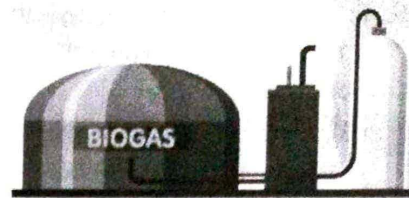


# 8 Microbes in Human Welfare



## 8.1 Microbes in Household Products

- Conversion of milk to curd improves its nutritional value by increasing the amount of:  
(A) Vitamin-B<sub>12</sub> (B) Vitamin-A  
(C) Vitamin-D (D) Vitamin-E. [NEET 2018]
- 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. [AIPMT 2004]
- During the formation of bread it becomes porous due to the release of CO<sub>2</sub> by the action of:  
(A) yeast (B) bacteria.  
(C) virus (D) protozoans. [AIPMT 2002]

## 8.2 Microbes in Industrial Products

4. Match List-I with List-II:

List-I (Microbes)	List-II (Products)
(a) <i>Streptococcus</i>	(i) Citric acid
(b) <i>Trichoderma polysporum</i>	(ii) Clot buster
(c) <i>Monascus purpureus</i>	(iii) Cyclosporin A
(d) <i>Aspergillus niger</i>	(iv) Statins

Choose the correct answer from the options given below:

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

[Re-NEET 2024]

5. Match List I with List II:

List I	List II
(a) <i>Clostridium butylicum</i>	(i) Ethanol
(b) <i>Saccharomyces cerevisiae</i>	(ii) Streptokinase
(c) <i>Trichoderma polysporum</i>	(iii) Butyric acid
(d) <i>Streptococcus sp.</i>	(iv) Cyclosporin-A

Choose the correct answer from the options given below:

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

[NEET 2024]

6. Identify the microorganism which is responsible for the production of an immunosuppressive molecule cyclosporin A.

- (A) *Clostridium butylicum*  
(B) *Aspergillus niger*  
(C) *Streptococcus cerevisiae*  
(D) *Trichoderma polysporum*

[NEET 2022]

7. Match List-I with List-II.

List-I	List-II
(a) <i>Aspergillus niger</i>	(i) Acetic Acid
(b) <i>Acetobacter aceti</i>	(ii) Lactic Acid
(c) <i>Clostridium butylicum</i>	(iii) Citric Acid
(d) <i>Lactobacillus</i>	(iv) Butyric Acid

Choose the correct answer from the options given below.

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

[NEET 2021]



8. For the commercial and industrial production of citric acid, which of the following microbe(s) is used?

(A) *Aspergillus niger*  
 (B) *Lactobacillus* sp.  
 (C) *Saccharomyces cerevisiae*  
 (D) *Clostridium butylicum*

[NEET Oct. 2020]

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

Column I	Column II
(a) <i>Clostridium butylicum</i>	(i) Cyclosporin-A
(b) <i>Trichoderma polysporum</i>	(ii) Butyric acid
(c) <i>Monascus purpureus</i>	(iii) Citric acid
(d) <i>Aspergillus niger</i>	(iv) Blood cholesterol lowering agent

Select the correct option.

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

[NEET Sept. 2020]

10. Match the following organisms with the products they produce:

List-I	List-II
(a) <i>Lactobacillus</i>	(i) Cheese
(b) <i>Saccharomyces cerevisiae</i>	(ii) Curd
(c) <i>Aspergillus niger</i>	(iii) Citric acid
(d) <i>Acetobacter aceti</i>	(iv) Bread
	(v) Acetic acid

Select the correct option.

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

[NEET 2019]

11. Which of the following is a commercial blood cholesterol lowering agent?

(A) Cyclosporin A (B) Statin  
 (C) Streptokinase (D) Lipases

[NEET 2019]

12. Which of the following is correctly matched for the product produced by them?

(A) *Acetobacter aceti* – Antibiotics  
 (B) *Methanobacterium* – Lactic acid  
 (C) *Penicillium notatum* – Acetic acid  
 (D) *Saccharomyces cerevisiae* – Ethanol

[NEET 2017]

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

Column I	Column II
(a) Citric acid	(i) <i>Trichoderma</i>
(b) Cyclosporin	(ii) <i>Clostridium</i>
(c) Statins	(iii) <i>Aspergillus</i>
(d) Butyric acid	(iv) <i>Monascus</i>

Select the correct option.

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

[NEET Phase-II 2016]

14. A good producer of citric acid is:

(A) *Aspergillus* (B) *Pseudomonas*  
 (C) *Clostridium* (D) *Saccharomyces*

[NEET 2013]

15. *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.

[AIPMT 2012]

16. A patient brought to a hospital with myocardial infarction is normally immediately given:

(A) penicillin (B) streptokinase  
 (C) cyclosporin-A (D) statins

[AIPMT 2012]

17. Yeast is used in the production of:

(A) citric acid and lactic acid  
 (B) lipase and pectinase  
 (C) bread and beer  
 (D) cheese and butter.

[AIPMT Screening 2012]

18. The most common substrate used in distilleries for the production of ethanol is:

(A) soya meal (B) ground gram  
 (C) molasses (D) corn meal.

[AIPMT Screening 2011]

19. Ethanol is commercially produced through a particular species of:

(A) *Clostridium* (B) *Trichoderma*  
 (C) *Aspergillus* (D) *Saccharomyces*

[AIPMT Screening 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

[AIPMT Mains 2011]

21. Read the following statement having two blanks (X and Y):

"A drug for ..... (X) ..... patients is obtained from a species of the organism ..... (Y) ....."

The one correct option for the two blanks is:

Blank-X	Blank-Y
(A) Heart	<i>Penicillium</i>
(B) Organ-transplant	<i>Trichoderma</i>
(C) Swine flu	<i>Monascus</i>
(D) AIDS	<i>Pseudomonas</i>

[AIPMT Mains 2011]

22. Which of the following plant species you would select for the production of bioethanol?

- (A) *Brassica* (B) *Zea mays*  
 (C) *Pongamia* (D) *Jatropha*

[AIPMT Screening 2009]

23. Which one of the following pair is wrongly matched?

- (A) Detergents — Lipase  
 (B) Alcohol — Nitrogenase  
 (C) Fruit juice — Pectinase  
 (D) Textile — Amylase

[AIPMT Screening 2009]

24. Modern detergents contain enzyme preparations of:

- (A) acidophiles (B) alkaliphiles  
 (C) thermoacidophiles (D) thermophiles

[AIPMT 2008]

25. Probiotics are:

- (A) cancer inducing microbes  
 (B) new kind of food allergens  
 (C) live microbial food supplement  
 (D) safe antibiotics.

[AIPMT 2007]

26. Which one of the following pairs is wrongly matched?

- (A) Yeast — Ethanol  
 (B) *Streptomyces* — Antibiotic  
 (C) Coliforms — Vinegar  
 (D) Methanogens — Gobar gas.

[AIPMT 2007]

27. An important step in the manufacture of pulp for paper industry from the woody tissues of plants is the:

- (A) preparation of pure cellulose by removing lignin  
 (B) treatment of wood with chemicals that break down cellulose

- (C) removal of oils present in the woods by treatment with suitable chemicals  
 (D) removal of water from the wood by prolonged heating at approximately 50°C. [AIPMT 2005]

28. The term "antibiotic" was coined by:

- (A) Edward Jenner (B) Louis Pasteur  
 (C) Selman Waksman (D) Alexander Fleming.

[AIPMT 2003]

29. Industrial production of ethanol from starch is brought about by:

- (A) *Saccharomyces* (B) *Lactobacillus*  
 (C) *Azotobacter* (D) *Penicillium*.

[AIPMT 2000]

30. Which one thing is not true about antibiotics?

- (A) The term "antibiotic" was coined by Selman Waksman in 1942.  
 (B) First antibiotic was discovered by Alexander Flemming.  
 (C) Each antibiotic is effective only against one particular kind of germ.  
 (D) Some persons can be allergic to a particular antibiotic. [AIPMT 1996]

31. The organism, used for alcoholic fermentation is:

- (A) *Pseudomonas* (B) *Penicillium*  
 (C) *Aspergillus* (D) *Saccharomyces*.

[AIPMT 1995]

### 8.3. Microbes in Sewage Treatment

32. Which of the following is put into anaerobic sludge digester for further sewage treatment?

- (A) Floating debris  
 (B) Effluents of primary treatment  
 (C) Activated sludge  
 (D) Primary sludge

[NEET 2020]

33. What gases are produced in anaerobic sludge digesters?

- (A) Methane and CO<sub>2</sub> only  
 (B) Methane, hydrogen sulphide and CO<sub>2</sub>  
 (C) Methane, hydrogen sulphide and O<sub>2</sub>  
 (D) Hydrogen sulphide and CO<sub>2</sub>

[AIPMT 2014]

34. 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 amounts of suspended solids and dissolved salts. [AIPMT Mains 2012]



35. Which of the following is mainly produced by the activity of anaerobic bacteria on sewage?  
 (A) Propane (B) Mustard gas  
 (C) Marsh gas (D) Laughing gas

[AIPMT Screening 2011]

36. Secondary sewage treatment is mainly a:  
 (A) mechanical process (B) chemical process  
 (C) biological process (D) physical process.

[AIPMT Screening 2011]

37. During anaerobic digestion of organic waste, such as in producing biogas, which one of the following is left undegraded?

- (A) Lipids (B) Lignin  
 (C) Hemicellulose (D) Cellulose [AIPMT 2003]

#### 8.4. Microbes in Production of Biogas

38. Which of the following statements about methanogens is not correct?

- (A) They produce methane gas.  
 (B) They can be used to produce biogas.  
 (C) They are found in the rumen of cattle and their excreta.  
 (D) They grow aerobically and breakdown cellulose-rich food. [NEET 2019]

39. The guts of cow and buffalo possess:

- (A) *Fucus* sps (B) *Chlorella* spp  
 (C) Methanogens (D) Cyanobacteria

[AIPMT Cancelled 2015]

40. In gobar gas, the maximum amount is that of:

- (A) butane (B) methane  
 (C) propane (D) carbon dioxide

[AIPMT Mains 2012]

41. Organisms called methanogens are most abundant in a:

- (A) cattle yard (B) polluted stream  
 (C) hot spring (D) sulphur rock.

[AIPMT Screening 2011]

42. 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 right source of aerobic bacteria. [AIPMT Screening 2010]

43. Which bacteria is utilised in gobar gas plant?

- (A) Methanogens  
 (B) Nitrifying bacteria  
 (C) Ammonifying bacteria  
 (D) Denitrifying bacteria

[AIPMT 2002]

44. Gobar gas contains mainly:

- (A)  $\text{CO}_2 + \text{H}_2$  (B)  $\text{CO}_2 + \text{H}_2\text{O}$   
 (C)  $\text{CH}_4$  only (D)  $\text{CH}_4 + \text{CO}_2$ .

[AIPMT 1997]

#### 8.5. Microbes as Biocontrol Agents

45. Bt cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (Bt) is resistant to:

- (A) fungal diseases (B) plant nematodes  
 (C) insect predators (D) insect pests. [NEET 2020]

46. A biocontrol agent to be a part of an integrated pest management should be:

- (A) species-specific and inactive on non-target organisms  
 (B) species-specific and symbiotic  
 (C) free living and broad spectrum  
 (D) narrow spectrum and symbiotic

[NEET Odisha 2019]

47. Select the correct group of biocontrol agents.

- (A) *Bacillus thuringiensis*, Tobacco mosaic virus, Aphids  
 (B) *Trichoderma*, Baculovirus, *Bacillus thuringiensis*  
 (C) *Oscillatoria*, *Rhizobium*, *Trichoderma*  
 (D) *Nostoc*, *Azospirillum*, Nucleo polyhedrovirus

[NEET 2019]

48. Which of the following can be used as a biocontrol agent in the treatment of plant disease?

- (A) *Trichoderma* (B) *Chlorella*  
 (C) *Anabaena* (D) *Lactobacillus*

[NEET 2019]

49. Microbe used for biocontrol of pest butterfly caterpillars is:

- (A) *Trichoderma* sp.  
 (B) *Saccharomyces cerevisiae*  
 (C) *Bacillus thuringiensis*  
 (D) *Streptococcus* sp.

[NEET Karnataka 2013]

50. 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

[AIPMT Screening 2012]



51. A common biocontrol agent for the control of plant diseases is:

- (A) Baculovirus (B) *Bacillus thuringiensis*  
(C) *Glomus* (D) *Trichoderma*.

[AIPMT Screening 2010]

52. *Trichoderma harzianum* has proved a useful micro-organism for:

- (A) bioremediation of contaminated soils  
(B) reclamation of wastelands  
(C) gene transfer in higher plants  
(D) biological control of soil-borne plant pathogens.

[AIPMT Screening 2008]

53. Which one of the following proved effective for biological control of nematodal diseases in plants?

- (A) *Pisolithus tinctorius*  
(B) *Pseudomonas cepacia*  
(C) *Gliocladium virens*  
(D) *Paecilomyces lilacinus*

[AIPMT Screening 2008]

54. Suppression of reproduction of one type of organism by utilising some features of its biology or physiology to destroy it or by use of another organism is known as:

- (A) competition (B) predation  
(C) biological control (D) physiological control.

[AIPMT 1996]

## 8.6. Microbes as Biofertilisers

55. Among the following pairs of microbes, which pair has both the microbes that can be used as biofertilisers?

- (A) *Aspergillus* and Cyanobacteria  
(B) *Aspergillus* and *Rhizopus*  
(C) *Rhizobium* and *Rhizopus*  
(D) Cyanobacteria and *Rhizobium* [NEET Odisha 2019]

56. 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*

[AIPMT 2012]

57. Which one of the following is not a biofertiliser?

- (A) *Rhizobium* (B) *Nostoc*  
(C) Mycorrhiza (D) *Agrobacterium*

[AIPMT Screening 2011]

58. An organism used as a biofertiliser for raising soyabean crop is:

- (A) *Azospirillum* (B) *Rhizobium*  
(C) *Nostoc* (D) *Azotobacter*.

[AIPMT Screening 2011]

59. Which one of the following is not used in organic farming?

- (A) *Glomus* (B) Earthworm  
(C) *Oscillatoria* (D) Snail [AIPMT 2010]

60. Which one of the following pair is not correctly matched?

- (A) *Streptomyces* — Antibiotic  
(B) *Serratia* — Drug addiction  
(C) *Spirulina* — Single cell protein  
(D) *Rhizobium* — Biofertiliser

[AIPMT 2004]

61. Which of the following is pair of bio-fertilisers?

- (A) *Azolla* and BGA  
(B) *Nostoc* and legumes  
(C) *Rhizobium* and grasses  
(D) *Salmonella* and *E.coli*

[AIPMT 2001]

62. Farmers have reported over 50% higher yields of rice by using which of the following biofertiliser?

- (A) Mycorrhiza  
(B) *Glomus*  
(C) *Azolla pinnata*  
(D) Legume-*Rhizobium* symbiosis

[AIPMT 2000, 1999, 98]

63. Due to which of the following organisms, yield of rice has been increased?

- (A) *Anabaena* (B) *Bacillus popilliae*  
(C) *Sesbania* (D) *Bacillus polymyxa*

[AIPMT 1999]

64. Which one of the following is non-symbiotic biofertiliser?

- (A) *Azotobacter* (B) *Anabaena*  
(C) *Rhizobium* (D) VAM [AIPMT 1998]

65. *Azotobacter* and *Bacillus polymyxa* are the examples of:

- (A) symbiotic nitrogen-fixers  
(B) non-symbiotic nitrogen-fixers  
(C) ammonifying bacteria  
(D) disease-causing bacteria.

[AIPMT 1996]

66. Non-symbiotic nitrogen fixers are:

- (A) *Azotobacter* (B) *Pseudomonas*  
(C) soil fungi (D) blue-green algae.

[AIPMT 1994]

67. A non-photosynthetic aerobic nitrogen fixing soil bacterium is:

- (A) *Rhizobium* (B) *Clostridium*  
(C) *Azotobacter* (D) *Klebsiella* [AIPMT 1994]



## SOLUTIONS

1. (A) Conversion of milk to curd improved its nutritional value by increasing the amount of vitamin-B<sub>12</sub>. Vitamin-A is present in milk, carrot, etc. Skin synthesise vitamin-D in the presence of sunlight. Vitamin-E is found in wheat, green leafy vegetables, etc.

### Related Theory

→ Vitamin-B<sub>12</sub>, also known as cobalamin, is a water-soluble vitamin involved in the metabolism of every cell of the human body. It act as a cofactor in DNA synthesis, and in both fatty acid and amino acid metabolism. It is naturally found in animal foods, including meats, fish, poultry, eggs and dairy.

2. (B) During the fermentation process, yeast converts sugar to carbon dioxide and alcohol in the absence of oxygen, causing dough to rise. Leavening agents make bread and other baked goods rise by causing a foaming action that traps air bubbles in the food as it cooks. The trapped air gives the final product a light and fluffy texture.

### Related Theory

→ Many breads containing yeast not only are leavened by yeast-produced carbon dioxide but also owe their distinctive flavour to the metabolic products of yeast.

3. (A) Yeast *Saccharomyces cerevisiae* is also known as baker's yeast. Upon fermentation, yeast release ethanol and carbon dioxide as byproducts. CO<sub>2</sub> forms bubbles which give the dough perfect consistency and structure to make it rise and become porous.

### Related Theory

→ During the baking process, most of the alcohol in the dough evaporates into the atmosphere. This is basically the same thing that happens to much of the water in the dough as well. And it has long been known that bread contains residual alcohol, up to 1.9% of it. Thus, bread isn't alcoholic.

4. (A) *Streptococcus* species are known for producing streptokinase, which is used as A clot buster. *Trichoderma polysporum* is known for producing cyclosporin A, an immuno suppressive drug. *Monascus purpureus* produces statins, which are used to lower cholesterol. *Aspergillus niger* is widely used for the industrial production of citric acid.

5. (B) (a) *Clostridium butylicum* is known for producing butyric acid.

(b) *Saccharomyces cerevisiae* is a yeast widely used in the production of ethanol.

(c) *Trichoderma polysporum* is recognised for producing cyclosporin-A, an immunosuppressive drug.

(d) *Streptococcus* sp. is well-known for producing the enzyme streptokinase, which is used medically to break down blood clots.

6. (D) A bioactive molecule is cyclosporin A. It is given to those who have received organ transplants. The fungus *Trichoderma polysporum* creates this immunosuppressive molecule.

7. (A) *Aspergillus niger* – Citric acid  
*Acetobacter aceti* – Acetic acid  
*Clostridium butylicum* – Butyric acid  
*Lactobacillus* – Lactic acid

8. (A) *Aspergillus niger* is used for the production of citric acid. *Lactobacillus* sp. is used to produce lactic acid, *Saccharomyces cerevisiae* (Brewer's yeast) is used for the production of alcohol. *Clostridium butylicum* is used for the production of butyric acid.

### Related Theory

→ Various microbes used for the human welfare are: Swiss cheese having large holes- *Propionibacterium shermanii*; Roquefort cheese- *Penicillium roqueforti*; Camembert cheese- *Penicillium camemberti*; Penicillin- *Penicillium notatum*; Streptomycin- *Streptomyces griseus*; Tetracycline- *Streptomyces aureofaciens*; Acetic acid- *Acetobacter aceti*; Biogas production- *Methanogen*; Biocontrol-Nucleopolyhedrovirus, *Bacillus thuringiensis*.

9. (A) Butyric acid is produced by *Clostridium butylicum*. Cyclosporin A is produced by fungus *Trichoderma polysporum*, which is used as an immunosuppressant. Statins are produced by *Monascus purpureus*, which act as a blood cholesterol lowering agent. Citric acid is produced by fungus *Aspergillus niger*.

### Related Theory

→ Cyclosporin is an immunosuppressant drug which is typically administered by mouth and can also be injected intravenously or as eye drops. It inhibits the activity of helper T-cells that act against foreign bodies. Cyclosporin is typically used to prevent the rejection of heart, kidney and liver transplants. It is also used to treat certain skin disorders such as severe atopic dermatitis. Cyclosporin have some side effects such as increase blood pressure, induce tingling, numbness and breathing problems. Cyclosporin has also been listed as a Group I carcinogen by the IARC (International Agency for Research on Cancer). Prolonged exposure will lead to specific skin and blood cancers.

10. (B) Curd is made of milk proteins that have been partially digested and coagulated by acids produced by *Lactobacillus*.

With the aid of baker's yeast, also known as *Saccharomyces cerevisiae*, bread dough is fermented.

Citric acid and acetic acid are produced commercially using *Aspergillus niger* and *Acetobacter aceti*, respectively.

11. (B) Statin is derived from the yeast *Monascus purpureus*, a type of fungus. It works by competitively blocking the cholesterol-synthesising enzyme.



12. (D) *Saccharomyces cerevisiae* is also called baker's yeast and is used in the fermentation of sugars to produce ethanol and carbon dioxide. *Acetobacter aceti* produce acetic acid. *Methanobacterium* produce methane. *Penicillium notatum* and *Streptococcus* produce antibiotics penicillin and streptomycin respectively. *Lactobacillus* produces lactic acid.
13. (B) Citric acid is produced by *Aspergillus niger*. Cyclosporin is an immunosuppressant drug produced by *Trichoderma polysporum*. Statins act as a blood cholesterol lowering agent and is produced by *Monascus purpureus*. Butyric acid is produced by *Clostridium butylicum*.



### Mnemonics

- **CA**  
C – Citric acid (produced by)  
A – *Aspergillus niger*
- **Count Trees**  
Count – Cyclosporin (produced by)  
Trees – *Trichoderma polysporum*
- **Seema bani Miss Patna**  
Seema – Statin (produced by)  
Miss Patna – *Monascus purpureus*
- **Boutique Closed**  
Boutique – Butyric acid (Produced by)  
Closed – *Clostridium butylicum*

14. (A) *Aspergillus niger* produce citric acid. *Clostridium butylicum* produce butyric acid. *Saccharomyces cerevisiae* is used in bread making and to produce alcohol. *Pseudomonas putida* is used in vitamin B<sub>12</sub> production.
15. (D) Yeast called *Monascus purpureus* is commercially produced to make statins, which lower blood cholesterol. The use of fungus, specifically red yeast rice, in the manufacture of fermented foods in China makes it the most significant of all. Research into its potential medical applications would have been stimulated by the discovery of cholesterol-lowering statins made by this.
16. (B) Adult patients with acute myocardial infarction receive streptokinase. It aids in the enhancement of ventricular function and subsequently lowers the infarction-related mortality.
17. (C) Yeast (*Saccharomyces cerevisiae*) is a fungi, which helps in the production of bread and beer by the process of fermentation.
18. (C) Ethanol is the major product obtained from the molasses (from sugar or sugarcane) by means of anaerobic fermentation using microorganisms.



### Related Theory

- Preparation of ethyl alcohol from molasses is done by:
- (1) **Dilution of molasses:** In this step, water and enzymes are added for the conversion of molasses into fermentable sugar.

(2) **Fermentation:** In this step, the mash is fermented using yeast, whereby the sugar is converted into ethanol and carbon dioxide.

19. (D) *Saccharomyces cerevisiae* produce ethanol. *Clostridium butylicum* produces butyric acid. *Aspergillus niger* produce citric acid. *Trichoderma polysporum* produce Cyclosporin A.
20. (C) *Clostridium butylicum* produces butyric acid and lactic acid is produced by bacterium *Lactobacillus*.
21. (B) An organism called *Trichoderma* produces a medication that is utilised in organ transplants. The fungus *Trichoderma polysporum* produces cyclosporin-A, a bioactive chemical used as an immunosuppressive drug in patients with organ transplant.
22. (B) Bioethanol fuel is produced by the sugar fermentation process. The main sources of sugar required to produce ethanol come from fuel or energy crops. These crops are grown specifically for energy use include corn, sugarcane, maize (*Zea mays*), wheat crops, waste straw, sawdust, reed canary grass and sorghum plants.



### Related Theory

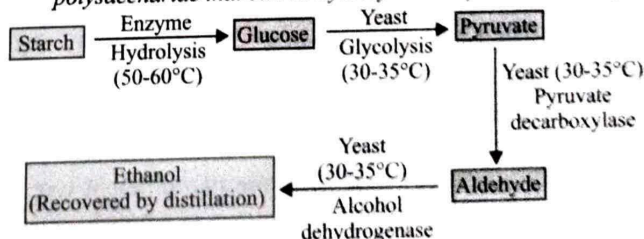
- Ethanol can be produced from biomass by the hydrolysis and sugar fermentation processes. Biomass wastes contain a complex mixture of carbohydrate polymers from the plant cell walls known as cellulose, hemicellulose and lignin. The lignin which is also present in the biomass is normally used as a fuel for the ethanol production plants boilers.

23. (B) This relates to the industrial applications of enzymes. Alcohol is not produced by the use of nitrogenase, but by the fermentation process of sugars which is carried out by yeast.



### Related Theory

- Alcohol (ethyl alcohol) can be produced by fermentation of any carbohydrate, containing a fermentable sugar on a polysaccharide that can be hydrolysed to a fermentable sugar.



24. (B) The hydrolases, proteases, and cellulases found in enzymes (25–30%) used to produce contemporary detergents. There are non-ionic soaps and detergents that can function in the pH range of 8 to 10. They operate in an alkaline, higher pH range.
25. (C) Probiotics are defined as live microorganisms, including *Lactobacillus* species, *Bifidobacterium* species and yeasts, that may beneficially affect the



host upon ingestion by improving the balance of the intestinal microflora. The dietary use of live microorganisms has a long history.

26. (C) Coliforms are a broad class of bacteria found in our environment, including the faeces of man and other warm-blooded animals. The presence of coliform bacteria in drinking water may indicate a possible presence of harmful, disease-causing organisms. Thus, they are a commonly used indicator of sanitary quality of foods and water.
27. (A) Paper production is basically a two-step process in which a fibrous raw material is first converted into pulp, and then the pulp is converted into paper. The harvested wood is first processed so that the fibres are separated from the unusable fraction of the wood, the lignin.



#### Related Theory

→ The pulping process is aimed at removing lignin without loosed fibre strength, thereby freeing the fibres and removing impurities that cause discoloration and possible future disintegration of the paper. Hemicellulose plays an important role in fibre-to-fibre bonding in paper making. Several extractives such as waxes, resins are contained in wood but they do not contribute to its strength properties; these too are removed during the pulping process. In general, the softwoods (e.g., pines, firs, and spruces) yield long and strong fibres and hardwoods produce a weaker paper as they contain shorter fibres.

28. (C) Selman Waksman who discovered streptomycin, first used the word "antibiotic". Penicillin, the first true antibiotic was discovered by Alexander Fleming. Edward Jenner discovered the vaccination for smallpox.

29. (A) The biological mechanism that turns starch into ethanol happens in two steps. In the first step, saccharification, an amylolytic microorganism or enzymes like glucoamylase and  $\alpha$ -amylase are used to turn starch into sugar. Using *Saccharomyces cerevisiae*, sugar is fermented into ethanol in the second step.

30. (D) The antibiotic is a chemical formed using microorganism which has the ability to kill or prevent the growth of other microorganisms. Based on how they work, there are two different types of antibiotics. An antibiotic known as a broad-spectrum antibiotic works against a variety of bacteria that cause disease. Contrary to narrow-spectrum antibiotics, which are effective only against particular families of bacteria, broad-spectrum antibiotics work against both Gram-positive and Gram-negative bacteria. Each antibiotic works only against a specific type of germ.

Rarely, some people may have an allergic reaction to antibiotics. In most cases, it may be mild to moderate.

31. (D) Alcoholic beverages are produced through the fermentation process, which uses yeast. One of the most prevalent yeasts in fermented foods and drinks is *Saccharomyces cerevisiae*.

32. (C) Anaerobic digesters receive activated sludge for additional sewage treatment. For further aerobic digestion of organic wastes, it comprises biological flocs containing bacteria and protozoan.

33. (B) In an anaerobic sludge digester, bacteria breakdown organic material in absence of oxygen. The gases produced during the anaerobic digestion process are methane, hydrogen sulphide and carbon dioxide.



#### Related Theory

→ Anaerobic digestion enhances the stabilization of sewage sludge, reduces pathogens and odour emission, and dry matter of sludge is reduced, which leads to a significant reduction in the final sludge volume.

34. (B) Sewage is waste water having food residue, animal and human-excreta, detergents, discharges from commercial and industrial establishments. The domestic sewage is processed first by aerobic and then by anaerobic bacteria in secondary treatment in Sewage Treatment Plants.

35. (C) Marsh gas, swamp gas, and biogas, a mixture of methane, hydrogen sulphide, and carbon dioxide, is produced by the anaerobic bacterial decomposition of vegetable matter and the rumen of herbivorous animals under water.



#### Related Theory

→ Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.

36. (C) There are three main stages of the wastewater treatment process, aptly known as primary, secondary and tertiary water treatment. Primary treatment involves the removing of floating and suspended solids by mechanical means. Secondary treatment of waste involves the biological degradation of organic material by micro-organisms under controlled conditions. Tertiary treatment is a chemical treatment, and aims at further purification of waste water and also for its recycling.



#### Related Theory

→ During secondary treatment, soluble biodegradable organics are degraded and removed by bacteria and protozoa through (aerobic or anaerobic) biological processes. This process may include the removal of nutrients (mainly nitrogen and phosphorous). Typical secondary treatments include aerated lagoons, activated sludge, trickling filters, oxidation ditches, and other extensive processes such as constructed wetlands.

37. (B) During biogas formation, digestion of cellulose is slow (rate-limiting) and most of the lignin is not decomposed. Lignin is a complex polymeric



molecule, made up of phenyl propanoid units. This complexity has thus far proven as resistant to microbial degradation. After cellulose, lignin is the most abundant plant polymer. It forms 20 to 30% of the wood of the tree. Cellulose is a large chained polymer of glucose molecules which are linked with each other by glycosidic bonds. Hemicellulose are branched polymers of glucose, xylose, galactose, mannose and arabinose.

38. (D) The anaerobic chemoautotrophs include methanogens. They break down cellulose-rich food as they develop anaerobically.
39. (C) Methanogens are archaeobacteria found in the gut and dung of ruminant animals like cow and buffalo. They are anaerobes and produce methane as by product.



#### Related Theory

- The group of methane-producing anaerobic bacteria is called as methanogens. Biogas is a mixture of methane and carbon dioxide. Methanogens produce methane, carbon dioxide and hydrogen gas by the anaerobic digestion of cellulosic plant part. Thus, methanogens helps in producing biogas.
40. (B) Biogas contains roughly 50-70% methane, 30-40% carbon dioxide, and trace amounts of other gases.



#### Related Theory

- Biogas is produced from cow dung in the waste water treatment plant that's why it is known as gobar gas. Biogas is used as a fuel. In the first and second sedimentation tank, the activated sludge reaches to the digested tank where it produces biogas. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.
41. (A) Methanogens are present in the gut of several ruminant animals such as cows and buffaloes and they are responsible for the production of methane (biogas) from the dung of these animals.



#### Related Theory

- Methanogens are archaeobacteria and thus lack peptidoglycan, a polymer that is found in the cell walls of bacteria but not in those of archaeobacteria.
42. (D) The activated sludge process is an aerobic suspended growth treatment system in which microorganisms use the organic content of wastewater as an energy source and for survival and replication. Biogas is produced by the activity of anaerobic bacteria on animal waste. Biogas, commonly called gobar gas, is a mixture of 50-70 percent methane, 30-40 percent carbon dioxide, and trace amounts of other gases. *Methanobacterium* is an anaerobic bacterium found in rumen of cattle.



#### Related Theory

- About 30 percent of the sludge is recirculated back into the aeration tank, where it is mixed with the primary effluent. This recirculation is a key feature of the activated sludge process.

43. (A) Methanogens produce methane, carbon dioxide and hydrogen gas by anaerobic digestion of cellulosic plant part. Thus, methanogens help in producing biogas or gobar gas.
44. (D) Biogas primarily contains methane with some carbon dioxide, carbon monoxide and traces of other gases.
45. (D) The *Bacillus thuringiensis* Bt toxin gene was used to create the Bt cotton variety, which is resistant to insect pests.
46. (A) A good biocontrol agent should be species-specific and inert towards organisms that are not its targets.
47. (B) Biocontrol agents include the fungus *Trichoderma*, Baculoviruses (NPV), and *Bacillus thuringiensis*. While TMV is a pathogen and aphids are pests that injure crop plants, *Rhizobium*, *Nostoc*, *Azospirillum*, and *Oscillatoria* are employed as biofertilizers.
48. (A) *Trichoderma* is a fungus. It is used to combat plant diseases as a biocontrol agent. *Chlorella pyrenoidosa* is a freshwater alga.
49. (C) The most often utilised species of bacteria for biological control against lepidopteran, coleopteran, and dipteran is *Bacillus thuringiensis*, a soil-dwelling bacterium.
50. (A) *Trichoderma* sp. against certain plant pathogens is an example of microbes carrying out biological control of pests/diseases.
51. (D) *Trichoderma* is a genus of imperfect fungi that produces toxins which inhibit the growth of other fungi and thus protects the plant from fungal diseases. Baculoviruses (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.
52. (D) *Trichoderma harzianum* is an effective biocontrol agent against several fungal soil borne plant pathogens and is used for foliar application, seed treatment and soil treatment for suppression of various disease-causing fungal pathogens.



#### Related Theory

- *Trichoderma longibrachiatum* is extremely harmful and toxic to humans. It produces toxic peptides called tritoxins, which aren't commonly found in protein we consume
53. (D) *Paecilomyces lilacinus* proved to be effective for the biological control of nematodal diseases in plant.
54. (C) Suppression of reproduction of one type of organism by utilising some features of its biology or physiology to destroy it or by the use of another organism is called biological control.



55. (D) Cyanobacteria like *Anabaena*, *Nostoc*, etc. and *Rhizobium* are able to fix atmospheric nitrogen and are used as biofertilisers.

### Caution

→ *Methanogens* should not be confused with *methanotrophs*, which consume methane rather than produce it.

56. (C) *Glomus* is a fungus that forms a symbiotic relationship with plant roots (Mycorrhiza) and aids in their ability to absorb nutrition.
57. (D) *Agrobacterium* is a Gram-negative bacterium that causes tumours in plants. Ti plasmid of *Agrobacterium tumefaciens* has been modified into a cloning vector which is not pathogenic to plant but still is able to use the mechanisms to deliver genes of interest into plants.
58. (B) *Rhizobium* are found in the soil and after infection, produce nodules in the legume such as soyabean where they fix nitrogen gas ( $N_2$ ) from the atmosphere turning it into a more readily useful form of nitrogen. *Azospirillum* fix nitrogen in the rhizosphere of non-leguminous plants such as cereals, millets, oil seeds, cotton, etc. *Nostoc* is blue-green algae that fixes atmospheric nitrogen into ammonia in the plants of *Azolla*. It acts as a free-living or symbiotic nitrogen-fixing bacterium. *Azotobacter* is a free living, nitrogen fixing cyanobacteria.

### Related Theory

→ Biofertilisers are substances that contain microorganisms which when applied to the soil increase the nutrient content and enhance the plant growth. *Rhizobium* is a bacterium found in soil that helps in fixing nitrogen in leguminous plants. It attaches to the roots of the leguminous plant and produces nodules. These nodules fix atmospheric nitrogen and convert it into ammonia that can be used by the plant for its growth and development.

59. (D) Earthworms frequently inhabit the soil where they live. They eat decaying organic material. They help in the transformation of substantial organic materials into rich humus. This characteristic enhances the soil fertility.

The genus of blue-green algae is called *Oscillatoria*. They are mostly found in freshwater. *Oscillatoria* enhances soil fertility and quality by assisting with nitrogen fixation. In paddy fields, they are frequently utilized as a biofertiliser.

The species *Glomus* is responsible for creating the mycorrhizal symbiosis with the roots of legume and oilseed plants. These fungus aid in the plants' mineral absorption.

60. (B) *Serratia* causes urinary tract infections, wound infections and pneumonia.

61. (A) The term "biofertilisers" refers to substances that contain living or dried powder of microorganisms. It can also be used to refer all the organic resources (manure) for plant growth that are made available in a form that plants can absorb through associations or interactions between microorganisms and plants. Three types of biofertilisers—nitrogen-fixing bacteria, nitrogen-fixing cyanobacteria, and mycorrhiza—have been used for a very long time. Examples include *Rhizobium*, *Azotobacter*, *Azolla*, *Nostoc*, *Azospirillum*, and blue-green algae.

62. (C) Farmers have reported the increased rice yields of more than 50% when using *Azolla pinnata* as a biofertiliser. In collaboration with the nitrogen-fixing blue green alga *Anabaena azollae*, *Azolla* is a free-floating water fern that floats in water and fixes atmospheric nitrogen.

### Related Theory

→ *Azolla* is a genus of seven water ferns which belong to Family *salviniaceae*. They are exceedingly specialised and reduced in appearance, resembling duckweed or some mosses rather than other ferns.

63. (A) The rice yield is enhanced by a symbiotic relationship between an aquatic fern and a nitrogen-fixing bacteria. *Anabaena* is a nitrogen-fixing symbiotically living bacteria. It lives in close association with *Azolla* which is an aquatic fern.
64. (A) Symbionts connected to the roots of vascular plants, *Azolla* plants, and leguminous plants, include VAM, *Anabaena*, and *Rhizobium* respectively. Only *Azotobacter* is classified as a free-living, non-symbiotic nitrogen-fixing bacteria. It boosts up crop output on a big scale and is mostly used for monocot vegetables.
65. (B) Non-symbiotic nitrogen fixer converts atmospheric nitrogen into nitrogen compounds independently. Examples include *Azotobacter*, *Bacillus polymyxa*.
66. (A) There are two types of nitrogen-fixing bacteria, free-living (non-symbiotic) bacteria, and non-free-living (symbiotic) bacteria. Examples of free-living bacteria include Cyanobacteria, *Azotobacter*, *Clostridium*, etc. Examples of symbiotic bacteria include *Rhizobium*, *Bradyrhizobium*, etc.
67. (C) *Azotobacter* are free-living non-photosynthetic aerobic nitrogen fixing soil bacteria. It is used as a biofertilizer for cultivating many crops. *Rhizobium* is symbiotic nitrogen-fixing bacteria. *Clostridium* is a genus of anaerobic.

