# Maa Shakumbhari University, Saharanpur

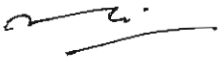
## Syllabus of the Subject

## Biochemistry

**For Four Year Undergraduate Program (FYUP)**

**(As per guidelines of Common Minimum Syllabus by U.P. Government according to National Education Policy-2020 amended with GO-2090/70-3-2024-09(01) Dated: 02-09-2024)**

# Members, Board of Studies (Biochemistry)

| S. No. | Name | Designation | College/University | |
|---|---|---|---|---|
| 1. | Prof. Garima Jain | Dean Science | D.A.V. (P.G). College, Muzaffarnagar |  |
| 2. | Prof. Mukesh Chand | Convener | D.A.V. (P.G). College, Muzaffarnagar |  |
| 3. | Prof. Anju Panwar | Member | D.A.V.(P.G.) College, Muzaffarnagar |  |
| 4. | Mr. Satyendra Kumar | Member | D.A.V.(P.G.) College, Muzaffarnagar | |
| 5. | Prof. Hari Om Sharma | Member | C.C.R. Degree College, Muzaffarnagar |  |
| 6. | Dr. Rachna Tyagi | Member | D.A.V.(P.G.) College, Muzaffarnagar |  |
| 7. | Prof. Nupur Chatterji | External expert | Meerut College, Meerut. | |
| 8. | Prof R. K. Shukla | External expert | Gurukul Kangri University, Haridwar | |

## Semester-wise Titles of Papers

| Year | Sem. | Course Code | Paper Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| 1st | I | | Fundamentals of Biochemistry | Theory | 4 |
| | | | Fundamentals of Biochemistry Lab. | Practical | 2 |
| | | | Cell Biology | Theory | 4 |
| | | | Cell Biology Lab. | Practical | 2 |
| | | | Minor Elective (Other faculty) | Theory | 6 |
| | | | Vocational Skill Development course | Theory | 3 |
| | | | Co-curricular Course | Theory | 2 |
| | | Total Credits:23 | | | |
| | II | | Proteins | Theory | 4 |
| | | | Proteins Lab. | Practical | 2 |
| | | | Human Physiology | Theory | 4 |
| | | | Human Physiology Lab. | Practical | 2 |
| | | | Vocational Skill Development course | Theory | 3 |
| | | | Co-curricular Course | Theory | 2 |
| | | Total Credits:17 | | | |
| **First Year Total credits: 40** | | | | | |

| Year | Sem. | Course Code | Paper Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| 2nd | III | | Enzymes and Enzymology | Theory | 4 |
| | | | Enzymes and Enzymology Lab. | Practical | 2 |
| | | | Metabolism of Carbohydrates and Lipids | Theory | 4 |
| | | | Metabolism of Carbohydrates and Lipids Lab. | Practical | 2 |
| | | | Minor Elective (Other Faculty) | Theory | 6 |
| | | | Vocational Skill Development course | Theory | 3 |
| | | | Co-curricular Course | Theory | 2 |
| | | Total Credits:23 | | | |
| | IV | | Membranes Biology and Bioenergetics | Theory | 4 |
| | | | Membranes Biology and Bioenergetics Lab. | Practical | 2 |
| | | | Metabolism of Amino Acids and Nucleotides | Theory | 4 |
| | | | Metabolism of Amino Acids and Nucleotides Lab. | Practical | 2 |
| | | | Co-curricular Course | Theory | 2 |
| | | | Research Project | | 3 |
| | | Total Credits:17 | | | |
| **Second Year Total credits: 40** | | | | | |

| Year | Sem. | Course Code | Paper Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| 3rd | V | | Concepts in Genetics | Theory | 4 |
| | | | Tools and Techniques in Biochemistry. | Theory | 4 |
| | | | Genetics and Tools, Techniques in Biochemistry Lab. | Practical | 2 |
| | | | Immunology | Theory | 4 |
| | | | Biostatistics and Bioinformatics | Theory | 4 |
| | | | Immunology,Biostatistics and BioinformaticsLab. | Practical | 2 |
| | | Total Credits:20 | | | |
| | VI | | Basic Microbiology | Theory | 4 |
| | | | Clinical Biochemistry | Theory | 4 |
| | | | Microbiology and Clinical Biochemistry Lab. | Practical | 2 |
| | | | Harmone Biochemistry | Theory | 4 |
| | | | Molecular Basis of Human Diseases | Theory | 4 |
| | | | Harmone Biochemistry and Molecular Basis of Human Diseases Lab. | Practical | 2 |
| | | Total Credits:20 | | | |
| **Third Year Total credits: 40** | | | | | |

| Year | Sem. | Course Code | Paper Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| 4th | VII | | Biophysical chemistry | Theory | 4 |
| | | | Molecular Biology | Theory | 4 |
| | | | Genetic Engineering | Theory | 4 |
| | | | Plant Biochemistry | Theory | 4 |
| | | | Practical | Practical | 4 |
| | | Total Credits:20 | | | |
| | VIII | | Analytical chemistry | Theory | 4 |
| | | | Bioenergetics | Theory | 4 |
| | | | Microbial Biochemistry | Theory | 4 |
| | | | Research Methodology | Theory | 4 |
| | | | Practical | Practical | 4 |
| | | Total Credits:20 | | | |
| **Fourth Year Total credits: 40** | | | | | |

| **Programme/Class:** Certificate | **Year:** First;<br>**Subject:** Biochemistry | **Semester:** First |
|---|---|---|
| **Course Code:** | **Course Title:** Fundamentals of Biochemistry | |

**Course outcomes**: After successful completion of the course, student will be able to

- Basic details of structure, function of carbohydrate molecules and its classification
- Details of structure, function and classification of amino acid &structural levels of protein molecules
- Structure and function offatty acids, storage and structural lipids, Nucleotide, DNA and RNA
- Basic details of Vitamin molecules and its classification

| **Credits:** 4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Basics of Biochemistry: History with special reference to contribution of Indian biochemists.General idea about normality, molarity, molality, percentage solutions, mole fraction. W/v and v/v solutions. Concept of pH determinations using indicators, buffer solutions and their biological importance. Water as universal solvent. | **No. of Lectures 60** |
| II | Amino acids and proteins: Structural features and classification, Physical properties, optical properties (Stereoisomerism), Chemical properties of amino acids, Uncommon amino acids and their function. Classification of protein, structural organization as primary, secondary, tertiary and quaternary structure of protein and characteristics of the peptide bond | |
| III | Carbohydrate: Monosaccharides - structure of aldoses and ketoses, Ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, Structure of biologically important sugar derivatives, oxidation and reduction of sugars, Formation of disaccharides, reducing and non-reducing disaccharide, Polysaccharides- homoand hetero-polysaccharides, structural and storage polysaccharides. | |
| IV | Lipids: Building blocks of lipids - fatty acids, glycerol, ceramide, Storage lipids - triacyl glycerol and waxes, Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, Plant steroids. | |
| V | Nucleic acids: Nucleotides - structure and properties, Nucleic acid structure – Watson-Crick model of DNA, Structure of major species of RNA - mRNA, tRNA and rRNA, Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA, Other functions of nucleotides - source of energy, component of coenzymes, second messengers. | |
| VI | Vitamins: Structure and active forms of water soluble and fat-soluble vitamins, Deficiency diseases and symptoms, hypervitaminosis, Sources, dietary requirements. | |
| VII | Plant Hormones:Classification, structural features & functions in Plants, Auxins, gibberellins, cytokinins, ethylene, and abscisic acid | |
| VIII | Animal Hormones: Classification, structural features &Functions of hormones secreted by endocrine glands: Hypothalamus, pituitary | |

| | | |
|---|---|---|
| | glandanterior pituitary and posterior pituitary, thyroid gland, adrenal gland, Pancreas, gonads | |

Suggested reading

1.Lehninger,Albert,Cox,MichaelM.Nelson, DavidL(2017)Lehningerprinciplesofbiochemistry/ NewYork:W.H.Freeman.
2. Voet,D.&Voet,J.G. (2011)Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – LubertStryer Freeman InternationalEdition.
4. Biochemistry – Keshav Trehan Wiley EasternPublications
5. Fundamentals of Biochemistry-J.L.Jain, S.Chand andCompany
6. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| **Programme/Class:** Certificate | **Year:** First; **Subject:** Biochemistry | **Semester:**First |
|---|---|---|
| **Course Code:** | **Course Title:** Fundamentals of BiochemistryLab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100 | **Min. Passing Marks**: As per University norms | |

| **Topics** | Total No of hrs. |
|---|---|
| • Safety measures in laboratories<br>• Preparation of normal and molar solutions<br>• Preparation of buffers<br>• Determination of pKa of acetic acid and glycine<br>• Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids<br>• Estimation of vitamin C<br>• Perform spot test for amino acids in a given sample | 60 |

| **Programme/Class:** Certificate | **Year:** First; **Subject:**Biochemistry | **Semester:**First |
|---|---|---|
| **Course Code:** | **Course Title:** Cell Biology | |

After successful completion of the course, student will be able to:

- Learn structure and functions of cell, itsorganelles and role of cytoskeleton.
- Understand chemical composition of biological membranes and membrane transport.
- Understand the cell cycle, mitosis, meiosis, and regulation mechanisms with

| **Credits:**4 | **Core:** Compulsory | |
|---|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |
| Unit | Topics | Total |
| I | Introduction to cell biology: Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models. | No. |
| II | Tools of cell biology: Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation. | of |
| III | Structure of different cell organelles: Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome. | Lectu res |
| IV | Protein trafficking: Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins | 60 |
| V | Cytoskeletal proteins: Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella. | |
| VI | Cell division - Cell cycle, mitosis and meiosis, regulations of cell cycle and check points and proteins involved in cell cycle check points. Basics in cell signaling- ligand molecules and receptors, G protein coupled receptors, Tyrosine kinase receptor, apoptosis and necrosis. | |
| VII | Cell wall and extracellular matrix: Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. | |
| VIII | Cell cycle, cell death and cell renewal: Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell | |

Suggested Reading

1. Molecular Biology of The Cell- B Albert, A Johnson, J Lewis, M Raff, K Roberts & P Walter.; G.S. Garland Science Taylor & Francis Group NY 10001-2299
2. Cell and Molecular Biology- G. Karp.; John Wiley& Sons, Inc. NY
3. Molecular Cell Biology, H. Lodish, A. B.P. Matsudaira C.A. Kaiser, M. Krieger, M. P. Scott, L. Zipursky, J. Darnell.; W.H. Freeman & Com., NY.
4. The World of the Cell- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test10 marks for presentation along with assignment
05 marks for Class interactions

| Programme/Class: Certificate | Year: First; Subject:Biochemistry | Semester:First |
|---|---|---|
| **Course Code:** | **Course Title:** Cell Biology Lab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100 | **Min. Passing Marks**: As per University norms | |

| Topics | Total No. of hrs. |
|---|---|
| • Visualization of animal and plant cell by methylene blue.<br>• Identification of different stages of mitosis in onion root tip.<br>• Identification of different stages of meiosis in grasshopper testis.<br>• Micrographs of different cell components (dry lab).<br>• Sub-cellular fractionation.<br>• Visualization of nuclear fraction by acetocarmine stain.<br>• Staining and visualization of mitochondria by Janus green stain. | 60 |

| Programme/Class: Certificate | Year: First; Subject:Biochemistry | Semester:Second |
|---|---|---|
| **Course Code:** | **Course Title:**Proteins | |

After successful completion of the course, student will be able to:

- Understand unique features and characteristics of proteins.
- Understand the relationship between three-dimensional structure of proteins and their functions

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Introduction to amino acids, peptides and proteins: Amino acids and their properties - hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function | 60 |
| II | Extraction of proteins for downstream processing: Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation. | |
| III | Separation techniques: Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Ionexchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC | |

| | | |
|---|---|---|
| IV | Characterization of proteins: Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis. | |
| V | Covalent structure of proteins: Organization of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass spectrometric analysis, tandem MS. Solid phase peptide synthesis | |
| VI | Three dimensional structures of proteins: Nature of stabilizing bonds - covalent and non-covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures - X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin | |
| VII | Protein folding and conformational diseases No. of Hours: 4 Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based. | |
| VIII | Myoglobin and haemoglobin. Antibody structure and binding to antigens. ATP activated actin - myosin contractions.Membrane proteins: Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin | |

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)
2. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex),
3. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi).

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class:** Certificate | **Year:** First; **Subject:**Biochemistry | **Semester:** Second |
| **Course Code:** | **Course Title:** Proteins Lab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100 | **Min. Passing Marks**: As per University norms | |

| Topics | Total No. Of Hrs. |
|---|---|
| • Estimation of proteins using UV absorbance and Biuret method.<br>• Microassay of proteins using Lowry/Bradford method.<br>• Isoelectric pH of casein.<br>• Ammonium sulphate fractionation of serum proteins.<br>• Separation of albumin from serum using anion-exchange chromatography.<br>• SDS-PAGE analysis of protein | 60 |

| **Programme/Class:**Certificate | **Year:** First;<br>**Subject:**Biochemistry | **Semester:**Second |
|---|---|---|
| **Course Code:** | **Course Title:**Human Physiology | |
| After successful completion of the course, student will be able to:<br>• Understand the Mechanism of digestion & absorption, Composition of blood and functions of heart<br>• Understand the physiology of kidney and reproduction.<br>• Understand the mechanism of muscle contraction, Nervous coordination. | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| Unit | Topics | Total No. of |
|---|---|---|
| I | Homeostasis and the organization of body fluid compartments: Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemia, polycythemia, haemophilia and thrombosis | |

| | | |
|---|---|---|
| II | Cardiovascular physiology: Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automacity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction. | **Lectures**<br><br>**60** |
| III | Respiration: Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea, pulmonary distress, emphysema, ARDS. | |
| IV | Renal physiology: Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition reflex and voluntary control of micturition. Regulation of ECF electrolyte and water content, blood volume and long-term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function. Acidosis and alkalosis. Glomerular nephritis, renal failure, dialysis and diuretics. | |
| V | Gastrointestinal and hepatic physiology: Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver | |
| VI | Musculosketetal system: Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle. | |
| VII | Reproductive physiology: Sex determination and differentiation. Development of female and male genital tracts. Spermatogenesis, Ovarian function and its control. Fertilization and implantation. Placenta as a feto-maternal unit. | |
| VIII | Neurochemistry and neurophysiology: Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory. | |

Suggested reading

1. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York)
2. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill
3. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi).
4. Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco),

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25

| |
|---|
| 10 marks for Test<br>10 marks for presentation along with assignment<br>05 marks for Class interactions |

| | | |
|---|---|---|
| **Programme/Class**: Certificate | **Year:** First;<br>**Subject:**Biochemistry | **Semester:**Second |
| **Course Code:** | **Course Title:** Human PhysiologyLab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100 | **Min. Passing Marks**: As per University norms | |

| **Topics** | Total |
|---|---|
| • Hematology.<br>o RBC and WBC counting<br>o Differential leucocyte count.<br>o Clotting time.<br>• Estimation of haemoglobin.<br>• Separation of plasma proteins.<br>• Determination of total iron binding capacity.<br>• Pulmonary function tests, spirometry and measurement of blood pressure.<br>• Separation of isoenzymes of LDH by electrophoresis.<br>• Histology of connective tissue, liver and/ brain permanent slides. | No. of hrs. 60 |

| | | |
|---|---|---|
| **Programme/Class:** Diploma | **Year:** Second<br>**Subject:**Biochemistry | **Semester:**Third |
| **Course Code:** | **Course Title:**Enzymes | |

After successful completion of the course, student will be able to:

- Understand classification and specificity of enzymes.
- Learn mechanism of enzyme action and enzyme kinetics.
- Explore various industrial applications of enzymes.

| | |
|---|---|
| **Credits:**4 | **Core:** Compulsory |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Introduction to enzymes: Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes. | No. |
| II | Features of enzyme catalysis: Factors affecting the rate of chemical reactions. collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power | of Lectu |

| | | |
|---|---|---|
| | and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. | res |
| III | Enzyme kinetics: Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant – mono-substrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme. | 60 |
| IV | Enzyme inhibition: Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors. | |
| V | Mechanism of action of enzymes: General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. | |
| VI | Regulation of enzyme activity: Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen. Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase). | |
| VII | Involvement of coenzymes in enzyme catalysed reactions: TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid. | |
| VIII | Applications of enzymes: Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes. | |

Suggested Reading

1.Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey)
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York)

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| Programme/Class: Diploma | Year: Second<br>Subject:Biochemistry | Semester:Third |
|---|---|---|
| **Course Code:** | **Course Title:** Enzymes Lab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100 | **Min. Passing Marks**: As per University norms | |

| Topics | Total No of hrs. |
|---|---|
| • Partial purification of acid phosphatase from germinating mung bean.<br>• Assay of enzyme activity and specific activity, e.g. acid phosphatase.<br>• Effect of pH on enzyme activity<br>• Determination of Km and Vmax using Lineweaver-Burk graph.<br>• Enzyme inhibition - calculation of Ki for competitive inhibition.<br>• Continuous assay of lactate dehydrogenase.<br>• Coupled assay of glucose-6-phosphate dehydrogenase | 60 |

| Programme/Class: Diploma | Year: Second;<br>Subject:Biochemistry | Semester: Third |
|---|---|---|
| **Course Code:** | **Course Title:**Metabolism of Carbohydrates and Lipids | |
| After successful completion of the course, student will be able to:<br>• Understand the chemistry of carbohydrate, fat, fatty acid, etc.<br>• know aboutbiosynthesis of the molecules, chemistry of natural cycles of citric acid, etc | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| Unit | Topics | Total |
|---|---|---|
| I | Basic design of metabolism: Autotrophs, heterotrophs, metabolic pathways, | |

| | | |
|---|---|---|
| | catabolism, anabolism, ATP as energy currency, reducing power of the cell. | **No.** |
| II | Glycolysis: Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia.<br>Gluconeogenesis and pentose phosphate pathway: Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance. | **of**<br>**Lect ures** |
| III | Glycogen metabolism: Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases. Citric acid cycle: Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways. | **60** |
| IV | Synthesis of carbohydrates: Calvin cycle, regulation of calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C4 and CAM pathways, synthesis of cell wall polysaccharides, integration of carbohydrate metabolism in plant cell. | |
| V | Fatty acid oxidation: Digestion, mobilisation and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis. | |
| VI | Fatty acid synthesis: Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation. | |
| VII | Biosynthesis of eicosanoids, cholesterol, steroids and isoprenoids: Synthesis of prostagladins, leukotrienes and thromboxanes. Synthesis of cholesterol, regulation of cholesterol synthesis. Synthesis of steroids and isoprenoids. | |
| VIII | Biosynthesis of membrane lipids: Synthesis of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, biosynthesis of triacylglycerol, biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases. | |

Suggested reading

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey)
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York)

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Program/Class**: Diploma | **Year:** Second<br>**Subject:**Biochemistry | **Semester:**Third |

| Course Code: | Course Title: Metabolism of Carbohydrates and LipidsLab. |
|---|---|
| Credits: 2 | Core: Compulsory |
| Max. Marks: 100 | Min. Passing Marks: As per University norms |

| Topics | Total No of Hrs. |
|---|---|
| • Estimation of blood glucose.<br>• Sugar fermentation of microorganisms.<br>• Assay of salivary amylase.<br>• Isolation of lecithin, identification by TLC, and its estimation.<br>• Isolation of cholesterol from egg yolk and its estimation | 60 |

| Programme/Class: Diploma | Year: Second<br>Subject:Biochemistry | Semester:Fourth |
|---|---|---|
| Course Code: | Course Title:Membranes Biology and Bioenergetics | |

After successful completion of the course, student will be able to:

- have idea on different biological membranes and their biochemical composition, mechanism of transport of different chemical and biological species, their energetics,
- Understand the basics of bioenergetics and how the principles of bioenergetics hold good in biological systems.

| Credits:4 | Core: Compulsory |
|---|---|
| Max. Marks: 100=75(UE)+25(CIE) | Min. Passing Marks: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Introduction to bio-membranes: Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems. | 60 |
| II | Membrane structures: Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture. | |
| III | Membrane dynamics: Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS | |

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|---|---|
| | labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity. |
| IV | Membrane transport: Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+ - glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na+ /K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin. |
| V | Vesicular transport and membrane fusion: Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin |
| VI | Introduction to bioenergetics: Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers. |
| VII | Oxidative phosphorylation: Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants. |
| VIII | Photophosphorylation: General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria,Green-sulfur bacteria and *Halobacterium salinarum*. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis. |

Suggested reading

1.Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)

2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York)

3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston).

4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York)

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

| Programme/Class: Diploma | Year: Second<br>Subject:Biochemistry | Semester:Fourth |
|---|---|---|
| **Course Code:** | **Course Title:** Membranes Biology and Bioenergetics Lab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| Topics | Total |
|---|---|
| • Effect of lipid composition on the permeability of a lipid monolayer.<br>• Determination of CMC of detergents.<br>• RBC ghost cell preparation and to study the effect of detergents on membranes.<br>• Separation of photosynthetic pigments by TLC.<br>• Isolation of mitochondria from liver and assay of marker enzyme SDH.<br>• Study photosynthetic O2 evolution in hydrilla plant.<br>• Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity. | No. of Hrs. 60 |

| Programme/Class: Diploma | Year: Second<br>Subject:Biochemistry | Semester:Fourth |
|---|---|---|
| **Course Code:** | **Course Title:**Metabolism of Amino Acids and Nucleotides | |

After successful completion of the course, student will be able to:

- learn regarding amino acid, protein, etc.
- understandseveral chemical and biochemical aspects of amino acids/proteins and nucleotides.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Overview of amino acid metabolism: Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus. Nitrogen balance, transamination, role of pyridoxal | No. of |

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|---|---|---|
| | phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle and inherited defects of urea cycle. | **Lect ures** |
| II | Catabolism of amino acids: Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease. | **60** |
| III | Biosynthesis of amino acids: Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation. | |
| IV | Precursor functions of amino acids: Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism. | |
| V | Biosynthesis of purine and pyrimidine nucleotides: De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. | |
| VI | Deoxyribonucleotides and synthesis of nucleotide triphosphate: Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides | |
| VII | Degradation of purine and pyrimidine nucleotides: Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency. | |
| VIII | Integration of metabolism: Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver). | |

Suggested reading

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York)

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class**: Diploma | **Year:** Second<br>**Subject:**Biochemistry | **Semester:**Fourth |
| **Course Code:** | **Course Title:** Metabolism of Amino Acids and NucleotidesLab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University | |

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| | norms |
| **Topics**<br>• Assay of serum transaminases – SGOT and SGPT.<br>• Estimation of serum urea.<br>• Estimation of serum uric acid<br>• Estimation of serum creatinine. | Total No. of Hrs. 60 |

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|---|---|---|
| **Programme/Class:** Degree | **Year:** Third;<br>**Subject:**Biochemistry | **Semester:** Fifth |
| **Course Code:** | **Course Title:**Concepts in Genetics | |
| After completion of the course the students will be able to<br>• Describe fundamentals of genetics and understand relationship between phenotype and genotype in human genetic traits;<br>• Understand Chromosome and genomic organization.<br>• Describe the basics of genetic mapping. | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Introduction to model organisms and Mendelism:Model organisms: *Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Caenorhabditis elegans, Danio rerio* and *Arabidopsis thaliana,* Basic principles of heredity.<br>Applications of Mendel's principles & chromosomal basis of heredity: Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences. | 60 |
| II | Extensions of Mendelism: Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non-epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy. | |

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|---|---|---|
| III | Gene: Complementation test, limitations of cis-trans test, intragenic complementation, rII locus of phage T4 and concept of cistron. Genetics of bacteria and viruses: Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria. | |
| IV | Linkage, crossing over and mapping: Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in Drosophila, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes. | |
| V | Genetic control of development and sex determination: Model organism for genetic analysis, Drosophila development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes.<br>Human pedigree analysis: Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis. | |
| VI | Organelle heredity and epigenetics: Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting. | |
| VII | Chromosomal aberrations: Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations. | |
| VIII | Inheritance of complex traits & population genetics: Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle. | |

Suggested reading


1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore)
2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York)
3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York)


Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class:** Degree | **Year:** Third<br>**Subject:**Biochemistry | **Semester:**Fifth |
| **Course Code:** | **Course Title:**Tools and Techniques in Biochemistry. | |
| After successful completion of the course, student will be able to: | | |

- learn about appropriate laboratory tools and practices.
- utilize the theoretical, technical and analytical skills to tackle issues and problems in the field of biochemistry.
- learn about the principle and application of cell culture and microscopic techniques.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Safety practices in the laboratory, Writing and maintaining lab reports, Introduction to various laboratory reagents: chemicals and liquid reagents, distilled/ RO water, Weighing of chemicals on an electronic balance | No. of Lectures 60 |
| II | Preparation and storage of solutions, labelling of prepared solutions, dilutions of solutions. Introduction and handling of acids and bases, Buffers, preparation of buffers using Handerson-Hasselbach equation, Hands-on training at pH meter, Preparation of a buffer with given pH and molarity. Hands-on training for micropipette. | |
| III | Microscopy Principle of light microscopy, phase contrast microscopy, fluorescence microscopy. Permanent and temporary slide preparation, histology and staining. | |
| IV | Separation techniques: Preparation of sample, different methods of cell lysis, salting out, dialysis. Principle and the factors affecting centrifugation Svedberg coefficient, types of rotors, principle and applications of differential and density gradient centrifugation | |
| V | Purification techniques: Classification of chromatographic techniques, principle and applications: Paper, thin layer, molecular sieve, ion exchange, and affinity chromatography | |
| VI | Electrophoretic techniques: Principle of electrophoresis, various types of electrophoresis: Polyacrylamide gel (native), SDS PAGE and agarose gel, staining procedures for protein and nucleic acids. | |
| VII | Spectroscopic techniques: Introduction to electromagnetic spectrum, Principle and working of UV-visible absorption spectrophotometer, single & double beam spectrophotometer, Beer's & Lambert's law, application of UV-visible spectrophotometer in biology. | |
| VIII | Microbiological/Cell culture techniques Types of media, selective and enrichment media, sterilization methods, bacterial culturing, CFU determination, growth curves, Generation/doubling times, cell counting, viable and nonviable. Growth and maintenance of cultures, biosafety cabinets, CO2incubator. Staining procedures, plating and microtomy | |

Suggested Readings


1. Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press.
2. Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall.
3. Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi).
4. Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi);


Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25

10 marks for Test

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|---|
| 10 marks for presentation along with assignment<br>05 marks for Class interactions |

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|---|---|---|
| **Program/Class**: Degree | **Year:** Third<br>**Subject:**Biochemistry | **Semester:** Fifth |
| **Course Code:** | **Course Title:** Geneticsand Tools and Techniques in Biochemistry. Lab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100 | **Min. Passing Marks**: As per University norms | |

| Topics | Total No. of Hrs. |
|---|---|
| • Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes<br>• Induction of polyploidy in onion roots.<br>• Smear technique to demonstrate sex chromatin in buccal epithelial cells<br>• Monohybrid crosses in Drosophila for studying autosomal and sex-linked inheritance.<br>• PTC testing in a population and calculation of allele and genotype frequencies.<br>• Study of abnormal human karyotype and pedigrees (dry lab)<br>• Conjugation in bacteria<br>• Preparation of cell free extract from E.coli culture.<br>• Separation and identification of amino acid acids by thin layer chromatography.<br>• Separation of molecules by gel filtration chromatography.<br>• Determination of absorption maxima (Amax).<br>• Calculate molar extinction coefficient of the given sample.<br>• Demonstration of PAGE and Agarose gel electrophoresis. | 60 |

| **Programme/Class:** Degree | **Year:** Third; **Subject:** Biochemistry | **Semester:** Fifth |
|---|---|---|
| **Course Code:** | **Course Title:** Immunology | |

After completion of the course the students will be able to:

- Understand the basic principles of immune system
- Understand the nature of antigen and antibodies, and antigen
- Understand the basic techniques to identify antigens.
- Understand the basis of allergy and allergic diseases
- Understand the importance of vaccines

| **Credits:** 4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Cells and organs of the immune system:Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.. | 60 |
| II | Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification. | |
| III | Biology of the B lymphocyte: Antigen independent phase of B cell maturation and selection, humoral response – Tdependent and T-independent response, anatomical distribution of B cell populations.<br>Biology of the T lymphocyte: Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. | |
| IV | Complement system: Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies. | |
| V | MHC complex and antigen presentation: General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of antigen processing and presentation. | |
| VI | Cell mediated cytotoxic responses: General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC). | |
| VII | Tolerance, autoimmunity and hypersensitivity: Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity | |
| VIII | Transplantation immunology and vaccines: Immunological basis of graft | |

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| | rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines. | |

Suggested Reading

1Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York)

2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey)

3. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York)

Suggested (CIE) methodsTotal marks: 25

10 marks for Test10 marks for presentation along with assignment

05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class:** Degree | **Year:** Third; **Subject:** Biochemistry | **Semester:** Fifth |
| **Course Code:** | **Course Title:**Biostatistics and Bioinformatics | |

After completion of the course the students will be able to

- Understand the principles of biological data collection, statistical analysis and presentation
- Learn and appreciate various factors that influence type of sample collected and sample size.
- Collect, analyse and interpret biological data using appropriate statistical toolsdevelop mathematical idea on biostatistics
- Understand scope of bioinformatics and applications of biological databases
- Learn mechanisms of molecular sequence analysis and phylogenetic analysis Types and methods of computer-aided drug design

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|---|---|
| **Credits:**4 | **Core:** Compulsory |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| **Unit** | **Topics** | **Total** |
|---|---|---|
| I | Data Collection and Presentation Importance of statistical analysis in biological data management. Sampling schemes – Simple Random sampling, systemic sampling, Stratified sampling, Cluster sampling, Non probability sampling; Types of numerical data – Nominal data, Ordinal Data, Ranked data, discrete data, continuous data; Modes of presenting data: Frequency distributions, Relative frequency | **No. of Lectures** |
| II | Measures of central tendency and analysis of variance Mean, median, mode; Co-efficient of variation and standard deviation; Range and interquartile range; Grouped mean and grouped variance; Frequency distributions; One way ANOVA; Two-way ANOVA; AMOVA; student's t test Probability Operations on events, Venn diagrams, Conditional Probability; Probability distributions. | 60 |
| III | Hypothesis Testing General concepts – Null hypothesis, alternative hypothesis, Rejection of hypothesis; Type I and Type II errors; P value and | |

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| | sample size estimation. | |
| IV | Regression and Correlation Chi Square Test – Observed and expected frequencies, Calculating p values, assumptions of a chi square goodness of fit; Correlation –Two-way scatter plot, Pearson's correlation coefficient; Regression – regression concepts, simple linear regression; Calculation of R2 and ρ | |
| V | Introduction to bioinformatics, scope and branches of bioinformatics. Applications of bioinformatics. biological data types. Biological search engine: Entrez, SRS concept and applications. Literature database: Pubmed, Biological database and its types: primary, secondary and composite databases. Nucleotide sequence databases: GenBank, EMBL and DDBJ. Protein sequence databases: UniProt, SwissProt, TrEMBL and PIR. Structural databases: PDB, CATH and SCOP PubChem, ChemBank, CCSD (in brief). | |
| VI | Sequence alignment: Pairwise sequence alignment: - Global and Local alignment, Multiple Sequence alignment (MSA): Progressive and Iterative Methods, Bioinformatics tools – BLAST, FASTA and CLUSTAL W | |
| VII | Molecular phylogenetic analysis: Phylogenetic tree and its components; dendrograms and cladogram. Construction of phylogenetic tree- Methods for construction of phylogenetic trees: maximum parsimony, maximum likelihood and distance methods (in brief). Phylogenetic analysis using PHYLIP. | |
| VIII | Protein structure analysis: visualization with RasMol, Swiss PDB viewer. Protein structure prediction: Steps involved in homology modelling with SWISS-MODEL. Brief list of the different types of omics databases, and their applications. | |

Suggested Reading

Parry-Smith DJ, Phukan S and Attwood TK, Introduction to bioinformatics San Francisco: Pearson, 2007.

Baxevanis AD and Ouellette BF, Bioinformatics: a practical guide to the analysis of genes and proteins (3rd ed.), Hoboken: John Wiley & Sons, Inc., 2005.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Program/Class:** Degree | **Year:** Third<br>**Subject:**Biochemistry | **Semester:** Fifth |
| **Course Code:** | **Course Title:** Immunologyand Biostatistics and | |

| | Bioinformatics Lab. | |
|---|---|---|
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |
| **Topics** | | Total No. of hrs. |
| • 1Isolation of lymphocytes from blood and macrophages from peritoneal cavity or spleen.<br>• Purification of immunoglobulins.<br>• Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.<br>• Assays based on agglutination reactions - Blood typing (active) & passive agglutination.<br>• Enzyme linked immune-sorbent assay (ELISA). | | 60 |

| **Programme/Class:** Degree | **Year:** Third<br>**Subject:**Biochemistry | **Semester:**Sixth |
|---|---|---|
| **Course Code:** | **Course Title:**Basic Microbiology | |
| After successful completion of the course, student will be able to:<br>• Understand the basics of microbiology and microbial classification<br>• Culture different bacteria and know how to preserve them<br>• Understand culturing of viruses and viral pathogenesis<br>• Understand general characteristics and classification of algae, fungi and protozoa<br>• Retrieve and use cotemporary information related to microbial world | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| **Unit** | **Topics** | **Total No. of Lectures** |
|---|---|---|
| I | History of Development of Microbiology: Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner | |
| II | Diversity of Microbial world: Binomial Nomenclature, Whittaker's five | |

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| | kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. | **60** |
| III | Viruses, viroids and prions: An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles. | |
| IV | Bacteria: An account of typical eubacteria, chlamydiae& rickettsiae (obligate intracellular parasites), mycoplasma, and archaebacteria (extremophiles). Applications of bacteria in industry, environment and food. | |
| V | Algae: History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food. | |
| VI | Fungi: Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins | |
| VII | Protozoa: General characteristics with special reference to Amoeba | |
| VIII | Scope of Microbiology | |

Suggested Reading

1.Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers.

2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class:** Degree | **Year:** Third<br>**Subject:**Biochemistry | **Semester:**Sixth |
| **Course Code:** | **Course Title:**Clinical Biochemistry | |

After successful completion of the course, student will be able to:

- Acquire knowledge on diagnosis, prognosis and treatment of disorders of

carbohydrate, protein, lipid and nucleic acid metabolism.

- Comprehend renal, liver and gastric function tests, and how they are employed in systematic diagnosis of diseases
- Acquire hands-on clinical laboratory training in estimating glucose, cholesterol, urea, creatinine and total protein from blood and urine.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Introduction: Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations | 60 |
| II | Evaluation of biochemical changes in diseases: Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile | |
| III | Assessment of glucose metabolism in blood: Clinical significance of variations in blood glucose. Diabetes mellitus. | |
| IV | Lipid profile: Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein. | |
| V | Liver function testsFunctions of the liver and classification of LFTs. Abnormalities in bile pigment metabolism: differential diagnosis of jaundice (hemolytic, hepatic and obstructive) | |
| VI | Gastric function tests: collection and examination of gastric contents after stimulation. Errors in collection of samples. Fractional test meal analysis and its interpretation, and tubeless gastric analysis | |
| VII | Renal function tests and urine analysis: Use of urine strip / dipstick method for urine analysis. | |
| VIII | Tests for cardiovascular diseases: Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin | |

Suggested Reading

1Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi).
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi)
3. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia),
4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi),

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| **Program/Class**: Degree | **Year:** Third | **Semester:**Sixth |
|---|---|---|

| | | |
|---|---|---|
| | **Subject:**Biochemistry | |
| **Course Code:** | **Course Title:**Microbiology andClinical BiochemistryLab. | |
| **Credits:** 2 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| **Topics** | Total No. of hrs. |
|---|---|
| • Microbiology Laboratory Practices and Biosafety.<br>• To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)<br>• Preparation and sterilization of culture media for bacterial cultivation<br>• Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/ pictographs<br>• Staining of bacteria using Gram stain<br>• Isolation of pure cultures of bacteria by streaking method.<br>• Estimation of CFU count<br>• Collection of blood and storage.<br>• Separation and storage of serum.<br>• Estimation of blood glucose by glucose oxidase peroxidase method<br>• Estimation of triglyceride<br>• Estimation of bilirubin (direct and indirect)<br>• Quantitative determination of serum creatinine and urea<br>• Estimation of creatine kinase MB | 60 |

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|---|---|---|
| **Programme/Class:** | **Year:** Third; | **Semester:** Sixth |

| Degree | **Subject:**Biochemistry | |
|---|---|---|
| **Course Code:** | **Course Title:**Harmone Biochemistry | |

After completion of the course the students will be able to

- Understand the different cognate and non-cognate modes of communication between cells in a multi-cellular organism
- Comprehend the roles of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function
- Describe the molecular, biochemical and physiologicalroles of all hormone, as well as the integrative regulations of their secretions in health and disease

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Introduction to endocrinology: Functions of hormones and their regulation. Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology | **No. of Lectures 60** |
| II | Hormone mediated signalling: Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca2+, NO. Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin, erythropoietin receptor; ras- MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk | |
| III | Hypothalamic and pituitary hormones: Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus. | |
| IV | Thyroid hormone: Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology- Goiter, Graves disease, cretinism, myxedema, Hashimato's disease | |
| V | Hormones regulating Ca2+ homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca2+ regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis. | |
| VI | Pancreatic and GI tract hormones: Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipolectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II | |
| VII | Hormones of adrenals: Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome | |
| VIII | Reproductive hormones: Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception. | |

Suggested Reading

1 Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (NewYork)

2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw

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| Hill International Publications.<br>3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc.<br>4. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). |
| Suggested (CIE) methods Total marks: 25<br>10 marks for Test 10 marks for presentation along with assignment<br>05 marks for Class interactions |

| | | |
|---|---|---|
| **Programme/Class:** Degree | **Year:** Third<br>**Subject:**Biochemistry | **Semester:**Sixth |
| **Course Code:** | **Course Title:**Molecular Basis of Human Diseases | |
| After successful completion of the course, student will be able to:<br>• articulate a comprehensive understanding of the molecular mechanisms underlying various diseases<br>• articulate a comprehensive understanding of the molecular mechanisms underlying various diseases<br>• critically analyse experimental data related to molecular aspects of diseases. | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Nutritional disorders: Overview of major and minor nutrient components in the diet. Balanced diet and the concept of RDA. Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beriberi, pellagra and B12 deficiency, Xerophthalmia and Night blindness, Vitamin D deficiency, Vitamin K deficiency. Discuss with relation to biochemical basis for symptoms. | 60 |
| II | Metabolic and Lifestyle disorders: Obesity and eating disorders like Anorexia nervosa and Bullemia. Diabetes mellitus A metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress. Cardio vascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition | |
| III | Multifactorial complex disorders and Cancer: Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases. Cancer: characteristics of a transformed cell, causes and stages of Cancer, molecular basis for neoplastic growth and metastasis, Proto-oncogenes and tumour suppressor genes; Cancer causing mutations; Tumour viruses; Biochemical analysis of cancer; Molecular approaches to cancer treatment. Disorders of mood: Schizophrenia, dementia and anxiety disorders. Polycystic ovarian syndrome, Parkinson's disease, ALS. | |
| IV | Diseases due to misfolded proteins: Introduction to protein folding and proteosome removal of misfolded proteins; etiology and molecular basis for | |

| | | |
|---|---|---|
| | Alzheimer's, Prion diseases, Huntington's Chorea, sickle cell anemia, Thalassemia.<br>Monogenic diseases: In born errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, Achondroplasia. Hemoglobinopathies and clotting disorders. | |
| V | Classification of infectious agents: Bacteria, Viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion. | |
| VI | Overview of diseases caused by bacteria: Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia. | |
| VII | Overview of diseases caused by Viruses: Detailed study of AIDS, history, causative agent, pathogenesis, Diagnostics, Drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio. | |
| VIII | Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis. Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment | |

SUGGESTED READINGS

1.Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York)
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition. Volume. 2. Churchill Livingstone Elsevier.
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
4. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences
5.Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York),
6. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
7. The World of the cell, 7th edition (2009)
8. Genetics (2012) Snustad and Simmons,
9. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Suggested (CIE) methodsTotal marks: 25
10 marks for Test10 marks for presentation along with assignment
05 marks for Class interactions

| Program/Class: Degree | Year: Third;<br>Subject:Biochemistry | Semester:Sixth |
|---|---|---|
| Course Code: | Course Title:Harmone BiochemistryandMolecular Basis of Human Diseases Lab. | |
| Credits: 2 | Core: Compulsory | |
| Max. Marks: 100 | Min. Passing Marks: As per University norms | |

| | Topics | Total No of hrs. |
|---|---|---|
| | • Glucose tolerance test<br>• Estimation of serum Ca2+.<br>• Estimation of serum T4.<br>• HCG based pregnancy test.<br>•<br>• Estimation of serum electrolytes.<br>• Anthropometric measurements for normal and high-risk individuals and identifications for Kwashiorkor, Marasmus and Obesity<br>• Estimation of glycosylated hemoglobin<br>• Diagnostic profile for assessment of CVS and Diabetes mellitus using case studies<br>• Permanent slides of pathogens. Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum<br>• WIDAL test<br>• Gram staining<br>• Acid fast staining<br>• PCR based diagnosis<br>• Dot Blot ELISA | 60 |

| Programme/Class: FYUP | Year: Fourth<br>Subject:Biochemistry | Semester:Seventh |
|---|---|---|
| **Course Code:** | **Course Title:**BiophysicalChemistry | |

After successful completion of the course, student will be able to:

- understand the basic facts and concepts of organic chemistry
- learn the acids and bases, buffers systems and solvents systems in biomolecules.
- learn the colloidal systems, rheological properties, law of thermodynamics and ionic equilibrium systems in biochemistry.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Solutions and Buffers: Concentration terms, Bronsted theory of acids and bases. Concept of pH, Henderson-Hasselbalch equation, Concept of pKa, Buffer solutions and their action, titration curves, buffers of red blood cells, buffers of tissues, buffers of blood plasma and their regulation | 60 |
| II | Aqueous and non-aqueous solvents: Structure of water, water quality parameters, Ionic products of water, interactions viz. ionic, polar-non polar. Non-aqueous solvents, types of non-aqueous solvents, colligative properties of aqueous solutions. | |
| III | Colloidal Systems in Biomolecules: Determination of the size of colloidal particles. Precipitation or flocculation of colloidal particles. Discuss the surface tension, surface energy, viscosity and adsorption. Chemistry of fats and oils, Emulsions and micro emulsions. | |
| IV | Thermodynamics: Thermodynamics Terminology of thermodynamics, First law of thermodynamics, internal energy, enthalpy of a system, heat capacity, spontaneous process, Second law of thermodynamics, concept of entropy, entropy of mixing, standard entropies, criteria for reversible and irreversible process, Gibbs-Helmholtz equation, Third law of thermodynamics, determination of absolute entropies of elements and compounds. Applications of first and second law of thermodynamics in living cells, chemical potential and equilibrium constant. | |

Suggested reading

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Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| **Programme/Class:** FYUP | **Year:** Fourth<br>**Subject:**Biochemistry | **Semester:** Seventh |
|---|---|---|
| **Course Code:** | **Course Title:** Molecular Biology | |

After successful completion of the course, student will be able to:

- Understand structure of DNA and RNA together with the reassociation kinetics and movement of DNA segments in the genome.
- understand Replication of DNA and transcription process and processing of pre-mRNA and the steps involved in translation and its regulation.
- understand various DNA repair systems in prokaryotes and eukaryotes along with regulation of gene expression.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Nucleic acid structure and function: DNA supercoiling: super-elical density, Lk, Wr and Tw, topoisomerases, Genome complexity: DNA re-association kinetics, Cot curve, C-value paradox, repetitive and unique sequences. DNA to Chromosome: Genomes of bacteria, eukaryotes, organelle and viruses: linear and circular chromosomes, single stranded and doubles stranded DNA/RNA viral genome, Organization DNA into chromosomes: DNase I sensitive regions, heterochromatin and euchromatin, DNA methylation (e.g. X chromosome inactivation) | 60 |
| II | DNA replication: DNA polymerases, synthesis of leading and lagging strands DNA replication in prokaryotes and eukaryotes: initiation, elongation and termination; regulation of replication, segregation of chromosomes to daughter cells. Transcription and RNA processing: Prokaryotic and Eukaryotic transcription; RNA modification: splicing, alternative splicing, capping, polyA addition, editing, rRNA processing, base modification, tRNA processing and modifications Translation: Genetic code, Translation initiation, elongation, termination, ribosome recycling in prokaryotes and eukaryotes, IRES in eukaryotes: Codon, anticodon interaction, ribosome profiling, co-translational protein folding. Non-ribosome protein synthesis. | |
| III | DNA repair and recombination: Pyrimidine dimer, nick and gap in DNA, AP sites, base mispairing; mismatch, base excision and nucleotide-excision repair mechanisms, SOS response. translation DNA synthesis, regulation of Y-family of polymerases in bacteria and eukaryotes, Non-homologous end joining (NHEJ), Homologous recombination, Holliday model, double strand break repair model, gene conversion, mating type switching in yeast, site specific recombination, FLP/FRT and Cre-Lox recombination, transposition-DNA transposons and retroposons and mechanism. | |
| IV | Regulation of gene expression: Promoters and enhancers. Transcriptional regulation in bacteria: regulation of lac and trp operons in bacteria, regulation by sigma factors, anti-sigma factors, anti-sense RNA, Two component regulatory systems in bacteria, Concept of eukaryotic gene regulation, RNA in gene regulation: RNA binding proteins, RNA stability, UTR mediated gene regulation, Riboswitch, RNA. Interference, nonsense and nonstop mediated decay, Post translational gene regulation: covalent modification of proteins: phosphorylation, methylation, acetylation, adenylation, arginylation. | |

Suggested reading

1.Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter

Walter. Molecular Biology of the Cell. New York: Garland Science, 2002.
2.Cooper, Geoffrey M, and Robert E. Hausman. The Cell: A Molecular Approach. Sunderland, MA: Sinauer Associates, 2013.
3.Krebs, Jocelyn E, Benjamin Lewin, Stephen T. Kilpatrick, and Elliott S. Goldstein. Lewin's Genes Xi. Burlington, Mass: Jones & Bartlett Learning, 2014.
4.Lodish, Harvey F, Arnold Berk, Chris Kaiser, Monty Krieger, Anthony Bretscher, Hidde L. Ploegh, Angelika Amon, and Kelsey C. Martin. Molecular Cell Biology. 2016.
5.Maniatis, Tom, Edward F. Fritsch, and Joseph Sambrook. Molecular Cloning: A Laboratory Manual. Cold Spring Harbor: Cold Spring Harbor Laboratory, 1982.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| **Programme/Class:** FYUP | **Year:** Fourth **Subject:**Biochemistry | **Semester:**Seventh |
|---|---|---|
| **Course Code:** | **Course Title:**Genetic Engineering | |

After successful completion of the course, student will be able to:

- acquire knowledge about basic reagents used in recombinant DNA technology (RDT).
- understand biology of plasmids, and phages and their uses in designing different cloning systems.
- understandvarious operons and their application into designing expression vectors for prokaryotic expression and fundamentals of eukaryotic expression systems.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| **Unit** | **Topics** | **Total No. of Lectures** |
|---|---|---|
| I | rDNA Technology:Restriction enzymes, restriction modification system, DNA ligase, E. coli DNA polymerase I and Klenow enzyme, T4 DNA polymerase, reverse transcriptase, polynucleotide kinase, alkaline phosphatase. | 60 |
| II | Cloning Methodologies: Plasmids and plasmid vectors, new generation of plasmid cloning vectors, Lambda vectors - insertion and replacement vectors, cosmids. High-capacity cloning vectors – YACs, BACs and PACs. Shuttle vectors. Expression vectors - pMAL, GST, pET-based vectors. Eukaryotic expression vectors. Protein purification: His-tag, GST-tag, MBP-tag etc. Vectors used for cloning in animal cells: SV-40, vaccinia/bacculo and retroviral vectors. Plant based vectors, Ti vectors. | |
| III | Genomic and cDNA library preparation:Methods for construction of genomic and cDNA libraries – vectors used, generation of cDNAs, preparation of genomic DNA for library construction. Lambda in vitro packaging. Methods used in the identification and analyses of recombinant DNA clones. Protein-protein interaction and yeast two hybrid system. Phage display. Principles of maximizing protein expression RNA interference &rDNA therapy: Introduction to siRNA, siRNA technology, microRNA, construction of siRNA vectors, principle and application of gene silencing. Production of insulin, drug, vaccines, diagnostic probe of genetic diseases. | |

| | | |
|---|---|---|
| | Gene therapy | |
| IV | Transgenic Technology: Gene knockout and knock-in, Generation of transgenic animals and its application, Cre-loxP recombination technology, Homologus and Non-homologus recombination, Gene isolation, gene transfer systems, Ti plasmid, plant virus vectors, electroporation, microinjection, microprojectile technology, particle bombardment, Generation of transgenic plants and its application, Plant tissue culture, anther and pollen culture, protoplast culture, protoplast fusion, cybrid, somatic hybrid, somatic embryogenesis, embryo rescue, application of recombinant DNA technology in photosynthetic efficacy, nitrogen fixation efficiency and resistance to environmental stresses. | |

**Recommended Books**:


1. T.A. Brown, Gene Cloning and DNA Analysis: An Introduction. Fifth Edition, WileyBlackwell, 2006.•
2. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2011.
3. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3,• CSHL, 2001.


Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class:** FYUP | **Year:** Fourth<br>**Subject:**Biochemistry | **Semester:** Seventh |
| **Course Code:** | **Course Title:**Plant Biochemistry | |

After successful completion of the course, student will be able to:

- Understand structure and function of plant cell including cell wall, plasmodesmata and secretary systems.
- Understandlight harvesting complexes, dark reactions regulation of photosynthesis C3, C4, and CAM plants.
- Understandbiological nitrogen fixation and ammonia assimilation, translocation of inorganic and organic solutes in plants.
- Understandplant hormones and their role in plant and tissue culture

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|---|---|
| **Credits:**4 | **Core:** Compulsory |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Plant cell: Structure, function and mechanisms of action of phytochromes, | |

| | | |
|---|---|---|
| | cryptochromes and phototropins, stomatal movement, transpiration, photoperiodism and biological clocks, plant movement. Photosynthesis: Photosynthetic apparatus, pigments of photosynthesis, Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon reduction and its regulation, Structure, function and regulation of RUBISCO, Crassulacean acid metabolism | **No. of Lectures** |
| II | Plants photorespiration: Photorespiration pathway and significance, cyanide resistance, relationship between photosynthesis, photorespiration. Unit-II | |
| III | Phytohormones: Biosynthesis, transport, physiological effects, mode of action and signal transduction of auxins, gibberlic acid, abscisic acid, ethylene and cytokinins in germination, embryogenesis, growth and development of plant. Nitrogen metabolism: Nitrogen fixation, nitrogenise complex, biochemistry and genetics of nitrogen fixation and ammonium assimilation, structure of 'NIF' genes and its regulation, structural features of nitrate reductase and nitrite reductase, regulation of nitrate and sulphate assimilation. Secondary plant metabolites: Nature, distribution, biosynthesis and function of plant metabolites, biosynthesis of nicotine. Biochemistry of plant toxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins, role of secondary metabolites in chemical defence. | **60** |
| IV | Plant stress physiology: Plant stress, plant responses to abiotic and biotic stresses, salinity, water, heat, chilling, anaerobiosis, heavy metals, radiations and their impact on plant growth and metabolism, mechanisms of resistance to biotic stress and abiotic stress, antioxidative defence mechanism. Plant defence: Genetic basis of plant-pathogen interactions, antio R-Avr gene interactions and isolation of R genes, hypersensitive response (HR), systemic acquired resistance (SAR) and induced systemic resistance (ISR). | |

Suggested reading


1. Introduction of Plant Biochemistry, by Goodwin T. W. and E.I. Mercer, Pergamon Press, Oxford, 1983.

2. Plant Physiology, 5th Edition, by Lincoln Taiz and Eduardo Zeiger, Amazon press, 2012

3. Introduction of Plant Biochemistry, by Goodwin T. W. and E.I. Mercer, PergamonPress,Oxford. Buchanan BB, Gruissem W& Jones RL. 2000.

4. Biochemistry and Molecular Biology of Plants. 2nd Ed. John Wiley. Dey PM & Harborne JB. 1997.

5. Plant Biochemistry. Academic Press. Heldt HS. 1997. Plant Biochemistry and Molecular Biology. Oxford Univ.Press


Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test10 marks for presentation along with assignment
05 marks for Class interactions

## PRACTICAL

**(Credits: 4)**

- Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration, centrifuge etc.
- Prepration of Acetate and phosphate buffer system and validate the Henderson-Hasselbach equation.
- Estimation of reducing sugar concentration by DNS method
- Estimation total sugar concentration by DPA
- Isolation and characterization of casein from milk.
- Studies on lipids: Acid value, saponification value and iodine number
- Extraction of Genomic DNA from Plant, Animal tissues, blood and microbes,
- Qualitative and quantitative analysis of nucleic acids,
- Cloning and construction of Recombinant clones,
- Preparation of cloning DNA: PCR,
- Restriction endonuclease digestion, Ligation,
- Competent cell preparation,
- DNA transformation,
- Characterization of recombinant clone:
- , Plasmid DNA isolation,
- RFLP analysis

- Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
- Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
- Separation of photosynthetic pigments by TLC
- Culture of plant plants (explants)

| **Programme/Class:** FYUP | **Year:** Fourth<br>**Subject:**Biochemistry | **Semester:**Eighth |
|---|---|---|
| **Course Code:** | **Course Title:**Analytical chemistry | |
| After successful completion of the course, student will be able to:<br>• Understand the criteria of choosing appropriate strategies and instrumentation for analysis of different biological sample types<br>• Know the applicability, advantages, limitations and sources of error of current analytical instruments through an understanding of the working principles of these instruments and the underlying biochemical basis<br>• Enable independent conduct of biochemical analyses and instrument evaluations in the laboratory and to link the practical applications to the learned theory | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| **Unit** | **Topics** | **Total** |
|---|---|---|
| I | Technology Fundamentals (Life Science): General scheme for purification of bio-components. Methods for studying cells and organelles. Sub-cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.<br><br>Centrifugation:Ultracentrifugation - velocity and buoyant density determination. Density gradient, centrifugation, molecular weight determination. | **No. of Lectures** |
| II | Chromatography:Basic principles and applications of ion-exchange, gel | **60** |

| | | |
|---|---|---|
| | filtration, partition, affinity, HPLC and reverse phase chromatography, gas chromatography, TLC, Paper chromatography. Chromatofocussing<br><br>Electrophoresis: Basic techniques, poly acrylamide/ starch/ agarose gel electrophoresis, use of SDS/urea, isoelectric focusing, capillary electrophoresis. Pulse field gel electrophoresis 2D elctrophoresis. Northern and southern and western blotting techniques | |
| III | Tracer Techniques: Principles and applications of tracer techniques in biology, Measurement of alpha, beta and gamma radiations. Radiation dosimetry, Types of Radioactive decay; rate of radioactive decay; radioactive isotopes and their half -lives; Units of radioactivity; Measurement of radioactivity-methods based upon gas ionization & excitation; quenching emulsion counting, Geiger Mueller counter Autoradiography; Specific activity of radioisotope; Safety aspects; Radiation Dosimetry; Detection and measurement of isotopes and application of isotopes in biological science, Autoradiography. | |
| IV | Spectroscopy:Principles and Biological Applications of Biophysical Techniques: X-ray diffraction, fluorescence, UV, visible, CD/ORD, NMR and Mass spectroscopy, atomic absorption spectroscopy. Plasma emission spectroscopy, scanning and transmission electron microscopy, Atomic force microscopy. | |

**Recommended Books**


1. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982

2.Tools in Biochemistry David Cooper

3. Methods of Protein and Nucleic acid Research, Osterman Vol I – III

4. Centrifugation D. Rickwood

5. Practical Biochemistry, V th edition, Keith, Wilson and Walker.

6. Wetter L.R and Canstabel eds. (1982) Plant Tissue Culture methods. Natl. Res. Council, Canada.

7. Marris. P., Scragg, A.H., Standford, A and Fowlew M.W eds. (1986) Secondary metabolism in plant tissue cultures. Cambridge UnivPress, Cambridge.

8. Komamine A., Misawa M and Dicosmo F eds. (1991) Plant cell culture in Japan. CMC Co. Ltd, Tokyo.


Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| **Programme/Class:** FYUP | **Year:** Fourth- **Subject:**Biochemistry | **Semester:**Eighth |
|---|---|---|
| **Course Code:** | **Course Title:**Bioenergetics | |

After successful completion of the course, student will be able to:

- Flow of carbon, nitrogen and oxygen in the environment besides evolving an understanding of basic laws of thermodynamics.
- Role of ATP as a universal currency of energy in biological system and also the ATP driven cellular processes.
- The basics of biological oxidation reduction reactions. Students shall also learn the architecture of electron flow in the cell in electron transport system.
- Fundamentals of ATP generation and proton motive force involved in production of ATP.

| **Credits:**4 | **Core:** Compulsory |
|---|---|
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Principles of bioenergetics:Oxidative phosphorylation Biochemical anatomy of a mitochondrion, Membrane-Bound electron carriers, Mitochondrial Electron-Transfer Chain, effects of inhibitors of electron transfer Agents that interfere with oxidative phosphorylation. ATP Synthesis Chemiosmotic model, Mitochondrial ATP synthase complex, Binding-Change mechanism for ATP Synthesis, , Malate-aspartate shuttle, Glycerol 3-phosphate shuttle, Regulation of oxidative phosphorylation, Heat generation by uncoupled mitochondria, Mitochondria evolved from endosymbiotic Bacteria, Mitochondrial genes: Their origin and the effects of mutations, Mutations in mitochondrial genes, The role of mitochondria in apoptosis and Oxidative stress. | 60 |
| II | Photosynthesis: Harvesting light energy General features of photophosphorylation, Light absorption, Reaction centers organization of photosystems in the thylakoid membrane. Hill reaction, The central photochemical event: Light-driven electron flow ATP synthesis by photophosphorylation, A proton gradient couples electron flow and Phosphorylation, Chloroplasts Evolved from endosymbiotic bacteria, Carbohydrate biosynthesis in plants and bacteria, Photorespiration, Calvin cycle (C3) and Hatch-Slack pathway, (C4) CAM pathways, Biosynthesis of starch and sucrose, Synthesis of cell wall polysaccharides. | |
| III | Nitrogen fixation:Types of nitrogen fixation, Symbiotic and non-symbiotic nitrogen fixation. Nitrogen cycle Root nodule formation, Nitrogenase enzyme complex,azoferredoxin and molybdoferrodoxin. Physiological electron donors and mechanism of nitrogen reduction, Nif genes and its regulation, Microbial fertilizers. Marine nitrogen fixation. | |
| IV | Biotransformation of toxicants:Uptake and excretion of hydrophilic and lipophilic compounds, reactions phase I (modifications) phase II (conjugation) and phase III (transport) and their interrelationships, Monooxygenases, Cytochrome P450 (CYP) enzymes and Mixed function oxidases, biotransformation in animals, biotransformation in microorganisms, biotransformation in fungi, biotransformation in plants, modifications in biotransformation, syndromes associated. | |

**Recommended Books**

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|---|
| 1. Biochemistry by Lubert Stryer 4th Edition.<br><br>2. Lehninger's Principles of Biochemistry by Nelson and Cox.<br><br>3. Biological nitrogen fixation by Frans J. de Bruijn.<br><br>4. Detoxication Mechanisms by R.T.Williams 2nd Edition |
| Suggested Continuous Internal Evaluation (CIE) methods<br>Total marks: 25<br>10 marks for Test<br>10 marks for presentation along with assignment<br>05 marks for Class interactions |

| | | |
|---|---|---|
| **Programme/Class:** Diploma | **Year:** Second;<br>**Subject:**Biochemistry | **Semester:**Eighth |
| **Course Code:** | **Course Title:**Microbial Biochemistry | |
| After successful completion of the course, student will be able to:<br>• appreciate the entire spectrum of microscopic life forms - from relatively simple, small but unique viruses to bacteria<br>• understand the fine mechanism of regulation of gene expression... | | |
| **Credits:**4 | **Core:** Compulsory | |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms | |

| Unit | Topics | Total No. of Lectures |
|---|---|---|
| I | Brief history of fermentation; Fermentation- general concepts, Applications of fermentation; Range of fermentation process- Microbial biomass, enzymes, metabolites, recombinant products, transformation process; Component parts of a fermentation process. | 60 |
| II | Types of fermentations:Aerobic and anaerobic fermentation, Submerged and solid-state fermentation; Factors affecting submerged and solid state fermentation; Substrates used in SSF and its advantages; Culture media-types, components and formulations. Sterilization: Batch and continuous sterilization | |
| III | Process development:Optimization of a process, Classical and statistical methods of optimization, Immobilization: different matrices, whole cell and enzyme immobilization; Scale up of bioprocess General concept of a fermenter- Batch, fed-batch and continuous fermentation. | |

| | | |
|---|---|---|
| IV | Aeration and agitation:Effect of aeration and agitation on fermentation, Oxygen requirement and oxygen supply, Oxygen transfer kinetics; Determination of KLa value; Effect of agitation and microbial biomass on KLa value; Newtonian and non-Newtonian fluids; Foam and antifoams, their effect on oxygen transfer; Fermentation economics. | |

**Recommended Books**


1. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann

2. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, Prentice Hall.

3. Vogel, H.C. Todaro, C.L. and Todaro C.C., Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment, Noyes Data Corporation/ Noyes Publications.

4. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates.

5.Reed, G., Prescott and Dunn's Industrial Microbiology, AVI publication

6. Casida L. E. J. R., Industrial Microbiology, New Age (1968)


Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

| | | |
|---|---|---|
| **Programme/Class:** FYUP | **Year:** Fourth<br>**Subject:**Biochemistry | **Semester:**Eighth |
| **Course Code:** | **Course Title:**Fundamentals of Research Methodology | |

After successful completion of the course, student will be able to:

- Learn and follow the ethical guidelines while doing research avoid plagiarism in research publications.
- Write a comprehensive literature review on a given research topic.
- Write a crisp research proposal or research project independently

| | |
|---|---|
| **Credits:**4 | **Core:** Compulsory |
| **Max. Marks:** 100=75(UE)+25(CIE) | **Min. Passing Marks**: As per University norms |

| Unit | Topics | Total |
|---|---|---|
| I | Introduction to Research Methods: Types of research philosophies (positivist, interpretivist, pragmatist and realistic), various steps in scientific research, | No. |

| | | |
|---|---|---|
| | Scientific temper and attitude, Experimental Design, Defining Controls, deductive and inductive reasoning; reductionist and holistic approaches of scientific research | **of** |
| II | Scientific Methodology: Problem identification, Critical thinking, hypothesis formulation and hypothesis testing (Power analysis) Difference between hypothesis, reasoning, theory and scientific law | **Lect ures** |
| III | Research in Practice: Literature review, Journals, Conference Proceedings, Journal Impact factor, Citation Index, h, g, h-g index, Reading a scientific paper. Research Ethics: Social implications of research, bio-safety issues Animal experimentation ethics, wild-life ethics and human experimentation ethics. Data fudging and plagiarism: Use of URKUND, Turnitin and iThenticate software | **60** |
| IV | Scientific Communication: Importance and Types, Logical organization of scientific data and documentation. Different modes of scientific communication: Scientific Writing, Report Writing: Types of research reports, Research Proposal writing, Research paper writing, Thesis writing. Oral forms of scientific Communication-Popular and Scientific talks, Poster presentations, Organizing Presentation Material, Use of audio-visual aids in presentation.Elements of presentation preparation. Legal forms of communication in science: Plagiarism and scientific misconduct, Ethics in scientific communication, patent submissions. | |

**Recommended Books**

1. John W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition SAGE

2. Sharan B. Merriam & Elizabeth J. Tisdell, Qualitative Research: A Guide to Design and Implementation, 4th Edition, John Wiley & Sons

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

# PRACTICAL

## (Credits: 4)

- Separation and identification of amino acids by TLC.
- Separation of amino acids/ sugars by paper chromatography.
- Verification of Beer- Lambert Law.
- Extraction of lipids from tissue and their separation using TLC.
- Separation of proteins by SDS-PAGE.
- Isolation of casein from milk and its quantification Estimation of carotenoids in the given leaf sample
- Fermentative production and quantification of: Antibiotics - penicillin/ streptomycin/tetracycline
- Fermentative production and quantification of Organic acid: citric acid/ lactic acid/ acetic acid
- Fermentative production and quantification of Enzymes: amylase/ protease/urease
- Fermentative production and quantification of Amino acid: glutamic acid/ lysine
- Fermentative production and quantification of Vitamins: B12/ B2/vitamin C Ethyl alcohol/ fruit wine and calculation of fermentation efficiency
- Review writing/ Report writing
- Scientific presentation of research paper from reputed journal

- *Students who want to opt for 4- year UG Degree, Honours with research (and has secured 75% marks in the subject in all the three years) will choose any three of the above given theory papers of VII and VIII semester (4 credits each) along with research project (4 credits each) in both VII & VIII Semester.
- *Under the Apprenticeship/Internship embedded UG degree programme the student should complete a Training Programme (1200 hrs. -40 credits) through NATS or from equivalent Organisation. The degree holder has to do 1-year PG Programme. It is purely optional for the University, to run and give this degree.