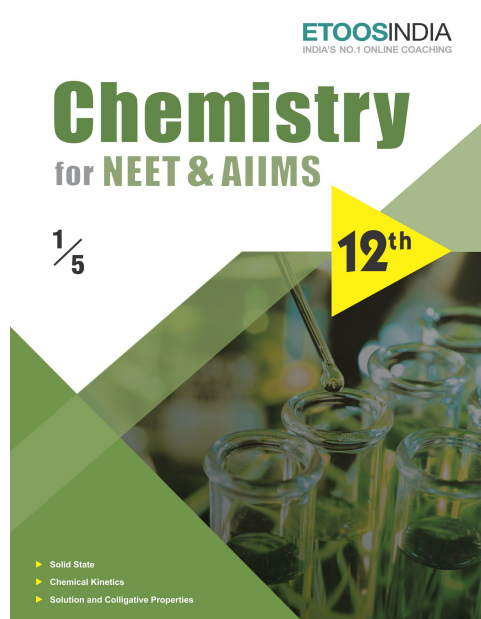
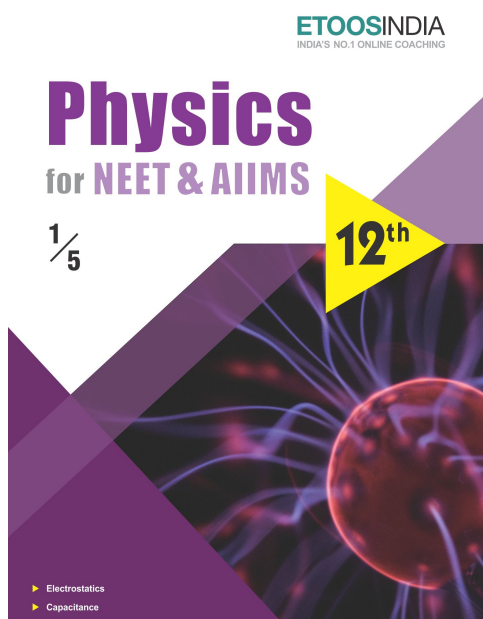
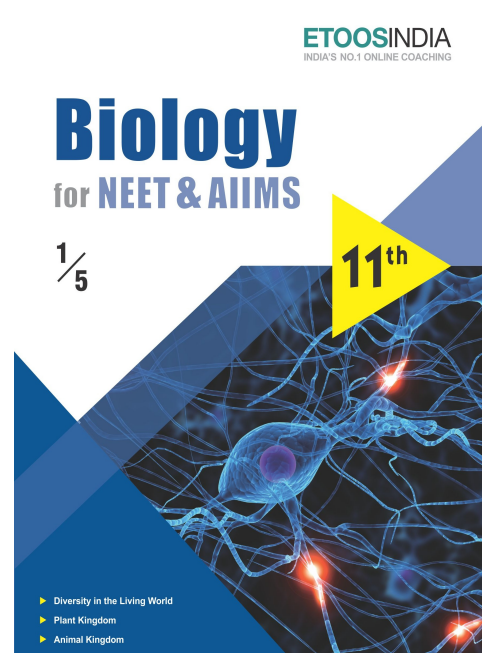
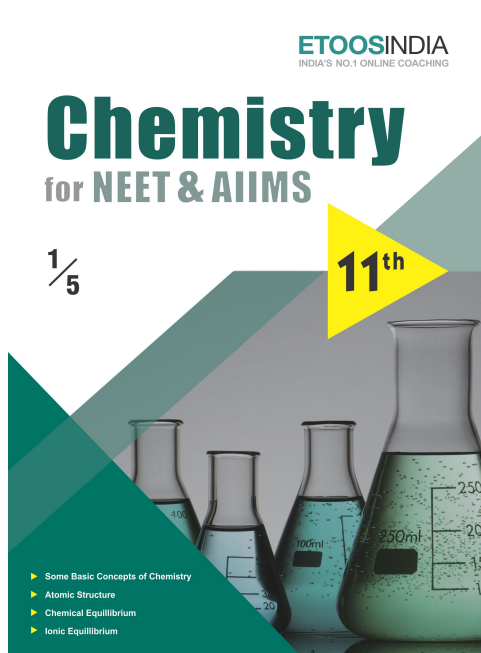
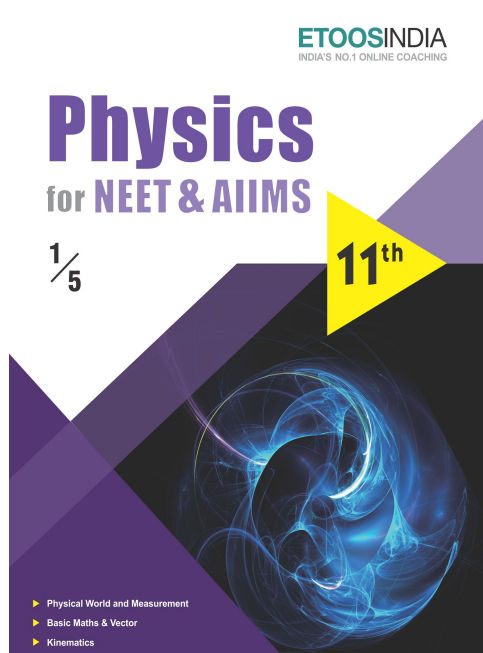


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BIOTECHNOLOGY & ITS APPLICATIONS

“Greatest discoveries come from passionate scientists with naive curiosity.”

“CRAIG MELLO (1960)”

INTRODUCTION

Biotechnology finds application in medicine, therapeutics, diagnostics, bioremediation, agriculture, waste treatment, food science (processes food) and energy production. It essentially deals with industrial scale production of biopharmaceuticals and biologicals using genetically modified fungi, microbes, plants and animals.

The different research areas of biotechnology includes:

1. Improved organism usually microbe or pure enzyme providing the best catalyst.
2. Creates optimum conditions through genetic engineering for a catalyst to act.
3. Downstream processing technologies to purify the protein or organic compound.

This chapter describes the application of PCR, gene cloning and other DNA analysis techniques in field of medicine, agriculture and biotechnology. Biotechnology is great combination of industry and technology, one of the reasons why biotechnology has received as much attention during the past three decades is because of gene cloning.

Biotechnology and Its Application

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 manufacture 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.

BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE :-

Three options that can be thought for increasing food production

- (i) agro-chemical based agriculture ;
- (ii) organic agriculture; and
- (iii) genetically engineered crop-based agriculture.

Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called **Genetically Modified Organisms (gmo)**.

Genetically modified crops –

A **transgenic crop** is a crop that contains and expresses a **transgene**. This crop is known as genetically modified crops or **GM crops**.

Two unique advantages :-

- (i) Any gene (from any organism or a gene synthesised chemically) can be used for transfer, and
- (ii) The change in genotype can be precisely controlled since only the transgene is added into the crop genome. For example – **Hirudin** is a protein that prevents blood clotting. The gene encoding hirudin was chemically synthesized and transferred into **Brassica napus**. Where hirudin accumulates in seeds. The hirudin is purified and used in medicine.

A soil bacterium **Bacillus thuringiensis**, produces **crystal [Cry] protein**. This Cry protein is toxic to Larvae of certain insects. Each Cry protein is toxic to a different group of insects. The gene encoding cry protein is called "**cry gene**". This Cry protein isolated and transferred into several crops. A crop expressing a cry gene is usually resistant to the group of insects for which the concerned Cry protein is toxic. There are a number of them, for example, the proteins encoded by the genes cryIac and cryIIAb control the cotton bollworms, that of cryIAb controls corn borer.

However, gene symbol italics, e.g., cry. The first letter or the protein symbol, on the other hand, is always capital and the symbol is always written in roman letters, e.g., Cry.

Bt Cotton :

Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). *B. thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic **insecticidal protein**. The Bt toxin protein exist as inactive protoxins but once an insect ingest the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals. The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect.

Transgenic variety of **Tomato – Flavr Savr** due to the inhibition of **polygalacturonase enzyme** which degrades pectin.

1. Application in agriculture :

- Three options that can be thought for increasing food production
 1. Agro-chemical based agriculture.
 2. Organic agriculture.
 3. Genetically engineered crop based agriculture.
- Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called Genetically Modified Organisms (GMO).
- Genetic modifications in plants has
 - (1) Made crops more tolerant to abiotic stresses (cold, drought, salt, heat)
 - (2) Reduce reliance on chemical pesticides (pest - resistant plants)
 - (3) Helped to reduce post harvest losses.
 - (4) Increased efficiency of mineral usage by plants.
 - (5) Enhanced nutritional value of food. (Golden rice)

Bt Cotton:

- Some strains of *Bacillus thuringiensis* (Bt) produce proteins that kill certain insects such as
- Lepidopterans (Tobacco budworm, armyworm)
- Colepterans (Beetles)
- Dipterans (Flies, mosquitoes)
- Bt forms protein crystals, (Toxic insecticidal protein) during a particular phase of their growth.
- This toxin exist as inactive protoxins but once ingested by insect it is converted into an active form of toxin due to alkaline pH of the gut. The activated toxin binds to surface of midgut epithelial cells and create pores that causes death of the insect.
- Specific Bt toxin genes were isolated from Bt and incorporated into the several crop plants (eg. Cotton, Corn etc.)
- The choice of genes depends upon the crop and the targeted pest as most Bt toxins are insect group specific.
- The toxin is coded by cry gene.
- Protein encoded by gene cry IAc & cry IIAb control cotton bollworm and cry I Ab controls corn borer.
- Pest resistant plants :
- Several nematodes parasite affect plants and animals.
- A nematode *Meloidogyne incognita* infects the roots of tobacco plants and greatly reduce the yield.
- To prevent infestation RNA interference. (RNAi) strategy was adopted.
- RNAi is a method of cellular defense in all eukaryotic organism.
- In this method nematode specific genes (DNA) that produced both sense and anti-sense RNA was introduced into the host plant.
- The two RNA's being complementary to each other formed double stranded RNA (dsRNA) that initiated RNAi and allowed silencing of specific m-RNA of the nematodes. As a result parasite could not survive in transgenic host plant.

2. Application in medicine :

- Genetically engineered insulin
- In mammals insulin is synthesised as a prohormone (which contains A, B & C peptide) during maturation C-peptide is removed so C-peptide is absent in mature insulin.
- The main challenge for production of insulin using r-RNA technique was getting insulin assembled into a mature form.

SOLVED EXAMPLE

Ex.1 Hybridomas are employed for
 (A) Synthesis of antibiotics
 (B) Killing cancer cells
 (C) Synthesis of monoclonal (somaclonal) antibodies
 (D) Production of somatic hybrids

Sol. (C) : Monoclonal/Magic antibodies (Mabs) are the specialize antibodies, which are obtained through Clonal culture of hybridoma.

Ex.2 Nuclear transplantation technique was discovered by
 (A) Briggs (B) Ian Wilmut
 (C) Gurdon (D) Griffith

Sol. (A)

Ex.3 A genetically engineered micro-organism used successfully in bioremediation of oil spills is a species of

- (A) Pseudomonas (B) Trichoderma
- (C) Xanthomonas (D) Bacillus

Sol. (A)

Ex.4 The vaccine of Hepatitis-B is a
 (A) First generation vaccine
 (B) Interferon
 (C) Second generation vaccine
 (D) Third generation vaccine

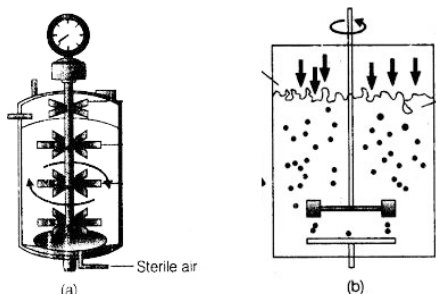
Sol. (C) : Second generation vaccines are produced by recombinant DNA technology or genetic engineering e.g., vaccine for Herpes virus and Hepatitis-B.

Ex.5 Which one of the following is now being commercially produced by biotechnological procedures

- (A) Nicotine (B) Morphine
- (C) Quinine (D) Insulin

Sol. (D)

Ex.6 The following apparatus are used for fermentation process Identify A and B respectively



- (A) Stirred tank and sparged tank bioreactor
- (B) Respirometer and sparged tank bioreactor
- (C) Stirred tank and Gene gun
- (D) None of these

Sol. (A)

Ex.7 Choose the correct statement with refernce to “Dolly”

- (A) She was created bytaking nucleus from unfertilised egg
- (B) She was created by taking nucleus from udder cell and cytoplasm from unfertilised egg
- (C) She was created by taking cytoplasm from udder cells and nucleus from fertilised egg
- (D) She was created in the test tube

Sol. (B) : Dolly has nuclear genes from the ewe whos supplied the udder cell and mitochondrial genes from the egg cytoplasm of the second ewe.

Ex.8 GEAC stands for

- (A) Genome Engineering Action Committee
- (B) Ground Environment Action Committee
- (C) Genetic Engineering Approval Committee
- (D) Genetic and Environement Approval Committee

Sol. (C)

Ex.9 A probe which is a molecule used to locate homologous sequence in a mixture of DNA or RNA molecules could be

- (A) A ssRNA
- (B) A ssDNA
- (C) Either RNA or DNA
- (D) Can be ssDNA but not ssRNA

Sol. (C)

Ex.10 The trigger for activation of toxin of Bacillus thuringiensis is

- (A) Acidic pH of stomach
- (B) High temperature
- (C) Alkaline pH of gut
- (D) Mechanical action in the insect gut

Sol. (C)

Exercise # 1**SINGLE OBJECTIVE****NEET LEVEL**

1. When and where first time word "biotechnology" was used
(A) In 1950 in England (B) In 1960 in Holand
(C) In 1920 in U.N. (D) In 1910 in Germany
2. In olden days cheese was prepared by
(A) Aspergillus (B) Rennet enzyme
(C) Clostridium bacteria (D) None of the above
3. Who first realized the use of yeast in fermentation
(A) Christian Hansen (B) Louis Pasteur
(C) A. Spike (D) D.A. Jackson
4. Beer is obtained by the fermentation of seeds of
(A) Hordeum vulgare (B) Rice
(C) Maize (D) All the above
5. Wine is prepared by fermentation of grape juice by
(A) Bacillus liquifaciens
(B) Penicillium roqueforti
(C) Saccharomyces cerevisiae
(D) Streptococcus aureus
6. Curding of milk takes place by
(A) Streptococcus lactis
(B) Streptococcus thermophilus
(C) Lactobacillus lactis
(D) All the above
7. In India, first time an international meeting on biotechnology was held in
(A) 1986 (B) 1987
(C) 1988 (D) 1989
8. Lactic acid is produced by
(A) Lactobacillus bulgaricus
(B) Streptococcus lactis
(C) Rhizopus oryzae (D) All the above
9. Who coined the term "antibiotics"
(A) Flemming (B) Florey
(C) Chain (D) S. Waksman
10. Lal Bahadur Shastri biotechnological centre is in
(A) Bombay (B) Calcutta
(C) Delhi (D) Kanpur
11. Which protein production was successfully introduced in E. coli
(A) Interferon (B) Xanthotoxin
(C) Somatostatin (D) Relaxin
12. Vinegar is produced from sugars with the help of
(A) Lactobacillus (B) Acetobacter
(C) Nitrosomonas (D) Salmonella
13. First antibiotic isolated was
(A) Terramycin (B) Neomycin
(C) Penicillin (D) Streptomycin
14. Yeast is used in the production of
(A) Ethyl alcohol (B) Acetic acid
(C) Cheese (D) Curd3
15. Which micro-organism is used in the formation of cheese
(A) Streptococcus (B) Aspergillus
(C) Acetic acid bacteria (D) Lactic acid bacteria
16. Streptomycin was first isolated in 1944-45 by
(A) Leeuwenhoek (B) Burkholder
(C) Alexander Fleming (D) Waksman
17. What is interferon
(A) A type of plasmid (B) A type of protein
(C) A type of gene (D) A type of hormone
18. In the production of leavened bread, the following is used
(A) Bacterium (B) Yeast
(C) Rhizopus (D) None of the above
19. Biotechnology is the modern branch of biology which deals with
(A) Genetic engineering (B) Biochemistry
(C) Microbiology (D) All the above
20. Micro-organism used in the production of yoghurt is
(A) Salmonella sp.
(B) Lactobacillus bulgaricus
(C) Streptococcus thermophilus
(D) Both (B) and (C)
21. For the manufacture of gluconic acid and citric acid, which of the following micro-organism is used
(A) Lactobacillus bulgaricus
(B) Acetobacter sp.
(C) Aspergillus niger
(D) Gluconobacter sp.
22. Raw cheese is known as
(A) Blue cheese (B) Cottage cheese
(C) Swiss cheese (D) None of these

Exercise # 2**SINGLE OBJECTIVE****AIIMS LEVEL**

1. Use of living organisms or their substances in industrial processes is called
(A) Microbiology
(B) Biotechnology
(C) Industrial engineering
(D) Genetic engineering
2. Sodium chloride is added during preparation of cheese as it
(A) Gives flavour
(B) Controls moisture
(C) Hardens cheese
(D) Controls moisture and gives flavour
3. Rennin used in cheese industry is
(A) Antibiotic (B) Alkaloid
(C) Enzyme (D) Inhibitor
4. 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
5. A compound which is produced by an organism and inhibits the growth of other organisms is called
(A) Antigen (B) Antibody
(C) Antibiotic (D) Antiallergic
6. Which of the following enzyme is secreted by yeast, responsible for fermentation
(A) Enolase (B) Dehydrogenase
(C) Zymase (D) Invertase
7. Which one of the following is used in the baking of bread
(A) Rhizopus stolonifer
(B) Zygosaccharomyces octosporous
(C) Saccharomyces cerevisiae
(D) Saccharomycodes ludwigii
8. Chloromycetin is produced by
(A) Bordetella pertusis
(B) Streptomyces venezuelae
(C) Streptomyces ramosus
(D) Clostridium botulinum
9. The phenomenon of antibiotic was discovered by
(A) Fleming (B) Pasteur
(C) Waksman (D) Babes
10. Rennet enzyme was purified by
(A) A. Flemming (B) S.A. Waksman
(C) Payen and Persoz (D) Christian Hansen
11. Which of the following enzymes are used for converting corn starch into high fructose syrup
(A) Glucoisomerases (B) Glucoamylases
(C) Amylases (D) All of these
12. Which of the following participates in the manufacturing of dextrans
(A) Lactobacillus (B) Leuconostoc
(C) Pseudomonas (D) Mucor
13. Steroids are used in
(A) Birth control
(B) Treatment of hormonal balance
(C) Treatment of auto-immune diseases
(D) All of these
14. Vaccine for small pox was developed by
(A) Cesor Milstein (B) Louis Pasteur
(C) Edward Jenner (D) Salman Waksman
15. Which of the following is used in biotechnology
(A) Cattle
(B) Yeast
(C) Both cattle and yeast
(D) Neither cattle nor yeast
16. Woodruff (1941) were responsible for the isolation of
(A) Neomycin (B) Actinomycin
(C) Penicillin (D) Streptomycin
17. Waksman got Nobel Prize for the discovery of
(A) Chloromycetin (B) Neomycin
(C) Streptomycin (D) Penicillin
18. nif genes occur in
(A) Rhizobium (B) Penicillium
(C) Aspergillus (D) Streptococcus
19. Neomycin is extracted from
(A) Streptomyces griseus
(B) Streptomyces venezuelae
(C) Streptomyces fradiae
(D) Streptomyces rimosus
20. Interferons are
(A) Antiviral proteins
(B) Complex proteins
(C) Anti-bacterial proteins
(D) Anti-cancer proteins

Exercise # 3**PART - 1****MATRIX MATCH COLUMN**

1. Match Column - I with Column - II and select the correct answer from the codes given below.

Column - I

- (A) α -1- antirypsin
(B) Transposon
(C) ELISA
(D) Retroviral
(A) A - (i), B - (iii), C - (ii), D - (iv)
(C) A - (i), B - (ii), C - (iii), D - (iv)

Column - II

- (i) AIDS
(ii) Gene therapy
(iii) Emphysema
(iv) Mobile genetic element
(B) A - (iii), B - (iv), C - (i), D - (ii)
(D) A - (iii), B - (i), C - (ii), D - (iv)

2. Match Column - I containing transgenic organisms with their specific characteristics in Column - II and select the correct answer from codes given below.

Column - I

- (A) Golden rice
(B) Bt cotton
(C) Flave Savr
(D) Rosie cow
(A) A - (iii), B - (iv), C - (ii), D - (i)
(C) A - (ii), B - (iv), C - (iii), D - (i)

Column - II

- (i) Protein - enriched milk
(ii) Increased shelf life
(iii) Enriched with vitamin A
(iv) High yield and pest resistant
(B) A - (iii), B - (ii), C - (iv), D - (i)
(D) A - (i), B - (iv), C - (ii), D - (iii)

3. Match Column - I with Column - II and select the correct answer from the codes given below.

Column - I

- (A) Biopiracy
(B) Biopatent
(C) Gene therapy
(D) RNAi
(A) A - (iv), B - (ii), C - (i), D - (iii)
(C) A - (iii), B - (iv), C - (i), D - (ii)

Column - II

- (i) Effort to fix the non-functional gene
(ii) Gene silencing
(iii) Illegal removal of biological materials
(iv) Right granted for biological entities
(B) A - (ii), B - (iv), C - (i), D - (iii)
(D) A - (iii), B - (iv), C - (ii), D - (i)

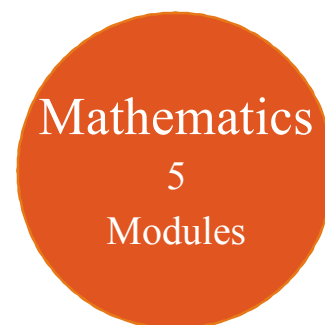
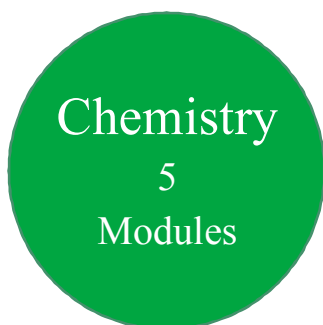
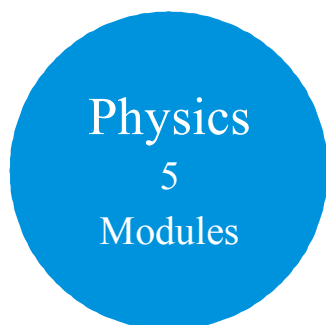
Exercise # 4**PART - 1****PREVIOUS YEAR (NEET/AIPMT)**

1. The first successfully cloned mammals (animal) that gained worldwide publicity was
(A) Molly (a sheep) (B) Polly (a sheep)
(C) Chance (a bull) (D) Dolly (sheep)
2. Producing a giant mouse in the laboratory was possible through
(A) gene mutation (B) gene manipulation
(C) gene synthesis (D) gene duplication
3. Introduction of food plants developed by genetic engineering is not desirable because
(A) economy of developing countries may suffer
(B) these products are less tasty as compared to the already existing products
(C) this method is costly
(D) there is danger of introduction viruses and toxins with introduced crop
4. Production of a human protein in bacteria by genetic engineering is possible because
(A) bacterial cell can carry out the RNA splicing reactions
(B) the human chromosome can replicate in bacterial cell
(C) the mechanism of gene regulation is identical in humans and bacteria
(D) the genetic code is universal
5. Human insulin is being commercially produced from a transgenic species of
(A) *Rhizobium* (B) *Saccharomyces*
(C) *Escherichia* (D) *Mycobacterium*
6. A transgenic food crop which may help in solving the problem of night blindness in developing countries is
(A) Bt soyabean (B) golden rice
(C) *flavr savr tomatoes* (D) starlink maize
7. Transgenic plants are the ones
(A) generated by introducing foreign DNA into a cell and regenerating a plant from that cell
(B) produced after protoplast fusion in artificial medium
(C) grown in artificial medium after hybridisation in the field
(D) produced by a somatic embryo artificial
8. An improved variety of transgenic basmatirice
(A) does not require chemical fertilisers and growth hormones
(B) gives high yield and is rich in vitamin-A
(C) is completely resistant to all insect pests and diseases of paddy
(D) gives high yield but has no characteristic aroma
9. Some of the characteristics of Bt cotton are
(A) long fibre and resistance to aphids
(B) medium yield, long fibre and resistance to beetle pests
(C) high yield and production of toxic protein crystals which kill dipteran pests
(D) high yield and resistance to bollworms
10. Genetic engineering has been successfully used for producing
(A) transgenic mice for testing safety of polio vaccine before use in humans
(B) transgenic models for studying new treatments for certain cardiac diseases
(C) transgenic cow Rosie which produces high fat milk for making ghee
(D) animals like bulls for farm work as they have super power
11. The Genetically Modified (GM) brinjal in India has been developed for
(A) insect resistance (B) enhancing self life
(C) enhancing mineral content
(D) drought-resistance
12. Continuous addition of sugars in 'fed batch' fermentation is done to
(A) produce methane (B) obtain antibiotics
(C) purify enzymes (D) edgrade sewage
13. The process of RNA interference has been used in the development of plants resistant to
(A) nematodes (B) fungi
(C) viruses (D) insects
14. Maximum number of existing transgenic animals is of
(A) fish (B) mice
(C) cow (D) pig

MOCK TEST

- Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of
(A) Omega 3 (B) Vitamin A (C) Vitamin B (D) Vitamin C
- What is true of Bt toxin ?
(A) The concerned Bacillus has antitoxins.
(B) Bt protein exists as active toxin in the Bacillus.
(C) The inactive protein gets converted into active form in the insect gut.
(D) Activate toxin enters ovaries of pest and sterilise them
- A transgenic food crop which may help in solving the problem of night blindness in developing countries is
(A) Golden rice (B) Flavr Savr tomatoes (C) Starlink maize (D) Bt soyabean.
- A dicotyledonous plant forms crown gall when
(A) Agrobacterium tumefaciens comes in contact with the plant.
(B) Agrobacterium rhizogenes comes in contact with the plant.
(C) A specific part of DNA from the Ti plasmid gets integrated with the plant chromosome.
(D) A specific part of DNA from the Ri plasmid gets integrated with the plant chromosome.
- Which of the following genes do not occur naturally in living organisms ?
(A) Bt genes (B) RNAi genes
(C) Cry genes (D) Endogeneous cytoplasmic defense genes
- Bacillus thuringiensis (Bt) strains have been used for designing novel
(A) Bio-fertilisers (B) Bio- Insecticidal plants
(C) Bio-insecticidal plants (D) Bio-metallurgical techniques.
- A transgenic plant is one into which
(A) A gene from another plant is introduced (B) A gene from an animals is introduced
(C) A gene from a microorganism is introduced (D) Both (A) and (C)
- Which kind of therapy was given in 1990 to a four- year-old girl with adenosine deaminase (ADA) deficiency?
(A) Gene therapy (B) Chemotherapy (C) Immunotherapy (D) Radiation therapy
- What is the advantage in clinical use of humulin (human insulin produced through rDNA technique) over use of conventional ox or pig insulin ?
(A) It does not cause immunological problems (B) It is cheaper for the patient
(C) It is produced by E.coli in our own intestine (D) There is no advantage.
- Gene therapy is a treatment that can be done with
(A) adults only (B) child or embryo only
(C) pregnant mothers only (D) persons of any age and any condition
- Ernst Chain and Howard Florey's contribution was
(A) Discovery of streptokinase
(B) Establishing the potential of penicillin as an effective antibiotic
(C) Discovery of the DNA sequencer
(D) Production of genetically engineered insulin.
- Human proteins can be produced in the milk or semen of farm animals . True or false ?
(A) True (B) False, proteins cannot be produced in milk
(C) False, proteins cannot be produced in semen (D) False, animals are not used for protein production

11th Class Modules Chapter Details



PHYSICS	CHEMISTRY	BIOLOGY
<p>Module-1</p> <ol style="list-style-type: none"> 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics <p>Module-2</p> <ol style="list-style-type: none"> 1. Law of Motion & Friction 2. Work, Energy & Power <p>Module-3</p> <ol style="list-style-type: none"> 1. Motion of system of particles & Rigid Body 2. Gravitation <p>Module-4</p> <ol style="list-style-type: none"> 1. Mechanical Properties of Matter 2. Thermal Properties of Matter <p>Module-5</p> <ol style="list-style-type: none"> 1. Oscillations 2. Waves 	<p>Module-1(PC)</p> <ol style="list-style-type: none"> 1. Some Basic Concepts of Chemistry 2. Atomic Structure 3. Chemical Equilibrium 4. Ionic Equilibrium <p>Module-2(PC)</p> <ol style="list-style-type: none"> 1. Thermodynamics & Thermochemistry 2. Redox Reaction 3. States Of Matter (Gaseous & Liquid) <p>Module-3(IC)</p> <ol style="list-style-type: none"> 1. Periodic Table 2. Chemical Bonding 3. Hydrogen & Its Compounds 4. S-Block <p>Module-4(OC)</p> <ol style="list-style-type: none"> 1. Nomenclature of Organic Compounds 2. Isomerism 3. General Organic Chemistry <p>Module-5(OC)</p> <ol style="list-style-type: none"> 1. Reaction Mechanism 2. Hydrocarbon 3. Aromatic Hydrocarbon 4. Environmental Chemistry & Analysis Of Organic Compounds 	<p>Module-1</p> <ol style="list-style-type: none"> 1. Diversity in the Living World 2. Plant Kingdom 3. Animal Kingdom <p>Module-2</p> <ol style="list-style-type: none"> 1. Morphology in Flowering Plants 2. Anatomy of Flowering Plants 3. Structural Organization in Animals <p>Module-3</p> <ol style="list-style-type: none"> 1. Cell: The Unit of Life 2. Biomolecules 3. Cell Cycle & Cell Division 4. Transport in Plants 5. Mineral Nutrition <p>Module-4</p> <ol style="list-style-type: none"> 1. Photosynthesis in Higher Plants 2. Respiration in Plants 3. Plant Growth and Development 4. Digestion & Absorption 5. Breathing & Exchange of Gases <p>Module-5</p> <ol style="list-style-type: none"> 1. Body Fluids & Its Circulation 2. Excretory Products & Their Elimination 3. Locomotion & Its Movement 4. Neural Control & Coordination 5. Chemical Coordination and Integration

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12th Class Modules Chapter Details

Physics
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Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS	CHEMISTRY	BIOLOGY
<p>Module-1</p> <ol style="list-style-type: none"> 1. Electrostatics 2. Capacitance <p>Module-2</p> <ol style="list-style-type: none"> 1. Current Electricity 2. Magnetic Effect of Current and Magnetism <p>Module-3</p> <ol style="list-style-type: none"> 1. Electromagnetic Induction 2. Alternating Current <p>Module-4</p> <ol style="list-style-type: none"> 1. Geometrical Optics 2. Wave Optics <p>Module-5</p> <ol style="list-style-type: none"> 1. Modern Physics 2. Nuclear Physics 3. Solids & Semiconductor Devices 4. Electromagnetic Waves 	<p>Module-1(PC)</p> <ol style="list-style-type: none"> 1. Solid State 2. Chemical Kinetics 3. Solutions and Colligative Properties <p>Module-2(PC)</p> <ol style="list-style-type: none"> 1. Electrochemistry 2. Surface Chemistry <p>Module-3(IC)</p> <ol style="list-style-type: none"> 1. P-Block Elements 2. Transition Elements (d & f block) 3. Co-ordination Compound 4. Metallurgy <p>Module-4(OC)</p> <ol style="list-style-type: none"> 1. HaloAlkanes & HaloArenes 2. Alcohol, Phenol & Ether 3. Aldehyde, Ketone & Carboxylic Acid <p>Module-5(OC)</p> <ol style="list-style-type: none"> 1. Nitrogen & Its Derivatives 2. Biomolecules & Polymers 3. Chemistry in Everyday Life 	<p>Module-1</p> <ol style="list-style-type: none"> 1. Reproduction in Organisms 2. Sexual Reproduction in Flowering Plants 3. Human Reproduction 4. Reproductive Health <p>Module-2</p> <ol style="list-style-type: none"> 1. Principles of Inheritance and Variation 2. Molecular Basis of Inheritance 3. Evolution <p>Module-3</p> <ol style="list-style-type: none"> 1. Human Health and Disease 2. Strategies for Enhancement in Food Production 3. Microbes in Human Welfare <p>Module-4</p> <ol style="list-style-type: none"> 1. Biotechnology: Principles and Processes 2. Biotechnology and Its Applications 3. Organisms and Populations <p>Module-5</p> <ol style="list-style-type: none"> 1. Ecosystem 2. Biodiversity and Conservation 3. Environmental Issues

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