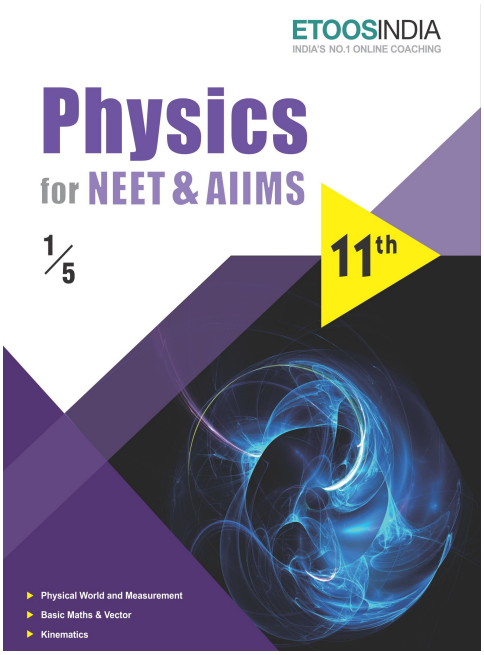
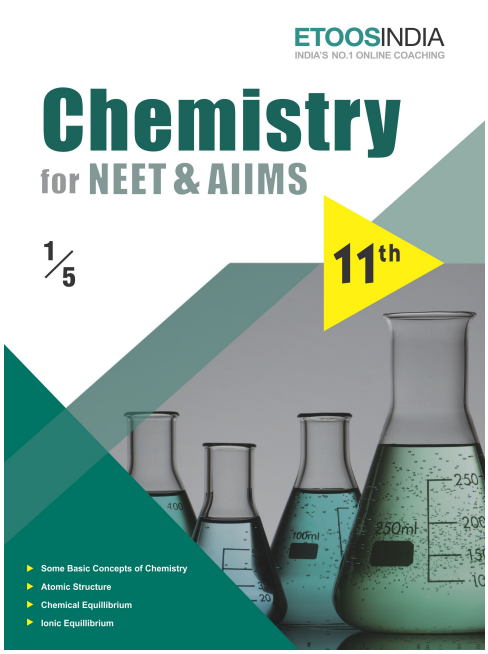
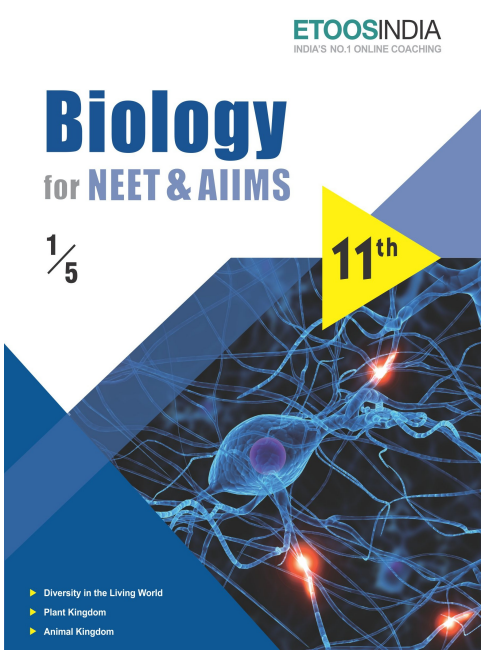
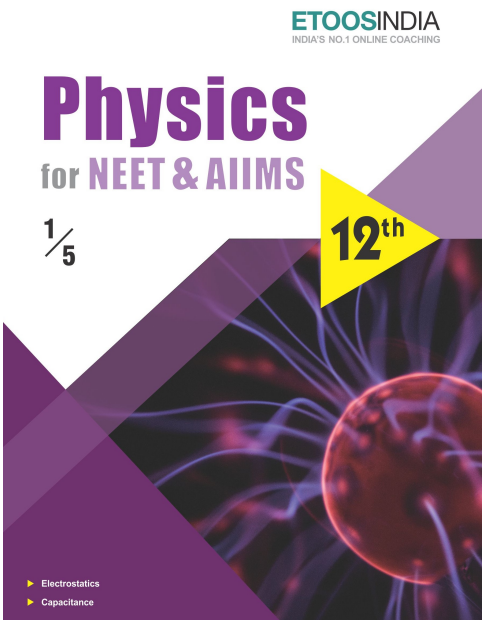
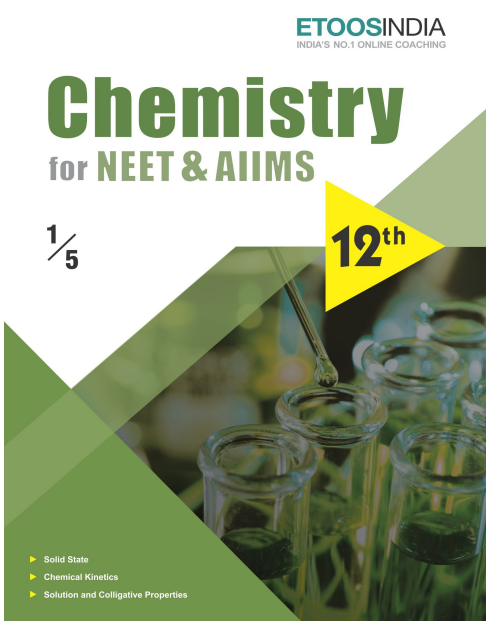
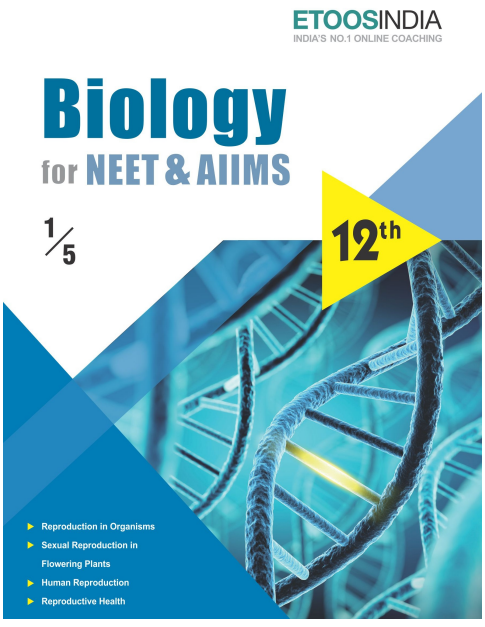












CHAPTER 11

BIOTECHNOLOGY: PRINCIPLE & PROCESSES

"Wonder is what sets us apart from other life forms. No other species wonders about the meaning of existence or the complexity of the universe or themselves.".

"HERBERT BOYER (1936)"

INTRODUCTION

Biotechnology is a technology based on biology, especially when used in agriculture, food science and medicine. it deals with using live organisms or enzymes from organisms to produce products and processes useful to humans. The term brings to thought to create or develop new animals.Others dream of almost unlimited sources of human therapeutic drugs.In this sense, making of curd, bread or wine, which are all microbe-mediated processes, colud also be thought as s form of biotechnology.However, it is used in a restricted sense today, to refer to such of those processes which use genetically modified organisms to achieve the same on a large scale.

This chapter deals with the basic principles of biotechnology, the components central to the process of gene cloning such as DNA manipulative enzymes and vectors which transport the desired gene into host cell.Later part of the chapter turns focus to PCR process and applications along with obtaining the desired product on large scale using bioreactors.

Biotechnology : Principles & Processes

Biotechnology is the use of living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

Or in simple language Biotechnology is a technology that involves the use of living organisms. Biotechnology is mainly used in agriculture, food science, and medicine. In biotechnology, living organisms are used to make useful chemicals and products or to perform an industrial task.

Old Biotechnology is based on the Natural. Capabilities of micro organism.

Ex - Formation of citric Acid, Production of Penicillin by Penicillum Notatum.

New Biotechnology is based on Recombinant DNA biotechnology

Ex - Human gene Production Insulin

it is has been used to Transformed an Bacteria like E.coli

Principles of Biotechnology -

The two core techniques enable the birth of mordern biotechnology.

1. **Chemical - Enginnering**:- Help the Biotechnology to Produce some Product

   Ex - Antibiotics, vaccines and enzyme etc.

   In mordern Biotechnology : different type of valuable Product are Produced with help of microbiology, Biotechnology, tissue culture, molecular - biology and Immunology

2. **Genetic Engineering** :- This technique is to alter the chemistry of genetic material (DNA and RNA) to introduce these into host organism and to change the phenotype of the host organism.

   CHECKPOINT: - Father of Genetic Engineering called Paul-Berg. He is a first time formed Recombinant DNA

Microbes an House hold Productes :-

1. A common example is the Production of curd from milk, micro-organism

Ex - Lactobacillus and other commonly called Lactic Acid Bacteria (L.A.B.) Grow over Milk and convert to curd, during growth the LAB produce acid coagulated and partially digest to milk protein A small amount of the curd add to the fresh milk and milk fluid contain some percentage of LAB, at sutiable temperature multiply. So converting milk to curd which also improve its nutrition quantity by increasing vit B_{12} in our stomach. The LAB play very beneficial role in checking disease causing microbes.

2. Yeast :- Louis Pasteur show in the middle of ninteenth century that a beer and butter milk are produced from ferementation is brought by yeast. Yeast is microscopic single called organisnm.

Saccharomyces - cerevisiae

Sucrose $\xrightarrow{\text{yeast}}$ Glucose+Fructose

Glucose $\xrightarrow{\text{yeast}} 2\,C_2H_5OH + 2CO_2$

$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{yeast}} C_6H_{12}O_6 + C_6H_{12}O_6$

$C_6H_{12}O_6 + H_2O \longrightarrow 2C_2H_5O_{12} + 2CO_2$

Complex organic compund convert alcohol by yeast fermention .

Note- First time Biotechnology word was proposed by Karl-Aerechy. The technique of genetic engineering which include creation of recombinant DNA, use of gene cloning and gene transfer, overcome this limitation and allow us to isolate and introduce only one or a set of desirable genes withput introducing undesirable genes into the target organism.

Etoos Tips & Formulas

→ Genetic engineering (Recombinant DNA Technology):
→ It is a type of biotechnology involving manipulation of DNA.
→ Biotechnology deals with techniques of using live organisms or enzymes from organisms to produce products & processes useful to humans.
→ Genetic engineering involves techniques to alter the chemistry of genetic material (DNA & RNA) to introduce these into host organism and thus change the phenotype of host organism.

→ Stanley Cohen & Herbert Boyer (1972) first of all contrast recombinant DNA by joining an antibiotic resistance gene to the plasmid of Salmonella typhimurium.

→ Paul Bergh (Father of genetic engineering) transferred a gene of SV-40 virus into E.coli with the help of λ-phage vector.

→ There are three basic steps in genetically modifying an organism :-
(i) Identification of DNA with desirable genes.
(ii) Introduction of the identified DNA into the host.
(iii) Maintenance of introduced DNA in the host & transfer of the DNA to its progeny.

TOOLS OF RECOMBINANT DNA TECHNOLOGY

→ Four types of tools are required :
1. Enzymes
2. Vectors
3. Passenger DNA
4. Host cells

(1) Enzymes : Five different enzymes are generally required.
(a) Lysing enzyme : Required for lysis of the cells. e.g. Lysozyme.
(b) Cleaving enzyme : Required for cutting of DNA molecules.

→ Restriction endonuclease enzymes are used for this purpose.

→ They are also known as 'molecular scissor'
→ The first restriction endonuclease discovered was Hind-II.
→ All the restriction endonuclease are naturally found in bacteria as a part of their defence system.'
→ All restriction enzymes cuts DNA at specific base sequence known as recognition / restriction sequence.
→ More than 900 restriction enzymes have been isolated from over 230 strains of bacteria.
→ In the naming of these enzymes, first letter of name comes from genes & second two letters from species of bacteria. The fourth letter indicates strain of bacteria. Roman number following the names indicates the order in which the enzyme were isolated from that strain of bacteria.
→ The restriction site of these enzyme is a specific pallindromic nucleotide sequence in the DNA.

(c) Synthesizing enzyme : Required for synthesis of DNA.
e.g. DNA polymerase, Reverse transcriptase.

(d) Joining enzyme : Required for joining of DNA segments. e.g. DNA ligase.

(e) Alkaline phosphatase : It cut off phosphate group from the 5' end of linearised circular DNA & prevents its recircularization.

(2) Vector/ Vechicle DNA:

→ They are the DNA used as carrier for transferring a fragment of DNA into suitable host cell.
→ A vector must have following three features :
(i) Presence of 'Ori' to start the replication.

SOLVED EXAMPLE

Ex.1 Which of these is used as vector in gene therapy for SCID

Or

Which of the following has the ability to transform normal cells into cancerous cell in animal

(A) Arbovirus **(B)** Rotavirus

(C) Enterovirus **(D)** Parvovirus

(E) Retrovirus

Sol. **(E)**

Ex.2 Which of the following organelle is related with genetic engineering/gene cloning

(A) Golgi apparatus **(B)** Lysosomes

(C) Mitochondria **(D)** Plasmids

Sol. **(D)** : Plasmids are extrachromosomal covalently closed circular double stranded molecules of DNA present in most prokaryotes. Therefore they are used as a vector in genetic engineering.

Ex.3 Recombinant DNA (rDNA) technology is related with

(A) C. Darwin **(B)** Stanley Cohen

(C) Herbert Boyer **(D)** Both **(B)** and **(C)**

Sol. **(D)** : The first recombinant DNA was constructed by Stanley cohen and Herbert in 1972. They cut the piece of DNA from a plasmid carrying antibiotic - resistance gene in the bacterium Salmonella typhimrium and linked it to the plasmid of Escherichia coli.

Ex.4 Which one of the following techniques made it possible to genetically engineer living organisms

Or

The experimental manipulation of DNA of different species producing recombinant DNA is known as

(A) Heavier isotope labelling

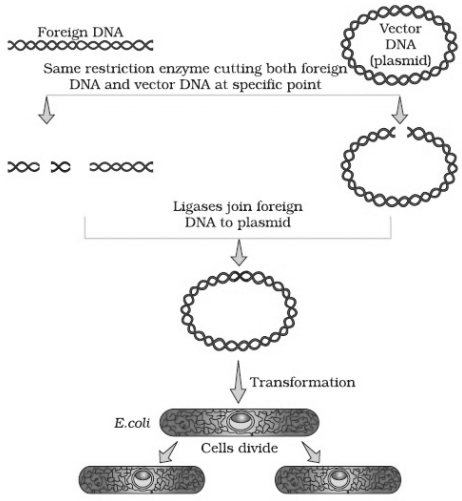
(B) Hybridization

(C) Recombinant DNA techniques

(D) X-ray diffraction

Sol. **(C)**

Ex.5 The below figure refers to recombinant DNA technology. Identify A, B, C and D respectively



	A	B	C	D
(A)	Restriction Endonuclease	Restriction Endonuclease	DNA ligase	Transformation
(B)	Exonuclease	Endonuclease	Hydrolase	Transduction
(C)	Endonuclease	Exonuclease	DNA ligase	Transformation
(D)	Exonuclease	Endonuclease	DNA ligase	Transformation

Sol. **(A)**

Ex.6 Which of the following enzymes catalyse the removal of nucleotides from the ends of DNA

(A) Endonuclease **(B)** Exonuclease

(C) DNA ligase **(D)** Hind - II

Sol. **(B)**

Ex.7 Which of the given statements is correct in the context of visualizing DNA molecules separated by agarose gel electrophoresis.

(A) DNA can be seen in visible light

(B) DNA can be seen without staining in visible light

(C) Ethidium bromide stained DNA can be seen in visible light

(D) Ethidium bromide stained DNA can be seen under exposure to UV light

Sol. **(D)**

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. The linking of antibiotic resistance gene with the plasmid vector became possible with
(A) DNA polymerase (B) Exonucleases
(C) DNA ligase (D) Endonucleases

2. Main objective of production/use of herbicide resistant GM crops is to
(A) Encourage eco-friendly herbicides
(B) Reduce herbicide accumulation in food articles for health safety
(C) Eliminate weeds from the field without the use of manual labour
(D) Eliminate weeds from the field without the use of herbicides

3. Which of these is used as vector in gene therapy for SCID

Or

Which of the following has the ability to transform normal cells into cancerous cell in animal
(A) Arbovirus (B) Rotavirus
(C) Enterovirus (D) Parvovirus
(E) Retrovirus

4. Which one among the following is just a cloning plasmid not an expression plasmid
(A) pBAD-18-Cam (B) pBCSK
(C) pUC18 (D) pET

5. Branch dealing with genetic engineering is
(A) Eugenics (B) Euthenics
(C) Euphenics (D) None of these

6. Genetic engineering means
(A) Manipulation of cell contents
(B) Test tube babies
(C) Manipulation of cytochromes
(D) Manipulation (modification) of genes

7. Who among the following scientists is associated with the discoveries in genetic engineering
(A) Khorana (B) Watson
(C) Crick (D) Messelson

8. It is now possible to breed plants and animals with desired characters through
(A) Genetic engineering
(B) Chromosome engineering
(C) lkebana technique
(D) Tissue culture

9. Which of the following organelles is related with genetic engineering/gene cloning
(A) Golgi apparatus (B) Lysosomes
(C) Mitochondria (D) Plasmids

10. In genetic engineering, a DNA segment (gene) of interest, is transferred to the host cell through a vector. Consider the following four agents (A-D) in this regard and select the correct option about which one or more of these can be used as a vector/vectors
Statements
(A) A bacterium (B) Plasmid
(C) Plasmodium (D) Bacteriophage

11. Recombinant DNA (rDNA) technology is related with
(A) C. Darwin (B) Stanley Cohen
(C) Herbert Boyer (D) Both (B) and (C)

12. A desirable change in genotype of an organism is obtained by
(A) DNA replication (B) Protein synthesis
(C) rDNA technology (D) m-RNA formation

13. Which of these is widely used in genetic engineering
(A) Anopheles (B) Dragon fly
(C) Dragon lizard (D) Fruit fly

14. Identify the plasmid
(A) AIU I (B) Hind III
(C) Eco RI (D) pBr 322

15. In recombination vector used is
(A) Protein
(B) Agrobacterium tumefaciens
(C) Nucleic acid
(D) Cellulose

16. First biochemical to be produced commercially by microbial cloning and genetic engineering is
(A) Human insulin (B) Penicillin
(C) Interferons (D) Fertility factors

17. Which of the following option is correct for recombinant DNA technology
(A) Exonuclease enzyme removes nucleotides from site within DNA
(B) Endonuclease enzyme removes nucleotides from the ends of DNA
(C) Endonuclease enzyme cut long polandric DNA strands
(D) Exonuclease enzyme removes nucleotides from ends of DNA

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. Restriction endonucleases are most widely used in recombinant DNA technology. They are obtained from
(A) Bacteriophages (B) Bacterial cells
(C) Plasmids (D) All prokaryotic cells

2. In recombinant DNA technique the term vector refers to
(A) Plasmids that can transfer foreign DNA into a living cell
(B) Cosmids that can cut DNA at specific base sequence
(C) Plasmids that can join different DNA fragments
(D) Cosmids that can degrade harmful proteins

3. An analysis of chromosomal DNA using the southern hybridization technique does not use
(A) Autoradiography (B) PCR
(C) Electrophoresis (D) Blotting

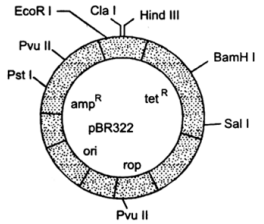
4. Genetic engineering has been successfully used for producing
(A) Animals like bulls for farm work as they have super power
(B) Transgenic mice for testing safety of polio vaccine before use in humans
(C) Transgenic models for studying new treatments for certain cardiac diseases
(D) Transgenic Cow-Rosie which produces high fat milk for making ghee

5. pBR322 which is frequently used as a vector for cloning gene in E. coli is a/an
(A) Original bacterial plasmid
(B) Modified bacterial plasmid
(C) Viral genome
(D) Transposon

6. Which one of the following techniques made it possible to genetically engineer living organisms
The experimental manipulation of DNA of different species producing recombinant DNA is known as
(A) Heavier isotope labeling
(B) Hybridization
(C) Recombinant DNA techniques
(D) X-ray diffraction

7. The enzyme which are absolutely necessary for recombinant DNA technology are
(A) Restriction endonucleases and topoisomerases
(B) Endonucleases and polymerases
(C) Restriction endonucleases and ligases
(D) Peptidases and ligases

8. The figure below is the diagrammatic representation of the E. coli vector pBR 322. Which one of the given options correctly identifies its certain component (s)



(A) Ori-original restriction enzyme
(B) Rop-reduced osmotic pressure
(C) Hind III, EcorRI - selectable markers
(D) ampR, tetR - Antibiotice resistance genes

9. PCR and Restriction Fragment Length Polymorphism are the methods for
(A) Study of enzymes
(B) Genetic transformation
(C) DNA sequencing
(D) Genetic-Fingerprinting

10. Fearing that the child to be born may have a genetic disorder, a couple goes to a doctor. Which one of the following techniques is likely to be suggested by the doctor to cure the genetic disorder
(A) Hybridoma technology
(B) Gene therapy
(C) rDNA technology
(D) Embryo transfer

11. In genetic engineering, the antibiotics are used
(A) As selectable markers
(B) To select healthy vectors
(C) As sequences from where replication starts
(D) To keep the cultures free of infection

12. The colonies of recombinant bacteria appear white in contrast to blue colonies of non-recombinant bacteria because of
(A) Inactivation of glycosidase enzyme in recombinant bacteria
(B) Non-recombinant bacteria containing beta-galactosidase
(C) Insertional inactivation of alpha-galactosidase in non-recombinant bacteria
(D) Insertional inactivation of alpha-galactosidase in recombinant bacteria

Exercise # 3

PART - 1 MATRIX MATCH COLUMN

1. Match Column - I and Column - II and select the right option given below.

Column - I	Column - II
(I) Recombinant DNA technology	(A) Vector
(II) Cloning Vehicle	(B) Sealing enzyme
(III) Macromolecular	(C) Electrophoresis
(IV) DNA Ligase	(D) Genetic engineering

(A) I - D, II - A, III - B, IV - C
(B) I - A, II - D, III - B, IV - C
(C) I - D, II - A, III - C, IV - B
(D) I - B, II - A, III - D, IV - C

2. Match the scientists in Column-I with their related discoveries in Column-II and select the correct option from the codes given below.

Column-I	Column-II
(A) Kary Mullis	(i) Father of genetic engineering
(B) Paul Berg	(ii) Nobel prize for the discovery of restriction endonucleases
(C) Stanley Cohen and Herbert Boyer	(iii) Developed polymerase chain reaction
(D) Arber, Smith and Nathan	(iv) Isolated an antibiotic resistant gene from a plasmid of the bacterium Salmonella typhimurium

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

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

Column-I	Column-II
(A) amp^r	(i) Artificial plasmid
(B) macromolecular separation	(ii) Selectable marker
(C) Hind III	(iii) Electrophoresis
(D) pBR322	(iv) Haemophilus influenza

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

4. Match the terms given in Column-I with their definitions in Column-II and select the correct anwser from codes given below.

Column-I	Column-II
(A) Transformation	(i) Sequences cut by restriction enzymes
(B) Recognition	(ii) Process by which DNA sequences fragments are separated based on their size
(C) Gel electrophoresis	(iii) Plasmid DNA that has incorporated human DNA
(D) Recombinant DNA	(iv) Process by which bacteria take up pieces of DNA from the environment

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

5. Match Column-I with Column-II with respect to the nomenclature of restriction enzyme Eco R I and select the correct answer from codes given below.

Column-I	Column-II
(A) E	(i) 1st in order of identification
(B) Co	(ii) Name of genus
(C) R	(iii) Name of species
(D) I	(iv) Name of strain

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

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

1. Plasmids are suitable vectors for gene cloning becauseu
   (A) these are small circular DNA molecules which can integrate with host chromosomal DNA
   (B) these are small circular DNA molecules with their own replication origin site
   (C) these can shuttle between prokaryotic and eukaryotic cells
   (D) these often carry antibiotic resistance genes

2. Plasmid is
   (A) fragment of DNA which acts as vector
   (B) a fragment which joins two genes
   (C) mRNA which acts as carrier
   (D) autotrophic fragment

3. In bacteria, plasmid is
   (A) extrachromosomal material
   (B) main DNA
   (C) non-functional DNA
   (D) repetitive gene

4. A muant strain of T_4-bacteriophage R-II, fails to lyse the E. coli but when two strains R-II^x and R-II^y are mixed then they lyse the E. coli. What may be the possible reason?
   (A) Bacteriophage transforms in wild
   (B) It is not mutated
   (C) Both strains have similar cistrons
   (D) Both strains have different cistrons

5. Manipulation of DNA in genetic engineering became possible due to the discovery of
   (A) restriction endonuclease
   (B) DNA ligase
   (C) transcriptase
   (D) primase

6. ELISA is used to detect viruses where the key reagent is
   (A) alkaline phosphatase (B) catalase
   (C) DNA probe (D) RNase

7. The Ti plasmid, is often used for making ransgenic plants. This plasmid is found in
   (A) *Azotobacter*
   (B) *Rhizobium of the roots of leguminous plants*
   (C) *Agrobacterium*
   (D) Yeast as a 2 μm plasmid

8. In transgenics, expression of transgene in target tissue is determined by
   (A) enhancer (B) transgene
   (C) promoter (D) reporter

9. Restriction endonucleases
   (A) are present in mammalian cells for degradation of DNA when the cell dies
   (B) are used in genetic engineering for ligating two DNA molecules
   (C) are used for *in vitro* DNA synthesis
   (D) are synthesised by bacteria as part of their defense mechanism

10. The limking of antibiotic resistance gene with the plasmid vector became possible with
    (A) DNA polymerase (B) exonucleases
    (C) DNA ligase (D) endonucleases

11. Gel electrophoresis is used for
    (A) construction of recombinant DNA by joing with cloning vectors
    (B) isolation of DNA molecules
    (C) cutting of DNA into fragments
    (D) separation of DNA fragments according to their size

12. The genetic defect - Adenosine Deaminase (ADA) deficinecy may be cured permanently by
    (A) periodic infusion of genetically engineered lymphocytes having functional ADA cDNA
    (B) administering adenosine deaminase activators
    (C) introducing bone marrow cells producing ADA into cells at early embryonic stages
    (D) enzyme replacement therapy

13. Polyethylene glycol method is used for
    (A) biodiesel production
    (B) seedless fruit production
    (C) energy production from sewage
    (D) gene transfer without a vector

14. Which one of the following is commonly used in transfer of foreign DNA into crop plants ?
    (A) *Trichoderma harzianum*
    (B) *meloidogyne incognita*
    (C) *Agrobacterium tumefaciens*
    (D) *Penicillium expansum*

MOCK TEST

1. Which one of the following te4chniques made it possible to genetically engineer living organisms?
(A) Recombinant DNA techniques (B) X-ray diffraction
(C) Heavier isotope labelling (D) Hybridisation

2. In genetic fingerprinting, the 'probe' refers to _____
(A) a radioactively labelled single stranded DNA molecule
(B) a radioactively labelled single stranded RNA molecule
(C) a radioactively labelled double stranded RNA molecule
(D) a radioactively labelled double starnded DNA molecule

3. Plants in comparison to animals are more rapidly manipulated by genetic engineering. Select out the most probale reason for this
(A) Totipotency shown by plant cells
(B) Single somatic cell can regenerate a whole plant body
(C) Genetic engineering is supplemented with plant tissue culture techniques
(D) All of the above

4. A foreign DNA and plasmid cut by the same restriction endonuclease can be joined to form a recombinant plasmid using
(A) EcoRI (B) Taq polymerase (C) Polymerase III (D) Ligase.

5. Which of the following restriction enzymes produces blunt ends ?
(A) SalI (B) EcoRV (C) XhoI (D) HindIII

6. Match the items in column I with their user in column II and choose the right option

Column I	Column II
(A) ELISA	(i) Antigen- antibody interaction
(B) PCR	(ii) Gene amplification
(C) Biolistics	(iii) Direct introduction of recombinant DNA
(D) Micr-injection	(iv) Gold coated DNA

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

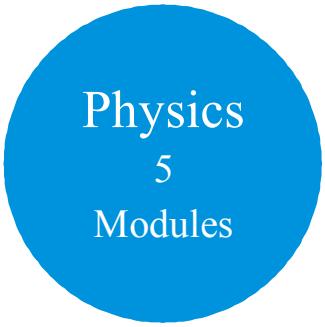
7. Match the items in column I with their uses in column II and choose the right option

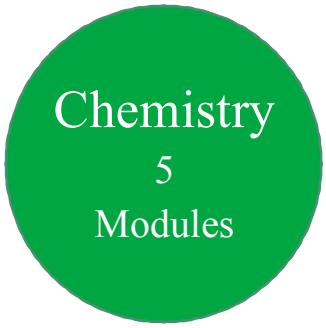
Column I	Column II
(A) Bacillus thuringiensis	(i) Restriction endonuclease
(B) Agrobacterium tumefaciens	(ii) Thermostable DNA polymerase
(C) Thermus aquaticus	(iii) Insecticidal protein
(D) Escherichai coli	(iv) Ti plasmid

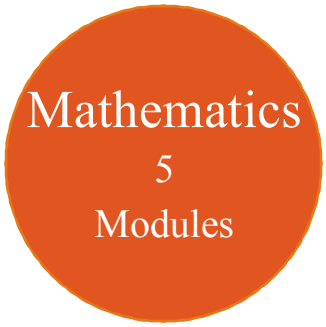
(A) A-(iii), B-(iv), C-(i), D-(ii) (B) A-(ii), B-(i), C-(iv), D-(iii)
(C) A-(iv), B-(i), C-(ii), D-(iii) (D) A-(i), B-(iv), C-(ii), D-(iii)
(E) A-(iii), B-(iv), C-(ii), D-(i)

8. Which organism is used to transfer T-DNA ?
(A) Streptomyces hygroscopicus (B) Agrobacterum fumefaciens
(C) Salmonella typhi (D) Escherichia coli

11th Class Modules Chapter Details

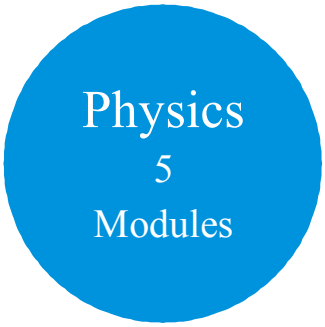


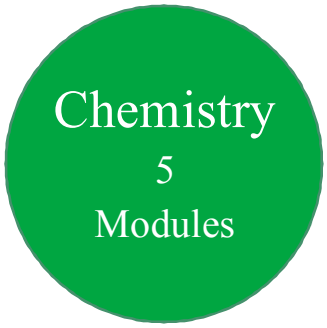


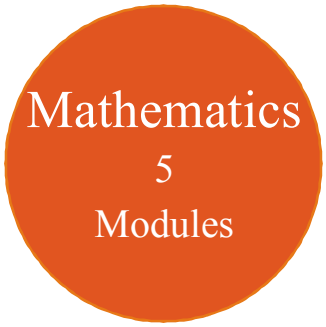


PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal 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