CHAPTER 10

Microbes in Human Welfare

10.1 Microbes in Household Products

1. Conversion of milk to curd improves its nutritional value by increasing the amount of
(a) vitamin D (b) vitamin A
(c) vitamin B_{12} (d) vitamin E.
(NEET 2018)

2. Dough kept overnight in warm weather becomes soft and spongy because of
(a) absorption of carbon dioxide from atmosphere
(b) fermentation
(c) cohesion
(d) osmosis. *(2004)*

3. During the formation of bread it becomes porous due to release of CO_2 by the action of
(a) yeast (b) bacteria
(c) virus (d) protozoans.
(2002)

4. In cheese manufacture, the microorganisms are important for
(a) the ripening only
(b) the souring of milk only
(c) the development of resistance to spoilage only
(d) both the souring and the ripening processes.
(1994)

10.2 Microbes in Industrial Products

5. Match the following columns and select the correct option.

	Column-I		Column-II
(A)	*Clostridium butylicum*	(i)	Cyclosporin-A
(B)	*Trichoderma polysporum*	(ii)	Butyric acid
(C)	*Monascus purpureus*	(iii)	Citric acid
(D)	*Aspergillus niger*	(iv)	Blood cholesterol lowering agent

	(A)	(B)	(C)	(D)
(a)	(iii)	(iv)	(ii)	(i)
(b)	(ii)	(i)	(iv)	(iii)
(c)	(i)	(ii)	(iv)	(iii)
(d)	(iv)	(iii)	(ii)	(i)

(NEET 2020)

6. Which of the following is a commercial blood cholesterol lowering agent?
(a) Lipases (b) Cyclosporin A
(c) Statin (d) Streptokinase
(NEET 2019)

7. Match the following organisms with the products they produce.

(A) *Lactobacillus*	(i) Cheese
(B) *Saccharomyces cerevisiae*	(ii) Curd
(C) *Aspergillus niger*	(iii) Citric acid
(D) *Acetobacter aceti*	(iv) Bread
	(v) Acetic acid

Select the correct option.

	(A)	(B)	(C)	(D)
(a)	(ii)	(i)	(iii)	(v)
(b)	(ii)	(iv)	(v)	(iii)
(c)	(ii)	(iv)	(iii)	(v)
(d)	(iii)	(iv)	(v)	(i)

(NEET 2019)

8. Which of the following is correctly matched for the product produced by them?
(a) *Methanobacterium* : Lactic acid
(b) *Penicillium notatum* : Acetic acid
(c) *Sacchromyces cerevisiae* : Ethanol
(d) *Acetobacter aceti* : Antibiotics *(NEET 2017)*

9. Match column I with column II and select the correct option using the codes given below.

	Column I		Column II
A.	Citric acid	(i)	*Trichoderma*
B.	Cyclosporin A	(ii)	*Clostridium*
C.	Statins	(iii)	*Aspergillus*
D.	Butyric acid	(iv)	*Monascus*

(a) A-(iii), B-(i), C-(ii), D-(iv)
(b) A-(iii), B-(i), C-(iv), D-(ii)
(c) A-(i), B-(iv), C-(ii), D-(iii)
(d) A-(iii), B-(iv), C-(i), D-(ii) *(NEET-II 2016)*

10. Which of the following is wrongly matched in the given table?

	Microbe	Product	Application
(a)	*Streptococcus*	Streptokinase	Removal of clot from blood vessel
(b)	*Clostridium butylicum*	Lipase	Removal of oil stains
(c)	*Trichoderma polysporum*	Cyclosporin A	Immuno-suppressive drug
(d)	*Monascus purpureus*	Statins	Lowering of blood cholesterol

(NEET-I 2016)

11. Match the following list of microbes and their importance.

Column I	Column II
A. *Saccharomyces cerevisiae*	(i) Production of immuno- suppressive agent
B. *Monascus purpureus*	(ii) Ripening of Swiss cheese
C. *Trichoderma polysporum*	(iii) Commercial production of ethanol
D. *Propionibacterium shermanii*	(iv) Production of blood-cholesterol lowering agents

(a) A-(iv), B-(ii), C-(i), D-(iii)
(b) A-(iii), B-(i), C-(iv), D-(ii)
(c) A-(iii), B-(iv), C-(i), D-(ii)
(d) A-(iv), B-(iii), C-(ii),D-(i) *(2015)*

12. A good producer of citric acid is
(a) *Clostridium* (b) *Saccharomyces*
(c) *Aspergillus* (d) *Pseudomonas.*
(NEET 2013)

13. *Monascus purpureus* is a yeast used commercially in the production of
(a) ethanol
(b) streptokinase for removing clots from the blood vessels
(c) citric acid
(d) blood cholesterol lowering statins. *(2012)*

14. A patient brought to a hospital with myocardial infarction is normally immediately given
(a) penicillin (b) streptokinase
(c) cyclosporin-A (d) statins. *(2012)*

15. Read the following four statements (A-D).
(A) Colostrum is recommended for the new born because it is rich in antigens.
(B) Chikungunya is caused by a Gram negative bacterium.
(C) Tissue culture has proved useful in obtaining virus-free plants.
(D) Beer is manufactured by distillation of fermented grape juice.
How many of the above statements are wrong?
(a) Two (b) Three
(c) Four (d) One *(Mains 2012)*

16. The most common substrate used in distilleries for the production of ethanol is
(a) corn meal (b) soya meal
(c) ground gram (d) molasses. *(2011)*

17. Ethanol is commercially produced through a particular species of
(a) *Saccharomyces* (b) *Clostridium*
(c) *Trichoderma* (d) *Aspergillus.* *(2011)*

18. Continuous addition of sugars in 'fed batch' fermentation is done to
(a) produce methane (b) obtain antibiotics
(c) purify enzymes (d) degrade sewage.
(2011)

19. Read the following statement having two blanks (A and B).
A drug used for __A__ patients is obtained from a species of the organism __B__.
The one correct option for the two blanks is

	A	B
(a)	heart	*Penicillium*
(b)	organ-transplant	*Trichoderma*
(c)	swine flu	*Monascus*
(d)	AIDS	*Pseudomonas.*

(Mains 2011)

20. Which one of the following is a wrong matching of a microbe and its industrial product, while the remaining three are correct?
(a) Yeast – Statins
(b) *Acetobacter aceti* – Acetic acid
(c) *Clostridium butylicum* – Lactic acid
(d) *Aspergillus niger* – Citric acid *(Mains 2011)*

21. Which one of the following pairs is wrongly matched?
(a) Alcohol - Nitrogenase
(b) Fruit juice - Pectinase
(c) Textile - Amylase
(d) Detergents - Lipase *(2009)*

22. Probiotics are
(a) cancer inducing microbes
(b) new kind of food allergens
(c) live microbial food supplement
(d) safe antibiotics. *(2007)*

23. Which of the following is used to manufacture ethanol from starch?
(a) *Penicillium* (b) *Saccharomyces*
(c) *Azotobacter* (d) *Lactobacillus* *(2000)*

24. Yeast (*Saccharomyces cerevisiae*) is used in the industrial production of
(a) tetracyline (b) ethanol
(c) butanol (d) citric acid. *(1998)*

25. Which of the following microorganisms is used for production of citric acid in industries?
(a) *Aspergillus niger*
(b) *Rhizopus nigricans*
(c) *Lactobacillus bulgaris*
(d) *Penicillium citrinum* *(1998)*

26. Which of the following is the false statement about antibiotics?
(a) Some persons have allergy from antibiotics.
(b) Antibiotics are capable of curing any disease.
(c) This term was given by Waksman in 1942.
(d) Antibiotics is produced by microorganisms. *(1996)*

27. The citric acid is produced by
(a) *Candida utilis*
(b) *Azotobacter suboxydans*
(c) *Aspergillus niger*
(d) *Streptococcus lactis.* *(1995)*

28. The organism, used for alcohol fermentation, is
(a) *Aspergillus* (b) *Saccharomyces*
(c) *Pseudomonas* (d) *Penicillium.* *(1995)*

29. The main reason why antibodies could not solve all the problems of bacteria mediated disease is
(a) decreased efficiency of the immune system
(b) insensitivity of the individual following prolonged exposure to antibiotics
(c) development of mutant strains resistant to antibodies
(d) inactivation of antibiotics by bacterial enzymes. *(1994)*

10.3 Microbes in Sewage Treatment

30. Which of the following is put into anaerobic sludge digester for further sewage treatment?
(a) Primary sludge
(b) Floating debris
(c) Effluents of primary treatment
(d) Activated sludge *(NEET 2020)*

31. Which of the following in sewage treatment removes suspended solids?
(a) Secondary treatment (b) Primary treatment
(c) Sludge treatment (d) Tertiary treatment *(NEET 2017)*

32. What gases are produced in anaerobic sludge digesters?
(a) Methane and CO_2 only
(b) Methane, Hydrogen sulphide and CO_2
(c) Methane, Hydrogen sulphide and O_2
(d) Hydrogen sulphide and CO_2 *(2014)*

33. The domestic sewage in large cities
(a) has a high BOD as it contains both aerobic and anaerobic bacteria
(b) is processed by aerobic and then anaerobic bacteria in the secondary treatment in Sewage Treatment Plants (STPs)
(c) when treated in STPs does not really require the aeration step as the sewage contains adequate oxygen
(d) has very high amount of suspended solids and dissolved salts. *(Mains 2012)*

34. Secondary sewage treatment is mainly a
(a) physical process (b) mechanical process
(c) chemical process (d) biological process. *(2011)*

35. Which of the following is mainly produced by the activity of anaerobic bacteria on sewage?
(a) Laughing gas (b) Propane
(c) Mustard gas (d) Marsh gas *(2011)*

10.4 Microbes in Production of Biogas

36. The guts of cow and buffalo possess
(a) methanogens (b) cyanobacteria
(c) *Fucus* sp. (d) *Chlorella* sp. *(2015 Cancelled)*

37. In gobar gas, the maximum amount is that of
(a) butane (b) methane
(c) propane (d) carbon dioxide. *(Mains 2012)*

38. Organisms called methanogens are most abundant in a
(a) sulphur rock (b) cattle yard
(c) polluted stream (d) hot spring. *(2011)*

39. Select the correct statement from the following.
(a) Biogas is produced by the activity of aerobic bacteria on animal waste.
(b) *Methanobacterium* is an aerobic bacterium found in rumen of cattle.
(c) Biogas, commonly called gobar gas, is pure methane.
(d) Activated sludge-sediment in settlement tanks of sewage treatment plant is a rich source of aerobic bacteria. *(2010)*

40. Which one of the following pairs is wrongly matched?
(a) Yeast - Ethanol
(b) *Streptomycetes* - Antibiotic
(c) Coliforms - Vinegar
(d) Methanogens - Gobar gas *(2007)*

41. A major component of gobar gas is
(a) ammonia (b) methane
(c) ethane (d) butane. *(2004)*

42. During anaerobic digestion of organic waste, such as in producing biogas, which one of the following is left undegraded?
(a) Lipids (b) Lignin
(c) Hemi-cellulose (d) Cellulose *(2003)*

43. Which bacteria is utilized in gobar gas plant?
(a) Methanogens
(b) Nitrifying bacteria
(c) Ammonifying bacteria
(d) Denitrifying bacteria *(2002)*

44. Gobar gas contains mainly
(a) $CO_2 + H_2$ (b) $CO_2 + H_2O$
(c) CH_4 only (d) $CH_4 + CO_2$. *(1997)*

10.5 Microbes as Biocontrol Agents

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

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

47. A biocontrol agent to be a part of an integrated pest management should be
(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. *(Odisha NEET 2019)*

48. Microbe used for biocontrol of pest butterfly caterpillars is
(a) *Saccharomyces cerevisiae*
(b) *Bacillus thuringiensis*
(c) *Streptococcus* sp.
(d) *Trichoderma* sp. *(Karnataka NEET 2013)*

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

50. A common biocontrol agent for the control of plant diseases is
(a) baculovirus
(b) *Bacillus thuringiensis*
(c) *Glomus*
(d) *Trichoderma*. *(2010)*

51. Which of the following is not used as a biopesticide?
(a) *Trichoderma harzianum*
(b) *Nucleopolyhedrovirus* (NPV)
(c) *Xanthomonas campestris*
(d) *Bacillus thuringiensis* *(2009)*

52. *Trichoderma harzianum* has proved a useful microorganism for
(a) gene transfer in higher plants
(b) biological control of soil-borne plant pathogens
(c) bioremediation of contaminated soils
(d) reclamation of wastelands. *(2008)*

53. Which one of the following proved effective for biological control of nematodal diseases in plants?
(a) *Gliocladium virens*
(b) *Paecilomyces lilacinus*
(c) *Pisolithus tinctorius*
(d) *Pseudomonas cepacia* *(2008)*

54. A genetically engineered microorganism used successfully in bioremediation of oil spills is a species of
(a) *Trichoderma* (b) *Xanthomonas*
(c) *Bacillus* (d) *Pseudomonas*. *(2007)*

55. Biological control component is central to advanced agricultural production. Which of the following is used as a third generation pesticide?
(a) Insect repellants
(b) Organophosphate and carbamates
(c) Pathogens
(d) Pheromones *(1998)*

56. Cochineal insects have proved very useful for
(a) cactus prevention (b) *Eichhornia* prevention
(c) weeds control (d) *Parthenium* control.
(1996)

57. When a natural predator (living being) is applied on the other pathogen organism to control them, this process is called
(a) artificial control (b) confusion technique
(c) biological control (d) genetic engineering. *(1996)*

58. The rotenone is
(a) a natural herbicide (b) a natural insecticide
(c) an insect hormone (d) a bioherbicide. *(1995)*

59. One of the major difficulties in the biological control of insect pest is that
(a) the method is less effective as compared with the use of insecticides
(b) the practical difficulty of introducing the predator to specific areas
(c) the predator develops a preference to other diets and may itself become a pest
(d) the predator does not always survive when transferred to a new environment. *(1995)*

60. Biological control of agricultural pests, unlike chemical control, is
(a) self perpetuating (b) polluting
(c) very expensive (d) toxic. *(1994)*

10.6 Microbes as Biofertilisers

61. Select the mismatch.
(a) *Rhodospirillum* – Mycorrhiza
(b) *Anabaena* – Nitrogen fixer
(c) *Rhizobium* – Alfalfa
(d) *Frankia* – *Alnus* *(NEET 2017)*

62. A nitrogen-fixing microbe associated with *Azolla* in rice fields is
(a) *Spirulina* (b) *Anabaena*
(c) *Frankia* (d) *Tolypothrix.* *(2012)*

63. Which one of the following microbes forms symbiotic association with plants and helps them in their nutrition?
(a) *Azotobacter* (b) *Aspergillus*
(c) *Glomus* (d) *Trichoderma* *(2012)*

64. A prokaryotic autotrophic nitrogen fixing symbiont is found in
(a) *Alnus* (b) *Cycas*
(c) *Cicer* (d) *Pisum.* *(2011)*

65. Which one of the following helps in absorption of phosphorus from soil by plants?
(a) *Glomus* (b) *Rhizobium*
(c) *Frankia* (d) *Anabaena* *(2011)*

66. Which one of the following is not a biofertiliser?
(a) *Agrobacterium* (b) *Rhizobium*
(c) *Nostoc* (d) Mycorrhiza *(2011)*

67. An organism used as a biofertilizer for raising soybean crop is
(a) *Azotobacter* (b) *Azospirillum*
(c) *Rhizobium* (d) *Nostoc.* *(2011)*

68. Consider the following statements (A–D) about organic farming.
(A) Utilizes genetically modified crops like Bt cotton
(B) Uses only naturally produced inputs like compost
(C) Does not use pesticides and urea
(D) Produces vegetables rich in vitamins and minerals
Which of the above statements are correct?
(a) B, C and D (b) C and D only
(c) B and C only (d) A and B only *(Mains 2011)*

69. The common nitrogen-fixer in paddy fields is
(a) *Rhizobium* (b) *Azospirillum*
(c) *Oscillatoria* (d) *Frankia.* *(2010)*

70. Which one of the following is not used in organic farming?
(a) *Glomus* (b) Earthworm
(c) *Oscillatoria* (d) Snail *(2010)*

71. An example of endomycorrhiza is
(a) *Nostoc* (b) *Glomus*
(c) *Agaricus* (d) *Rhizobium.* *(Mains 2010)*

72. Nitrogen fixation in root nodules of *Alnus* is brought about by
(a) *Frankia* (b) *Azorhizobium*
(c) *Bradyrhizobium* (d) *Clostridium.* *(2008)*

73. Which one of the following pairs is not correctly matched?
(a) *Streptomyces* - Antibiotic
(b) *Serratia* - Drug addiction
(c) *Spirulina* - Single cell protein
(d) *Rhizobium* - Biofertilizer *(2004)*

74. A free living nitrogen-fixing cyanobacterium which can also form symbiotic association with the water fern *Azolla* is
(a) *Tolypothrix* (b) *Chlorella*
(c) *Nostoc* (d) *Anabaena.* *(2004)*

75. Which one of the following plants are used as green manure in crop fields and in sandy soils?
(a) *Crotalaria juncea* and *Alhagi camelorum*
(b) *Calotropis procera* and *Phyllanthus niruri*
(c) *Saccharum munja* and *Lantana camara*
(d) *Dichanthium annulatum* and *Azolla nilotica* *(2003)*

76. Which of the following is the pair of biofertilizers?
(a) *Azolla* and BGA
(b) *Nostoc* and legume
(c) *Rhizobium* and grasses
(d) *Salmonella* and *E.coli* *(2001)*

77. Which aquatic fern is used to increase the yield in paddy crop?
(a) *Azolla* (b) *Salvinia*
(c) *Marsilea* (d) *Isoetes* *(2000)*

78. Which of the following fern is an excellent biofertilizer?
(a) *Marsilea* (b) *Pteridium*
(c) *Azolla* (d) *Salvinia* *(1999)*

79. Due to which of the following organism, yield of rice is increased?
(a) *Sesbania* (b) *Bacillus popilliae*
(c) *Anabaena* (d) *Bacillus subtilis* *(1999)*

80. Which of the following is non-symbiotic biofertilizer?
(a) *Anabaena* (b) *Rhizobium*
(c) VAM (d) *Azotobacter* *(1998)*

81. Farmers have reported over 50% higher yields of rice by using which of the following biofertilizer?
(a) *Cyanobacteria*
(b) legume-*Rhizobium* symbiosis
(c) *Mycorrhiza*
(d) *Azolla pinnata* *(1998)*

82. The biofertilizers are
(a) *Anabaena* and *Azolla*
(b) cow dung, manure and farmyard waste
(c) quick growing crop ploughed under soil
(d) none of these. *(1997)*

83. Which of the following species does not have the ability to fix atmospheric nitrogen?
(a) *Azotobactor* (b) *Anabaena*
(c) *Nostoc* (d) *Spirogyra* *(1994)*

84. Which one of the following statements is correct?
(a) Legumes fix nitrogen only through the specialized bacteria that live in their roots.
(b) Legumes fix nitrogen independently of the specialized bacteria that live in their roots.
(c) Legumes fix nitrogen only through specialized bacteria that live in their leaves.
(d) Legumes are incapable of fixing nitrogen. *(1994)*

ANSWER KEY

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(d)	**5.**	(b)	**6.**	(c)	**7.**	(c)	**8.**	(c)	**9.**	(b)	**10.**	(b)
11.	(c)	**12.**	(c)	**13.**	(d)	**14.**	(b)	**15.**	(b)	**16.**	(d)	**17.**	(a)	**18.**	(c)	**19.**	(b)	**20.**	(c)
21.	(a)	**22.**	(c)	**23.**	(b)	**24.**	(b)	**25.**	(a)	**26.**	(b)	**27.**	(c)	**28.**	(b)	**29.**	(c)	**30.**	(d)
31.	(b)	**32.**	(b)	**33.**	(b)	**34.**	(d)	**35.**	(d)	**36.**	(a)	**37.**	(b)	**38.**	(b)	**39.**	(d)	**40.**	(c)
41.	(b)	**42.**	(b)	**43.**	(a)	**44.**	(d)	**45.**	(b)	**46.**	(c)	**47.**	(d)	**48.**	(b)	**49.**	(a)	**50.**	(d)
51.	(c)	**52.**	(b)	**53.**	(b)	**54.**	(d)	**55.**	(d)	**56.**	(a)	**57.**	(c)	**58.**	(b)	**59.**	(d)	**60.**	(a)
61.	(a)	**62.**	(b)	**63.**	(c)	**64.**	(b)	**65.**	(a)	**66.**	(a)	**67.**	(c)	**68.**	(c)	**69.**	(b)	**70.**	(d)
71.	(b)	**72.**	(a)	**73.**	(b)	**74.**	(d)	**75.**	(a)	**76.**	(a)	**77.**	(a)	**78.**	(c)	**79.**	(c)	**80.**	(d)
81.	(d)	**82.**	(a)	**83.**	(d)	**84.**	(a)												

Hints & Explanations

1. (c) : *Lactobacillus* bacteria convert milk into curd. It produces acids that coagulate and partially digest the milk proteins. A small amount of curd added to the fresh milk as inoculum or starter contains millions of *Lactobacillus* bacteria which at suitable temperature multiply, thereby converting milk to curd which also improves its nutritional value by increasing vitamin B_{12} content and a number of organic acids.

2. (b)

3. (a) : *Saccharomyces* converts starch or sugars to pyruvic acid through EMP pathway. Then this pyruvic acid is converted to acetaldehyde and finally to ethyl alcohol in the absence of oxygen. This entire process is called fermentation.

$C_6H_{12}O_6 \rightarrow 2CH_2COCOOH \rightarrow 2C_2H_5OH + 2CO_2$

This released carbon dioxide makes the dough to rise and gives spongy nature to bread.

4. (d) : Cheese is a protein rich nutritive preparation obtained after fermentation and curdling of milk. Cheese contains proteins (20-35%), fats (20-30%), minerals, vitamins and water. Milk is first curdled (soured) with the help of a lactic acid bacterium. Curd is gently heated to separate cheese from liquid called whey. Curd is placed in cloth-lined porous containers for draining out whey. The left out solidified material is called cottage cheese. For preservation and ripening, blocks of cottage cheese are salted and placed in brine solution. Salt

solution is drained out. Cheese blocks are wiped and placed in sterilised rooms for ripening with the help of microorganisms.

5. (b)

6. (c) : Statins are products of fermentation activity of yeast *Monascus purpureus* which resemble mevalovate and are competitive inhibitors of β–hydroxy–β–methylglutaryl or HMG CoA reductase. This inhibits cholesterol synthesis. Statins are, therefore, used in lowering blood cholesterol, *e.g.*, lovastatin, pravastatin, simvastatin.

7. (c)

8. (c) : *Methanobacterium* is useful in the production of biogas. *Penicillium notatum* is used to produce penicillin, an antibiotic. *Acetobacter aceti* is used to obtain acetic acid.

9. (b)

10. (b) : *Clostridium butylicum* helps in the production of butyric acid. *Candida lipolytica* and *Geotrichum candidum* help in production of lipases that are added in detergents for removing oily stains from laundry.

11. (c)

12. (c) : *Aspergillus niger* produces citric acid, *Clostridium butylicum* produces butyric acid, *Saccharomyces* is used for commercial production of ethanol, *Pseudomonas* produces alkaline proteases.

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

14. (b) : Streptokinase (Tissue Plasminogen Activator or TPA) is an enzyme obtained from the culture of some haemolytic bacterium *Streptococcus* which is modified genetically to function as clot buster. Therefore, it helps in clearing blood clots inside the blood vessels through dissolution of intravascular fibrin during myocardial infarction.

15. (b) : Chikungunya is caused by Chikungunya virus. Colostrum is the first breast milk of mother which contains antibodies (especially IgA) which protect the infant by the age of three months. Beer is manufactured by fermentation of barley malt by yeast species.

16. (d)

17. (a) : Ethanol is commercially produced through a particular species of yeast *Saccharomyces* (*Saccharomyces cerevisiae*).

18. (c) : A fed batch is a biotechnological batch process which is based on feeding of a growth limiting nutrient substrate to a culture. Continuous addition of sugars in fed batch fermentation is done to purify enzymes.

19. (b) : Cyclosporin A used as an immuno-suppressive agent in organ-transplant patients, is produced by the fungus *Trichoderma polysporum*.

20. (c) : Microbes are used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes. Examples of acid producers are *Aspergillus niger* (a fungus) of citric acid, *Acetobacter aceti* (a bacterium) of acetic acid; *Clostridium butylicum* (a bacterium) of butyric acid and *Lactobacillus* (a bacterium) of lactic acid.

21. (a) : Yeast species are used in alcoholic fermentation due to the presence of zymase enzyme. It was known that the yeast extract contained an enzyme zymase, which is nondialyzable and a coenzyme which is dialyzable. It is now well known that the zymase is a complex mixture of many enzymes and that several coezymes are necessary for their function. The activity of this enzyme was lost because the main enzyme was separated from its coezyme during dialyzation. Thus, it was established later that extracellular enzyme zymase, secreted by yeast cells, carry out the process of fermentation.

22. (c) : Probiotics are dietary supplements containing potentially beneficial bacteria or yeast, with lactic acid bacteria (LAB) as the most common microbes used. LAB have been used in the food industry for many years because they are able to convert sugars (including lactose) and other carbohydrates into lactic acid. They not only provide the characteristic sour taste to fermented dairy foods such as yogurt, but also acts as a preservative, by lowering the pH and creating fewer opportunities for spoilage organisms to grow.

23. (b) : *Refer to answer 17.*

24. (b)

25. (a) : Citric acid is obtained through the fermentation carried out by *Aspergillus niger* on sugary syrups. Citric acid is employed in dyeing, engraving, medicines, inks, flavouring and preservation of food and candies.

26. (b) : Antibiotics are not capable of curing any disease. Antibiotics are those substances that destroy or inhibit the growth of microorganisms, particularly disease producing bacteria and fungi. The term antibiotic was introduced by Waksman in 1942. Antibiotics are obtained form microorganisms (especially moulds) or synthesized. Common antibiotics include penicillins, streptomycin and tetracyclines. They are used to treat various infections but tend to weaken the body's natural defence mechanisms and can cause allergies. Overuse of antibiotic can lead to the development of resistant strains of microorganism.

27. (c) **28. (b)**

29. (c) : Bacteria develop mutant strains that become resistant to antibodies, so these antibodies become incapable of removing bacteria mediated diseases.

30. (d) : The sediment in a settling tank is called activated sludge. A small part of it is pumped back into the aeration tank to serve as the inoculum. While the remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters.

31. (b): Primary or physical treatment is the process of removal of small and large, floating and suspended solids from sewage through two processes of filtration and sedimentation.

32. (b): The type of gases produced by microbial activity depend upon the microbes and the organic substrates they utilise. Certain bacteria, called methanogens, grow anaerobically on cellulosic material and produce large amount of methane along with carbon dioxide. These bacteria are commonly found in the anaerobic sludge during sewage treatment. Other anaerobic bacteria, involved in the process of anaerobic digestion produce other gases like ammonia and hydrogen sulphide.

33. (b): Sewage water can be purified by passing it through sewage treatment plants with the action of heterotrophic microorganisms. There are three stages of this treatment – primary, secondary and tertiary. Primary treatment removes floating and suspended solids from sewage through two processes of filtration and sedimentation. First floating matter is removed through sequential filtration. The filtrate is kept in large open settling tanks where grit settles down. The sediment is called primary sludge while the supernatant is called effluent. The primary sludge traps a lot of microbes and debris. In secondary treatment, the primary effluent is taken to aeration tanks. A large number of aerobic heterotrophic microbes grow in the aeration tank. They form flocs. Flocs are masses of bacteria held together by slime and fungal filaments to form mesh like structures. The microbes digest a lot of organic matter, converting it into microbial biomass and releasing a lot of minerals. As the BOD of the waste matter is reduced to 10-15% of raw sewage, it is passed into settling tank. Thus secondary treatment is more or less biological. The sediment of settling tank is called activated sludge. The remaining is passed into a large tank called anaerobic sludge digester. It is designed for continuous operation. The aerobic microbes present in the sludge get killed. Anaerobic microbes digest the organic mass as well as aerobic microbes of the sludge. They are of two types, non-methanogenic and methanogenic. Methanogenic bacteria produce a mixture of gases containing methane, H_2S and CO_2.

34. (d)

35. (d): Marsh gas or methane gas is mainly produced by the activities of anaerobic bacteria on sewage. Sewage contains large amounts of organic matter and microbes, many of which are pathogenic. These microbes (bacteria and fungi) are digested during secondary treatment process of sewage by anaerobic bacteria. During digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases are called biogas and can be easily used as a source of energy as it is inflammable.

36. (a): Methanogens like *Methanobacterium* are found in the rumen (a part of the stomach) of cattle. A lot of cellulosic material is also available in the rumen. In rumen, these bacteria help in the breakdown of cellulose and play an important role in nutrition of cattle.

37. (b): Biogas or gobar gas is a methane rich fuel gas produced by anaerobic breakdown or digestion of biomass with the help of methanogenic bacteria. It is made up of methane (50 -70%), carbon dioxide (30 -40%) with traces of nitrogen, hydrogen sulphide and hydrogen.

38. (b): Methanogens are any of various archaebacteria that produce methane; they include genera such as *Methanobacillus* and *Methanothrix.* Methanogens are obligate anaerobes found in oxygen-deficient environments, such as marshes, swamps, sludge and the digestive systems of ruminants. They are also utilised in gobar gas plants.

39. (d)

40. (c): Coliform bacteria are a commonly used bacterial indicator of sanitary quality of food and water. It is not involved in the production of vinegar.

41. (b)

42. (b): Lignin is a complex polymer of phenylpropane units, which are cross-linked to each other with a variety of different chemical bonds. This complexity has thus far proven as resistant to microbial degradation.

43. (a)

44. (d): Biogas or gobar gas is made up of methane (50 -70%), carbon dioxide (30 -40%) with traces of nitrogen, hydrogen sulphide and hydrogen.

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

46. (c) **47. (d)**

48. (b): Biopesticides are those biological agents that are used for control of weeds, insects and pathogens. The microorganisms used as biopesticides are viruses, bacteria, protozoa, fungi and mites. Some of the biopesticides are being used at a commercial scale. Most important example is the soil bacterium, *Bacillus thuringiensis* (Bt). Spores of this bacterium produce the insecticidal cry protein. Therefore, spores of this bacterium kill larvae of insects which eat them.

49. (a): A biological control being developed for use in the treatment of plant disease is the fungus *Trichoderma*. *Trichoderma* species are free living fungi that are very common in the root ecosystems. They are effective biocontrol agents of several plant pathogens.

50. (d): The natural method of pest and pathogen control involving use of viruses, bacteria and other insects (which are their natural predators and pests) is called biocontrol or biological control. For example, free living fungus *Trichoderma* exerts biocontrol over several plant pathogens for the control of plant diseases. Baculoviruses (mostly of genus *Nucleopolyhedrovirus*) are also used as biocontrol agents but they are used for the control of insects and arthropods. *Bacillus thuringiensis* is a soil bacterium which is used as biopesticide. *Glomus* species

are the most common fungal partners of mycorrhiza residing in the roots of higher plants.

51. (c) : *Xanthomonas campestris* is a bacterial species that causes a variety of plant diseases. Rest all the others are used as a biopesticide.

52. (b)

53. (b) : *Paecilomyces lilacinus* proved effective for biological control of nematodal diseases in plant.

54. (d) : Bioremediation is the process of using living microorganisms to clean up a contaminated site. Microorganisms do this by removing toxins from materials. They decompose these compounds by using enzymes, specific proteins that control reactions in living cells. Organisms that produce enzymes capable of degrading petroleum are useful in cleaning up oil spills. Some common ones that break down oil are genetically engineered species of *Pseudomonas* and *Azotobacter*. Bioremediation accounts for 5 to 10 percent of all pollution treatment and has been used successfully in cleaning up leaking underground gasoline storage tanks. Bioremediation has many applications, from the ordinary garden compost to the removal of selenium and other toxic metals from waste. The best agents for bioremediation are the ones that can break down contaminants without becoming contaminated or harmful themselves.

55. (d) : Pheromones are volatile chemicals produced by a given species to communicate with other individuals of the same species to change their behaviour. The synthetic versions of lepidopteran pheromones can be used as pesticides. Sometimes the relative amount of several pheromone chemicals in a pesticide product determine which specific pests are controlled when the pesticide product releases pheromone into the air where males are looking for females, the males become confused and cannot easily locate the females. As a result, many of the females do not mate and lay eggs and there are many fewer offspring than usual. These insect pheromones are third generation pesticides. Other third generation pesticides are insect growth regulators, chitin synthesis inhibitors and juvenile hormones.

56. (a) : Extensive growth of *Opuntia* (Cactus) in Australia was checked through introduction of its natural herbivore, cochineal insect (*Cactoblastis cactorum*).

57. (c) : The control of insect pests by the introduction, encouragment and artificial increase of biological agencies like predaceous and parasitic insects, other animals and diseases is termed as biological control. It is basically a natural control in which man plays significant role of making the biological agencies more effective. Of these agencies, insect enemies play important role in nature for managing the phytophagous insect pests and keep a balance *e.g.*, lady bugs or praying mantis, frog, toads, lizard and birds are employed by man to eat up the insect pests like aphids. It is a self perpetuating method.

58. (b) : Natural insecticides are those which are obtained from microorganisms and plants. The first natural insecticide used by man is azadirachtin obtained from *Azadirachta indica*. Rotenone is another natural insecticide which is obtained from the roots of *Derris* and *Lonchocarpus*. It is harmless to warm blooded animals.

59. (d) : Insect enemies play an important role in nature for managing the phytophagous insect pests and keep a balance. It is just possible that predators of a particular plant pest are unable to get established and multiply in a particular environment. In such cases, the predators are reared in the laboratory and let off at a particular time when the pests are about to threaten the crops. And then this practice become expensive.

60. (a) : *Refer to answer 57.*

61. (a) : *Rhodospirillum* is a free-living nitrogen fixing bacteria. Mycorrhiza is the symbiotic association between fungi and roots of higher plants. The most common fungal partners of mycorrhiza are *Glomus* species.

62. (b) : *Azolla* plays a very important role in rice production. *Azolla* and its nitrogen-fixing partner, *Anabaena*, have been used as green manure to fertilise rice paddies and increase production. With the help of *Azolla*, rice can be grown year after year, several crops a year, with little or no decline in productivity; hence no rotation of crops is necessary. So, *Azolla* is an excellent biofertilizer.

63. (c) : *Azotobacter*, *Aspergillus* and *Trichoderma* all are free living microbes that help plants in their nutrition. *Glomus* is a fungus that symbiotically forms endomycorrhiza that helps in absorption of nutrition specially phosphorus from soil.

64. (b) : *Cycas* forms facultative symbiotic association with autotrophic nitrogen fixing cyanobacteria. *Cycas* provides carbon and a stable environment to the cyanobacteria in exchange for fixed nitrogen. These cyanobacteria are endosymbionts and live within the roots of *Cycas*. In addition to normal roots, *Cycas* develops specialised symbiotic organs at a young age called pre-coralloid roots which transform into coralloid roots upon successful colonisation by cyanobacteria.

65. (a) : Some fungi form symbiotic associations with plants (mycorrhiza). Many members of the genus *Glomus* form mycorrhiza. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.

66. (a) : Biofertilisers are organisms that enrich the nutrient quality of the soil. The main sources of biofertilisers are bacteria, fungi and cyanobacteria. *Rhizobium* bacteria is found in the nodules on the roots of leguminous plants by symbiotic association. These bacteria fix atmospheric nitrogen into organic forms, which is used by the plants as nutrient. Fungi

are also known to form symbiotic associations with plants called mycorrhiza. Cyanobacteria are autotrophic microbes widely distributed in an aquatic and terrestrial environments. Many of which can fix atmospheric nitrogen, *e.g.*, *Anabaena*, *Nostoc*, *Oscillatoria,* etc. *Agrobacterium tumefaciens* is a pathogen of several dicot plants. It causes gall tumour in the plants.

67. (c) : *Rhizobium* is used as a biofertilizer for raising leguminous crop. *Rhizobium japonicum* forms symbiotic association in the roots of the leguminous plant, soybean.

68. (c) : Organic farming is the form of agriculture that relies on techniques such as crop rotation, green manure, compost and biological pest control to maintain soil productivity and control pest on a farm. Organic farming excludes or strictly limited the use of manufactured fertilizers, pesticides (which include herbicides, insecticides and fungicides), plant growth regulators such as hormones, food additives and genetically modified organisms.

69. (b) : *Azospirillum* is an anaerobic nitrogen fixing bacteria which forms loose association with roots of some plants. Inoculation of paddy fields with these bacteria helps in increasing yield and saving of nitrogen fertilizers.

70. (d) : Organic farming is a method of farming system which primarily aimed to keep the soil alive and in good health by use of organic wastes and other biological material alongwith beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an ecofriendly, pollution free environment. Basic components of organic farming are green manures, farm yard manure, vermicompost, crop rotation, biopesticides and biofertilizers. *Glomus* being a mycorrhizal component, earthworm being a vermicompost and *Oscillatoria* being a nitrogen fixing blue green algae can be used in organic farming. Snail cannot be a component of organic farming.

71. (b) : The Genus *Glomus* form endomycorrhiza, a symbiotic associations with plants. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.
Nostoc is a blue green algae, *Agaricus* is a basidiomycetes, *Rhizobium* is a eubacteria.

72. (a) : The most common symbiotic association of legume and bacteria on roots is as nodules, which are small outgrowth on the roots. The microbe *Frankia* is symbiont in root nodules of several non-legume plants like *Casurina* and *Alnus*. Both *Rhizobium* and *Frankia* are free living in soil but as symbiont can fix atmospheric nitrogen.

73. (b) : *Serratia marcescens* is considered a harmful human pathogen which has been known to cause urinary tract infections, wound infections and pneumonia. *Serratia* bacteria also have many antibiotic resistance properties which may become important if the incidence of *Serratia* infections dramatically increases.

74. (d) : *Anabaena* is a free living nitrogen fixing cyanobacterium which can form symbiotic association with the water fern *Azolla*.

75. (a) : Green manures are fast growing herbaceous crops which are ploughed down and mixed with the soil while still green for enrichment of soil. These provide both organic matter and nitrogen to the soil, in which Indian soils are generally poor. The green manure checks soil erosion by forming protective soil cover and also prevents leaching. Increase in yield by 30-50% has been observed by use of green manures. Some important green manure crops, which are mostly members of Family Leguminosae are *Alhagi* and *Crotolaria juncea*.

76. (a)

77. (a) : *Azolla* plays a very important role in rice production. *Azolla* and its nitrogen-fixing partner, *Anabaena*, have been used as green manure to fertilise rice paddies and increase production. With the help of *Azolla*, rice can be grown year after year, several crops a year, with little or no decline in productivity; hence no rotation of crops is necessary. So, *Azolla* is an excellent biofertilizer.

78. (c)

79. (c) : *Refer to answer 77.*

80. (d) : Biofertilizers are organisms which bring about nutrient enrichment of the soil. *Azotobacter* is a free living, aerobic, nitrogen fixing bacteria. *Anabena* is a nitrogen fixing cyanobacteria that occurs in both free living and symbiotc associations with *Azolla*, *Cycas* roots, etc. *Rhizobium* lives symbiotically in root nodules of legumes and non-legumes. Vesicular-arbuscular mycorrhiza (VAM) is an example of endomycorrhiza in which fungal hyphae penetrate the cortical cells of grasses to form vesicles.

81. (d) : *Azolla* plays a very important role in rice production. *Azolla* and its nitrogen-fixing partner, *Anabaena*, have been used as green manure to fertilise rice paddies and increase production.

82. (a)

83. (d) : Members of Kingdom Monera - bacteria and cyanobacteria (blue green algae) have the ability to fix nitrogen. *Azotobacter* is a N_2-fixing bacteria. *Anabaena* and *Nostoc* are heterocystous blue-green algae. The heterocysts are the sites of N_2-fixation. *Spirogyra* is one of the commonest green algae. It has no function in nitrogen fixation.

84. (a) : The nitrogen-fixing ability of leguminous plants is not a property of the plants as such but results from infection of their roots by bacteria in the soil, infection leading to the formation of nodules. These organisms are Gram-negative motile rods that are classified in the genus *Rhizobium*.

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