### B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)

**Three-Year (6 Semester) Full Time Degree Programme**

**B.Sc. (Hons.) Biotechnology – First Year**

**Semester – I**

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UNIT I: Introduction to Biochemistry:  
A historical prospective.

UNIT II:  
Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein’s and their biological functions.

UNIT III:  
Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.
Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines., Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

UNIT IV:  
Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.

UNIT V:  
1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry:
   (i) Verification of Beer's law, estimation of protein.
   (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

**SUGGESTED READING**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –I
C-2: CELL BIOLOGY (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I
No. of Hours: 12
Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.
Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II
No. of Hours: 13
Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.
Endoplasmic reticulum: Structure, function including role in protein segregation.
Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III
No. of Hours: 13
Lysosomes: Vacuoles and micro bodies: Structure and functions
Ribosomes: Structures and function including role in protein synthesis.
Mitochondria: Structure and function, Genomes, biogenesis.
Chloroplasts: Structure and function, genomes, biogenesis
Nucleus: Structure and function, chromosomes and their structure.

UNIT IV
No. of Hours: 12
Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

UNIT V
No. of Hours: 10
Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.
1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

Preamble:

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

The present course hopes to address some of these aspects through an interactive mode of teaching-learning process and by focusing on various dimensions of communication skills. Some of these are:

- Language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, note taking etc.

While, to an extent, the art of communication is natural to all living beings, in today’s world of complexities, it has also acquired some elements of science. It is hoped that after studying this course, students will find a difference in their personal and professional interactions.

The recommended readings given at the end are only suggestive; the students and teachers have the freedom to consult other materials on various units/topics given below. Similarly, the questions in the examination will be aimed towards assessing the skills learnt by the students rather than the textual content of the recommended books.

1. **Introduction**: Theory of Communication, Types and modes of Communication
2. **Language of Communication**:
   - Verbal and Non-verbal
     - (Spoken and Written)
   - Personal, Social and Business
   - Barriers and Strategies
   - Intra-personal, Inter-personal and Group communication
3. **Speaking Skills:**
   - Monologue
   - Dialogue
   - Group Discussion
   - Effective Communication/ Mis- Communication
   - Interview
   - Public Speech

4. **Reading and Understanding**
   - Close Reading
   - Comprehension
   - Summary Paraphrasing
   - Analysis and Interpretation
   - Translation (from Indian language to English and vice-versa)
   - Literary/Knowledge Texts

5. **Writing Skills**
   - Documenting
   - Report Writing
   - Making notes
   - Letter writing

**SUGGESTED READING**

4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas
GENERIC ELECTIVE SUBJECTS
SEMESTER – I

GE-1: BIOTECHNOLOGY AND HUMAN WELFARE (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I
No. of Hours: 12
Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II
No. of Hours: 12
Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III
No. of Hours: 12
Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV
No. of Hours: 12
Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V
No. of Hours: 12
Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E.coli, human genome project.

GE-1: BIOTECHNOLOGY AND HUMAN WELFARE (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentation using Baker’s yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

SUGGESTED READING

### B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)

**Three-Year (6 Semester) Full Time Degree Programme**

#### B.Sc. (Hons.) Biotechnology – First Year

**Semester – II**

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**TOTAL**
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –II
C-3: MAMMALIAN PHYSIOLOGY (THEORY)
TOTAL HOURS: 60                          CREDITS: 4

UNIT I:  No. of Hours: 12
Digestion and Respiration Digestion: Mechanism of digestion & absorption of carbohydrates,
Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal
juice
Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride
shift.

UNIT II:  No. of Hours: 12
Circulation Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis,
Mechanism of coagulation of blood.
Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III:  No. of Hours: 12
Muscle physiology and osmoregulation Structure of cardiac, smooth & skeletal muscle, threshold
stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction,
Physical, chemical & electrical events of mechanism of muscle contraction.
Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV:  No. of Hours: 12
Nervous and endocrine coordination Mechanism of generation & propagation of nerve impulse,
structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

UNIT V:  No. of Hours: 12
Mechanism of action of hormones (insulin and steroids)
Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and
adrenals, hypo & hyper-secretions.
C-3: MAMMALIAN PHYSIOLOGY PRACTICAL
TOTAL HOURS: 60                          CREDITS: 2

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMMESTER –II
C-4: PLANT AND MICROBIAL PHYSIOLOGY (THEORY)
TOTAL HOURS: 60                          CREDITS: 4

UNIT I:  No. of Hours: 12
Nutritional classification of microorganisms based on carbon, energy and electron sources,
Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active
transport, Group translocation (phosphotransferase system), symport, antiport and uniport,
electrogenic and electro neutral transport, transport of Iron.

UNIT II:  No. of Hours: 12
Effect of the environment on microbial growth
Temperature- temperature ranges for microbial growth, classification based on temperature
ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and
water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism,
Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and
methanogens.

UNIT III:  No. of Hours: 12
Photosynthesis- Photosynthesis pigments, anoxygenic and oxygenic photosynthesis, concept of
two photo systems, photosynthetic pigments photophosphorylation, , physiology of bacterial
photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide
fixation, calvin cycle, CAM plants, photorespiration, compensation point.

UNIT IV:  No. of Hours: 12
Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium
assimilation in plants.
Growth and development: Definitions, phases of growth, growth curve,

UNIT V:  No. of Hours: 12
Growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)
Physiological role and mode of action, seed dormancy and seed germination, concept of
photoperiodism and vernalization
1. Separation of photosynthetic pigments by paper chromatography.
2. Demonstration of aerobic respiration.
3. Preparation of root nodules from a leguminous plant.
4. To study and plot the growth curve of E. coli using turbidometric method and to calculate specific growth rate and generation time.
5. To study and plot the growth curve of Aspergillus niger by radial growth measurements.
6. To study the effect of pH on the growth of E. coli
7. To study the effect of temperature of Aspergillus niger by dry weight method.
8. Demonstration of the thermal death time and decimal reduction time of E. coli.

SUGGESTED READING

5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
ABILITY ENHANCEMENT COMPULSORY COURSE
SEMESTER –II
ENVIRONMENTAL STUDIES

TOTAL HOURS: 50                          CREDITS: 2

UNIT I
Introduction to environmental studies
• Multidisciplinary nature of environmental studies;
• Scope and importance; Concept of sustainability and sustainable development.

UNIT II
Ecosystems
• What is an ecosystem? Structure and Function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT III
Natural Resources:
Renewable and Non-renewable Resources
• Land resources and land use change; Land degradation, soil erosion and desertification.
• Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
• Water: Use and over-exploitation of surface and groundwater, floods, droughts, conflicts over water (international& inter-state).
• Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

UNIT IV
Biodiversity and Conservation
• Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
• India as a mega-biodiversity nation; Endangered and endemic species of India
• Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
• Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic And Informational value.

UNIT V
Environmental Pollution
• Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution
• Nuclear hazards and human health risks
• Solid waste management: Control measures of urban and industrial waste.
• Pollution case studies.

UNIT VI

Environmental Policies & Practices

• Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
• Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT VII

Human Communities and the Environment

• Human population growth: Impacts on environment, human health and welfare.
• Resettlement and rehabilitation of project affected persons; case studies.
• Disaster management: floods, earthquake, cyclones and landslides.
• Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
• Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
• Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

UNIT VIII

Field work

• Visit to an area to document environmental assets: river/forest/flora/fauna, etc.
• Visit to a local polluted site---Urban/Rural/Industrial/Agricultural.
• Study of common plants, insects, birds and basic principles of identification.
• Study of simple ecosystems---pond, river, Delhi Ridge, etc.

SUGGESTED READING

UNIT I INTRODUCTION
Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II ESTABLISHING AN ENTERPRISE
Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III FINANCING THE ENTERPRISE
Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV MARKETING MANAGEMENT
Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product life cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS
Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

2. Kaplan JM Patterns of Entrepreneurship.
### B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
Three-Year (6 Semester) Full Time Degree Programme

#### B.Sc. (Hons.) Biotechnology – Second Year

**Semester – III**

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**TOTAL** 18 - 16 26
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –III
C-5: GENETICS (THEORY)

UNIT I
Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.
Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.
Mendelian genetics: Mendel’s experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT II
Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.
Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

UNIT III
Genetic organization of prokaryotic and viral genome.
Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT IV
Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy.
Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.
UNIT V
No. of Hours: 12

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.
Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.
Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

C-5: GENETICS (PRACTICAL)
TOTAL HOURS: 60 CREDITS: 2

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.

SUGGESTED READING
UNIT I
No. of Hours: 12
Fundamentals, History and Evolution of Microbiology.
Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

UNIT II
No. of Hours: 12
Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT III
No. of Hours: 12
Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT IV
No. of Hours: 12
Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.
Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

UNIT V
No. of Hours: 12
Control of Microorganisms: By physical, chemical and chemotherapeutic Agents
Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.
Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.
1. Isolation of bacteria & their biochemical characterization.

2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.

3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.

4. Determination of bacterial cell size by micrometry.

5. Enumeration of microorganism - total & viable count.

SUGGESTED READING


B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –III
C-7: CHEMISTRY-1 (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I Stereochemistry

No. of Hours: 18
Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformations: Restricted rotation about single bonds, Various conformations of ethane, butane, ethane-1,2-diol and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, CisTrans and E/ Z notation along with CIP rules for geometrical isomers. Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. Rand S- configuration (upto two chiral centres).

UNIT II Addition Reaction

No. of Hours: 10

UNIT III Substitution Reactions

No. of Hours: 15

UNIT IV Elimination Reactions

No. of Hours: 6
Alkyl halides (dehydrohalogenation, Saytzeff’s rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann’s elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution
UNIT V Oxidation & Reduction  

**Oxidation:** Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate  
Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2–diols with periodic acid and lead tetraacetate. Aldehydes: Oxidation with potassium permanganate, chromic acid and Tollens's reagent  
Ketones: Oxidation with potassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer–Villiger oxidation  

**Reduction:** Aldehydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner  
Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction.  
Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

C-7: CHEMISTRY-1 (PRACTICAL)  

**TOTAL HOURS: 60**  
**CREDITS: 2**  
1. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol  
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).  
3. Determination of optical activity by using polarimeter  
Organic preparations: Carry out the following preparations using 0.5 - 1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample.  
4. To prepare acetalnilide by the acetylation of aniline.  
5. To prepare p-bromoacetanilide.  
6. Benzoylation of aniline or β-naphthol by Schotten-Baumann reaction  
7. Hydrolysis of benzamide or ethyl bezoate.  
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde.  
10. Oxidation of benzaldehyde by using alkaline potassium permanganate.  

**SUGGESTED READING**  
3. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand  
7. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.  
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
GENERIC ELECTIVE SUBJECTS
SEMESTER –III
GE-2: BIOETHICS AND BIOSAFETY (THEORY)
TOTAL HOURS: 60                   CREDITS: 4

Unit-I
No. of Hours: 12
Biosafety: Introduction, Historical prospective, objectives, risk assessment in biotechnological research and their regulation, physical and biological contaminants, field trial and planned introduction of GMOs, Biosafety guidelines in India, Biosafety levels for plant, animal and microbial researches.

Unit-II
No. of Hours: 12
Bioethics: Introduction, Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues, possible benefits of successful cloning, Ethical concerns of gene cloning, hazards of environmental engineering, Ethical issues in Human Cloning and stem cell research.

Unit-III
No. of Hours: 12
Intellectual Property Right: Introduction, intellectual property: trade secret, patent, copyright, plant variety protection, WIPO, GATT, TRIPs, plant breeder’s rights, protection of plant varieties and former’s right act (2001), Choice and management of IPRs, advantage and limitations of IPRs.

Unit-IV
No. of Hours: 12

Unit-V
No. of Hours: 12
Regulatory framework in Biotechnology: Regulation of RDT research, Regulation of food and food ingredients, Regulatory framework in India governing GMOs, Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Prevention Food Adulteration Act (1955), Food Safety and Standards Bill (2005),
GE-2: BIOETHICS AND BIOSAFETY (PRACTICAL)
TOTAL HOURS: 60                          CREDITS: 2
(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)
1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING
5. Biotechnology-B. D. Singh- Kalyani Publications
UNIT I
No. of Hours: 6
Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II
No. of Hours: 6

UNIT III
No. of Hours: 6
Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT IV
No. of Hours: 6
Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT V
No. of Hours: 6
Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

PRACTICAL
1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

**SUGGESTED READING**

5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSE
SEMESTER –III
SEC-2: BASICS OF FORENSIC SCIENCE (THEORY)

TOTAL HOURS: 30                          CREDITS: 2

UNIT I
Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science,

No. of Hours: 6

UNIT II
Causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

No. of Hours: 6

UNIT III
Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

No. of Hours: 6

UNIT IV
Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of fingerprint as science for personal identification,

No. of Hours: 6

UNIT V

No. of Hours: 6

PRACTICALS

1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.
   b. To lift footprints from crime scene.
3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking
SUGGESTED READING


### B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
#### Three-Year (6 Semester) Full Time Degree Programme

**B.Sc. (Hons.) Biotechnology – Second Year**

**Semester – IV**

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B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –IV
C-8: MOLECULAR BIOLOGY (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I: DNA structure and replication  
No. of Hours: 12
DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and 
eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA 
polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling 
circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II: DNA damage, repair and homologous recombination  
No. of Hours: 12
DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: 
Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion 
synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: 
models and mechanism.

UNIT III: Transcription  
No. of Hours: 12
RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role 
of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in 
eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, 
mechanism of transcription initiation, promoter clearance and elongation

UNIT IV: RNA processing and Regulation of gene expression  
No. of Hours: 12
RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, 
splicing, rRNA and tRNA splicing. Regulation of gene expression in prokaryotes: Operon concept 
(inducible and repressible system),

UNIT V: Regulation of translation  
No. of Hours: 12
Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure 
and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, 
elongation and termination of polypeptides, Fidelity of translation, Inhibitors of 
translation.,Posttranslational modifications of proteins.
C-8: MOLECULAR BIOLOGY (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method.
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA.
5. Preparation of restriction enzyme digests of DNA samples.
6. Demonstration of AMES test or reverse mutation for carcinogenicity.

SUGGESTED READING

UNIT I

No. of Hours: 12

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells),

UNIT II

No. of Hours: 12

T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT III

No. of Hours: 12

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT IV

No. of Hours: 12

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT V

No. of Hours: 12

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.
C-9: IMMUNOLOGY (PRACTICAL)

TOTAL HOURS: 60

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –IV
C-10: CHEMISTRY-2 (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I The covalent bond and the structure of molecules
No. of Hours: 10

Valence bond approach, Concept of resonance in various organic and inorganic compounds, Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent’s rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

UNIT II Molecular Orbital Approach
No. of Hours: 18

LCAO method, symmetry and overlap for s-s ,s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B2, C2 ,N2, O2 , F2 ) and heteronuclear diatomic molecules (CO, NO) and their ions.

Intermolecular forces: van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

UNIT III Transition Elements (3d series)
No. of Hours: 12

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

UNIT IV Coordination Chemistry
No. of Hours: 10

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. Coordination compounds in biological systems: Fe, Cu, Co, Mn, Ni, Zn and heavy metal ions.

UNIT V Crystal Field Theory
No. of Hours: 10

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.
C-10: CHEMISTRY-2 (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

Titrimetric Analysis: Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)

(A) Titrations involving Acids-Bases: Principles of acid-base titrations, Principle behind selection of an appropriate indicator.
1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
2. Determination of concentration of carbonate and hydroxide present in a mixture.
3. Determination of concentration of carbonate and bicarbonate present in a mixture.
4. Determination of concentration of free alkali present in soaps/detergents/shampoos.

(B) Titrations involving redox reactions: Concept of electrode potential, principle behind selection of an appropriate indicator.
5. Standardization of KMnO4 solution (standard solution of Mohr’s salt to be prepared).
6. Determination of concentration of Fe(II) in Mohr’s salt and/or K2Cr2O7 using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of K2Cr2O7 and /or Mohr’s salt to be prepared).
7. Determination of iron content in ores / alloys using appropriate redox titration.

(C) Complexometric Titrations Principles of complexometric titrations
8. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
9. Determination of concentration of Ca/Mg in drugs or in food samples.
10. Determination of concentration of total hardness of a given sample of water by complexometric titration.

(At least 2 experiments from each set.)

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
GENERIC ELECTIVE SUBJECTS
SEMESTER –IV
GE-4: DEVELOPMENTAL BIOLOGY (THEORY)

TOTAL HOURS: 60                      CREDITS: 4

UNIT I Gametogenesis                   No. of Hours: 12
Definition, scope & historical perspective of development Biology, Gametogenesis –
Spermatogenesis, Oogenesis

UNIT II Fertilization                  No. of Hours: 12
Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk

UNIT III: Early embryonic development   No. of Hours: 12
Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism
Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos

UNIT IV: Embryonic Differentiation     No. of Hours: 12
Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT V: Organogenesis                  No. of Hours: 12
Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers
Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals

GE-4: DEVELOPMENTAL BIOLOGY (PRACTICAL)

TOTAL HOURS: 60                      CREDITS: 2

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of Anopheles.
4. Study of the developmental stages of Drosophila from stock culture/ photographs..
5. Study of different types of placenta.

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSE
SEMESTER –IV
SEC-1: MOLECULAR DIAGNOSTICS (THEORY)
TOTAL HOURS: 30                          CREDITS: 2

UNIT I
No. of Hours: 6

**Enzyme Immunoassays:**

UNIT II
No. of Hours: 6

Molecular methods in clinical microbiology:
Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

UNIT III
No. of Hours: 6

Laboratory tests in chemotherapy:
Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:

UNIT IV
No. of Hours: 6


UNIT V
No. of Hours: 6

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.
Transgenic animals.
PRACTICALS
(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-based detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

SUGGESTED READING
1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
9. Microscopic Techniques in Biotechnology, Michael Hoppert
UNIT I

No. of Hours: 6

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT II

No. of Hours: 6

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples:- chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed back control, covalent modification.

UNIT III

No. of Hours: 6

UNIT IV

Enzyme Technology: Methods for large scale production of enzymes.

UNIT V

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

PRACTICALS

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry’s method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as $K_m$, $V_{max}$, $K_{cat}$

SUGGESTED READING

### B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)

*Three-Year (6 Semester) Full Time Degree Programme*

**B.Sc. (Hons.) Biotechnology – Third Year**

**Semester – V**

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**TOTAL** | **16** | - | **16** | **24**
UNIT I
No. of Hours: 12


UNIT II
No. of Hours: 12

Design of bioprocess vessels—Significance of Impeller, Baffles, Sparger; Types of culture/production vessels—Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing—Media preparation, Inocula development and sterilization.

UNIT III
No. of Hours: 12

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV
No. of Hours: 12

Introduction to downstream processing, product recovery and purification. Effluent treatment.

UNIT V
No. of Hours: 12

Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.
C-11: INDUSTRIAL FERMENTATIONS (PRACTICAL)

1. Calculation of bacterial growth curve.
2. Calculation thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –V
C-12: RECOMBINANT DNA TECHNOLOGY (THEORY)
TOTAL HOURS: 60                          CREDITS: 4

UNIT I
No. of Hours: 12
Molecular tools and applications -restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR

UNIT II
No. of Hours: 12
Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering

UNIT III
No. of Hours: 12
Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

UNIT IV
No. of Hours: 12
Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT V
No. of Hours: 12
Genetic engineering in plants: Use of Agrobacterium tumefaciens and Arhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.
C-12: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)
TOTAL HOURS: 60                          CREDITS: 2

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E.coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-1: CHEMISTRY 3 (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I Chemical Energetics                  No. of Hours: 10

UNIT II Chemical & Ionic Equilibrium        No. of Hours: 20


UNIT III Chemical Kinetics                   No. of Hours: 08

UNIT IV Spectroscopy                        No. of Hours: 16
Introduction to spectroscopy: Electromagnetic radiation, fundamental definitions, electromagnetic spectrum, introduction to concepts of absorption and emission spectroscopy, Beer-Lambert law. 43 IR Spectroscopy: Fundamental and non-fundamental molecular vibrations,
IR spectrum, fingerprint and group frequency regions and their significance, Hooke’s law and vibrational frequency. Factors affecting vibrational frequency. Characterization of functional groups: alkanes, alkenes, alkynes (only alicyclic systems), aldehydes, ketones, carboxylic acids and their derivatives, hydroxy compounds and amines. Study of hydrogen bonding. Electronic Spectroscopy: Electronic transitions, singlet and triplet states, dissociation and predissociation. UV spectroscopy: Types of electronic transitions, UV spectrum, λmax, εmax, chromophores, auxochromes, bathochromic shift, hypsochromic shift (definitions and elementary examples) and solvent effect. Characteristic UV transitions in common functional groups. General applications of UV spectroscopy including distinction between cis-trans isomers. Woodward rules for calculating λmax in the following systems:

- Conjugated dienes: alicyclic, homoannular, heteroannular.
- α,β-Unsaturated aldehydes and ketones.
- Extended conjugated systems: dienes, aldehydes and ketones.

PMR spectroscopy: Basic principles of NMR spectroscopy, PMR scale, chemical shifts (concept of shielding and deshielding), factors influencing chemical shifts, simple spin-spin couplings, coupling constant, chemical shift equivalence, anisotropic effects in alkenes, alkynes, aldehydes and aromatics. Interpretation of PMR spectra of simple compounds. Application of UV, IR and PMR in solving structures of simple molecules.

UNIT V Photochemistry


DSE-1: CHEMISTRY 3 (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

(I) Thermochemistry
1. Determination of heat capacity of a calorimeter for different volumes.
2. Determination of the enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (endothermic and exothermic).

(II) pH-metric and potentiometric measurements
4. Preparation of sodium acetate-acetic acid buffer solutions and measurement of their pH.
5. Potentiometric titrations of
6. Determination of dissociation constant of a weak acid.

(III) Study the kinetics of the following reactions:

2. Initial rate method: Iodide-persulphate reaction
3. Integrated rate method:
   i. Acid hydrolysis of methyl acetate with hydrochloric acid.
   ii. Saponification of ethyl acetate

(V) Colourimetry

4. Verification of Lambert-Beer’s Law for potassium dichromate/ potassium permanganate solution.
5. Determination of pK (indicator) for phenolphthalein.
6. Study the kinetics of interaction of crystal violet with sodium hydroxide colourimetrically.

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER -V

DSE-1: ANIMAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I
No. of Hours: 12
Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II
No. of Hours: 12

UNIT III
No. of Hours: 12

UNIT IV
No. of Hours: 12
Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT V
No. of Hours: 12

DSE-1: ANIMAL BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.
SUGGESTED READING


B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-2: BIOINFORMATICS (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I                                                                 No. of Hours: 12
History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II                                                                 No. of Hours: 12
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.

UNIT III                                                                No. of Hours: 12
Introduction of Data Generating Techniques and Bioinformatics problem posed by them Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT IV                                                                No. of Hours: 12
Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT V                                                                 No. of Hours: 12
Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

DSE-2: BIOINFORMATICS (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
3. Protein information resource (PIR)
4. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-2: MEDICAL MICROBIOLOGY (THEORY)
TOTAL HOURS: 60                          CREDITS: 4

UNIT I
No. of Hours: 12
Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

UNIT II
No. of Hours: 12

UNIT III
No. of Hours: 12

UNIT IV
No. of Hours: 12
Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT V
No. of Hours: 12
Fungal and Protozoan infections. Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)
1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.

2. Growth curve of a bacterium.

3. To perform antibacterial testing by Kirby-Bauer method.

4. To prepare temporary mounts of Aspergillus and Candida by appropriate staining.

5. Staining methods: Gram’s staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SUGGESTED READING


### B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)

#### Three-Year (6 Semester) Full Time Degree Programme

#### B.Sc. (Hons.) Biotechnology – Third Year

**Semester – VI**

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**TOTAL** 16 16 24
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)  
SEMESTER –VI  
C-13: BIO-ANALYTICAL TOOLS (THEORY)  

TOTAL HOURS: 60  
CREDITS: 4  

UNIT I  
No. of Hours: 12  
Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy  

UNIT II  
No. of Hours: 12  
Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.  

UNIT III  
No. of Hours: 12  
Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.  

UNIT IV  
No. of Hours: 12  
Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing,  

UNIT V  
No. of Hours: 12  
Western blotting. Introduction to Biosensors and Nanotechnology and their applications.  

C-13: BIO-ANALYTICAL TOOLS (PRACTICAL)  

TOTAL HOURS: 60  
CREDITS: 2  

5. Native gel electrophoresis of proteins  
6. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.  
7. Preparation of the sub-cellular fractions of rat liver cells.  
8. Preparation of protoplasts from leaves.  
10. To identify lipids in a given sample by TLC.  
11. To verify the validity of Beer’s law and determine the molar extinction coefficient of NADH.  

SUGGESTED READING  

UNIT I
No. of Hours: 12

UNIT II
No. of Hours: 12
Managing and Distributing Genome Data: Web based servers and software’s for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III
No. of Hours: 12
Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV
No. of Hours: 12
Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

UNIT V
No. of Hours: 12
C-14: GENOMICS & PROTEOMICS (PRACTICAL)
TOTAL HOURS: 60                          CREDITS: 2

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)

DISCIPLINE CENTRIC SUBJECTS

SEMESTER –VI

DSE-3: PLANT BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I

No. of Hours: 12

Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation,

UNIT II

No. of Hours: 12

Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT III

No. of Hours: 12

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT IV

No. of Hours: 12

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.

Somaclonal variation Nomenclature, methods, applications basis and disadvantages.

UNIT V

No. of Hours: 12

DSE-3: PLANT BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60

1. Preparation of simple growth nutrient (knop’s medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog’s medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)  
DISCIPLINE CENTRIC SUBJECTS  
SEMESTER –VI  
DSE-3: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)  
TOTAL HOURS: 60                         CREDITS: 4

UNIT I  
No. of Hours: 12
Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II  
No. of Hours: 12
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation.

UNIT III  
No. of Hours: 12
Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT IV  
No. of Hours: 12
Treatment of municipal waste and Industrial effluents. Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT V  
No. of Hours: 12
Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

DSE-3: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)  
TOTAL HOURS: 60                         CREDITS: 2

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.

3. Calculation of COD of water sample.

4. Bacterial Examination of Water by MPN Method.

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
5. Agricultural Biotechnology, S.S. Purohit
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy
B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –VI
DSE-4: BIOSTATISTICS (THEORY)

TOTAL HOURS: 60                          CREDITS: 4

UNIT I
No. of Hours: 12
Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II
No. of Hours: 12
Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III
No. of Hours: 12
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test.

UNIT IV
No. of Hours: 12
Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT V
No. of Hours: 12
Correlation and Regression. Emphasis on examples from Biological Sciences.

DSE-4: BIOSTATISTICS (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –VI
DSE-4: CHEMISTRY 4 (THEORY)

TOTAL HOURS: 60  CREDITS: 4

UNIT I Carbohydrate
No. of Hours: 10
Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of diachharides (sucrose, maltose, lactose) and polysachharides (starch and cellulose) excluding their structure elucidation.

UNIT II Amino Acids, Peptides and Proteins
No. of Hours: 12
Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT III Enzymes and correlation with drug action
No. of Hours: 12
Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition). Drug action - receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring.

UNIT IV Nucleic Acids & Lipid
No. of Hours: 18
Nucleic Acids: Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.
Lipid: Introduction to lipids, classification. 38 Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

UNIT V Concept of Energy in Biosystems
No. of Hours: 08
DSE-4: CHEMISTRY 4 (PRACTICAL)

TOTAL HOURS: 60                          CREDITS: 2

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

SUGGESTED READING