biofertiliser in paddy fields?
(a) *Anabaena* (b) *Azospirillum*
(c) *Nostoc* (d) Both (a) and (c)

76 *Azolla* is used as a biofertiliser because it ***AIIMS 2018***
(a) has association of mycorrhiza
(b) multiplies at faster rate to produce massive biomass
(c) has association of nitrogen-fixing *Rhizobium*
(d) has association of nitrogen-fixing cyanobacteria

77 A biocontrol agent used for pest butterfly caterpillars is
(a) *Trichoderma* (b) *Bacillus thuringiensis*
(c) *Pseudomonas* (d) *Rhizobium*

78 Select the group of organisms that are used as biofertilisers in organic farming.
(a) *Clostridium, Beijerinckia, Glomus* and *Anabaena*
(b) *Trichoderma*, Baculovirus and *B. thuringiensis*
(c) *Nostoc, Azolla pinnata* and Tobacco mosaic virus
(d) *Penicillium, Streptococcus* and *Aspergillus*

NEET

SPECIAL TYPES QUESTIONS

I. Assertion and Reason

■ **Direction** (Q. No. 79-87) *In each of the following questions, a statement of Assertion (A) is given by corresponding statement of Reason (R). Of the statements, mark the correct answer as*

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true, but R is not correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

79 **Assertion** (A) Besides curdling of milk, LAB also improve curd's nutritional quality.

Reason (R) LAB, when presents in human stomach, check disease causing microbes.

80 **Assertion** (A) Biogas is used as fuel for cooking and lighting.

Reason (R) It is considered as an ecofriendly and a pollution free source of energy.

81 **Assertion** (A) Disadvantages of synthetic pesticides can be overcome by the use of biopesticides.

Reason (R) Biopesticides control weeds and pest without causing any damage to living organisms.

82 **Assertion** (A) Chemical pesticides are preferred over biopesticides.

Reason (R) Chemical pesticides are mostly expensive, hazardous and pollute the atmosphere.

83 **Assertion** (A) Leguminous plants are best preferred in rotation of crops.

Reason (R) They have root nodules, which have nitrogen-fixing bacteria *Clostridium*.

84 **Assertion** (A) Use of fertilisers greatly enhances crop productivity.

Reason (R) Irrigation is very important in increasing crop productivity.

85 **Assertion** (A) Beer and wine are called soft liquours.

Reason (R) These beverages have lower percentage of alcohol.

86 **Assertion** (A) An organ transplant patient is administered regular dose of cyclosporin-A.

Reason (R) Cyclosporin-A is an immunosuppresant agent.

87 **Assertion** (A) Baculoviruses are broad spectrum insecticides.

Reason (R) These viruses are excellent choices for biocontrol in an ecologically sensitive area for integrated pest management.

II. Statement Based Questions

88 Which of the statement given below is incorrect?
(a) Yeast is used in making bread and beverages is a prokaryotic fungus
(b) Streptokinase is produced by *Streptococcus* and modified by genetic engineering is used as a clot buster
(c) Lipases are added in detergent for removing oily stains from laundry
(d) Pectinases are used in clearing of bottled fruit juices

89 Which of the following statements is incorrect?
(a) Methanogens are present in human intestine and acts on fibrous component of food
(b) *Methanobacterium* is a methanogenic bacteria
(c) Methanogens play an important role in the nutrition of cattle
(d) Gobar gas is rich in *Methanobacterium*

90 Which of the following statements is correct?
(a) Ethanol is produced by the fermentation of malted cereals and fruit juices
(b) Wine is produced without distillation
(c) *Saccharomyces* is used for bread making
(d) All of the above

91 Which of the following statement (s) is/are correct with regard to biocontrol agents?
(a) Ladybird beetles and dragonflies are used to get rid of aphids and mosquitoes, respectively
(b) *Bacillus thuringiensis* bacteria are used to control butterfly and caterpillars
(c) *Trichoderma* species are used to control several plant pathogens
(d) All of the above

92 Which of the following statements about methanogens is incorrect? ***NEET (Odisha) 2019***
(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

93 Which of the following statement is/are correct?

(a) Biochemical Oxygen Demand (BOD) represents the amount of dissolved oxygen that would be consumed if all the organic matter in 1 L of water were oxidised by microorganism

(b) Sewage water is treated to reduce its BOD

(c) High value of BOD means the water is less polluted by organic matter

(d) Both (a) and (b)

94 Benefits of mycorrhizae are indicated by which statement?

(a) It shows resistance to root borne pathogen

(b) It shows tolerance to salinity and pathogen

(c) It helps in the overall increase in the plant growth and development

(d) All of the above

95 Which of the following statements regarding baculoviruses as biocontrol agents are correct?

(a) Baculoviruses are pathogens that attack insects and other arthropods

(b) Most of these biocontrol agents belong to the genus *Nucleopolyhedrovirus*

(c) They do not harm plants mammals, birds, fish and other non-target insects

(d) All of the above

96 Consider the following statements about organic farming. Which of the statement given below is correct?

(a) Organic farming promotes the use of crop rotations, cover crops and encourages balanced host/predator relationships

(b) Integrated pest, weed management and soil conservation systems are valuable tools of an organic farm

(c) Organic farming protects the environment, minimise soil degradation and erosion and decrease pollution

(d) All of the above

97 Consider the following statements. Which of the statement given below is incorrect?

(a) Microbes are also used to ferment fish, soybean and bamboo shoots to make foods

(b) Different varieties of cheese are known by their characteristic texture, flavour and taste, the specificity coming from the microbe used

(c) *Trichoderma* sp., free-living fungi, are present in root ecosystems where they act against several plant pathogens

(d) *Rhizobium* is a symbiotic bacterium that lives in the stem of legumes

98 Which of the following statement(s) represents the main benefits of LAB?

I. Increase vitamin-B_{12} amount, thus increasing nutrient quality of milk.

II. Check disease causing microbes in stomach.

Choose the correct option.

(a) Only I (b) Only II

(c) I and II (d) None of these

99 Consider the following statements.

I. Antibiotics are chemical substances produced by some microorganisms which can kill or retard the growth of other disease-causing microorganisms.

II. Penicillin was the first antibiotic discovered by Alexander Fleming (1928), while working on bacterium *Staphylococcus aureus*.

III. The function of penicillin as an antibiotic was established by Ernst Chain and Howard Florey.

Which of the statements given above are correct?

(a) I and II (b) I and III

(c) II and III (d) I, II and III

100 Which of the following statements are correct?

I. Wine and beer are produced without distillation of fermented broth.

II. Byproducts of alcoholic fermentation are CO_2 and methane.

III. *Penicillium* species is used for fermenting malted cereals to produce alcohol.

Choose the correct option.

(a) Only I (b) I and II (c) II and III (d) Only III

101 Sewage or municipal waste should not be directly passed into rivers, streams and other water bodies because

I. it contains human excreta and other organic waste.

II. it contains a number of pathogenic microbes.

Which of the statement (s) given above is/are correct?

(a) Only I (b) Only II

(c) I and II (d) None of these

102 Consider the following statements.

I. After primary treatment of sewage, all solids that settle down forms the primary sludge and the supernatant form the effluent.

II. Spent slurry of biogas plant is used as fertiliser.

Which of the statements given above are correct?

(a) Only I (b) I and II

(c) Only II (d) None of these

103 Consider the following statements about, secondary sewage treatment.

I. In secondary treatment, useful aerobic microbes grow rapidly and form flocs. Flocs are masses of bacteria associated with fungal filaments to form mesh-like structures.

II. The growing microbes consume organic matter and thus, reduce the biochemical oxygen demand. When BOD of sewage has reduced, the effluent is passed into settling tank.

III. In settling tank, the bacterial flocs settle and the sediment is called activated sludge.

IV. A small part of the sludge is used as an inoculum in the aeration tank and the remaining part is passed into large tanks called anaerobic sludge digesters.

V. In the digesters, heterotrophic microbes anaerobically digest bacteria and fungi in sludge producing mixture of gases such as, carbon dioxide, nitrogen and carbon monoxide which form the biogas.

Which of the statements given above are correct?

(a) I, II, III and IV (b) I, III, IV and V
(c) II, III, IV and V (d) I, II, III, IV and V

104 Consider the following statements about *Bt*.

I. The bacteria *Bacillus thuringiensis* (*Bt*) are used to control butterfly catterpillars.

II. Fresh spores of *Bt* are mixed with water and sprayed on to vulnerable plants such as brassicas and fruit trees.

III. Insect larvae, after eating *Bt* , are killed by the toxin released in their gut.

IV. *Bt* toxin genes have been introduced into plants to provide resistance to pests.

Which of the statements given above are correct?

(a) I, II and III (b) I, III and IV
(c) II, III and IV (d) I, II, III and IV

105 Which of the following statement(s) is correct?

I. The dough, which is used for making bread, is fermented using Baker's yeast, i.e. *Saccharomyces cerevisiae*.

II. Production on an industrial scale, requires growing microbes in very large vessels called fermentors.

III. The municipal wastewater is also called sewage.

IV. It is necessary to treat sewage in Sewage Treatment Plants (STPs) to make it less polluting.

Which of the statements given above are correct?

(a) I and II (b) Only III
(c) I, II and IV (d) I, II, III and IV

106 Which of the following is/are the approache(s) for biological farming?

I. Familiarity with various life forms inhabiting the field.

II. Gain knowledge about the life cycles, patterns of feeding and habitat of predators and pests.

Choose the correct option.

(a) Only I (b) Only II
(c) I and II (d) None of these

107 Read the following statements and select the correct option.

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

II. Use of biocontrol measures will greatly reduce our dependence on toxic chemicals and pesticides.

(a) Both statements I and II are correct
(b) Statement I is correct, but statement II is incorrect
(c) Statement I is incorrect, but statement II is correct
(d) Both statements I and II are incorrect

108 Read the following statements about disadvantages of chemical agents.

I. Chemicals are toxic and harmful to human beings and animals.

II. Chemicals pollute the environment and plants.

III. Weedicides used to remove weeds also pollute the soil.

Choose the correct option.

(a) I, II and III (b) I and II
(c) I and III (d) II and III

109 Read the following statements. ***AIIMS 2018***

I. Colostrum is recommended for the newborns because it is rich in antigens.

II. Chikungunya is caused by a Gram negative bacterium.

III. Tissue culture has proved useful in obtaining virus-free plants.

IV. Beer is manufactured by distillation of fermented grapes.

How many of the statement(s) is/are correct ?

(a) Two (b) One (c) Three (d) Four

III. Matching Type Questions

110 Match the following columns.

	Column I (Organisms)		**Column II** (Uses)
A.	*Lactobacillus*	1.	Roquefort cheese
B.	*Saccharomyces cerevisiae*	2.	Swiss cheese
C.	*Propionibacterium shermanii*	3.	Bread
D.	*Penicillium roqueforti*	4.	Milk into curd

Codes

	A	B	C	D		A	B	C	D
(a)	4	3	2	1	(b)	3	2	1	4
(c)	4	1	2	3	(d)	1	4	3	2

111 Match the following columns.

	Column I		**Column II**
A.	*Azolla*	1.	Symbiotic N_2-fixer
B.	Rotenone	2.	Symbiotic association with N_2 -fixing cyanobacteria
C.	*Crotolaria juncea*	3.	Natural insecticide
D.	*Frankia*	4.	Green manure

Codes

	A	B	C	D
(a)	2	3	4	1
(b)	2	4	3	1
(c)	2	1	4	3
(d)	1	3	4	2

112 Match the following columns. ***NEET 2016***

	Column I		Column II
A.	Citric acid	1.	*Trichoderma*
B.	Cyclosporin	2.	*Clostridium*
C.	Statins	3.	*Aspergillus*
D.	Butyric acid	4.	*Monascus*

Codes

	A	B	C	D		A	B	C	D
(a)	3	1	2	4	(b)	3	1	4	2
(c)	1	4	2	3	(d)	3	4	1	2

113 Match the following columns.

	Column I		Column II
A.	*Mycorrhiza*	1.	*Nucleopolyhedrovirus*
B.	*Bacillus thuringiensis*	2.	*Rhizobium*
C.	Root nodules	3.	*Bt* cotton
D.	Baculovirus	4.	Phosphorus nutrition

Codes

	A	B	C	D		A	B	C	D
(a)	4	3	2	1	(b)	3	2	1	4
(c)	3	4	1	2	(d)	4	1	2	3

114 Match the following list of microbes and their importance. ***CBSE-AIPMT 2015***

A.	*Saccharomyces cerevisiae*	1.	Production of immunosuppressive agents
B.	*Monascus purpureus*	2.	Ripening of Swiss cheese
C.	*Trichoderma polysporum*	3.	Commercial production of ethanol
D.	*Propionibacterium shermanii*	4.	Production of blood-cholesterol lowering agents

Codes

	A	B	C	D
(a)	3	4	1	2
(b)	4	3	2	1
(c)	4	2	1	3
(d)	3	1	4	2

115 Match the following columns.

	Column I		Column II
A.	Symbiotic nitrogen-fixing bacteria	1.	Mosquitoes
B.	Dragonflies	2.	*Rhizobium*
C.	*Bacillus thuringiensis*	3.	*Azotobacter*
D.	Free-living N_2-fixing bacteria	4.	Butterfly, caterpillars

Codes

	A	B	C	D		A	B	C	D
(a)	1	4	3	2	(b)	4	3	2	1
(c)	2	1	4	3	(d)	2	1	3	4

116 Match the following columns. ***NEET 2019***

	Column I		Column II
A.	*Lactobacillus*	1.	Cheese
B.	*Saccharomyces cerevisiae*	2.	Curd
C.	*Aspergillus niger*	3.	Citric acid
D.	*Acetobacter aceti*	4.	Bread
		5.	Acetic acid

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	3	5	(b)	3	4	5	1
(c)	2	1	3	5	(d)	2	4	5	3

117 Match Column I (Antibiotic) with Column II (Source). ***AIIMS 2018***

	Column I		Column II
A.	Fumagillin	1.	*Gliocladium virens*
B.	Bacitracin	2.	*Streptomyces griseus*
C.	Streptomycin	3.	*Bacillus polymyxa*
D.	Viridin	4.	*Aspergillus fumigatus*
E.	Polymixin	5.	*Bacillus licheniformis*

Codes

	A	B	C	D	E
(a)	1	2	3	4	5
(b)	4	5	2	1	3
(c)	3	1	4	2	5
(d)	2	3	5	4	1

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

118 Which one of the following processes evidently prove that microbes release gases during metabolism?
(a) Making of curd from milk
(b) Rising of dough by yeast
(c) Making of alcohol from malt
(d) None of the above

119 Lactic acid bacteria are found in
(a) milk (b) curd
(c) Both (a) and (b) (d) None of these

120 Which of the following is antibiotic producing fungi?
(a) *Monascus*
(b) *Peronospora*
(c) *Penicillium*
(d) *Rhizopus*

121 Find out the incorrect pair from the following.
(a) Biogas—Methanogens (b) *Penicillium* — Antibiotic
(c) Curd — LAB (d) Citric acid — *Trichoderma*

122 Read the following and choose the incorrect statement.
(a) Most biofertilisers are obtained from microbes
(b) VAM is the example of biofertiliser giving organism
(c) SCP is used as source of biofertiliser
(d) None of the above

NCERT Exemplar

123 The vitamin whose content increases following the conversion of milk into curd by lactic acid bacteria is
(a) vitamin-C (b) vitamin-D
(c) vitamin-B_{12} (d) vitamin-E

124 Wastewater treatment generates a large quantity of sludge, which can be treated by
(a) anaerobic digesters (b) floc
(c) chemicals (d) oxidation pond

125 Methanogenic bacteria are not found in
(a) rumen of cattle
(b) gobar gas plant
(c) bottom of water-logged paddy fields
(d) activated sludge

126 Match the following columns of bacteria and their commercially important products.

	Column I (Bacterium)		**Column II** (Products)
A.	*Aspergillus niger*	1.	Lactic acid
B.	*Acetobacter aceti*	2.	Butyric acid
C.	*Clostridium butylicum*	3.	Acetic acid
D.	*Lactobacillus*	4.	Citric acid

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	4	1	(b)	2	4	3	1
(c)	4	3	2	1	(d)	4	1	3	2

127 Which one of the following alcoholic drinks is produced without distillation?
(a) Wine (b) Whisky (c) Rum (d) Brandy

128 The free-living fungus *Trichoderma* can be used for
(a) killing insects
(b) biological control of plant diseases
(c) controlling butterfly caterpillars
(d) producing antibiotics

129 What would happen if oxygen availability to activated sludge flocs is reduced?
(a) It will slow down the rate of degradation of organic matter
(b) The centre of flocs will become anoxic, which would cause death of bacteria and eventually breakage of flocs
(c) Flocs would increase in size as anaerobic bacteria would grow around flocs
(d) Protozoa would grow in large numbers

130 Big holes in Swiss cheese are made by
(a) a machine
(b) a bacterium that produces methane gas
(c) a bacterium producing a large amount of carbon dioxide
(d) a fungus that releases a lot of gases during its metabolic activities

131 The residue left after methane production from cattle dung is
(a) burnt (b) burried in land fills
(c) used as manure (d) used in civil construction

132 Methanogens do not produce
(a) oxygen (b) methane
(c) hydrogen sulphide (d) carbon dioxide

133 Activated sludge should have the ability to settle quickly, so that it can
(a) be rapidly pumped back from sedimentation tank to aeration tank
(b) absorb pathogenic bacteria present in wastewater, while sinking to the bottom of the settling tank
(c) be discarded and anaerobically digested
(d) absorb colloidal organic matter

134 Match the following list of bioactive substances and their roles.

	Column I (Bioactive substances)		**Column II** (Roles)
A.	Statin	1.	Removal of oil stains
B.	Cyclosporin-A	2.	Removal of clots from blood vessels
C.	Streptokinase	3.	Lowering of blood cholesterol
D.	Lipase	4.	Immunosuppressive agent

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	1	4	(b)	4	2	1	3
(c)	4	1	3	2	(d)	3	4	2	1

135 The primary treatment of wastewater involves the removal of
(a) dissolved impurities (b) stable particles
(c) toxic substances (d) harmful bacteria

136 BOD of wastewater is estimated by measuring the amount of
(a) total organic matter
(b) biodegradable organic matter
(c) oxygen evolution
(d) oxygen consumption

137 The technology of biogas production from cow dung was developed in India largely due to the efforts of

(a) Gas Authority of India

(b) Oil and Natural Gas Commission

(c) Indian Agricultural Research Institute and Khadi and Village Industries Commission

(d) Indian Oil Corporation

138 Mycorrhiza does not help the host plant in

(a) enhancing its phosphorus uptake capacity

(b) increasing its tolerance to drought

(c) enhancing its resistance to root pathogens

(d) increasing its resistance to insects

139 Match the items in Column I and Column II and choose correct answer.

	Column I		Column II
A.	Ladybird	1.	*Methanobacterium*
B.	Mycorrhiza	2.	*Trichoderma*
C.	Biological control	3.	Aphids
D.	Biogas	4.	*Glomus*

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	3	1	(b)	3	4	2	1
(c)	4	1	2	3	(d)	3	2	1	4

140 Which one of the following is not a nitrogen-fixing organism?

(a) *Anabaena* (b) *Nostoc* (c) *Azotobacter* (d) *Pseudomonas*

Answers

› Mastering NCERT with MCQs

1 (d)	**2** (b)	**3** (a)	**4** (b)	**5** (c)	**6** (b)	**7** (d)	**8** (a)	**9** (b)	**10** (a)	**11** (a)	**12** (c)	**13** (b)	**14** (b)	**15** (c)
16 (c)	**17** (c)	**18** (c)	**19** (d)	**20** (b)	**21** (b)	**22** (d)	**23** (d)	**24** (a)	**25** (a)	**26** (d)	**27** (d)	**28** (d)	**29** (a)	**30** (d)
31 (a)	**32** (c)	**33** (c)	**34** (b)	**35** (a)	**36** (a)	**37** (b)	**38** (c)	**39** (c)	**40** (d)	**41** (a)	**42** (d)	**43** (a)	**44** (a)	**45** (c)
46 (a)	**47** (c)	**48** (b)	**49** (c)	**50** (c)	**51** (b)	**52** (c)	**53** (c)	**54** (b)	**55** (c)	**56** (a)	**57** (d)	**58** (a)	**59** (d)	**60** (c)
61 (d)	**62** (a)	**63** (a)	**64** (d)	**65** (d)	**66** (b)	**67** (c)	**68** (c)	**69** (c)	**70** (b)	**71** (c)	**72** (c)	**73** (d)	**74** (c)	**75** (d)
76 (d)	**77** (b)	**78** (a)												

› NEET Special Types Questions

79 (b)	**80** (b)	**81** (a)	**82** (d)	**83** (c)	**84** (b)	**85** (a)	**86** (a)	**87** (d)	**88** (a)	**89** (a)	**90** (d)	**91** (d)	**92** (c)	**93** (d)
94 (d)	**95** (d)	**96** (d)	**97** (d)	**98** (c)	**99** (d)	**100** (a)	**101** (c)	**102** (b)	**103** (a)	**104** (d)	**105** (d)	**106** (c)	**107** (a)	**108** (a)
109 (b)	**110** (a)	**111** (a)	**112** (b)	**113** (a)	**114** (a)	**115** (c)	**116** (a)	**117** (b)						

› NCERT & NCERT Exemplar Questions

118 (b)	**119** (c)	**120** (c)	**121** (d)	**122** (c)	**123** (c)	**124** (a)	**125** (d)	**126** (c)	**127** (a)	**128** (b)	**129** (b)	**130** (c)	**131** (c)	**132** (a)
133 (a)	**134** (d)	**135** (b)	**136** (d)	**137** (c)	**138** (d)	**139** (b)	**140** (d)							

Answers & Explanations

2 *(b)* Prions are the microscopic protein particles similar to a virus, but lack nucleic acid. These are assumed to be the infectious agent, responsible for scrapie and certain other degenerative diseases of the nervous system.

3 (*a*) The nutritive medium for growing bacteria and many fungi in the laboratory is called culture media. This media contains all the essential requirements necessary for bacterial and fungal growth such as carbon, sugar, minerals, etc. The growth of microbes is visible as colonies that can be seen with the naked eyes. Such cultures are useful in studies on microorganisms.

5 (*c*) *Lactobacillus* is added to milk which converts lactose (sugar of milk) into lactic acid. Lactic acid causes coagulation and partial conversion of milk protein casein to calcium paracaseinate. These chemical changes in milk help in its conversion into curd, yoghurt and cheese.

7 (*d*) Heterotrophic bacteria are the most abundant life forms. Many of them have a significant impact on humans, such as these are helpful in making curd from milk, e.g. *Lactobacillus* sp., and production of antibiotics, e.g. *Streptomyces* sp.

10 (*a*) The dough, which is used for making foods such as dosa, bread and idli are also fermented by bacteria. The puffed up appearance of dough is due to the production of CO_2 gas by these bacteria.

12 (*c*) Swiss cheese is formed with the help of single strain of *Propionibacterium shermanii*. Its characteristic feature is the formation of large holes due to the production of a large amount of CO_2.

15 (*c*) Bioreactor is an essential equipment required for growing microbes on large scale, i.e. for the industrial production of enzymes, antibiotics, beverages, etc. These

large vessels provide biologically active environment suitable for microbial production of such products.

16 (*c*) Distilled spritis are alcoholic beverages in which the concentration of ethyl alcohol is more than the original fermented mixture which is obtained by distillation. These beverages are whisky, brandy and rum.

Other beverages like wine and beer are produced without distillation.

17 (*c*) An yeast, *Saccharomyces cerevisiae*, is used in the production of alcoholic beverages like wine, beer, whisky, brandy or rum. Beverages are generally formed by fermenting malted cereals and fruit juices with this yeast to produce ethanol or alcohol.

22 (*d*) Penicillin was the first antibiotic to be discovered by Alexander Fleming (1928). The antibiotic was, however, commercially extracted by efforts of Ernst Chain and Howard Florey. Fleming, Chain and Florey were together awarded Nobel Prize in 1945, for this discovery.

23 (*d*) Antibiotics have greatly improved our capacity to treat deadly diseases such as diphtheria (gal ghotu), whooping cough (kali khansi), plague, leprosy (kusht rog), which is used to kill millions of people all over the world.

26 (*d*) Only option (d) is correctly matched. Other options are incorrectly matched and can be corrected as

- *Acetobacter aceti* produces acetic acid.
- *Methanobacterium* produces methane.
- *Penicillium notatum* produces penicillin.

28 (*d*) Streptokinase produced by the bacterium *Streptococcus* and modified by genetic engineering is used as a clot buster for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.

31 (*a*) Statins are the commercial blood cholesterol lowering agents as these competitively inhibit the enzymes involved in cholesterol synthesis. These are obtained from the yeast, *Monascus purpureus*.

32 (*c*) Option (c) is incorrectly matched in the table. It can be corrected as

Butyric acid is produced by fermentative activity of the bacteria called *Clostridium butylicum*. It does not produce lipase. Lipase is obtained from *Candida albicans*.

Rest of the options contain correct matches.

35 (*a*) Primary treatment is the physical removal of large and small particles from sewage through filtration and sedimentation.

38 (*c*) In sewage treatment, suspended solids are removed during primary treatment. It is also known as physical treatment.

It consists of shredding, churning, screening and sedimentation. Sequential filtration removes floating and large suspended solids.

39 (*c*) In the biological treatment of sewage, flocs are formed. These are masses of bacteria associated with fungal filaments to form a mesh-like structure. The growing microbes consume organic matter and thus reduce the Biochemical Oxygen Demand (BOD) and lowers the level of pollutants.

41 (*a*) In the sewage treatment, when Biochemical Oxygen Demand (BOD) of sewage has reduced, the effluent is passed into settling tank. Here, the bacterial flocs settle and the sediment thus formed is called activated sludge.

43 (*a*) Option (a) is correct.

Primary sludge possesses flocs of decomposer (aerobic) microbes, which consume a major part of the organic matter in the effluent to reduce the BOD.

45 (*c*) Primary treatment does not involve microbes. It is the physical removal of large and small particles from sewage.

However, secondary treatment of the effluent from the primary settling tank is purely a biological treatment involving microbial activity. Further, in the anaerobic sludge digesters, heterotrophic microbes anaerobically digest bacteria and fungi in the sludge producing mixture of gases such as methane, hydrogen sulphide and CO_2, which form biogas.

Thus, microbes are used in secondary treatment, anaerobic sludge digesters and biogas production.

46 (*a*) BOD is a measure of the organic matter present in water. Thus, greater the value of BOD in a sample of water, more will be its polluting potential. This indicates that the water body will be highly polluted.

47 (*c*) In order to protect the major rivers of India from water pollution, the Ministry of Environment and Forests, has initiated development of the sewage treatment plants under the National River Conservation Authority, so that only treated sewage may be discharged in the rivers, e.g. Ganga Action Plan (GAP), Yamuna Action Plan (YAP), Satluj Action Plan and Gomti Action Plan.

48 (*b*) The major component of biogas is methane (about 50-68%), and it is highly inflammable. The other gaseous components of biogas are carbon dioxide (25-35%), hydrogen (1-7%) and rarely hydrogen sulphide.

49 (*c*) Methanogens, particularly *Methanobacterium*, are the anaerobic bacteria, which breakdown cellulosic material to produce methane, CO_2 and H_2. These are found in the anaerobic sludge in sewage treatment plants and rumen (a part of stomach) of cattle. These play an important role in nutrition.

51 (*b*) Methanogens are a group of obligate anaerobic ancient or primitive bacteria (prokaryote). These are involved in methanogenesis and produce methane gas (biogas) from the dung of ruminant animals.

53 (*c*) The correct option for *A*, *B* and *C* is (c) as

Anaerobic microbes, methanogenic bacteria, CO_2 and methane (biogas), respectively.

In stage - I, anaerobic microorganisms, (A) bring about enzymatic breakdown of complex organic compounds into simple soluble compounds or monomers.
In stage -II, monomers are converted into organic acids by fermentating microbes.

In stage -III, organic acids are acted upon by methanogenic bacteria (B) to produce methane rich mixture of gases called biogas (C).

55 (*c*) *Bacillus thuringiensis* is a soil bacterium used as biocontrol agent that can control infestations by insect pests such as butterfly, caterpillars, ants, moths, etc. Some strains of these bacteria can kill animal and plant parasitic nematodes, snails, protozoans, etc.

56 (*a*) The *Bt* toxin is an inactive protoxin, which gets activated due to the alkaline pH of the insect gut.

Proteins are solubilised and proteolytically processed when exposed to alkaline pH and thus are activated. The toxins then attack the gut cells of the insect, creating holes in the lining casusing lysis and death of the insect.

57 (*d*) In *Bt* cotton, *Bt* means carrying an endotoxin gene from *Bacillus thuringiensis*.

Specific *Bt* toxin genes were isolated from *Bacillus thuringiensis* and incorporated into several crop plants such as cotton, corn, etc. The toxin is coded by a gene named *cry* and imparts resistance to a wide range of insect pests.

59 (*d*) *Trichoderma* can be used as a biocontrol agent of several plant pathogens. It is a filamentous soil fungus having mycoparasitic activity.

On the other hand, *Anabaena* helps in nitrogen-fixation, *Lactobacillus* helps in the production of organic acid, e.g. lactic acid and *Chlorella* is a single cell protein, which acts as food supplement.

60 (*c*) Baculoviruses (*Nucleopolyhedrovirus*) do not show effect on non-target insects. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. These have been known to shown no negative impacts on plants, mammals, birds, fish or even on non-target insects.

61 (*d*) For a biocontrol agent to be a part of an Integrated Pest Management (IPM) programme, it should be species-specific and inactive or have no negative impacts on non-target organisms like plants, mammals, birds, fish and even another non-target insects. It should kill only targeted insects/pests (organisms).

62 (*a*) Option (a) gives an example of biological pest/disease control being carried out by microbes. *Trichoderma* species are effective biocontrol agents of several plant pathogens. They are free-living fungi that are very common in the root ecosystems.

63 (*a*) The correct group of biocontrol agents is given by option (a), i.e. *Trichoderma,* baculovirus and *Bacillus thuringiensis.*

- Baculoviruses are pathogens that attack insects and other arthropods. Most of baculoviruses used as biocontrol agent belong to the genus–*Nucleopolyhedrovirus.*
- *Trichoderma* is extensively used against pathogenic fungi which causes soil-borne diseases.
- *Bacillus thuringiensis* secretes toxin cyrstals which kill the insect larvae.

64 (*d*) Organic farming includes several methods to enhance soil fertility. In such farming, methods of biological origin are used, e.g. biopesticide, biofertilisers, IPM (Integrated Pest Management), locally developed pest resistant varieties, green manure, etc.

66 (*b*) *Rhizobium* is a soil bacterium that fixes nitrogen in symbiotic association with root nodules of legumes (Fabaceae). *Rhizobium* requires a plant host, as it cannot independently fix atmospheric nitrogen.

67 (*c*) Cyanobacteria and *Rhizobium* can be used as biofertilisers. Biofertilisers are the organisms that enrich the nutrient quality of the soil. Whereas, *Aspergillus* and *Rhizopus* are not used as biofertilisers.

68 (*c*) *Azospirillum* and *Azotobacter* are free-living nitrogen-fixing bacteria. These bacteria fix atmospheric nitrogen in the soil and make it available for the higher plants. On the other hand, *Rhizobium* is the symbiotic nitrogen-fixing bacterium.

69 (*c*) A mycorrhiza is a symbiotic (mutually beneficial) association between a fungus and the roots of a vascular (higher) plant. These are important components of soil life and soil chemistry.

71 (*c*) Genus–*Glomus* forms mycorrhiza with roots of higher plants. It is a fungus which helps in nutrient uptake from soil, mainly aiding the absorption of phosphorus.

73 (*d*) *Nostoc*, *Anabaena* and *Oscillatoria* are all cyanobacteria which fix atmospheric nitrogen and increase the organic matter of the soil through photosynthetic activity.

75 (*d*) *Nostoc* and *Anabaena* are cyanobacteria, which serve as important biofertilisers in paddy fields. These fix atmospheric nitrogen and increase the organic matter of soil through their photosynthetic activity. These also increase the soil fertility by adding organic matter to the soil.

76 (*d*) *Azolla* is a pteridophyte and it is used as a biofertiliser because it has association with a nitrogen-fixing cyanobacteria called *Anabaena azollae.*

77 (*b*) *Bacillus thuringiensis* is the most effective biocontrol agent for insect pests such as butterfly caterpillars. Spores of this bacterium produce a toxic insecticidal protein called Cry. These proteins enter the host's body and reach gut where on activation they kill the host by lysis.

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

LAB also improve curd's nutritional quality during coagulation of milk by increasing the content of vitamin-B_{12} and other nutrients. It is present in curd and also checks the growth of disease causing microbes in stomach and other parts of digestive tract in humans.

80 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. The correct explanation is as follows

Biogas is used as fuel for heating, cooking, lighting because it is flammable. It is an alternative of firewood, kerosene, etc., and acts as an ecofriendly and a pollution free source of energy.

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

Synthetic pesticides are chemicals which have several disadvantages such as their high cost, long term pollution, toxicity and tendency to accumulate in living organisms, etc. These disadvantages can be overcome by the use of biopesticides that are simple components of biological origin because these cause no damage or toxicity in living organisms.

82 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Chemical pesticides are not preferred over biopesticides. This is because chemical fertilisers are generally more expensive and hazardous in nature. These unnecessarily pollute the natural resources like soil and water over a long time.

83 (*c*) Assertion is true, but Reason is false. Reason can be corrected as

Leguminous crops are grown in rotation of crops. These plants have the ability to fix atmospheric nitrogen to form nitrogen compounds through the help of certain bacteria, like *Rhizobium*, present in their root nodules.

In rotation of crops, leguminous crops like pulses, beans, peas, groundnut and Bengal gram are sown in between the seasons of cereal crops like wheat, maize and pearl millet. These are leguminous plants when grown alternately with non-leguminous plants restore the fertility of the soil.

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

Use of fertilisers greatly enhances crop productivity by addition of nitrogen, phosphorus and potassium to the soil. Irrigation practices are also helpful in enhancing the crop yield by fulfilling the demand of water in crops. In this way, both fertilisers and irrigation are equally important for high crop yield.

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

Beer and wine are called as soft liquours because these are produced without undergoing distillation and have lower percentage of alcohol content as compared to hard liquours like rum, whisky, brandy, etc.

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

An organ transplant patient is kept on a regular dose of cyclosporin-A to reduce the risk of transplant rejection. Cyclosporin-A is used as immunosuppessive agent in organ transplanted patients to inhibit the activation of T-cells and interferes with the destruction of non-self cells. It thus, increases the chances of graft being accepted recepient's body.

87 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Baculoviruses are species-specific narrow spectrum insecticides.

These features make them an excellent choice for conservation of beneficial insects during integrated pest management programme in an ecologically sensitive area.

88 (*a*) The statement in option (a) is incorrect. It can be corrected as
Yeast is used in making bread and beverages is a type of eukaryotic fungus.

Rest of the statements are correct.

89 (*a*) The statement in option (a) is incorrect and can be corrected as

Methanogens are present in the rumen (a part of stomach) of cattle (runminant) where it acts on the cellulosic content to yield a methane rich mixtrue of gases.

Rest of the statements are correct.

92 (*c*) The statement in option (c) is incorrect and can be corrected as

Certain bacteria, which grow anaerobically on cellulosic material, produce large amount of methane along with CO_2 and H_2.

These bacteria are collectively called methanogens and one such example is *Methanobacterium.*

Rest of the statements in other options are correct.

93 (*d*) The statements in options (a) and (b) are correct, while the statement in option (c) is incorrect. It can be corrected as

High value of BOD means that the water body is highly polluted by organic matter.

97 (*d*) The statement in option (d) is incorrect and can be corrected as

Rhizobium is a symbiotic bacterium that lives in the root nodules of legumes and fixes atmospheric nitrogen.

Rest of the statements are correct.

100 (*a*) Statement I is correct. The correct form of the incorrect statements II and III are

- The byproducts of alcoholic fermentation are CO_2 and ethanol (not methane).
- *Saccharomyces cerevisiae* is used for fermenting malted cereals to produce alcohol. *Penicillium* on the other hand is used for the production of the antibiotic, penicillin.

103 (*a*) Statements I, II, III and IV are correct, but statement V is incorrect and it can be corrected as

In the digesters, heterotrophic microbes anaerobically digest the bacteria and fungi in the sludge. During this digestion, bacteria produce mixture of gases such as methane, hydrogen sulphide and CO_2, which form biogas.

106 (*c*) Both the approaches given in statements I and II are correct for biological farming.

An important part of the biological farming approach is to become familiar with the various life forms that inhabit the field, predators as well as pests and also their

life cycles, patterns of feeding and the habitats that they prefer. This will help to develop appropriate means of biocontrol.

109 (*b*) Only one statement, i.e. statement III is correct. Rest statements are incorrect and can be corrected as

- Colostrum is the first breastmilk of mother, which contains antibodies (especially IgA). It provides immunity to infants against various pathogens.
- Chikungunya is caused by chikungunya virus.
- Beer is manufactured without distillation, by fermentation of barley malt by yeast.

118 (*b*) The process given in option (b) evidently proves that microbes release gases during metabolism. Rising of dough occurs by the activity of yeast metabolism. It happens due to the bubble formation because of the release of CO_2. It is the easiest way to understand that yeast releases CO_2.

119 (*c*) Lactic Acid Bacteria (LAB) found in curd and especially, *Lactobacillus casei* are abundantly found in raw milk. These are commonly used as probiotics.

121 (*d*) Option (d) shows the incorrect pair and can be corrected as

Citric acid–*Aspergillus niger*.

Rest of the options contain the correct pairs.

122 (*c*) The statement in option (c) is incorrect and can be corrected as

Single Cell Protein (SCP) is a source of protein, e.g. *Spirulina* products.

Rest of the statements are correct.

123 (*c*) Microorganisms such as *Lactobacillus* and others commonly called Lactic Acid Bacteria (LAB) grow in milk and convert it into curd. LAB improve nutritional quality of milk and curd by increasing the content of vitamin-B_{12}.

124 (*a*) Wastewater treatment generates a large quantity of sludge, which is further treated by anaerobic digesters. These are large heated tanks in which various methanogenic anaerobic bacteria digest the bacteria and fungi present in the sludge.

125 (*d*) Methanogenic bacteria (that produce methane) are not found in activated sludge. The microbes present in the activated sludge are aerobic bacteria that grow rapidly and form flocs. On the other hand methanogens are the anaerobic bacteria present in anaerobic sludge digesters.

127 (*a*) Wine is an alcoholic drink produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

128 (*b*) *Trichoderma* species are free-living fungi that are very common in root ecosystems or soil.

These are effective biocontrol agents of several plant pathogens.

129 (*b*) Activated sludge microorganisms need oxygen as they oxidise wastes to obtain energy for growth. Thus, if oxygen availability to activated sludge flocs is reduced, insufficient oxygen (anoxic) conditions will slow down or kill off aerobic microorganisms, make facultative organisms work less efficiently and ultimately lead to the breakage of flocs.

130 (*c*) The large holes in 'Swiss cheese' are due to the production of a large amount of CO_2 by a bacterium named, *Propionibacterium shermanii*.

132 (*a*) In the digesters (during secondary treatment of waste water), heterotrophic microbes like methanogens anaerobically digest biodegradable waste in sludge producing mixture of gases such as methane, hydrogen sulphide and CO_2 which form the biogas. Thus, O_2 is not produced by methanogens.

133 (*a*) Activated sludge should have the ability to settle quickly, so that it can be ready pumped back from sedimentation tank to aeration tank because a small part of the activated sludge is used as inoculum in the aeration tank.

135 (*b*) The primary treatment of wastewater involves physical removal of both larger and small particles (stable particles) from the sewage through filtration and sedimentation. These are removed in stages, initially, floating debris is removed by sequential filtration. Then, the grit (soil and small pebbles) are removed by sedimentation.

138 (*d*) Mycorrhiza does not help the host plant in increasing its resistance to insects. Infact, plants having such associations show resistance only to root-borne plant pathogens, tolerance to salinity and drought and an overall increase in plant growth and development.

140 (*d*) *Pseudomonas* is a denitrifying bacterium, which converts ammonia and nitrates into free nitrogen, i.e. to liberate free nitrogen in the environment through nitrogen cycle. Therefore, it is not a nitrogen-fixing organism.

Other options (a), (b) and (c) show nitrogen-fixing organisms.