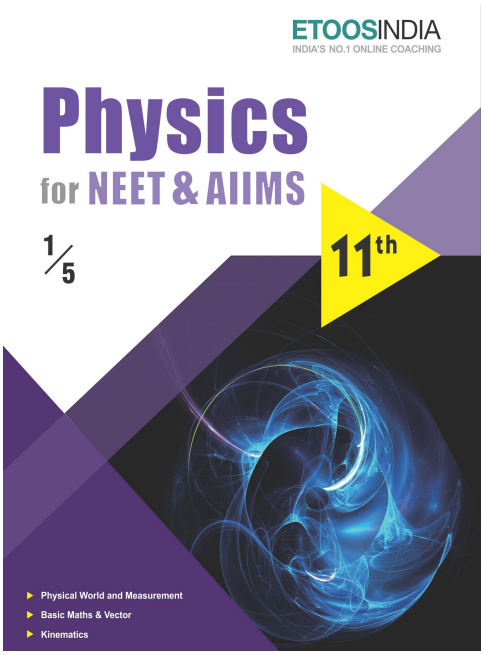
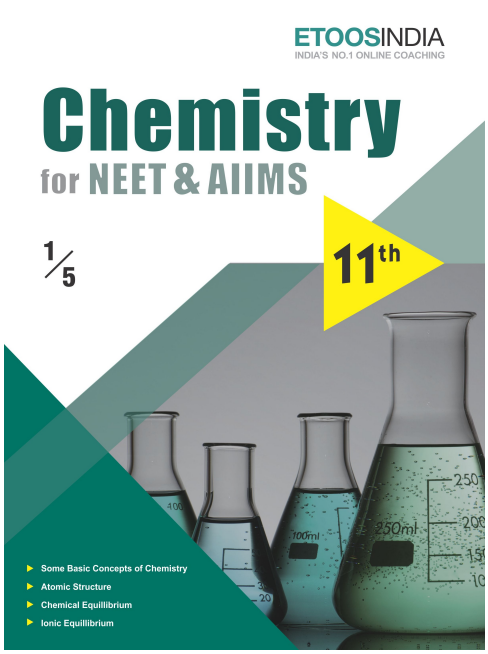
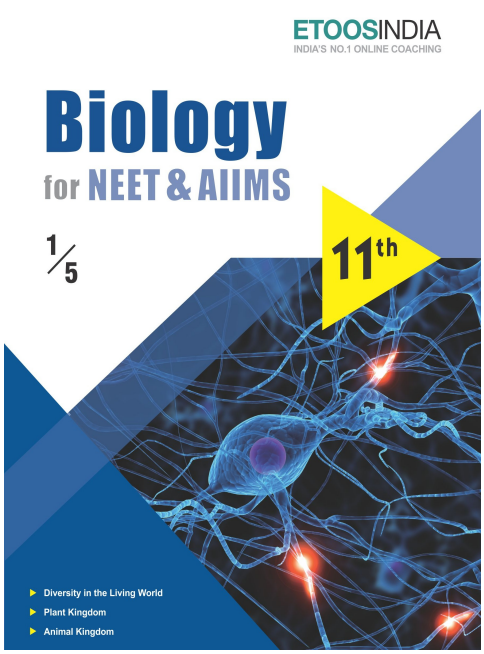
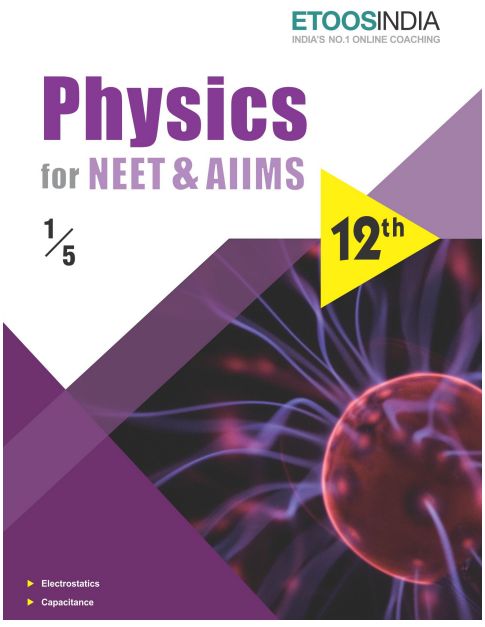
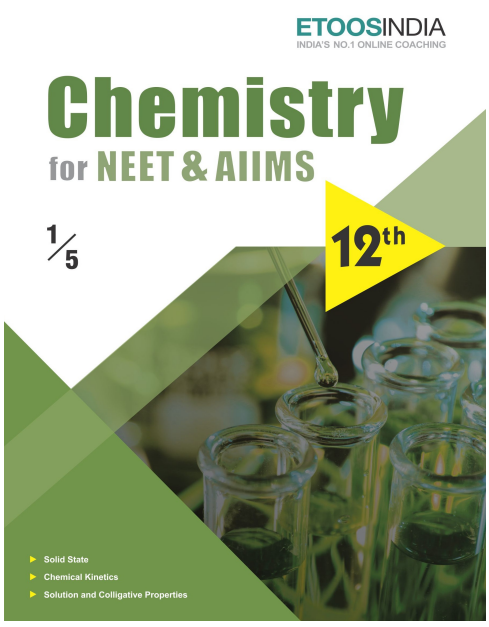
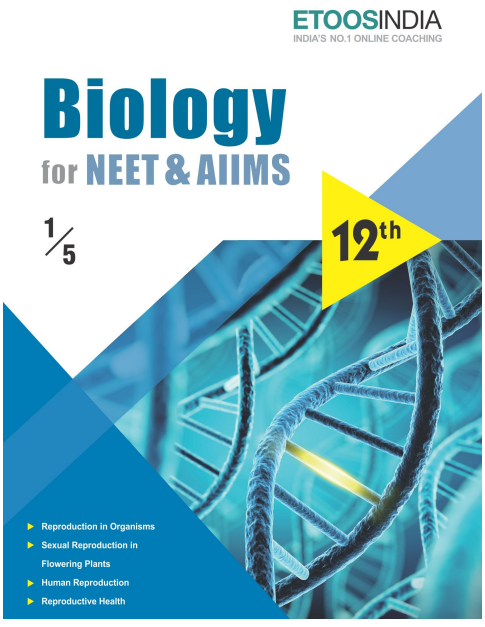












CHAPTER 10

MICROBES IN HUMAN WELFARE

"Man's survival, from the time of Adam and Eve until the invention of agriculture, must have been precarious because of his inability to ensure his food supply.".

"NORMAN ERNEST BORLAUG (1914)"

INTRODUCTION

Besides macroscopic plants and animals, microbes are the major component of biological systems on this earth.Microbes are present everywhere in water, soil, inside our bodies and that of other animals and planrts. They even exist where ther is no other life-form could possibly exist such as deep inside the geysers (thermal vents) where the temperature may be as high as 100^0C deep in the soil, under the layers of snow several meters thick and in highly acidic environments.

Microbes are diverse-protozoa, bacteria, fungi and microscopic plants viruses, viroids and also prions that are usually proteinaceous infectious agents. Microbes like fungi and bacteria can be grown on nutritive and various media to form colonies. Such cultures are useful in studies on micro-organisms (Microbiology).

Microbes in Human Welfare

introduction

Definition –

"**Biotechnology** may be defined as use of micro-organism, animals, or plant cells or their products to generate different products at industrial scale and services useful to human beings."

A powerful industry based on microbes has been developed in recent time. A careful selection of microbial strains, improved method of extraction and purification of the product, have resulted in enormous yields.

The use of living organisms in systems or process for the manufacturer of useful products, It may involve algae, bacteria, fungi, yeast, cells of Higher plants & animals or subsystems of any of these or Isolated components from living matter.

Old biotechnology are based on the natural capabilities of micro organisms.

e.g. formation of Citric acid, production of penicillin by Penicillium notatum

New biotechnology is based on Recombinant DNA technology.

e.g. Human gene producing Insulin has been transferred and expressed in bacteria like E.coli.

In, **modern biotechnology**, different types of valuable products are produced with help of microbiology, biochemistry, tissue culture, chemical engineering and genetic engineering, molecular biology and immunology.

microbes in household products

1. A common example of microbes acitivity in household is the production of curd from milk. Micro-organisms such as Lactobacillus and others commonly called **lactic acid bacteria (lab)** which grow in milk and convert it to curd. During growth, the LAB produce acids that coagulate and partially digest the milk proteins.
2. A small amount of curd added to the fresh milk as inoculum or starter contain millions of LAB, which at suitable temperatures multiply, thus converting milk to curd, which also improves its nutritional quality by increasing vitamin B_{12}. In our stomach too, the LAB play very beneficial role in removing disease causing microbes.
3. The dough , which is used for making foods such as dosa and idli is mainly also fermented by bacteria. The puffed-up appearance of dough is due to the production of CO_2 gas. Similarly the dough, which is used for making bread, is fermented using baker's yeast (Saccharomyces cerevisiae).
4. A number of traditional drinks (e.g. "Todi' prepared from sap of palms) and foods are also made by fermentation by the microbes.Microbes are also used to ferment fish, soyabean and bamboo shoots to make foods.
5. Cheese, is one of the oldest food items in which microbes were used. Different varieties of cheese are known by their characteristic textur flavour and taste, the specificity coming from the microbes used. For example, the large holes in 'Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named **Propionibacterium sharmanii**. The 'Roquefort cheese' are ripened by growing a specific fungi on them, which gives them a particular flavour.

Yeast

Louis Pasteur showed in the middle of nineteenth centuary that **beer** and **butter milk** are product of fermentation brought about by "**yeast**". It is a microscopic single celled organism – **Saccharomyces cerevisiae**. Presently however yeast product for human and animal consumption are produced on commercial scale.

"**Alcohol** was the first product of ancient biotechnology"

There are basically two types of yeasts (i) Baker's yeast (ii) Alcohol yeast or Brewer's yeast

Baker's yeast generally utilize during the preparation of food materials to increase the taste of food, flavour in food and nutrients in food. It is also utilized as "**leavening agent**".

By the incomplete degradation of complex organic compounds [sucrose] by yeast fermentation, alcohol is formed.

$$\underset{\text{[Sucrose]}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{invertase}]{\text{yeast}} \underset{\text{[Glucose]}}{C_6H_{12}O_6} + \underset{\text{[Fructose]}}{C_6H_{12}O_6}$$

Etoos Tips & Formulas

Microbes in Household products

1. Curd:
   Milk ——→ Curd
   (1) During growth LAB produce acids that coagulate and partially digest the milk protein.
   (2) LAB increase vitamin B_{12} and check diseases causing microbes in stomach.

2. Dough ——→ Bread
   Puffed up appearance of Dough is due to production of CO_2 gas.

3. Cheese : Different varieties of cheese are known by their characterstic texture, flavour and taste. The Specificity coming from the microbes used.

   Type of cheese :
   1. Unripened cheese.
   2. Ripened cheese. e.g. Roquefort cheese, Swiss cheese.

   Microbes in industrial products :

1. **Fermented Beverages :**

1.	Bear	Barley	4 - 6 %
2.	Wine	Grapes	10 - 20 %
3.	Brandy	Distillation of wine	55 - 60 %
4.	Rum	Molasses	40 - 45 %
5.	Whisky	Cereal	20 - 40 %
6.	Gin	Secale cerealae	40 %

2. **Antibiotics**
   (Anti = against, bio = life)
   Penecillin:
   1. First discovered antibiotics.
   2. Discovered by Alexander Fleming.
   3. Full potential of penecillin was established by Ernest chain and Howard Florey.

3. Chemical, Enzymes and other Bioactive molecules.

	Organic acid	Microbes
1.	Citric acid	Aspergillus niger
2.	Acetic acid	Acetobacter aceti
3.	Butyric acid	Clostridium butylicum
4.	Lactic acid	Lactobacillus

   Enzymes:
   1. Lipases : Used in detergents for removing oily stains from the laundry.
   2. Pectinases and proteases : For clearing bottled juices.
   3. Streptokinase (Clot buster) : Used for a removing clots from the blood vessels (in case of myocardiual infarction)

   Bioactive molecules :
   1. Cyclosporin A : Used as an imunosuppressive agent in organ - transplant patients (produced from fungus Trichoderma polysporum)
   2. Statin : Blood cholestrol lowering agents. (From yeast = Monascus purpureus)

   Microbes in production of biogas :

SOLVED EXAMPLE

Ex.1 The puffed up appearamce of dough in bakery is due to
(A) CO_2 production during fermentation by yeast
(B) CO_2 production during aerobic respiration by yeast
(C) Death of yeast
(D) Spoiling of the dough due to death of yeast and production of many gases

Sol. **(A)** : The dough which is used for making foods such as dosa, idlim jalebi, biscuit and bread etc. are fermented by bacteria or yeast (Saccharomyces cerevisiae). The puffed-up appearance of dough is due to the production of CO_2 gas. Bacteria are present in the atmosphere and the yeast has to be added to the dough.

Ex.2 Curding of milk takes place by
(A) Streptococcus lactis
(B) Streptococcus thermophilus
(C) Lactobacillus lactis
(D) All the above

Sol. **(D)**

Ex.3 Streptomycin is produce bu or from which micro-organism streptomycin is prepared
(A) Streptomycin venezuelae
(B) Streptomyces griseus
(C) Streptomyces scoleus
(D) Streptomyces fradie

Sol. **(B)** : Streptomycin is produced from streptomyces griseus. Streptomycin inhibits the bacterial protein synthesis by affecting 30S subunit of ribosome.

Ex.4 The organism used for alcohol fermentation is
(A) Penicillium
(B) Pseudomonas
(C) Aspergillus
(D) Saccharomyces

Sol. **(D)** : Brewing industry produces alcoholic beverages of several types depending upon the fermentating agent and the medium. Fermenting agents are Saccharomyces cerevisiae, S. sake S. ellipsoidens (wine yeast) and S. pireformis, (ginger yeast).

Ex.5 Monascus purpureus is a yeast used commercially in the productions of
(A) Ethanol
(B) Streptokinase for removing clots from the blood vessels
(C) Citric acid
(D) Blood cholesterol lowering stains

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

Ex.6 Which one of the following is used in the baking of the bread

Or

Baker's yeast is

Or

Thedough used for making bread is fermented by
(A) Rhizopur stolonifer
(B) Zygosaccharomyces
(C) Saccharomyces cerevisiae
(D) Saccharomycodes ludwigii

Sol. **(C)** : Invertase enzyme is obtained from Saccharomyces cerevisiae and is used to bread baking is also called baker's yeast.

Ex.7 During which stage of sewage treatment microbes are used
(A) Primary treatment
(B) Secondary treatment
(C) Tertitary treatment
(D) All of these

Sol. **(B)** : Secondary treatment/biological treatment the primary effuent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into flocs.

Ex.8 The solids which settle after primary treatment of sewages are called
(A) Primary sludge
(B) Activated sludge
(C) Flocs
(D) Total solids

Sol. **(A)** : All solids that settle down forms the primary sludge the supernatant forms the effluent. The effluent from the primary settling tank is taken for sewage treatment.

Ex.9 BOD of waste water is estimated by measuring the amount of
(A) Total organic matter
(B) Biodegradable organic matter
(C) Oxygen evolution
(D) Oxygen consumption

Sol. **(D)**

Ex.10 What would happen if oxygen availability to activated sludge flocs is reduced
(A) It will slow down the rate of degradation of organic matter
(B) The center of flocs will become anoxic, which would cause death of bateria and eventually breakage of flocs
(C) Flocs would increase in size as anaerobic bacteria would grow in large numbers
(D) Protozoa would grow in large numbers

Sol. **(B)**

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. In olden days cheese was prepared by
(A) Aspergillus (B) Rennet enzym
(C) Clostridium bacteria (D) None of the above

2. Which micro-organism is used in the formation of cheese
(A) Streptococcus (B) Aspergillus
(C) Acetic acid bacteria (D) Lactic acid bacteria

3. Rannet is used in
(A) Fermentation
(B) Cheese making
(C) Bread making
(D) Synthesis of antibiotic

4. Butter is produced from
(A) Propanoic acid (B) Butyric acid
(C) Pentanoic acid (D) Ethanoic acid

5. Which of the following organism is useful in the organism is useful in the preparation of roquefort cheese
(A) Mucor (B) Rhizopus
(C) Aspergillus (D) Pencillium

6. Lactic acid bacteria (LAB) at suitable temperature converts milk to curd, which improves its nutritional quality enhancing vitamin
(A) A (B) B (B_{12})
(C) C (D) D

7. Which antibiotic inhibits peptide bond formation
(A) Streptomycin (B) Tetracyclin
(C) Chloramphenicol (D) Neomycin

8. Which of the following is maintained for optimum production of vinegar
(A) Anaerobic condition
(B) Temperature of 65°C
(C) Aerobic condition
(D) Microaerophilic condition

9. A compound which is produced by an organism and inhibits growth of other organism is called
(A) Antigen (B) Antibiotic
(C) Antibody (D) Interferon

10. Lactic acid is produced by
(A) Lactobacillus bulgaricus
(B) Streptococcus lactis
(C) Rhizopus oryzae
(D) All the above

11. Who coined the term "antibiotics"
(A) Kornberg (B) Okazaki
(C) Waston and Crick (D) Jacob and Monod
Or
Streptomycin was first isolated in 1944-45 by
(A) Flemming (B) Florey
(C) Chain (D) S. Waksman

12. Vinegar is produced from sugars with the help of
Or
In the formation of ascorbic acid, the micro-organism used is
(A) Lactobacillus (B) Acetobacter
(C) Nitrosomonas (D) Salmonella

13. First antibiotic isolated was
Or
Antibiotics are produced by
(A) Terramycin (B) Neomycin
(C) Penicillin (D) Streptomycin

14. Ernest chain and Howard Florey's contribution was
(A) Establishing the potential of penicillin as an effective antibiotic
(B) Discovery of streptokynase
(C) Production of genetically engineered insulin
(D) Discovery of DNA sequence

15. The microbe Pseudomonas denitrificans produces Vitamin
(A) K (B) D
(C) B_2 (D) B_{12}

16. Highest number of antibiotics are produced by
(A) Bacillus (B) Penicillium
(C) Streptomyces (D) Cephalosporium

17. The initial step in preparation of beer is
(A) Malting (B) Carboxylation
(C) Clarification (D) Distillation

18. Penicillin was used in
(A) I nworld war (B) II world war
(C) Both I and II world war
(D) None of these

19. The enzyme diastase was identified by
(A) S.A. Waksman (B) A. Fleming
(C) Christian Hasen (D) Payen and Persoz

Exercise # 2

SINGLE OBJECTIVE | AIIMS LEVEL

1. Dough kept overnight in warm weather becomes soft and spongy because of
(A) Cohesion
(B) Osmosis
(C) Absorption of carbon dioxide from atmosphere
(D) Fermentation

2. Cheese are usually classified on the basis of
(A) Texture (B) Flavour
(C) Colour (D) All the above

3. The micro-organism grown on molasses and sold as a food flacouring substance is
(A) Saccharomycetes (B) Rhizopus
(C) Acetobacter (D) Lactobacillus

4. Cheese is prepared from
(A) Lactobacillus
(B) Streptgococcus
(C) Myrothecium
(D) Streptococcus, Lactobacillus and Leuconstoc

5. Lactobacillus mediated conversion of milk to curd results because of
(A) Coagulation and partial digestion of milk fats
(B) Coagulation and partial digestion of milk proteins
(C) Coagulation of milk proteins and complete digestion of milk fats
(D) Coagulation of milk fats and complete digestion milk protein

6. 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

7. Sir Alexander Flemming extracted penicillin from
(A) Penicillium citrinum
(B) Penicillium notatum
(C) Penicillium chrysogenum
(D) Bacillus brevis

8. Which of the following is not an antibiotic
(A) Griseofulvin (B) Cephalosporin
(C) Citric acid (D) Streptomycin

9. Conversion of sugar into alcohol during fermentation is due to the direct action of
(A) Temperature
(B) Micro-organism
(C) Concentration of sugar solution
(D) Zymase

10. Cheese and Yoghurt are products of the process
(A) Distillation (B) Pasteurization
(C) Fermentation (D) Dehydration

11. Streptomycin is used to cure the diseases caused by the bacteria
(A) Gram-positive
(B) Gram-negative
(C) Gram-neutral
(D) Both gram-positive and gram-negative

12. Yeast in an important source of
(A) Vitamin C (B) Vitamin B
(C) Vitamin B (D) Vitamin D

13. The antibiotic "chlorellin" is extracted from the genus
(A) Chalmydomonas (B) Chlorella
(C) Spirogyra (D) Batrachospermum

14. Stirred-tank bioreactors have been designed for
(A) Availability of oxygen throughout the process
(B) Addition of preservation to the product
(C) Purification of the product
(D) Ensuring anaerobic conditions in the culture vessel

15. Rennin used in cheese industry is
(A) Antibiotic (B) Alkaloid
(C) Enzyme (D) Inhibitor

16. Which one of the following is not used in the production of yoghurt
(A) Streptococcus lactis
(B) Streptococcus thermophilus
(C) Lactobacillus bulgaricus
(D) Acetobacter aceti

17. Antibodies in our body are complex
(A) Prostaglandins (B) Glycoproteins
(C) Lipoproteins (D) Steroids

18. Penicillin is obtained from
(A) Aspergillus fumigatus
(B) Penicillium chrysogenum
(C) Penicillium griseofulvum
(D) Streptomyces griseus

19. Saccharomyces is commonly used in the production of
(A) Ethyl alcohol (B) Curd
(C) Citric acid (D) Acetic acid

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. Match the following list of microbes and their importance

Column - I	Column - II
(A) Saccharomyces	(i) Production of immunosuppressive
(B) Monascus	(ii) Ripening of swiss cheese
(C) Trichoderma polysporum	(iii) Commerical production of ethanol
(D) Propionibacterium sharmanii	(iv) Production of blood cholesterol lowering agents

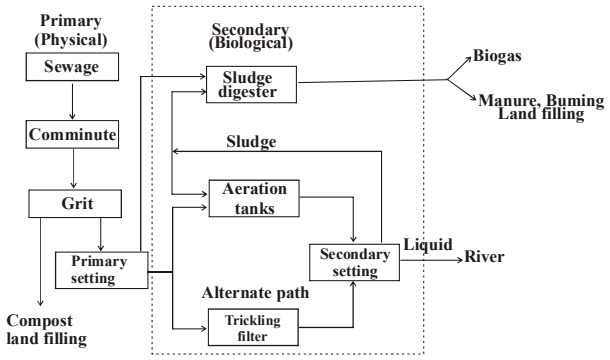
	A	B	C	D
(A)	(iii)	(ii)	(i)	(iv)
(B)	(iv)	(ii)	(i)	(iii)
(C)	(iii)	(i)	(iv)	(ii)
(D)	(iii)	(iv)	(i)	(ii)

2. Match the microbes in column - I with their commercial/industrial products in column II and choose the correct answer

Column - I	Column - II
(A) Aspergillus niger	(1) Ethanol
(B) Clostridium butylicum	(2) Stains
(C) Saccharomyces	(3) Citric acid
(D) Trichoderma polysporum	(4) Butyric acid
(E) Monascus purpureus	(5) Cyclosporin A

(A) A - 4, B - 5, C - 2, D - 1, E - 3
(B) A - 5, B - 4, C - 1, D - 2, E - 3
(C) A - 3, B - 4, C - 1, D - 2, E - 5
(D) A - 3, B - 4, C - 5, D - 1, E - 2
(E) A - 2, B - 3, C - 4, D - 5, E - 1

3. Refer the given flowchart of sewage treatment, accordingly match Column I with Column II and select the correct answer from the codes given below.



Column - I	Column - II
(A) The stage in which physical treatment of sewage is done	(i) Anaerobic digestion of activated sludge and production of biogas
(B) The stage in which biological treatment of sewage is done	(ii) Activated sludge
(C) Name of the sediment in primary treatment	(iii) Aeration tanks
(D) It is carried to aeration tanks from primary settling	(iv) Primary effluent
(E) Name of the sediment in secondary treatment	(v) Primary sludge
(F) Site of flocs growth	(vi) Secondary treatment
(G) Function of sludge digester	(vii) Primary treatment

Exercise # 4

PART - 1 | PREVIOUS YEAR (NEET/AIPMT)

1. Farmers have reported over 50% higher yields of rice by sing which of the following biofertiliser?
(A) Mycorrhiza
(B) Azolla pinnata
(C) Cyanobacteria
(D) Legume -Rhizobium symbiosis

2. The aquatic fern, which is an excellent biofertiliser is
(A) Azolla (B) Pteridium
(C) Salvinia (D) Marselia

3. Which of the following plants are used as green manure in crop fields and in sandy soils?
(A) Saccharum munja and Lantana camara
(B) Dichanthium annulatum and Azolla nilotica
(C) Crotalaria juncea and Alhagi comelorum
(D) Calotropis procera and Phyllanthus niruri

4. During anaerobic digestion of orgalic waste, such as in producing biogas, which one of the following is Ieft undegraded?
(A) Hemicellulose (B) Cellulose
(C) Lipids (D) Lignin

5. The most likely reason for the development of resistance against pesticides in insect damaging a crop is
(A) random mutations
(B) genetic recombinations
(C) directed mutations
(D) acquired heritable changes

6. 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

7. Which one of the following is being utilised as a source of bio-diesel in the lndian countryside?
(A) Euphorbia (B) Beet root
(C) Sugarcane (D) Pongamia

8. Which one of the following statements is correct?
(A) Extensive use of chemical fertilisers may lead to eutrophication of nearby water bodies
(B) Both Azotobacter and Rhizobium fix atmospheric nitrogen in root nodules of plants
(C) Cyanobacteria such as Anabeana and Nostoc are important mobilisers of phosphates and potassium for plant nutrition in soil
(D) At present it is not possible to grow maize without chemical fertilisers

9. Which one of the following proved effective for biological control of nematode diseases in plants?
(A) Glicoladium virens
(B) Paecilomces lalacinus
(C) Pisolithus tinctorius
(D) Pseudomonas cepacia

10. Which one of the following proved effective f o r biological control of nemato diseases in plants?
(A) Pisolithus tinctorius
(B) Pseudomyces lilacinus
(C) Gliocladium virens
(D) Paecilomyces lilacinus

11. Main objective of production/use of herbicide resistant GM crops is to
(A) eliminate weeds from the field without the use of manual labour
(B) eliminate weeds from the field without the use of herbicides
(C) encourage eco-friendly herbiclcies
(D) reduce herbicide accumulation in food particles for health safety

12. Cry-I endotoxins obtained from Bacillus thuringiensis are effective against
(A) mosquitoes (B) flies
(C) nematodes (D) bollworms

13. What is true about Bt toxin?
(A) The inactive protoxin gets converted into active form in the insect gut
(B) Bt protein exists as active toxin in the Bacillus
(C) The activated toxin enters the ovaries of the pest to sterilise it and thus, prevent its multiplication
(D) The concerned Bacillus has antitoxins

14. Which of the following is not used as abiopesticide?
(A) Bacillus thurirgiensis
(B) Trichoderma hazianum
(C) Nuclear Polyhedrosis Virus (NPV)
(D) Xanthomonas campestris

15. The bacterium Bacillus thuringiensis is widely used in contemporary biology as a/an
(A) indicator of water pollution
(B) insecticide
(C) agent for production of dairy products
(D) source of industrial enzyme

MOCK TEST

1. Ernst Chain and Howard Florey's contribution was
   (A) Establishing the potential of penicillin as an effective antibiotic
   (B) Discovery of streptokinase
   (C) Productionm of genetically engineered insulin
   (D) Discovery of DNA sequence

2. Identify a micro-organism that can produce biomass of protein.
   (A) Methylophilus methylotrophus (B) Monoscis purpureas
   (C) Trichoderma polysporum (D) Aspergillus niger

3. Consider the following four statements (A-D) and select the option which includes all the correct ones only.
   (A) Single cell Spirulina can produce large quantities of food rich in protein, minerals, vitamins, etc.
   (B) Body weight-wise the microorganism Methylophilus methylotrophus mayt be able to produce several times more proteins than the cows per day.
   (C) Common button mushrooms are a very rich source of vitamin C.
   (D) A rice variety has been developed which is very rich in calcium.
   (A) Statements (C) and (D) (B) Statements (A), (C) and (D)
   (C) Statements (B), (C) and (D) (D) Statements (A) and (B)

4. Which of the following is not correctly matched for the organism and its cell degrading enzyme ?

(A) Algae	–	Methylase
(B) Fungi	–	Chitinase
(C) Bacteria	–	Lysozyme
(D) Plant cells	–	Cellulase

5. 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

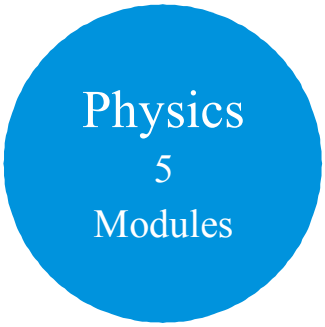
   (A) A - (iii) , B - (i), C - (ii), D - (iv) (B) A - (iii) , B - (i), C - (iv), D - (ii)
   (C) A - (i) , B - (iv), C - (ii), D - (iii) (D) A - (iii) , B - (iv), C - (i), D - (ii)

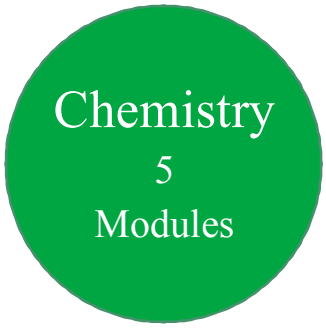
6. Match the following :

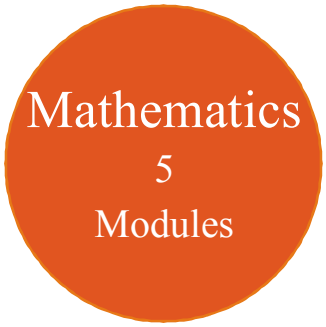
List - I	List - II
(i) Statins	A. Propionibacterium shermani
(ii) Swiss cheese	B. Streptococcus
(iii) Cyclosporin A	C. Aspergillus niger
(iv) Citric acid	D. Trichoderma polysporum
(v) Clot buster	E. Monascus purpureus

   (A) (i) - E , (ii) - A, (iii) - D, (iv) - C, (v) - E (B) (i) - B , (ii) - A, (iii) - D, (iv) - E, (v) - C
   (C) (i) - E , (ii) - A, (iii) - B, (iv) - C, (v) - D (D) (i) - C , (ii) - E, (iii) - B, (iv) - C, (v) - D
   (E) (i) - E , (ii) - C, (iii) - A, (iv) - D, (v) - B

11th Class Modules Chapter Details

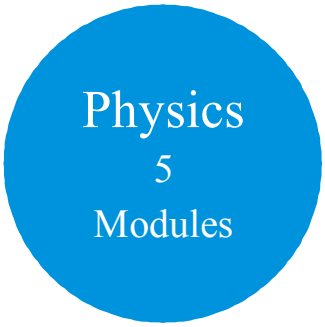


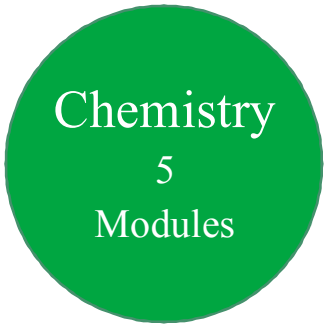


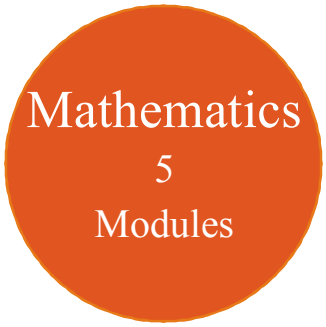


PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal Properties of Matter **Module-5** 1. Oscillations 2. Waves	**Module-1(PC)** 1. Some Basic Conceps of Chemistry 2. Atomic Structure 3. Chemical Equilibrium 4. Ionic Equilibrium **Module-2(PC)** 1. Thermodynamics & Thermochemistry 2. Redox Reaction 3. States Of Matter (Gaseous & Liquid) **Module-3(IC)** 1. Periodic Table 2. Chemical Bonding 3. Hydrogen & Its Compounds 4. S-Block **Module-4(OC)** 1. Nomenclature of Organic Compounds 2. Isomerism 3. General Organic Chemistry **Module-5(OC)** 1. Reaction Mechanism 2. Hydrocarbon 3. Aromatic Hydrocarbon 4. Environmental Chemistry & Analysis Of Organic Compounds	**Module-1** 1. Diversity in the Living World 2. Plant Kingdom 3. Animal Kingdom **Module-2** 1. Morphology in Flowering Plants 2. Anatomy of Flowering Plants 3. Structural Organization in Animals **Module-3** 1. Cell: The Unit of Life 2. Biomolecules 3. Cell Cycle & Cell Division 4. Transport in Plants 5. Mineral Nutrition **Module-4** 1. Photosynthesis in Higher Plants 2. Respiration in Plants 3. Plant Growth and Development 4. Digestion & Absorption 5. Breathing & Exchange of Gases **Module-5** 1. Body Fluids & Its Circulation 2. Excretory Products & Their Elimination 3. Locomotion & Its Movement 4. Neural Control & Coordination 5. Chemical Coordination and Integration

12th Class Modules Chapter Details







PHYSICS

Module-1

1. Electrostatics
2. Capacitance

Module-2

1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3

1. Electromagnetic Induction
2. Alternating Current

Module-4

1. Geometrical Optics
2. Wave Optics

Module-5

1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)

1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)

1. Electrochemistry
2. Surface Chemistry

Module-3(IC)

1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)

1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)

1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1

1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2

1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3

1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4

1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5

1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues