CHAPTER
10

Microbes in Human Welfare

CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the following and answer any four questions from 1(i) to 1(v) given below:
Microorganisms include bacteria, viruses, fungi and protozoa. In our mind, we presume, most of the time, that microbes are always harmful. Microbes are, of course, the causal agents of many infections diseases of plants and animals including humans but they also have lots of beneficial role. Lactic acid bacteria (LAB) are one of this kind of useful group. These are Gram positive, non-sporulating, either rod-shaped or spherical bacteria. They produce lactic acid in milk products as major metabolic end product of carbohydrate fermentation. LAB are considered as natural fermentors. *Lactobacillus* is a common LAB which converts lactose sugar of milk into lactic acid, that causes coagulation and partial digestion of milk protein casein. Milk is then changed into curd, yoghurt and cheese. *Lactobacillus* is also used in probiotics which have potentially beneficial effect on gut ecosystem of humans. Some other probiotic strain used belong to the Genus *Bifidobacterium*.

Syllabus
Microbes in food processing, industrial production, sewage treatment, energy generation and microbes as bio-control agents and bio-fertilisers. Antibiotics; production and judicious use.

(i) Which of the following is not considered as microorganisms?
(a) Bacteriophage (b) *Streptococcus* (c) *Porphyra* (d) *Staphylococcus*

(ii) Select the incorrect option regarding the characteristics of lactic acid bacteria.
(a) They are rod-shaped or spherical.
(b) They are Gram positive.
(c) They take part in carbohydrate fermentation.
(d) They are acid intolerant.

(iii) Which of the following is not a lactic acid producing bacteria?
(a) *Streptococcus* (b) *Lactococcus* (c) *Saccharomyces* (d) *Enterococcus*

(iv) Probiotics are
(a) gut friendly live bacteria (b) acid balancing alternated bacteria
(c) beneficial amount of dead bacteria (d) Gram negative attenuated bacteria.

(v) **Assertion :** *Lactobacillus* bacteria do not retain crystal violet stain while staining.
Reason : *Lactobacillus* have a very thin layer of peptidoglycan layer in their cell wall.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

2

Read the following and answer any four questions from 2(i) to 2(v) given below:

Discovery of penicillin by Alexander Fleming in 1928 marked the beginning of the remarkable era in medical field. Penicillin was the first antibiotic extracted from *Penicillium notatum*. Antibiotics are used to treat bacterial diseases. These can be broad spectrum which can kill diverse group of disease causing bacteria and narrow spectrum which is effective only against one group of pathogenic strain. Antibiotics can act as bactericides or bacteriostatic. Bactericidal antibiotics kill bacteria by — disruption of cell wall synthesis (*e.g.*, penicillin, cephalosporin, etc.), inhibition of 50S ribosome function (*e.g.*, erythromycin), inhibition of 30S ribosome function (*e.g.*, streptomycin, neomycin), inhibition of amino acid-*t*RNA binding to ribosome (*e.g.*, tetracyline), etc. Bacteriostatic antibiotics do not kill the bacteria rather they restrict the growth of bacteria. Penicillin belongs to β-lactum group of antibiotics and it inhibits bacterial cell wall synthesis by binding and inactivating protein. It inhibits transpeptidation of reaction and blocks cross-linking of the cell wall. It is used to treat tonsilitis, sore throat, gonorrhoea, rheumatic fever and some pneumonia types.

(i) The first antibiotic was extracted from a

(a) lichen (b) fungus (c) eubacteria (d) actinomycetes.

(ii) Which of the following kills bacteria by interfering 50S ribosome function?

(a) Cephalosporin (b) Erythromycin

(c) Streptomycin (d) Neomycin

(iii) β-lactum group of antibiotics kill the bacterial pathogen by

(a) disruption of plasma membrane (b) inhibition of translation of *m*RNA

(c) disruption of cell wall (d) inhibition of transcription of *m*RNA.

(iv) Penicillin is not used to treat

(a) pneumonia (b) tonsilitis

(c) rheumatic fever (d) candidiasis.

(v) **Assertion :**Cephalosporins act by disruption of bacterial cell wall synthesis mechanism.
Reason : Cephalosporins are bacteriostatic antibiotics.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.

(b) Both assertion and reason are true but reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false.

3

Read the following and answer any four questions from 3(i) to 3(v) given below:

Enzymes are best known for their ability to catalise biochemical reactions without undergoing any change. A large number of enzymes are being used in biotechnological industry. Most of them are obtained from microbes. Proteases degrade proteins and polypeptides. Most of the commercially applicable proteases are alkaline and are biosynthesised mainly by bacteria such as *Pseudomonas, Bacillus* and some fungi like, *Aspergillus*. These enzymes are used in clearing beer, softening of bread and meat, degumming of silk, etc. Alkaline serine proteases have the largest applications in bio-industry. Alkaline proteases have shown their capability to work under high pH, temperature and in presence of inhibitory compounds. Another important group of enzymes is amylases. Amylolytic enzymes act on starch. These are obtained from *Aspergillus*, *Rhizopus* and *Bacillus* sp. These are used in softening and sweetening of bread, production of alcoholic beverages from starchy materials, clearing of turbidity in juices caused by starch, etc.

(i) Polypeptides are degraded by
(a) amylases (b) proteases (c) pectinases (d) lipases.

(ii) Amylolytic enzymes are not obtained from
(a) *Aspergillus* (b) *Rhizopus* (c) *Mucor* (d) *Bacillus.*

(iii) Clearing of turbidity in juices caused by starch is achieved by
(a) amylases (b) proteases (c) rennet (d) both (a) and (b).

(iv) Select the incorrect option from the following.
(a) Enzymes are proteinaceous substances.
(b) Enzymes are substrate specific.
(c) Enzymes are large sized molecules.
(d) Microbial enzymes can work only in normal temperature and pH.

(v) A farmer harvests corns and prepares corn starch. He wants to prepare some corn syrup from this. For the conversion he needs to use enzyme_____.
(a) amylase (b) glucoamylases
(c) glucoisomerases (d) all of these

4

Read the following and answer any four questions from 4(i) to 4(v) given below:

Alcohols are important industrial solvents. Ethanol, methanol, propanol and butanol are produced commercially by fermentation activity of some fungi, majorly yeasts. During fermentation, yeast cells convert cereal derived sugars into ethanol and CO_2. At the same time hundreds of secondary metabolites that influence the aroma and taste of alcohol are produced. Sugar concentration affects the rate of fermentation reactions. Yeast cannot grow in very strong sugar solution. In case of complex carbohydrate containing nutrient media, 1% malt or *Rhizopus* is used along with yeasts. Hydrolysis of starch is carried out at high temperature for 30 mins. The crushed food mixed with hot water for obtaining malt in called mash. The nutrient medium prior to fermentation in called wort. Wort is cooled down to appropriate temperature and inoculated with strain of yeast.

(i) The rate of alcohol production is measured on the basis of
(a) amount of sugar present in the medium (b) amount of CO_2 produced per unit time
(c) amount of yeast added in the medium (d) all of these.

(ii) A number of chemicals are produced at the time of alcoholic fermentation with the change of nutrient media, pH and aeration. Select such by-product from the following.
(a) Phenylethanol (b) Amyl alcohol (c) Glycerol (d) All of these

(iii) During alcoholic fermentation of cereals and potato, the crushed food mixed with hot water for obtaining malt is called
(a) juice (b) mash (c) wort (d) none of these.

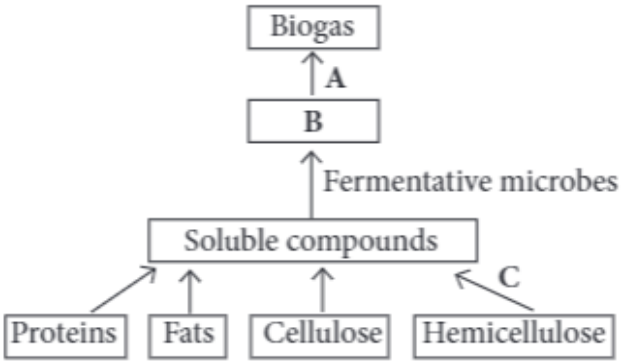
(iv) Distilled alcohol with 95% ethanol content is called
(a) absolute alcohol (b) rectified spirit
(c) gin (d) brandy.

(v) **Assertion :** *Rhizopus* or 1% malt is used in the nutrient medium when it contains complex carbohydrates.
Reason : Yeast does not possess sufficient diastase or amylase.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

5

Read the following and answer any four questions from 5(i) to 5(v) given below:
Villagers in a place near Chambur started planning to make power supply for agricultural purposes from cow dung. They have started a biogas plant for the purpose. Study the flow chart for biogas production given below and answer the following questions.



(i) Biogas is composed of majorly
(a) methane, CO_2 and O_2 (b) CO_2, H_2S and H
(c) methane, CO_2 (d) H_2S, H and O_2.

(ii) In the given flow chart, 'A' denotes
(a) aerobic bacteria (b) methanogenic bacteria
(c) cellulose degrading bacteria (d) yeast and protozoa.

(iii) What is represented by 'B' in the flow chart?
(a) Carbohydrates (b) Protein polymers
(c) Organic acids (d) Fat globules

(iv) 'C' in the given flow chart causes
(a) aerobic breakdown of complex organic compounds
(b) anaerobic digestion of complex organic compounds
(c) fermentation of organic compounds
(d) fermentation of monomers.

(v) If 'A' is not added in the procedure
(a) methane will not be formed (b) CO_2 will not be formed
(c) organic compounds will not be converted to H_2S (d) O_2 will not be formed.

6

Read the following and answer any four questions from 6(i) to 6(v) given below:
In today's world, more than 25% of human population is suffering from hunger and malnutrition. Scientists have developed techniques where microbes are grown on industrial scale as a source of good protein which can be

grown from waste water, animal manure and even sewage. Single cell proteins are such products. The biomass or protein is extracted from pure or mixed cultures of algae, yeasts, fungi or bacteria. These are a very good source of food for human consumption.

(i) Why the name single cell protein is applied?
(a) It contains only one type of protein.
(b) It is obtained from unicellular edible microbes.
(c) It contains only one type of microorganism.
(d) All of these

(ii) Which of the following is considered under single cell protein?
(a) Algae (b) Fungi
(c) Cyanobacteria (d) All of these

(iii) Microorganisms can be a useful food resource for increasing human population because
(a) these are easy to harvest
(b) these can grow in water system
(c) they have a high rate of multiplication thus producing huge biomass
(d) they have high level of nucleic acid.

(iv) Single cell protein can be grown from
(a) waste water (b) animal manure
(c) sewage (d) all of these.

(v) **Assertion :** Production of single cell protein reduces pollution.
Reason : Single cell protein can be grown from waste water and even sewage.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

7

Read the following and answer any four questions from 7(i) to 7(v) given below:
Disposal of untreated sewage into the river or freshwater pond causes huge water pollution. Four water samples from different sources (A, B, C, D) are collected and tested for BOD value in a lab to assess their quality. The BOD values are presented in the given table. Water samples are collected from primary effluent, secondary effluent, untreated sewage and river water. Study the given table and answer the following.

Sample	BOD
A	20 mg/L
B	5 mg/L
C	300 mg/L
D	400 mg/L

(i) The source of sample 'C' is
(a) river water (b) primary effluent
(c) secondary effluent (d) untreated sewage water.

(ii) If sewage in untreated condition is disposed off in a freshwater body then
(a) BOD and dissolved oxygen both will increase
(b) BOD will increase and dissolved oxygen will decrease
(c) BOD will decrease and dissolved oxygen will increase
(d) BOD and dissolved oxygen both will decrease.

(iii) A large number of pathogenic microbes can be present in water sample of
(a) C (b) A
(c) D (d) both (a) and (c).

(iv) High value of BOD in sample D is due to
(a) high amount of organic wastes and aerobic microbes
(b) high amount of inorganic wastes and anaerobic microbes
(c) high amount of organic wastes and anaerobic microbes
(d) high amount of inorganic wastes and aerobic microbes.

(v) River water is represented by the sample
(a) A (b) B (c) C (d) D.

8

Read the following and answer any four questions from 8(i) to 8(v) given below:
Green manuring is the farming practice where a leguminous plant which has derived enough benefits from its association with appropriate species of *Rhizobium*, is ploughed into the field soil and then a non-legume is sown and allowed to get benefitted from the already present nitrogen fixer. Some legumes, such as, *Crotolaria juncea*, *Sesbania rostrata*, *Lencaena leucocephala*, etc. are used as green manure. Rhizobia, that fix atmospheric nitrogen in the form of nitrate, live in the roots of leguminous plants. These nutrients are used by non-leguminous plants through the practice of green manuring.

(i) Green manures mainly provide nutrient enriched in
(a) magnesium (b) sulphur (c) nitrogen (d) both (a) and (b).

(ii) Which of the following plants is used as green manure in crop fields?
(a) *Saccharum* (b) *Dichanthium* (c) *Phyllanthus* (d) *Crotolaria*

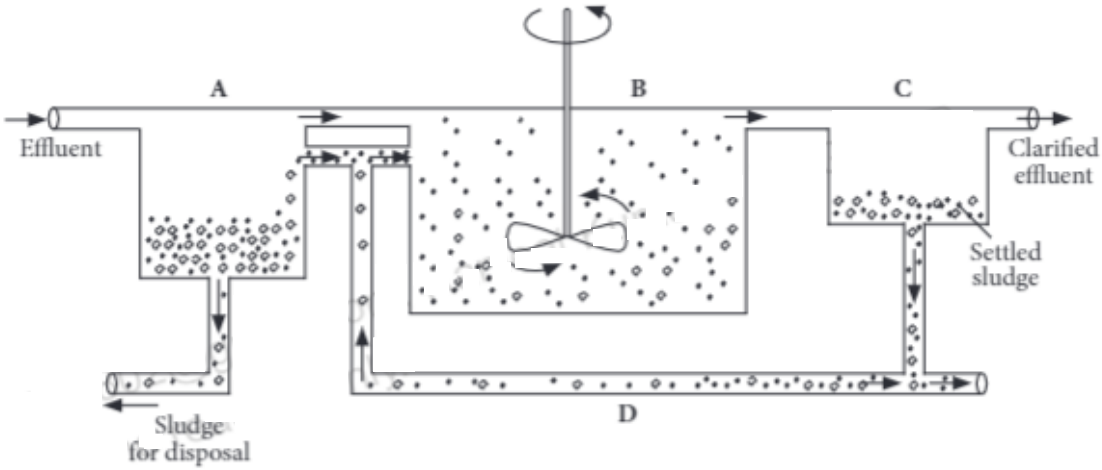
(iii) Green manure plants belong to the Family
(a) Lamiaceae (b) Papilionaceae (c) Liliaceae (d) Poaceae.

(iv) Due to excess use of chemical fertilisers rich in nitrate, _____ disease occurred in children.
(a) jaundice (b) septicemia
(c) methemoglobinemia (d) botulism

(v) A green manure is
(a) rice (b) maize (c) sorghum (d) *Sesbania*.

9

Read the following and answer any four questions from 9(i) to 9(v) given below:
Saurin, a M.Sc student, get an assignment on sewage treatment plant (STP) to study the microbial load. After visiting such plant in his locality, he makes a simplified diagram of the STP for his project. Study the diagram given below and answer the following questions.



(i) In the diagram 'A' denotes

(a) aeration tank (b) primary settling tank

(c) secondary settling tank (d) sludge digester.

(ii) Which of the following is incorrect regarding the sludge released from A?

(a) It is formed after primary treatment.

(b) It does not require aeration.

(c) It possesses flocs of decomposer microbes.

(d) It is used in landfills.

(iii) A large number of aerobic heterotrophic microbes grow in

(a) A (b) B

(c) C (d) both (a) and (b).

(iv) What is denoted by 'D' in the given diagram?

(a) Primary sludge (b) Primary effluent

(c) Activated sludge (d) Secondary effluent

(v) **Assertion :** The colloided and finely suspended matter of sewage form aggregates which are called flocs.
Reason : Flocs contain masses of bacteria, slime and fungal filaments.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.

(b) Both assertion and reason are true but reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false.

10

Read the following and answer any four questions from 10(i) to 10(v) given below:

When it comes to biopesticides, one of the most widely used fungi is *Beauveria bassiana*. It infects a range of insects like, pecan weevil, Colorado potato beetle, kudzu bug, etc. It causes a disease known as the white muscardine. Even after an insect is killed, the white mold continues to produce millions of new infective spores that are released into the environment. It is commercially formulated as products including Naturalis L, Mycotrol, BotaniGard, etc. Some other widely used molds are *Trichoderma*, *Metarhizium*, etc. Some of them release enzymes that dissolve potential pathogens, others form barriers around plant roots and make it impossible for harmful bacteria and pathogens to pass through.

(i) The key benefits of the biopesticides are that they are
(a) highly effective (b) target specific
(c) reduced environmental risks (d) all of these.

(ii) Naturalis-L is a commercial formulation containing
(a) bacterial biopesticide (b) fungal biopesticide
(c) fungal biofertiliser (d) chemical pesticide.

(iii) Which of the following is used as an effective bacterial biopesticide?
(a) *Trichoderma* (b) *Beauveria*
(c) *Bacillus thuringiensis* (d) All of these

(iv) *Baeuveria* causes a disease called
(a) white muscardine (b) aspergillosis
(c) green muscardine (d) powdary mildews.

(v) **Assertion :** *Trichoderma*, found in root ecosystem, exerts biological control over several plant pathogens.
Reason : *Trichoderma* release enzyme which inhibits growth of several disease causing pathogens.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

ASSERTION & REASON

For question numbers 11-25, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

11. **Assertion :** *Azotobacter* fixes nitrogen in symbiotic form.
Reason : *Azotobacter* form root nodules in the roots of leguminous plants.

12. **Assertion :** *Rhizobium* forms nodules on the roots of legume plants.
Reason : *Rhizobium* fixes atmospheric nitrogen into organic forms which is used by the plant as nutrients.

13. **Assertion :** *Azolla* is used as a biofertiliser in rice fields.
Reason : *Azolla* shows the presence of N_2 - fixing bacteria in its leaf cavities.

14. **Assertion :** An organism which acts as herbicide is called bioherbicide.
Reason : *Phytophthora palmivora* is a mycoherbicide.

15. **Assertion :** Intercropping checks the population of insects.
Reason : Plant pests can be controlled biologically by their natural parasites and pathogens.

16. **Assertion :** Whisky develops colour during the aging process.
Reason : Vodka is colourless.

17. **Assertion :** Immobilised yeasts cause less fermentation.
Reason : Brewer's yeast produces beer not wine.

18. **Assertion :** Curdling is required in the manufacture of cheese.
Reason : Lactic acid bacteria and rennet is used for the purpose.

19. **Assertion :** In ripening of cheese, insoluble proteins are cleaved to form soluble peptides.
Reason : Hard cheese and soft cheese, both are ripened by lactic acid bacteria.

20. **Assertion :** Enzymes application in industry is enhanced by its immobilisation.
Reason : Immobilisation provides protection to enzymes without affecting their activity.

21. **Assertion :** Vitamins B_2 is found in cereals, green vegetables, brewer's yeast, egg white, milk and liver.
Reason : Vitamins B_2 can be commercially produced by some yeasts.

22. **Assertion :** Acetic acid is prepared by acetic acid bacteria.
Reason : Alcoholic fermentation and the conversion of alcohol to acetic acid are aerobic processes.

23. **Assertion :** *Aspergillus niger* produces lactic acid.
Reason : *Rhizopus* produces citric acid.

24. **Assertion :** The alcoholic content of fortified wines are high.
Reason : The fermentation is stopped before all the sugars are being converted.

25. **Assertion :** Champagne gives off bubbles.
Reason : Alcoholic content is 12 - 16% in champagne.

HINTS & EXPLANATIONS

1. (i) (c) : *Porphyra* is a coldwater seaweed belongs to red algae.
(ii) (d) : LAB are acid tolerant bacteria.
(iii) (c) : *Saccharomyces cerevisiae*, also known as Brewer's yeast, is used in alcoholic fermentation.
(iv) (a) : Probiotics are live bacteria which are beneficial for digestive system.
(v) (d) : *Lactobacillus* is a Gram positive bacteria. Gram positive bacteria have a very thick cell wall layer comprising of peptidoglycan. They retain crystal violet stain during Gram staining and appear violet in colour under microscope.

2. (i) (b) : The first antibiotic was extracted from a fungus *Penicillium notatum*.
(ii) (b)
(iii) (c)
(iv) (d) : Penicillin is given to patients with an infection caused by bacteria including pneumonia, sore throat, gonorrhoea, etc. Candidiasis is a fungal disease.
(v) (c) : Cephalosporins are bactericidal in nature. They kill the bacteria by disruption of cell wall synthesis.

3. (i) (b) : Proteases are enzymes that degrade proteins and polypeptides.
(ii) (c)
(iii) (a)
(iv) (d) : Enzymes obtained from microbes can work in extreme condition like high temperature and high pH.
(v) (d) : Amylase, glucoamylases and glucoisomerases are employed in conversion of corn starch to fructose rich corn syrup.

4. (i) (b) : The fermentation rate of the yeast can be calculated by measuring the volume of CO_2 and dividing it by the amount of time it took for that volume to form.
(ii) (d)
(iii) (b) : The crushed food mixed with hot water for obtaining malt is called mash. The nutrient medium prior to fermentation is called wort. Wort is added into the bioreactor tank, sterilised and then inoculated with yeast.
(iv) (b) : Alcoholic content in gin is 40%, brandy in 60-70%. These are hard liquors. Rectified spirit contains 95% alcohol and absolute alcohol is 100% alcohol. Rectified spirit and absolute alcohol are extensively used in laboratory works.
(v) (a)

5. (i) (c) : Biogas is composed of methane (50-70%), carbon dioxide (30-40%) with traces of nitrogen, hydrogen sulphide and hydrogen.

(ii) (b)
(iii) (c) : In the second stage of biogas production, the simple soluble compounds or monomers are acted upon by fermentation causing microbes and converted into organic acids especially acetic acid.
(iv) (b)
(v) (a)

6. (i) (b)
(ii) (d)
(iii) (c) : Microorganisms have a high rate of multiplication, which means a large quantity of biomass can be produced in a comparatively shorter duration.
(iv) (d)
(v) (a)

7. (i) (b) : A – Secondary effluent, B – River water, C – Primary effluent, D – Untreated sewage water
(ii) (b)
(iii) (d) : A number of pathogenic microbes mostly present in sewage water. They are removed during secondary or biological treatment. During primary treatment, small and large, floating and suspended solids are removed through filtration and sedimentation.
(iv) (a)
(v) (b)

8. (i) (c)

(ii) (d) : Some legumes such as *Crotolaria juncea*, *Sesbania rostrata*, *Lencaena leucocephala*, etc. are used as green manure.

(iii) (b)

(iv) (c) : Drinking water with high nitrate can cause a potentially fatal disorder called methemoglobinemia.

(v) (d)

9. (i) (b) : In the given diagram, A-primary settling tank, B-aeration tank, C-secondary settling tank.

(ii) (c) : Primary sludge does not possess flocs of decomposer microbes. These are formed during secondary treatment.

(iii) (b) : A large number of aerobic heterotrophic microbes grow in the aeration tank (B).

(iv) (c)

(v) (b)

10. (i) (d)

(ii) (b)

(iii) (c) : The most widely used microbial pesticides are strains of *Bacillus thuringiensis* (Bt). In target insects, the bacteria disrupt the digestive system by an endotoxin (Bt toxin) that is often specific to the particular insect pest.

(iv) (a) : White muscardine is a disease of insects caused by *Beauveria bassiana*.

(v) (a)

11. (d) : *Azotobacter* is a non-symbiotic nitrogen fixing bacteria that is it lives freely in the soil and perform nitrogen fixation. It is saprotrophic living on organic remains. Root nodules are formed by *Rhizobium*, a symbiotic nitrogen fixing bacteria.

12. (b) : *Rhizobium* forms nodules on the roots of legume plants. There are about a dozen species of *Rhizobium* which form association with different legume roots, *e.g.*, *R. leguminosarum*, *R. lupini*, *R. trifolii*, *R. meliloti*, *R. phaseoli*. They develop the ability to fix nitrogen only when they are present inside the root nodules.

13. (a) : *Azolla* can co-exist with rice plants because it does not interfere with their growth. In some South East Asian countries, especially China, the rice fields are regularly provided with *Azolla*. The fern is stocked in a corner of rice field and provided with manure, ash and straw before transplantation. When the field is flooded at the time of transplantation, the fern spreads rapidly and covers the space in between the rice plants. *Anabaena*, a blue green algae resides in the leaf cavities of the fern. It fixes nitrogen. A part of the fixed nitrogen is excreted in the cavities and becomes available to the fern. The decaying fern plants release the same for utilisation by the rice plants.

14. (b) : An organism which controls or destroys unwanted plant growth without harming the useful plant is called bioherbicide. The first bioherbicide happened to be mycoherbicide (fungal herbicide). It was elaborated in 1981. This herbicide is *Phytophthora palmivora*. The fungus does not allow the Milkweed vine to grow in citrus orchards.

15. (b) : Intercropping keeps the population of insects at low level. In intercropping, the pest-susceptible crop is grown alongwith other crops which are repellent to pests. Plant pests are controlled biologically through the means of their natural parasites and pathogens.

For example, *Baculovirus heliothis* can control cotton bollworm, *Bacillus thuringenesis* can control the cabbage hooper and *Entomophthora ignobilis* can control the green peach aphid of potato.

16. (**b**) : At first several principles are present which makes whisky harsh and unpalatable. It must be aged to allow these principles to disappear. The whiskies are aged in charred oak containers. At first the whisky is colourless, the colour develops during the aging process. The vodka is not aged and bottled immediately after distillation and therefore it remains colourless.

17. (**d**) : In immobilised fermentation process, living yeast cells are immobilised in calcium alginate beads. The beads containing living cells are kept in columns in the fermentation tank. The technique allows quicker fermentation about 20 times as compared to batch process. The fermentation rapidly becomes vigorous with the evolution of large quantities of CO_2. Different kinds of alcoholic beverages are produced by using different brewer's yeast and the fermenting medium. For example - (I) Beer is an undistilled product of grain-mesh fermentation brought about by *Saccharomyces cerevisiae* and *S. carisbergensis*, (II) wine is an undistilled product of fruit juice fermentation brought about by *Saccharomyces ellipsoidens*.

18. (**b**) : The manufacture of cheese requires two main steps curdling and the ripening. Curdling the milk proteins forms a solid material from which the liquid is drained away. The curdling process may be exclusively microbiological, since acid production of lactic acid bacteria is sufficient to coagulate milk proteins. However, an enzyme known as rennin (extracted from the stomachs of calves or rennet) which curdles milk is often used for this purpose.

19. (**c**) : The ripening of cheese is a complex process. In the young cheese, all nitrogen is present in the form of insoluble proteins, but as ripening proceeds, the protein is progressively cleaved to soluble peptides. Hard cheeses are ripened largely by lactic acid bacteria, which grow throughout the cheese, die, autolyze and release hydrolytic enzymes. Soft cheeses are ripened by the enzymes from yeasts and other fungi that grow on the surface.

20. (**a**) : An immobilised enzyme is physically entrapped or covalently bonded by chemical means to an inert and usually insoluble matrix, where it can act upon its natural substrate. The matrix is usually a high molecular weight polymer such as polyacrylamide, cellulose, starch, glass, beads, etc. Because of its binding with a matrix the immobilised enzyme has better stability in many cases. Efficiency of immobilised enzyme is better. The enzyme can be recovered at the end of the reaction and can be used repeatedly.

21. (**b**) : Besides cereals, green vegetables, brewer's yeast, egg white, vitamin B_2 is also produced by intestinal bacteria. The vitamin was first obtained in 1938 using wild strain of mould *Ashbya gossypii*. Vitamin B_2 is essential for normal growth and reproduction in a number of laboratory animals. It is essential for the maintenance of good health in humans. Better strains of the mould have been discovered which give 100-300 times more yield of the vitamin than the original one. Other sources include yeast cells, *Eremothecium ashbyii*, *Clostridium* species.

22. (**c**) : Acetic acid is prepared from fermented alcohols with the help of acetic acid bacteria, *Acetobacter aceti*. Alcoholic fermentation is anaerobic process but the conversion of alcohol to acetic acid is aerobic one.

23. (**d**): Citric acid is obtained through the fermentation carried out by *Aspergillus niger* and *Mucor* species on sugary syrups. Lactic acid was the first organic acid to be produced from the microbial fermentation. Lactic acid fermentation is carried out by both bacteria (*e.g. Streptococcus lactis, Lactobacillus* species and fungi (*e.g. Rhizopus*).

24. (**b**) : In fortified wines, the fermentation is stopped before all the sugar is being converted and at least 1 percent is still present. The still wines have a higher alcoholic content due to the addition of wine, brandy or alcohol.

25. (**b**): Champagne wines are bottled before fermentation is complete. These wines give off bubbles of gas. Alcohol content is 12 - 16%.