BIOTECHNOLOGY (878)

Aims:

1. To enable candidates to acquire the knowledge and develop an understanding of how materials are provided by biological agents to provide goods and services.
2. To appreciate the role played by biotechnology in improving health care for human beings.
3. To understand the interdisciplinary nature of this subject.
4. To create awareness about the appreciation of biological processes to industries.
5. To develop the ability to appreciate biological phenomenon in nature and the contribution of biotechnology to human welfare.
6. To develop scientific attitude towards biological phenomenon.

CLASS XI

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	*… 3 marks*

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. Introduction to Biotechnology

(a) Historical background and the future of Biotechnology: definition and a brief introduction of the traditional techniques which are now covered under the heading Biotechnology and different ways the present man is utilising the traditional principles for the betterment of mankind.

Kitchen, the first biotechnological laboratory - reasoning behind the technology involved in simple biological products like curd, beer and wine. A brief note on the causative micro-organisms.

Application of these technologies for large-scale production, with special reference to fermentation. Quality control management of the products, good laboratory practices and a brief note on international marketing.

(b) Basic concepts of Biochemical technology: What does the biochemical technology mean? An understanding of various principles and statistical methods involved in research under the umbrella of biotechnology.

Concept of buffer, pH, physical variables, dimensions and units. Fluid flow and mixing, heat and mass transfer, growth kinetics and fermentation process. An understanding of bio-reactors. Concept of probability, methods of sampling, collection of data – primary and secondary data, classification and tabulation, confidence levels, idea of sampling, distribution and standard error.

(c) Scope and importance of biotechnology: different branches of biotechnology and different regulatory, social, ethical and legal issues that a biotechnologist comes across while doing the work.

Names, definitions and importance of various fields that can be covered under biotechnology such as - agricultural/ plant biotechnology, animal biotechnology/medical biotechnology, industrial biotechnology, immunology and health care, energy, environment and services.

Intellectual Property Rights (IPRs) in biotechnology- concept of intellectual property, intellectual property rights and the choice of intellectual property rights protection. Various types of IPRs. Concept of patenting and its need. Process patenting and product patenting. Various precautions to be taken while carrying

out biotechnological work. Various types of intellectual property rights.

Concept of ethical, legal and social issues with one common example. How these issues are being tackled at national and international level.

Bio safety issues: release of genetically modified organisms into the environment.

Bridging the gap between bioscience, engineering and technology.

2. Cell Biology

(a) Cell - Basic unit of life: Justification of cell as a basic unit of life. A brief note on the cell components with special reference to nucleus and its components. Various cytological techniques used in counting and identifying the cell and chromosomes.

An understanding of cell components, their structure, and functions - cell wall, cell membrane, cytoplasmic reticulum, golgi apparatus, mitochondria, ribosomes, vacuoles, plastids, lysosomes, nucleus and other important inclusions of the cell. Differentiation between plant and animal and prokaryotic and eukaryotic cellular systems.

Chromosomal structure and composition – organisation of chromatids, concept of homologous and non-homologous chromosomes, sister and non-sister chromatids, classification of chromosomes on the basis of position of the centromere on the chromosome, basic idea about telomere, chromatin and nucleosome. An idea about banding patterns and their application.

Concept of chromosomal number in different species, e.g. man and mouse.

Techniques in cytology - microscopy, cell sorting and counting, karyotyping and banding techniques.

(b) Cell Division and cell cycle: necessity for a cell to divide. Types of cell division and various other activities of cell such as biochemical transformations.

Types and significance of cell division and a brief note about the different stages of cell division.

Concept of crossing over, chiasmata.

Basic concept of cell cycle and cell cycle regulation.

Cell communication and signal transduction, movement, nutrition, gaseous exchange, internal transport and maintenance of the internal transport and cell reproduction.

Biochemical Transformations:

An understanding of biochemical transformations, different biochemical pathways involved in respiration - aerobic and anaerobic.

Aerobic respiration - Glycolysis, Kreb's cycle, electron transport chain and oxidative phosphorylation.

Anaerobic respiration - lactic acid formation, fermentation and lactic acid alcohol formation.

Photosynthesis – brief historical account and light and dark reactions.

(c) Errors in cell division: what happens if the cell does not divide normally? An understanding of different numerical and structural abnormalities which can be detected with the help of a microscope.

Concept of non-disjunction: meiotic non-disjunction and mitotic non-disjunction. Non-disjunction in sex chromosomes – Turner's syndrome and Klienfelter's syndrome, identification and symptoms. Importance of these syndromes in studying human behavioural genetics.

Numerical chromosomal aberrations with respect to autosomes, i.e. Down's syndrome/ trisomy 21.

Structural chromosomal abnormalities – deletions, duplications, translocations, inversions, ring chromosomes and uniparental disomy.

Chromosomal abnormalities and gene mapping.

Polyploidy and its significance in plants.

3. Growth and Development in living beings

(a) Animal and plant development: development of a complete organism from zygotic cell in both plants and animals. An understanding of defence strategies in all types of living organisms.

Animal development – zygote to a stage of complete development of the foetus in a stage where it can absorb food.

Plant development. Fertilised ovules to a complete plant.

Immune response in plants and animals - immune system in higher animals, concept of immunity, immunisation, antigen and antibody. Various cells involved in immune system in humans. An introduction to human leukocyte antigens. Types of immunity - innate and acquired. ELISA Technique (Enzyme Linked Immuno Sorbant Assay).

Plant pathogen interaction. Secondary metabolism.

Defence strategies in microbes and insects.

(b) Biodiversity and evolution of populations: an understanding of biodiversity in both plants and animals and the concept of population. *Significance of biodiversity, Indian plants and animals.*

Concept and value of biodiversity. Understanding the concept of biodiversity. To appreciate various reasons for valuing and conserving biodiversity (ethical, moral, economic, aesthetic). An understanding of speciation, types of speciation - allopatric and sympatric; concept of ecosystem; adaptation and natural selection.

Organisation of life, size and complexity, interaction with the environment.

4. Genetics

(a) Laws of Inheritance: how can one establish if a trait/disease is genetic or environmental? An account of Mendel's experiments. Different types of genetic inheritance and various complicating factors in genetic research.

Mendel's experiment on pea plant and his conclusions - law of segregation and law of independent assortment.

Concept of trait, gene, allele, phenotype, genotype, homozygosity, heterozygosity and hemizygosity. Types of inheritance.

Pedigree construction using different standard symbols.

Construction of pedigree showing different modes of inheritance, autosomal inheritance - dominant, co-dominant and recessive.

Sex chromosome inheritance - with special reference to X chromosomal inheritance with suitable examples.

Mitochondrial / cytoplasmic inheritance.

Establishment of genetic reasons for a trait - family and twin studies.

Various problems in genetic research - variable expressivity, incomplete penetrance, one gene several effects, one phenotype several genes and Lyon's hypothesis.

(b) Gene Mapping: mapping of genes on chromosomes using linkage analysis. An understanding of mutations and cancer genetics.

Mapping of genes on chromosomes with respect to genetic diseases.

Basic concept of linkage and crossing over. Genetic recombination, concept of centi morgan (cM), Morgan's experimental results, explanation of linkage and mapping with suitable examples, discovery of DNA as the genetic material.

Concept of mutation and various factors causing mutations.

Cancer genetics: a brief note.

(c) Genes in populations: how do genes behave in populations from generation to generation? Various ways of studying population genetics.

Concept of gene pool and allele frequency, polymorphism, definition of Hardy Weinber law, its applications.

Possibility of disease resistant and susceptible genes in population. Concept of pharmacogenetics and pharmacogenomics.

PAPER II

PRACTICAL WORK – 20 Marks.

Candidates are required to complete the following experiments.

1. Preparation of Buffers:

   This experiment should be done to make the basics clear to the students and for this, the approach should be to utilise easily available chemicals at reasonable costs. For this "Phosphate buffer, Acetate buffer and Borate buffer" are good for practice. (pH 5 & pH 8).

2. Colour reactions of Carbohydrates:

   The following experiments should be performed:

   - *Iodine test for starch, etc.*
   - *Benedict's test for reducing sugar.*
   - *Fehling's test.*

3. Colour reaction for Proteins:

   The tests to perform are:

   - *Biuret test.*
   - *Bradford test (it can be qualitative as well as quantitative – for qualitative assessment the extent of colour development can be used as rough estimate).*

4. Study of various stages of Mitosis and Meiosis:

   The students should be given practice in preparing slides for study of mitosis by crush smear method. They should be able to identify different stages (at least four stages). For the study of meiosis the students should be shown permanent slides of meiosis and they should be able to identify at least six stages of meiosis from the slides.

   The requirement for this set of experiments is Acetocarmine stain slides, coverslips, microscopes and spirit-lamp.

5. Preparation of Karyotypes:

   Demonstration of any metaphasic plate of mitosis (pea onion root tips).

   Diad formation, pairing of homologous chromosomes during meiosis.

6. Determination of Blood Groups:

   The students can perform this experiment on their own and work out their own blood group. Proper instructions 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. Constructing of pedigrees showing different types of inheritance:

   The students are to establish Mendel's Laws of inheritance by selecting varied seeds/flowers with different colours out of the lot provided to them. They can also perform exercises and numericals on monohybrid and dihybridisation.

   Additionally, they can be asked to set up sets to show –

   - *incomplete dominance.*
   - *Epistatis.*

8. Usage of pH meter:

   To measure the pH of a given sample by pH meter or sensitive pH strips/handheld pH meter.

PROJECT WORK AND PRACTICAL FILE – 10 Marks

Project Work – 7 Marks

Candidates are to creatively execute **one** project/assignment on any 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.

Practical File – 3 Marks

Teachers are required to assess students on the basis of the practical file maintained by them during the academic year.

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	*… 3 marks*

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 lipids, 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, (Watson and Crick's), Chargaff's Law method of replication of DNA, various replicative enzymes in both procaryotic and eucaryotic organisms, example topoisomerases, helicase, SSBs polymerases, primases, ligases. Concept of semi conservative and semi-discontinuous replication, leading and lagging strands, okazaki fragments.

RNA – definition, various types of RNAs such as mRNA, tRNA (Clover leaf model), 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.

From gene to protein: Transcription - DNA to RNA, various enzymes involved eg RNA polymerases, an explanation of the complete process; post transcriptional changes-polyadenylation, 5' capping and splicing .

Genetic code – properties of genetic code, Start and Stop codons. The translation of RNA to protein – complete mechanism of chain initiation, elongation and termination, the role of tRNA in protein synthesis. ***(Post translational changes not included)***

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

Gene regulation – Operon concept.

Inborn errors of metabolism - basic concept and examples like Albinism, sickle cell anaemia. Phenyl ketonuria, alkaptonuria.

2. Genetic Engineering

(b) 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 industrial enzymes.

(vi) Single cell protein concept.

(b) Introduction to gene cloning and genetic engineering: concept of cloning and vectors.

Tools of recombinant DNA technology, types of restriction endonucleases and other enzymes used in cloning: types of vectors, such as plasmids, cosmids, phages, YACs, BACs, animal and plant viruses, role of Shuttle and expression vectors in DNA manipulation, construction of a recombinant DNA molecule.

Techniques involved in extraction and purification of DNA from bacterial and plants cells.

A basic understanding of DNA libraries – construction and cloning of genomic and cDNA libraries.

Transfer of recombinants into host cells-basic concept of transformation, transfection, electroporation, microinjection, biolistic and Agrobacterium induced gene transfer.

Methods of identification of recombinants-Direct selection / Insertional inactivation / Blue-white selection.

DNA probes.

(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. Site directed mutagenesis.

Polymerase chain reaction (PCR)– definition, principle and the technique involved, use of the enzyme taq DNA polymerase, concept of oligonucleotide primer; significance and applications of PCR.

Human Genome Project - its objectives, the countries involved, its achievements and significance.

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. 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.

(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.

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

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. Application of triploids in plant improvement.

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

Zygotic embryo culture concept and applications.

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

The scope biotechnology offers in developing favourable traits in crops, like pest resistance, drought resistance, salinity resistance.

4. Bio-informatics

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

Introduction to computer software and hardware - RAM and ROM, Microprocessor. 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). Information sources such as EMBL, NCBI GDB, MGD.

Data retrieval tools- ENTREZ, BLAST, Taxonomy Browser , FASTA, Locus link.

(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. Basic criteria in selecting the organism for its genome sequencing. 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 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:

   (i) Dry Physical method – heat or radiation.

   (ii) Wet Physical methods – steam sterilization.

   (iii) Chemical Sterilization/ Surface sterilization Disinfection with 70% alcohol and Sodium hypochlorite solution /savlon/carbolic acid.

2. Preparation of buffers:

   This experiment should be done to make the basics clear to the students. Basic calculation for buffer preparation should be known. 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) Bacterial culture Media - Luria Bertanii (L.B.) media - Peptone/ Tryptone , yeast extract and NaCl. (Nutrient broth / Nutrient Agar).

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

4. Preparation of slant or nutrient plates.

   Luria Bertanii (L.B) media to be prepared autoclaved and cooled to 60 degrees C. To prepare nutrient plates the media is poured into pre sterilized petri-dishes under a LAF. To prepare slants the media is poured into several test tubes, plugged and kept in a tilted position until it sets.

5. Growth of bacteria in culture:

   Growth of bacteria in nutrient broth / nutrient agar. Bacterial streaking, time related growth curve of bacterial culture to be studied.

6. Identification of gram positive and gram negative bacteria by gram staining.

   (i) Prepare a bacterial smear on a slide (ii) Stain with crystal violet stain. (iii) Rinse with water. (iv) Add a few drops of iodine solution. (v) Add few drops of 90 % ethanol (vi) Counterstain with safranine solution (vii) Observe the red and blue colonies under the microscope.

7. Isolation of proteins:

   (i) Pea germinating seeds proteins should be isolated in buffers. Presence of protein to be identified by colour reaction (Biuret's Test / Xanthoproteic Test).

   (ii) Milk proteins are isolated by adding 0.4 N HCl into the milk sample. Caseins start coagulating at their isoelectric point (pH 4.6) The precipitate is filtered and weighed to quantify the protein present.

8. 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.

9. Salivary amylase activity on starch

   (i) To study the action of the enzyme on starch.

   Soluble starch solution (0.5% - 1%) to be prepared. Test with iodine. Collect saliva, dilute 1: 5, add 1 ml of saliva to 10 ml of starch solution. Incubate for 15 minutes. Again test for presence of starch with iodine. Also test for the presence of reducing sugars in solution.

   (ii) To study the effect of variable temperature on the activity of the enzyme salivary amylase.

10. 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 methanol/ acetic acid, n-butanol or benzene. The rising fluid should always be at the bottom below the point of loading of chlorophylls. After 30 minutes, three spots: yellow, bluish green and light green will be observed corresponding to carotenes, chlorophyll A & chlorophyll B.

11. 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.

12. Isolation of DNA from plant tissues

    Take half a ripe and peeled banana into a beaker and add 50 ml of extraction fluid (1.5gm table salt +10 ml liquid detergent +90 ml distilled water). Place the beaker in a water bath set at 60 degrees C for 15 minutes. Stir gently with a glass rod. Filter 5ml of cooled content into a clean test tube and add 5ml of cold 90% ethanol. DNA molecules separate out and appear as white fibres. [DNA can also be extracted from pea seeds and soaked wheat grains]

13. Estimation of proteins by colour reaction

    Bradford's Assay is a Dye binding assay based on the differential change of colour of a dye in response to various concentrations of proteins. Bradford's assay can be performed for qualitative as well as quantitative assessment of proteins in a sample.

    Dilute 1 volume of Bradford's dye with 4 volumes of distilled water. Filter the dye through Whatman filter paper and store at room temperature in a brown glass bottle. Take different aliquots of standard Bovine Serum Albumin (BSA solution) , for example (0.2, 0.4, 0.6, 0.8 and 1.0 ml) in different test tubes Make up the volume to 1ml with distilled water .To each tube add 2ml of Bradford's dye. Extent of colour development can be made by rough estimate using + signs to show the concentration of protein in the sample. Alternatively, OD can be read using colorimeter or spectrophotometer. Take the unknown sample to be estimated and perform the experiment. Similarly read the OD and note the corresponding concentration of protein in it using the graph.

14. 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.

List of Equipment for Biotechnology practicals for Classes XI & XII

1. Table-top Centrifuge
2. Vortex - Mixer
3. Thermostatic water-bath shaker
4. Spectrophotometer (UV visible range)
5. Refrigerator
6. Deep freezer
7. Vacuum evaporator/concentrator
8. pH meter
9. Air-dry oven
10. Autoclave (Vertical)
11. Sterilisation chamber
12. Desiccators
13. Micro-filtration unit
14. Chromatography columns
15. UV Chamber (inoculation chamber)
16. TLC Plates
17. DNA gel photographs showing plasmid and chromosomal DNA bands
18. Colourimeter
19. Magnetic stirrer with hot plate
20. Laminar flow cabinet (Vertical)
21. Weighing Balance (Electrical)
22. Hot plate
23. Binocular Microscope
24. Haemocytometer
25. Colony counter
26. Antiserum
27. Antibodies
28. Micropipettes
29. Microcentrifuge