# DEPARTMENT OF BIOCHEMISTRY AND BIOTECHNOLOGY
## M.Sc. BIOCHEMISTRY
### Choice Based Credit System (CBCS)– 2 year Programme (2018 – 2019)
#### Revised Scheme of Examinations and Syllabus

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Theory &amp; Practical</th>
<th>Credit</th>
<th>Internal Assessment Marks</th>
<th>End Semester Examination Marks</th>
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### Distribution of Credits
- Core Courses and Project: 70 credits
- Soft Skills and Optionals: 20 credits
- Total: 90 credits
Optionals: Any 4 from the following:
1. Chemistry
2. Microbiology
3. Statistical Methods
4. Drug Design and Drug Action
5. Genetic Engineering
6. Yoga
7. Vermiculture & Sericulture
8. Structural Biology
9. Marine Biology
10. Any other course offered by other departments from time to time.
Objective: To understand the structure and functions of biomolecules.

Unit-I Proteins I
Secondary structures- \( \alpha \)-helix, \( \beta \)-sheet and \( \beta \)-turns. Pauling and Corey model for fibrous proteins. Collagen triple helix.
Superssecondary structure- helix-loop-helix, hairpin \( \beta \) motif, Greek key motif and \( \beta-\alpha-\beta \) motif. Structural classification of proteins.

Unit-II Proteins II
Tertiary structure- All \( \alpha \), all \( \beta \), \( \alpha/\beta \), \( \alpha+\beta \) domains. Structural motifs-protein family and superfamily. Quaternary structure- protomers, multimers—rotational and helical symmetry.

Unit-III Nucleic Acids
DNA double helical structure- Watson and Crick model.A, B and Z forms of DNA. Unusual structures- palindrome, inverted repeats, cruciform and hairpins. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA: buoyant density, viscosity, UV absorption, denaturation, the cot curve. Differences between DNA and RNA. Major classes of RNA- mRNA, rRNA, tRNA: structure and biological functions. Minor classes of RNA.
Nucleic acid-binding proteins- HTH, HLH, zinc finger motif, leucine zipper motif.

Unit-IV Glycosaminoglycans and Glycoconjugates
Glycosaminoglycans- structure, location and biological role of hyaluronic acid, chondroitin sulphate, keratin sulfate, heparin sulfate, dermatan sulfate and heparin. Sialic acid- structure and significance. Proteoglycans.
Glycoproteins and their biological importance. Principal sugars in human glycoproteins. Lectins- structure, function, applications.
Major classes of glycoproteins- O-linked, N-linked, GPI linked oligosaccharides. Blood group antigens and bacterial cell wall polysaccharides.

**Unit-V Lipids**

Lipoproteins—classification and composition. Amphipathic lipids (membranes, micelles, emulsions and liposomes).

**Text Books**

**Reference Books**

**BIO C 102: CELL BIOLOGY AND GENETICS**

**Objective:** To learn the organization of cells and tissues, cell division, differentiation, cell cycle, and cell death. Students will also learn the principles and applications of plant and animal tissue culture as well as the principles of genetics.

**Unit – I Cell and Tissue organization**

Major classes of cell junctions—anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs)—cadherins, integrins. Brief account of the extracellular matrix.

**BIOO6: CLINICAL BIOCHEMISTRY**

**Objective:** This course will enable students to understand the biochemical basis of diseases.

**Unit–I**

**Unit–II**
Structure and functions of the liver. Composition and functions of bile. Jaundice: classification, causes and biochemical findings.

Normal and abnormal constituents of urine. Pathogenesis, biochemical findings and management of nephrotic syndrome.

**Unit–III**

**Unit–IV**

**Unit–V**

Protein Energy Malnutrition: Marasmus and Kwashiorkor: clinical features and biochemical findings. Obesity: Causes, consequences and management (brief account only).

**Books Recommended**
BIOO5: GENETIC ENGINEERING

Objective: To master the basic principles and applications of genetic engineering.

Unit–I Restriction enzymes and cloning vectors
Basic principles of rDNA technology. Type II Restriction endonucleases—nomenclature and types of cleavage types. Cloning vectors—essential features. Mechanism of cloning in plasmid (pBR322) and phage (λ phage) vectors. Cosmids. Brief introduction to high-capacity cloning vectors.

Unit–II Ligation and rDNA transfer

Unit–III rDNA Screening and Cloning strategies

Unit–IV Transgenic plants and animals

Unit–V Techniques
DNA sequencing—Sanger method. Southern Western hybridization. DNA fingerprinting—principle and applications. PCR: basic reaction, and applications. Gene therapy—basic principles. The human genome project (elementary details). Hazards and safety aspects of genetic engineering.

Text Books
Text Books

Reference Books

BIOP 103:PRACTICAL – I
BIOMEMOLES, GENETICS AND CELL BIOLOGY
1. Estimation of glucose by anthrone method.
2. Qualitative analysis of amino acids
3. Estimation of protein by Lowry et al method/ Bradford method
4. Estimation of DNA by diphenylamine method.
5. Estimation of RNA by orcinol method
6. Thermal denaturation of DNA.
7. Microscopic examination of epithelial cells, plant cells.
8. Tissue culture techniques: Surface sterilisation techniques, media preparation and storage, serum inactivation.
9. Staining of cell cultures and observations under microscope.
10. cry<sup>+</sup> mutants of Drosophila melanogaster.

BIOO4: IMMUNOLOGY
Objective: To acquire knowledge on immunological mechanisms and immunotechniques.

Unit–I

Unit–II

Unit–III

Unit–IV

Unit–V
Agglutination and precipitation techniques. Immunelectrophoresis, RIA, Immunoblotting, Avidin-biotin mediated immunoassay. Immunohistochemistry, immunofluorescence. ELISA-principle and applications.

Text Books
BIOO3: BIOCHEMICAL TECHNIQUES

Objective: To learn the principle, operation, and applications of various techniques for analyzing biomolecules.

Unit–I Spectroscopic techniques
Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, spectrofluorimetry and atomic spectroscopy.

Unit–II Radioisotope techniques

Unit–III Electrophoresis and blotting techniques
Principle, technique and applications of PAGE, SDS-PAGE, agarose gel electrophoresis and isoelectric focusing. Blotting techniques: Southern and Western.

Unit–IV Chromatography
General principles of partition and adsorption chromatography. Principle, operation and applications of thin layer, ion-exchange, molecular exclusion, and affinity chromatography. HPLC—principle, instrumentation and applications.

Unit–V Centrifugation

Text Books

BIO C 201: ENZYMES

Objective: At the end of the course, students will appreciate the characteristics of enzymes, enzyme kinetics, mechanism of enzyme action and regulation. The developments in enzyme engineering and potential uses of enzymes are also included.

Unit–I

Unit–II

Unit–III
Enzyme inhibition—irreversible and reversible, competitive, noncompetitive, uncompetitive, mixed inhibition (derivation not required). Clinical uses of competitive inhibition using methotrexate, methanol and insecticide poisoning.

Mechanism of enzyme action—acid base catalysis, covalent catalysis, strain, proximity and orientation effects. Mechanism of action of chymotrypsin.

Unit–IV

Unit–V


Text Books

Reference Books

BIO C 202: METABOLISM AND REGULATION
Objective: The objective of this course is to understand metabolic pathways, their interrelationship and the mechanisms of regulation.

Unit–I Bioenergetics and Biological Oxidation
Free energy and entropy, endergonic and exergonic reactions. Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain- organization of respiratory chain complexes and electron flow.


Unit–II Carbohydrate metabolism

BIOO2: BASIC BIOTECHNOLOGY
Objective: To master the basic principles and applications of biotechnology.

Unit–I Bioprocess Engineering and Downstream Processing

Unit–II Environmental and Energy Biotechnology

Unit–III Enzyme and Food Technology

Unit–IV Recombinant DNA technology
Basic steps in cloning. Restriction endonucleases, cloning vectors e.g. pBR322. Introduction of rDNA into host cells by calcium phosphate coprecipitation, electroporation, lipofection, microinjection. Screening of recombinants by marker inactivation. Applications of rDNA technology.

Unit–V Plant, Animal, and Medical Biotechnology

Text Books
OPTIONALS OFFERED TO OTHER DEPARTMENTS
BIOO1: BASIC BIOCHEMISTRY

Objective: To understand the physiochemical principles in biochemistry and the basic concepts of the chemistry and metabolism of major biomolecules.

Unit–I
Classification of carbohydrates. Functions of biologically important monosaccharides, disaccharides, homopolysaccharides, and heteropolysaccharides. Carbohydrate metabolism: glycolysis, citric acid cycle, gluconeogenesis, glycogen metabolism (overview only, structures not required). Diabetes mellitus (elementary details).

Unit–II

Unit–III

Unit–IV

Unit–V
DNA structure- Watson and Crick model. A, B, and Z forms of DNA. DNA denaturation. Differences between DNA and RNA. Major classes of RNA- structure and biological functions.

Text Books


Unit–III Lipid metabolism

Unit–IV Amino acid and Porphyrin metabolism

Biosynthesis and degradation of porphyrins and heme. Porphyrrias.

Unit–V Metabolism of purines and pyrimidines and Metabolic integration


Text Books
BIO C 203: IMMUNOLOGY

Objective: To acquire comprehensive knowledge of immunology and immunochemical techniques

Unit–I

Unit–II
Types of immunity- innate and acquired immunity, Antigen recognition- T-cell and B-cell receptor complexes, antigen processing and presentation. Interaction of T and B-cells. Immunological memory, Effector mechanisms: phagocytosis, cell mediated cytotoxicity, antibody dependent CMC. Vaccines- killed, attenuated organisms, toxoids, recombinant vaccines, subunit vaccines, DNA vaccines, synthetic peptide vaccines, antidiotypic vaccines.

Unit–III

Unit–IV

Unit–V
Imunochemical techniques- production of antibodies- polyclonal and monoclonal antibodies. Applications of Mab. Immunodiffusion techniques, Immunoprecipitation, RIA, ELISA, fluorescence immune-


Text Books
8. Twyman. Principles of Proteomics. 2nd ed. 2013

Reference Books

BIO P 403: Practical – V
Clinical Biochemistry & Bioinformatics

A. Estimation of blood constituents
1. Blood glucose
2. Blood urea
3. Serum uric acid
4. Serum creatinine
5. Serum cholesterol
6. Serum HDL cholesterol
7. Serum calcium
8. Serum iron
9. Serum inorganic phosphorus
10. Serum bilirubin
11. Serum protein- Biuret method – A/G ratio

B. Sequence alignment and searching
1. Phylogenetic analysis
2. Protein sequence analysis
**BIO C 402: GENOMICS, PROTEOMICS AND BIOINFORMATICS**

**Objective:** To understand the principles of genome mapping, sequencing, genome analysis, and the tools and applications of proteomics and bioinformatics.

**Unit–I Genome mapping and sequencing**
Genome mapping-rationale. Types of gene map-genetic, cytogenetic and physical. Molecular markers for mapping-RFLPs, microsatellites and SNPs. Assembling a physical map of the genome - chromosome walking and jumping. Genome sequencing approaches: whole-genome shotgun, hierarchical shotgun. Identifying genes- sequence inspection, EST comparison, similarity searches.

**Unit–II Genome projects, post-genome analysis**
Genome projects: genome sequence data of model organisms- *E.coli, D.melanogaster,* and mouse. The Human Genome Project: goals, mapping strategies, markers, sequencing technologies, results of final sequence, potential benefits and risks, ELSI. Post-genome analysis- differential display, DNA microarray, ChIPs, knock-out analysis.

**Unit–III Protein separation, identification and quantitation**
Proteomics-introduction. Protein separation- general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry-basic principle and instrumentiation, ESI, MALDI-TOF, SELDI-TOF, tandem MS. Peptide mass fingerprinting (elementary details).

**Unit–IV Structural & functional proteomics & applications**
Structural proteomics: X-ray and NMR for protein structure analysis. Comparative and homology modeling, secondary structure prediction, fold recognition and *ab initio* prediction. SCOP. Protein sequence analysis: substitution score matrices, pairwise similarity search, pattern recognition.

Protein function determination: database search for homology, phylogenetic profile method, domain fusion. Protein-protein interactions: yeast 2-hybrid system. Protein arrays and chips (concept and applications). Applications of proteomics.

**Unit–V Bioinformatics**

**Text Books**

**Reference Books**

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**BIO C 204: MOLECULAR BIOLOGY**

**Objective:** This course is designed to educate students on chromatin structure, gene complexity and genomic information flow.

**Unit–I Chromatin and Genome complexity**
The central dogma of molecular biology. The *E. coli* chromosome and DNA-binding proteins. Plasmids- classification and properties. Eukaryotic chromatin: nucleosomes, 30 nm fiber and higher order chromatin structure. Concept of the gene. Definitions of the following: gene, cistron, coding region (ORF), transcription unit, untranslated region (UTR), pseudogenes, euchromatin and heterochromatin. Typical structure of protein-coding genes in prokaryotes and eukaryotes. Split genes- exons and introns. DNA sequence elements: unique sequence DNA, repetitive DNA (SINEs, LINEs, satellite, minisatellites and microsatellites).

**Unit–II Replication, Repair and Recombination**

Unit–III Transcription and Post-transcriptional processing


Classes of introns. Post-transcriptional processing of prokaryotic and eukaryotic rRNA, and tRNA, and eukaryotic mRNA. Brief account of ribozymes, RNA editing and Reverse transcription.

Unit IV Genetic code and Translation


Unit–V Regulation of Gene expression


Text Books

Reference Books


Unit–III Liver


Unit–IV Gastrointestinal and Renal disorders

Gastric function tests. Peptic ulcer: pathogenesis, biochemical findings and management. Pancreatic and intestinal function tests. Causes, biochemical findings and consequences of pancreatitis, cystic fibrosis and malabsorption.

Kidney function tests. Abnormal constituents of urine. Pathogenesis, biochemical findings and management of glomerulonephritis, renal failure, nephrotic syndrome and nephrolithiasis.

Unit–V Molecular Diagnosis and Molecular Therapeutics


Text Books
2. Clinical chemistry in diagnosis and treatment Mayne ELBS. (1994)

Reference Books
BIO P 305: PRACTICAL – IV
ANALYTICAL TECHNIQUES, PHYSIOLOGY, ENDOCRINOLOGY AND BIOTECHNOLOGY

1. UV-Absorption spectrum of proteins and nucleic acids.
2. Separation of lipids by TLC
4. Separation of proteins by SDS-PAGE and Western blotting.
5. HPLC - Demonstration.
6. Subcellular fractionation - isolation and analysis of nuclear and mitochondrial fractions.
7. Enumeration of RBCs, WBCs (Total & differential)
8. Estimation of bleeding time and clotting time.
10. Hormone assay
11. Restriction enzyme digestion of DNA.
12. PCR and analysis of PCR products.
13. Real-time qPCR - Demonstration.

BIO C 401: CLINICAL BIOCHEMISTRY

Objective: To understand the biochemical and molecular aspects of diseases.

Unit–I Molecular Basis of Diseases-I
Role of tissues and hormones in blood glucose homeostasis. Diabetes mellitus: classification, metabolic abnormalities, diagnosis, acute (diabetic ketoacidosis, HONK coma) and long term (nephropathy, neuropathy, retinopathy, diabetic foot) complications, management. Hypoglycemia: classification, clinical manifestations, diagnosis and management.

Unit–II Molecular Basis of Diseases–II

BIO P 206: PRACTICAL–III
MICROBIOLOGY AND IMMUNOLOGY

1. Microscopic examination of bacteria, fungi, yeast.
2. Isolation of microbes from spoiled foods
3. Staining of microorganisms: Gram staining, acid fast staining.
4. Culture of microorganisms: media preparation, Serial dilution, inoculation, Culture of bacteria in culture tubes, agar plates.
5. Antibiotic sensitivity and resistance pattern of bacteria.
6. Blood grouping and Rh typing
7. Radial immunodiffusion
8. Double diffusion
9. Agglutination, rosette formation, complement fixation
10. Preparation of antisera
11. Immunoelectrophoresis (demonstration)
12. ELISA (demonstration)
BIO C 301: ANALYTICAL TECHNIQUES

Objectives: To learn the basic principles, instrumentation and applications of the analytical tools of biochemistry

Unit–I Spectroscopy

Unit–II Radioisotope techniques and Microscopy

Microscopy- basic principles, and components of light, bright field, phase contrast, and fluorescence microscopy. Electron microscopy- principle, preparation of specimens for TEM and SEM. Confocal microscopy.

Unit–III Electrophoresis and blotting techniques

Unit–IV Chromatography
General principles of partition and adsorption chromatography. Principle, instrumentation and applications of thin layer and gas chromatography. Principle, procedure, and applications of ion-exchange, molecular exclusion, and affinity chromatography. HPLC-principle, instrumentation and applications.

Unit–V Centrifugation


Unit–V Preparation of probes. DNA sequencing. Chemical, enzymatic and automated methods. DNA fingerprinting-principle and applications. Brief outline of RFLP and FISH. PCR: basic reaction and applications. Modified PCR techniques- RT-PCR, real-time qPCR. Basic concepts of site-directed mutagenesis, protein engineering and uses. Basic principles of gene knock-in and knock-out technology. The human genome project-goals, results, benefits and hazards. Hazards and safety aspects of genetic engineering.

Text books

References
BIO C 304: BIOTECHNOLOGY

Objective: To understand the classification, growth and cultivation of microorganisms and the industrial applications.

Unit–I

Downstream processing: solid-liquid separation, release of intracellular compartments, concentration of biological products, purification, preservation and stabilization, product formulation. Monitoring.

Unit–II


Unit–III
Basic steps in cloning. Restriction endonucleases, cloning vectors (pBR322, pUC), phages (λ and M13), cosmids, BACs, and YACs. Methods of ligating vector and insert DNA—cohesive end method, homopolymer tailing, blunt-end ligation, linkers and adapters.


Text Books

Reference Books
3. Pavia Intro to spectroscopy 5th ed. 2015.

BIO C 302: MOLECULAR ENDOCRINOLOGY AND SIGNALING

Objective: This course emphasizes the general aspects of hormone action and physiological and biochemical effects of individual hormones. Disorders related to hormonal actions are included to understand the regulatory role of hormones.

Unit–I Hypothalamic and Pituitary hormones

Unit–II Thyroid and Parathyroid hormones

Unit–III Adrenal hormones
Adrenal medullary hormones—synthesis, secretion, metabolism, regulation and biological effects of catecholamines. Phaeochromocytoma.

Unit—IV Gonadal, Gastrointestinal and Pancreatic hormones

Unit—V Signal transduction

Text Books

BIO C 303: PHYSIOLOGY & NUTRITION

Objective: To acquire knowledge of the physiology of different systems.

Unit—I Neuromuscular system

Structure of skeletal muscle. Muscle proteins—myosin, actin, troponin and tropomyosin and other proteins. Sequence of events in contraction and relaxation of skeletal muscle. Cardiac and smooth muscle (Brief account only).

Unit—II Digestive and Excretory System
Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.


Unit—III Blood, Lymph and CSF

Unit—IV Hydrogen ion and fluid electrolyte homeostasis
Hydrogen ion homeostasis: Factors regulating blood pH—buffers, respiratory and renal regulation. Causes, biochemical findings and management of metabolic and respiratory acidosis and alkalosis.


Unit—V Nutrition

Text Books

Reference Books