CLASS XII

There will be two papers in the subject

***Paper I:** Theory:*	*3 hours ... 70 marks*
***Paper II**: Practical:*	*3 hours ... 20 marks*
Project Work	*... 7 marks*
Practical File	*... 3marks*

PAPER I –THEORY- 70 Marks

*There will be **one** paper of **three** hours duration divided into **two** parts.*

***Part 1 (20 marks)** will consist of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.*

***Part 2 (50 marks)** will consist of **eight** questions out of which the candidates will be required to answer **five** questions. Each question in this part shall carry 10 marks.*

1. Molecular Biology

(a) Biomolecules: introduction to biomolecules-definition and types. Carbohydrates, proteins, lipids, vitamins and enzymes – their structure and properties.

Structure and functions of carbohydrates.

Sugars and derivatives – some important mono, di and polysaccharides. Glycogen, cellulose, chitin and peptidoglycon. Chemical properties of sugars.

Structure and functions of proteins – building blocks of proteins, the amino acids. Chemical structure, types and chemical properties of amino acids. Different methods employed in determining the amino acid sequence in proteins - 3D - structure of proteins. Different types of proteins - primary, secondary, tertiary quarternary. Vitamins and co-enzymes.

Structure and functions of enzymes: chemical nature of enzymes and the properties of enzymes. An understanding of enzyme activity.

Structure and functions of lipids – building blocks of amino acids, their structures, types and chemical properties.

Optical activity / steriochemistry of biomolecules.

Concept of supramolecular assembly.

(b) Nucleic acids: an understanding of nucleic acids, their importance in biotechnological work, biochemical structure and capacity to replicate.

DNA - definition, double helical model of DNA, replication of DNA basic concept, molecular basis of DNA replication, various replicative enzymes in both procaryotic and eucaryotic organisms, example topoisomerases, helicase, polymerases, primase. Concept of semi-discontinuous replication.

RNA – definition, various types of RNAs such as mRNA, tRNA, their structure and functions.

(c) Protein Synthesis: synthesis of different RNAs, and the complete mechanism of polypeptide chain formation. Different metabolic diseases which occur due to a change in the DNA structure.

Genetic code – basic concept of genetic code, chain initiation and chain termination, biochemical process of protein synthesis.

Transcription - DNA to RNA, and various enzymes involved with an explanation of the complete process. The translation of RNA to protein – complete mechanism of chain initiation, elongation and termination.

Concept of central dogma, an overview of transcription factors and mechanism. An understanding of one gene one enzyme hypothesis and amino acid metabolism. Fine structure of gene, exon, intron.

Gene regulation – Operon concept.

Inborn errors of metabolism - basic concept and examples like Albinism.

2. Genetic Engineering

(a) Innovations in Biotechnology: select examples of products already available, produced by using modern biotechnological tools.

(i) Plants: Flavr Savor tomatoes; designer oil.

(ii) Healthcare: recombinant hepatitis-B vaccine; insulin or interferon.

(iii) Animal: Dolly the cloned sheep; stem-cells research.

(iv) Environmental biotechnology: oil-eating bacteria.

(v) Industrial biotechnology: production of enzymes.

(b) Introduction to gene cloning: concept of cloning and vectors. Various vectors used for recombinant DNA.

Definition, significance of gene cloning and detecting the target DNA.

Techniques involved in extraction and purification of DNA from bacterial plants and animal cells, concept of vectors, cloning of few vectors such as plasmids, phages, YACs and BACS and the use of plasmid vectors in DNA manipulation.

A basic understanding of genomic libraries – construction and cloning.

Cloning using the restriction enzymes.

(c) Biochemical techniques: classification of techniques based on various factors.

Classification of techniques based on various factors.

Molecular weight or size: centrifugation, gel permeation, osmotic pressure.

Polarity or charge: ion exchange chromatography, electrophoresis, iso-electric focussing, hydrophobic interaction, partition chromatography, spectroscopy colorimetry, UV visible spectrophotometry, florescence spectroscopy, crystallography and mass spectrometry.

Solubility: salt precipitation and precipitation with organic solvent.

(d) Gene analysis techniques: various techniques involved in any work in recombinant DNA technology.

Low resolution mapping techniques: gel electrophoresis, northern blotting, southern blotting.

High resolution techniques: DNA sequencing-sequencing by chemical degradation, sequencing by chain termination, automated DNA sequencing.

Polymerase chain reaction (PCR)– definition, principle and significance.

Genotyping using PCR technology, concept of oligonuecleotide primers, taq polymerase, identifying genes by positional cloning using a classic example of human disease cystic fibrosis.

Major contributors and goals of Human Genome Project.

3. Cell Culture Technology

(a) Introduction and Techniques: basic understanding of cell culture technology and its significance in biotechnology. Different materials and methods used in this technology.

Introductory History: definition of cell culture, different types of tissues and organ cultures. Role of auxins, cytokinins in cell tissue culture. Importance of media in cell culture.

Preparation and cloning of cell culture along with regeneration of single cell to whole plant.

Role of cell and tissue culture in plant genetic manipulation – genetic variability, invitro pollination, induction of haploidy somatic hybridisation and genetic transformation.

Media and aseptic manipulation: definition of media, composition of media – inorganic nutrients, organic nutrients, macronutrients, micronutrients and other important supplements. Solidifying agents and pH.

Sterilisation of apparatus and instruments used in cell culture, culture rooms and transfer area.

(b) Cell culture and cellular totipotency: types of cell culture and the concept of cellular totipotency.

Cell culture: importance of single cell culture. Different methods involved in isolation of single cells from plant organs - mechanical and enzymatic methods.

Concept and types of suspension culture: batch cultures and continuous cultures. Culture medium for cell suspensions, synchronisation of suspension cultures.

Chemical methods – starvation, inhibition, mitotic arrest and plating techniques.

Cellular totipotency: definition of cellular totipotency. Concepts like cell differentiation, dedifferentiation and redifferentiation, vascular differentiation. Different aspects of cell differentiation: cytological, cytochemical, physiological and physical.

(c) Germplasm conservation: definition and significance of germplasm conservation and various methods involved in it.

Definition and need of germplasm conservation. Modes of conservation: in-situ conservation, ex-situ conservation. Materials used for conservation. Principles involved in freeze preservation. Various types of freeze preservation, the factors affecting freezing and the various methods of maintaining the frozen cultures. Applications and limitations of germplasm conservation using cell and tissue cultures. Single cell protein concept.

(d) Applications of cell culture technology: different fields in which cell culture technology is used and the ways it is used.

Application of cell culture technology in plant breeding: haploid production – an understanding of haploid production and in vivo techniques employed to induce haploid production such as gynogenesis, androgenesis, genome elimination by distant hybridisation and semigamy, chemical treatment, temperature shocks and irradiation effects.

Triploid production: understanding and need of triploid production. Various techniques involved in triploid production. Application of triploids in plant improvement.

In vitro pollination: concept, methodology and application of in vitro pollination.

Zygotic embryo culture concept, types and techniques and applications.

Concept of somatic hybridisation and cybridisation protoplast fusion, genetic transformation and their applications in plant improvement.

4. Bio-informatics

(a) Introduction: an introduction to computers, both hardware and software aspects. Global biological data bases.

Introduction to computer software and hardware. Definition, significance and application of bio-informatics. Enormity of data generated by biological systems; managing the data using tools provided by Information Technology

An introduction to global bio-informatics databases (nucleotide and protein databases) such as EMBL, NCBI.

(b) Genomics: basic understanding of genome, types of genome, criteria for selecting an organism for sequencing. Various theoretical aspects of searching genes using the computer.

Definition of genomics, organisation of prokaryotic and eukaryotic genomes. Basic criteria in selecting the organism for its genome sequencing. Concept of transposons. Searching for genes using computers. All the theoretical aspects – exons, intron, promoter region, start codon, end codon, coding regions, non coding regions, ESTs (Expressed Sequence Tags) and STSs (Sequence Tagged Sites) and the different softwares used like gene scan. Types of sequence analysis –global, local, pair wise and multiple. A brief note on various sequence alignment programs and the significance of sequence analysis. A mention of different computer software and programs used in sequence analysis.

(c) Proteomics: definition and introduction.

Different softwares commercially available for structural prediction of proteins. Softwares available easily on the internet, important protein databases available for the public on the internet like PDB (protein data bank), PIR (protein identification resources). Use of computers in new drug development research - concept of single nucleotide polymorphisms (SNPs).

Biotechnology - global and Indian scenario. Various institutes, centers and funding agencies which deal with biotechnology and bioinformatics in India.

PAPER II

PRACTICAL WORK – 20 marks

Candidates are required to complete the following experiments.

1. Sterilization techniques:

   Dry Physical method – heat or radiation.

   Wet Physical methods – steam sterilization.

   Disinfection with 70% alcohol. Chlorine/ Savlon/Carbolic acid.

2. Preparation of buffers:

   This experiment should be done to make the basics clear to the students. The approach should be to utilize easily available chemicals at reasonable costs. For this "Phosphate buffer, Acetate buffer and Borate buffer" are good for practice. (pH 4 - pH 9.2).

3. Preparation of culture media:

   (i) 1% Peptone Water (Nutrient broth)/Nutrient Agar.

   (ii) (Sugars + Coconut milk + Agar Agar) Plant Tissue culture medium.

4. Growth of bacteria in culture:

   Growth of bacteria in culture in nutrient broth.

   (Time related growth).

5. Isolation of proteins:

   Pea germinating seeds proteins should be isolated in buffers. Presence of protein to be identified by colour reaction.

6. Determination of Blood Groups:

   Students can perform this experiment on their own and work out their own blood group. Proper instruction however are to be given for 'prick' – e.g. (a) Sterilize finger with alcohol/disinfectant. (b) Use only disposable sterile needle. (c) Use the needle only once and destroy it. (d) Do not prick or use blood drop in an indiscriminatory way.

7. Salivary amylase activity on starch

   (i) Soluble starch solution (0.5% - 1%) to be prepared.

   (ii) Test with iodine.

   (iii) Take saliva, dilute 1:5, add 1 ml of saliva to 10ml of starch solution. Incubate for 15 minutes.

   (iv) Again test for presence of starch with iodine.

   (v) Test for presence of reducing sugars in solution 1 and solution 3.

8. Separation of plant pigments by chromatography: (Paper chromatograph or TLC)

   Take any leaf. Extract chlorophyll in 80% acetone. Take a strip of paper or prepare a thin layer of silica gel on a slide. Load chlorophyll extract at one end of the paper/gel. Keep paper or gel in the rising medium in test tube or jar for about 30 minutes. The rising medium should have acetic acid, n-butanol or benzene. The rising fluid should be always at the bottom below the point of loading of chlorophylls. After 30 minutes, three spots: yellow, green and light green will be observed corresponding to carotenes, chlorophyll A & chlorophyll B.

9. Identification of Plasmid DNA and Genomic (chromosomal) DNA bands in the gels (by photographs only).

   Plasmid DNA is covalently closed circular DNA (CCC-DNA). Therefore its molecular size is very small but the molecular weight is sufficiently high. During electrophoresis, this DNA will move faster than the genomic DNA which has low density and is linear in nature.

Therefore, the bottom-most band, much away from the rest of the bands is Plasmid DNA whereas lagging bands represent the genomic (chromosomal) DNA fragments.

10. Estimation of DNA either by Colourimeter or Spectrophotometer.

    The principle behind estimation of DNA by colourimeter is to develop some sort of colour during reaction of DNA with some chemical or colouring agents. The developed colour will have some absorption at a particular wave-length. This absorbance can be plotted against the standard curve made with the help of standard solutions and by that the amount of DNA in a given solution can be calculated.

    In case of spectrophotometric determination of DNA, the capacity of DNA to absorb UV rays in the region of 285 nm is taken as the base for working out the amount of DNA in a given solution. Again the help of a standard curve is taken to estimate the quantity of DNA.

PROJECT WORK AND PRACTICAL FILE – 10 Marks

Project Work – 7 Marks

The Project Work is to be assessed by a Visiting Examiner appointed locally and approved by the Council.

Candidates are to creatively execute **one** project / assignment on an aspect of Biotechnology. Teachers may assign or students may choose any one project of their choice. The report should be kept simple, but neat and elegant. No extra credit shall be given for type-written material/decorative cover, etc.

A list of suggested projects is as follows:

1. Effluent analysis.
2. A study of the technological details of malt preparation.
3. A study of the technological details of the brewing industry.
4. A study of the organisation of a fermentor.
5. Technological analysis of the process of drug development, drug designing and drug targeting.
6. A study of the technological details of vaccine development.
7. Diagnosis of diseases by modern techniques like ELISA, RIA and Antibody targeting.
8. DNA finger-printing.
9. DNA foot-printing.
10. Microbiological contaminants in food and food products.
11. Isolation of microbes from air, water and soil.
12. Methods of identifying microbes (various staining techniques and biochemical reactions).

Practical File – 3 Marks

The Visiting Examiner is required to assess students on the basis of the practical file maintained by them during the academic year.