DEPARTMENT OF BIOCHEMISTRY

University College of Science

Osmania University

Hyderabad – 500 007

Biochemistry Syllabus

I - SEMESTER

HEAD
Department of Biochemistry
University College of Sciences
Osmania University

Dr. RAJU PADI
M.Sc.,
Assistant

Department of Biochemistry, University College of Science, Osmania University, Hyderabad
Approved M. Sc, CBCS Syllabus : Effective from 2023 – 2024 Batch

Semester - I

Theory

paper	Title	Credits	Teaching hrs/wk	Internal Marks	End Semester Exams	Total Marks
I	BI 101 : Core I Chemiatry of Biomolecules	3	3	50	50	100
II	BI 102 : Core II Endocrine Biochemistry, Vitamins and Nucleic Acids	3	3	50	50	100
III	BI 103 : Core III Cell Biology and Bioenergetics	3	3	50	50	100
IV	BI 104 : Core IV Basic Bioanalytical Techniques	3	3	50	50	100
Total		12	12	200	200	400

Practicals

paper	Title	Credits	Teaching Hrs/wk	Total Marks
V	Chemiatry of Biomolecules	2	4	50
VI	Endocrine Biochemistry, Vitamins and Nucleic Acids	2	4	50
VII	Cell Biology and Bioenergetics	2	4	50
VIII	Basic Bioanalytical Techniques	2	4	50
Total		8	16	200

Total End Semester (Theory + Practicals) = 600 Marks

20-12-2023
Chairperson
Board of Studies in Biochemistry
Osmania University
Hyderabad-500 007 (TS)

PAPER-I BI 101: CHEMISTRY OF BIOMOLECULES

(5 credits: theory credits= 3+ practical credits= 2)

THEORY		
CREDIT 1	**Amino Acids, & Proteins (15h)**	
	1. Classification and structure of amino acids, 2. Essential, non essential, and non protein or unusual amino acid. 3. General properties and Acid- Base Reactions of AA, (pKa Values) 4. Peptide bond – stability and formation, polypeptides. 5. Methods for determining amino and carboxy terminal and molecular weight 6. Primary structure of proteins 7. Secondary structure α helix, β sheet, 310 helix 8. GN Ramachandran plots: *Phi, Psi* and *omega* angle 9. Tertiary & Quaternary structure (myoglobin, hemoglobin) 10. Small peptides (glutathione, peptide hormones) 11. Cyclic peptides (Gramicidin) 12. Classification of proteins - globular, fibrous 13. Membrane, Metallo - proteins, SCOP,CATH 14. Denaturation (pH, temperature, chaotropicagents), renaturation 15. Protein folding, role of chaperones in folding	
CREDIT 2	**Carbohydrates (15h)**	
	1. Classifications and structure of Carbohydrates 2. Configurations and conformations 3. Reactions of Monosaccharides 4. Stability and formations of glycosidic bond 5. Disaccharides and Oligosaccharides 6. Polysaccharides Structural (Cellulose, Chitin) 7. Storage (Starch, Glycogen, Inulin) 8. Hemicelluloses- Lignin, Pectin 9. Hetero-Polysacharides/ acidic Mucopolysaccharides Glycosaminoglycan 10. Chemistry and biological role of Hyaluronic acids, Chondroitin sulphate, 11. Keratansulphate, dermatansulphate, heparin 12. Glycoproteins and Proteoglycans 13. Bacterial cell wall Polysaccharides, Peptidoglycans 14. Blood group glycoproteins 15. Structural determination of polysaccharides.	
CREDIT 3	**Lipids & Porphyrins (15h)**	
	1. Classification of lipids & fatty acids 2. Biological significance of lipids &fatty acids 3. Steroids, Sterols, relation to vitamin D 4. Steroid hormones 5. Bile acids and salts 6. Phospholipids 7. Oils, waxes, isoprene units 8. Lipoproteins 9. Glycolipids 10. Sphingolipids 11. Structure &function of porphyrins : Heme 12. Structure &function of porphyrins : Chlorophyll 13. Cerebrosides, Gangliosides 14. Prostaglandins, Prostacyclins, Eicosanoids 15. Thromboxanes, Leukotrienes	

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PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Amino acid analysis (30 h)**
	1. Qualitative analysis of amino acids 2. Determine pKa and pI of acidic, basic, and neutral amino acids 3. Estimation of amino acids by Ninhydrin methods 4. Quantification of glycine by formal titration 5. Estimation of tryptophan by Spies and Chambers method
CREDIT 5	**Lipid analysis (30 h)**
	1. Qualitative analysis of lipids 2. Saponification value of fats 3. Iodine number of oil 4. Peroxide value of fats 5. Acid value of fats

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PAPER-II BI 102 : ENDOCRINE BIOCHEMISTRY, VITAMINS AND NUCLEIC ACIDS

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**Endocrine System (15h)** 1.Endocrine glands and their hormones 2. Control of hormone secretion 3. Mechanism of hormone action 4. Pituitary gland: Structure, Anterior Pituitary : hormones and their functions 5. Posterior Pituitary- Hormones and their functions 6. Disorders related to pituitary hormones 7. Thyroid gland and Parathyroid gland: Structure and functions 8. Disorders: hypothyroidism, hyperthyroidism 9. Parathormone and associated disorders 10. Adrenal gland: Structure 11.Secretions of adrenal cortex and their functions, hypoadrenalism, hyperadrenalism 12. Secretions of adrenal medulla and their functions 13. Pancreas: Islets of Langerhans, alpha and beta cells 14. Functions of Insulin and glucagon, deficiency of insulin 15. Testes and Ovaries Structure, functions of testosterone, estrogens and progesterone
CREDIT 2	**Vitamins (15h)** 1. Water Soluble Vitamins: Structure and Classification 2. Water Soluble Vitamins: Chemistry, Biological Source and physiological significance 3. Fat Soluble Vitamins: Structure and Classification 4. Fat Soluble Vitamins: Chemistry, Biological Source and Significance 5. Structure, function and the deficiency disorders of Vit B1 (Thiamine), B2 (Riboflavin) 6. Structure, function and the deficiency disorders of and B3 (Niacin) and Vit B5 (Pantothenic acid) 7. Structure, function and the deficiency disorders of B6 (Pyridoxine) andB7(Biotin) 8. Structure, function and the deficiency disorders of Vit B9(Folic acid) and B12 (Cobalmins) 9. Structure, function and the deficiency disorders of Vit C (Ascorbic acid) 10. Structure, function and the deficiency disorders of Vit A (Retinol) 11. Structure, function and the deficiency disorders of Vit D (Calciferol) 12. Structure, function and the deficiency disorders of Vit E (Tocopherol) 13. Structure, function and the deficiency disorders of Vit K (Phytonadione) 14. Recommended daily allowance of vitamins 15. Vitamin supplementation
CREDIT 3	**Chemistry of Nucleic acids (15h)** 1. Purines: structure and function 2. Pyrimidines: structure and function 3. Nucleosides, nucleotides, phospho-diester bond 4. Unusual bases, Modified bases: structure and properties 5. Structure of DNA – Watson Crick Model A – and Z - forms 6. Supercoiling of DNA–negative and positive, linking number 7. Properties of DNA denaturation and renaturation 8. Tm (factors affecting T_m) and C_0t curves 9. Structure of RNA: mRNA, tRNA 10. Structure of RNA: rRNA, siRNA and miRNA 11. Properties of RNA denaturation and renaturation 12. Difference between DNA and RNA 13. Heteroduplexmapping 14. D loops and R loops 15. Catalytic RNA

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PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Carbohydrate analysis (30 h)**
	1. Qualitative analysis of carbohydrates 2. Quantitative analysis of carbohydrates 3. Estimation of Fructose 4. Estimation of total sugars by phenol sulfuric acid method 5. Estimation of reducing sugars by DNS
CREDIT 5	**Nucleic acid analysis (30 h)**
	1. Estimation of DNA by DPA 2. Assessment of DNA purity by A260/A280 method 3. Estimation of RNA by Orcinol method 4. Separation of purines by paper chromatography 5. Separation of pyrimidines by paper chromatography

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PAPER-III BI 103 : CELL BIOLOGY AND BIOENERGETICS

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**Structure of Prokaryotic & Eukaryotic cells (15 h)**
	1. Classification of prokaryotes and eukaryotes (systems of classification) 2. Ultrastructure of eubacteria, cyanobacteria, mycoplasma 3. Ultra structure of plant cell 4. Ultrastructure of animal cell 5. Composition of cytoskeleton: microfilaments, microtubules, intermediate filaments 6. Function of cytoskeleton (transport and cell division) 7. Nuclear skeleton : lamina scaffold 8. Structure of chromosome (centromere, telomere, kinetochore) 9. Euchromatin & heterochromatin 10. Formation and structure of special chromosomes (polytene and lampbrush) 11. Cell cycle 12. Mitosis and Meiosis 13. Cell cycle check points and regulation 14. Apoptosis 15. Regulation of apoptosis
CREDIT 2	**Bio Membranes (15 h)**
	1. Composition and Structure of Cell membrane 2. Membrane Dynamics 3. Membrane Lipids: Composition distribution and functions 4. Membrane Proteins: Composition distribution and functions 5. Trans membrane proteins and their classification 6. Methods of detecting Trans membrane proteins, Hydropathy plots 7. Membrane Asymmetry 8. Fluid Mosaic Model of Membrane 9. Membrane fluidity and its regulations, Flip flop. 10. RBC membrane structure 11. Membrane transport: active and passive transport, symport and antiport; NaK ATPase 12. Transport channels: voltage gated, ion gated and ligand-gated channels 13. Aquaporin, Glucose transporters, valinomycin: structure and mechanism of action 14. Artificial membranes: Reconstitution of functional membrane system from purified components 15. Liposomes, Micelles and vesicles
CREDIT 3	**Bioenergetics (15 h)**
	1. Elements of importance in Biochemistry (H,C,N,O,P,S), types and energy of bonds and interactions (ionic, covalent, coordinate, H-bonds, van der Waals, hydrophobic interactions) 2. Laws of thermodynamics, Gibbs free energy, relevance of entropy and enthalpy in biological systems and reactions. 3. Thermodynamically coupled reactions 4. Order of the reactions: first and second order reactions 5. Log and Inscalesin biological processes (exponential growth curves, radioactivedecay) 6. Biological oxidation, Redox potential, Nernst equation 7. Enzymes involved in biological oxidation 8. High energy compounds 9. Oxidative phosphorylation 10. High energy bonds, phosphate potential, Forces stabilizing membrane 11 ETC in mitochondria 12 ETC in chloroplasts, 13. Un–couplers and inhibitors of energy transfer. 14. Shuttle pathways: Glycerol phosphate shuttle, Malate-Aspartate shuttle 15. Biological fluorescence (GFP and derivatives), Bioluminescence

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PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Laboratory maintenance, safety and basic methods (30 h)**
	1. GLP: Use of balance and pH meter, Lab safety, 2. Calculations and preparation of standard solutions (primary, working standard) 3. Preparation of buffers: Phosphate, Citrate and Tris buffer 4. Titration: Estimation of Calcium in milk 5. Titration: Estimation of Vitamin C in lemon juice
CREDIT 5	**Separation and identification of biomolecules (30 h)**
	1. SDS PAGE for protein 2. Agarose gel for DNA 3. Desalting of proteins by dialysis 4. Gel filtration (size exclusion) 5. Cell fractionation (centrifuge)

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PAPER-IV BI 104 : BASIC BIOANALYTICAL TECHNIQUES

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**Spectroscopy and Chromatography (15h)**
	1. Colorimetry, Beer Lambert's Law-application and limitation, Molar extinction coefficient, Absorption maximum, 2. UV - Vis: Spectrophotometer – Instrumentation, application 3. Fluorescence Spectroscopy – principle, instrumentation, application 4. Infra red(IR) spectroscopy - principle, instrumentation, application 5. Raman spectroscopy - principle, instrumentation, application 6. CD – and ORD – principle, instrumentation, application 7. Partitioning and counter current distribution; 8. PC and TLC –principle ,instrumentation ,application 9. GC – principle, instrumentation, application 10. Ion – exchange chromatography – principle, instrumentation, application 11. Gel filtration (Gel exclusion chromatography) – principle, application 12. Affinity chromatography: principle, instrumentation, application; immunoprecipitation 13. HPLC and RP–HPLC – principle, instrumentation, application 14. FPLC, LC – principle, instrumentation, application 15. Peptide mapping and N – terminal sequencing of proteins
CREDIT 2	**Centrifugation, Electrophoresis and Tracer techniques (15h)**
	1. Centrifugation, RCF and types of rotors Ultra centrifugation – principle, instrumentation,application 2. CsCl density gradient and sucrose gradient centrifugation – principle, application 3. Electrophoresis – moving boundary and zonal electrophoresis, Native and SDS PAGE 4. IEF and 2D PAGE,PAGE for DNA sequencing 5. AgaroseGels, PFGE Zymography 6. Denaturing gels for RNA, Southern and Northern Blots 7. Western Blot 8. Stable and radioactive isotopes, theory of radioactivity 9. Half life and emission spectra of biologically useful isotopes:^{2}H, ^{3}H, ^{14}C, ^{18}O, ^{32}P, ^{35}S, ^{125}I; Isotopes used for labelling proteins (^{3}H ^{14}C ,^{35}S ,^{125}I) and nucleic acids (^{3}H, ^{32}P) 10. Detection of radioactivity by Scintillation counting Autoradiography 11. GM counter, gamma counter 12. Fluorography, applications of Phosphorimaging, luxometry and chemiluminescence as alternative to radioactivity 13. Radiation hazards and safe disposal of radio activity waste 14. Isotope dilution method – pulsechase 15. Historic examples -^{14}C and ^{18}O to study photosynthesis; ^{32}P and ^{35}S to study viral replication (Hershey – Chase experiment), ^{14}N and ^{15}N in DNA replication (Meselson and Stahl experiment)
CREDIT 3	**Microscopy and Methods of Cell Study (15h)**
	1. Light Microscopy: Simple and compound microscope 2. Phase contrast microscopy 3. Dark field and polarization microscopy 4. Electron microscopy: SEM, freeze fracture 5. Electron microscopy: TEM 6. Fluorescence microscopy 7. Confocal microscopy: imaging live cells. 8. FRET 9. FRAP 10. Flow cytometry and Fluorescence assisted cell sorting (FACS) 11. Cell counting -hemocytometer 12. Plant tissue culture. 13. Animal tissue culture 14. Insect tissue culture 15. Methods of cell disruption and fractionation and isolation of organelles

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PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Quantitation of Biomolecules by Spectroscopy (30 h)**
	1 Absorption spectrum of tyrosine, determination of molar extinction coefficient, 2 Estimation of concentration of biomolecules based on Beer Lambert's Law 3 Estimation of inorganic phosphate by Fiske-Subbarow method 4 Estimation of protein by Biuret method 5 Estimation of protein by Lowry method
CREDIT 5	**Separation of Biomolecules by Chromatography (30 h)**
	1 Separation of plant pigments by paper chromatography 2 1-D and 2-D paper chromatography of amino acids 3 TLC of plant pigments and lipids 4 Anion/ Cation-exchange capacity of resin 5 Separation of amino acids by ion-exchange chromatography

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A. SHALINI

DEPARTMENT OF BIOCHEMISTRY

University College of Science

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Biochemistry Syllabus

II - SEMESTER

With Effect From 2022 Admitted batch

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Chairman
Board of Studies in Nutrition
Osmania University,
Hyderabad-500 007.

Department of Biochemistry, University College of Science, Osmania University, Hyderabad
Approved M. Sc, CBCS Syllabus : Effective from 2023 – 2024 Batch

Semester - II

Theory

paper	Title	Credits	Teaching hrs/wk	Internal Marks	End Semester Exams	Total Marks
I	BI 201 : Core I Metabolism	3	3	50	50	100
II	BI 202 : Core II Enzymology	3	3	50	50	100
III	BI 203 : Core III Molecular Biology	3	3	50	50	100
IV	BI 204 : Core IV Biochemical Genetics	3	3	50	50	100
Total		12	12	200	200	400

Practicals

paper	Title	Credits	Teaching Hrs/wk	Total Marks
V	Metabolism	2	4	50
VI	Enzymology	2	4	50
VII	Molecular Biology	2	4	50
VIII	Biochemical Genetics	2	4	50
Total		8	16	200

Total End Semester (Theory + Practicals) = 600 Marks

20-12-2023
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Hyderabad-500 007 (TS)

PAPER-I BI 201: METABOLISM

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**Metabolism of Amino Acids and Proteins (15h)**
	1. Metabolic fate of dietary proteins and amino acids 2. Overview of biosynthesis of amino acids 3. Biosynthesis of aromatic amino acids 4. Degradation : Glucogenic and ketogenic amino acids 5. Degradation of aminoacids to pyruvate and oxaloacetate 6. Degradation of aminoacids to acetyl - CoA 7. Degradation of aminoacids to succinyl– CoA 8. Metabolism of branched chain amino acids 9. Role of glutamate cycle in the formation and circulation of ammonia 10. Glucose-alanine cycle 11. Urea cycle 12. Linking of citric acid and urea cycles 13. Genetic defects in metabolism of amino acids: albinism, phenylketonuria, maple syrup urine disease 14. Genetic defects in metabolism of amino acids: homocystinuria, alkaptonuria, methylmalonic acidemia 15. Genetic defects in metabolism of urea: argininemia, arigininosuccinic aciduria, carbamoyl phosphate synthetase– I deficiency
CREDIT 2	**Metabolism of Carbohydrates (15h)**
	1. Reactions and energy balance in glycolysis 2. Regulation of glycolysis; entry of other sugars 3. Reactions and energy balance in gluconeogenesis 4. Reactions and energy balance in TCA cycle 5. Pentose phosphate pathway 6. Pasteur effect and Crabtree effect 7. Anaplerotic reactions 8. Glyoxylate cycle 9. Glucuronic acid cycle 10. Glycogen metabolism 11. Photosynthesis reactions for biosynthesis of glucose 12. C3 carbon fixation 13. C4 carbon fixation and Crassulacean acid metabolism 14. Biosynthesis of starch and sucrose 15. Concept of metabolomics
CREDIT 3	**Metabolism of Lipids, Porphyrins& Nucleic Acids (15h)**
	1. Fate of dietary lipids,apo-lipoproteins 2. Fatty acid biosynthesis, desaturation of fatty acids 3. Beta oxidation and its regulation, break downof odd chain fatty acids and energy yield 4. ω-oxidation and α – oxidation pathway and their regulation 5. Metabolism of phospholipids and sphingolipids 6. Biosynthesis of cholesterol and other steroids and their regulation 7. Fate of acetyl CoA, formation of ketone bodies and ketosis 8. Biosynthesis of prostaglandins, prostacyclins, thromboxanes and leukotrienes

	9. Metabolism of porphyrins 10. Biosynthesis of purines 11. Degradation of purines 12. Biosynthesis of pyrimidines 13. Degradation of pyrimidines 14. *de novo* purine and pyrimidine synthesis 15. Salvage pathway of purine and pyrimidine synthesis
PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Metabolism of Amino acids, Proteins and Porphyrins (30 h)**
	1. Estimation of dietary proteins 2. Estimation of urea 3. Estimation of ketone bodies 4. Estimation of creatinine (urine) 5. Estimation of bile pigments
CREDIT 5	**Metabolism of Carbohydrates, Lipids and Nucleic Acids (30 h)**
	1. Estimation of blood glucose 2. Estimation of sucrose and starch 3. Estimation of serum cholesterol 4. Estimation of purines and pyrimidines 5. Estimation of phospholipids and lecithin

References:

1. Lehninger Principles of Biochemistry, DavidL.Nelson, Michael M. Cox; Publisher: W.H.Freeman.

2. Biochemistry – Jeremy MBerg, JohnLTymoczko, and Lubert Stryer.; Publisher: W H Freeman

3. Biochemistry, 4th Edition – Donald Voet, Judith G. Voet. – Publisher John Wiley and Sons.

4. Principles of Biochemistry Mammalian Biochemistry: Smith EL, Hill RL, White A Publisher: McGraw Hill

5. Principles and Techniques of Biochemistry and Molecular Biology. Edited by Keith Wilson & John Walker. Cambridge Univ.Press.

6. Experimental Biochemistry; A student Companion by Beedu Sashidhar Rao and Vijay Deshpande. I.K. Pvt. Ltd.

PAPER-II BI 202:ENZYMOLOGY

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**Enzymes and Coenzymes (15h)**
	1. Thermodynamics of catalysis, Energy of activation, Relation of ΔG and Keq 2. Coupled reactions (endergonic and exergonic) in biochemical pathways 3. Methods to isolate and purify enzymes 4. Assays, Activity Units, Specific activity 5. Nomenclature and classification of enzymes: EC,SCOP 6. CATH 7. Metal, co-factor and co-enzyme requirements 8. Vitamin cofactors: TPP, FMN/FAD 9. NAD/NADP, Pantothenic acid 10. Vitamin cofactors: PLP, Biotin 11. Folate, Cobalamin, Phylloquinone 12. Factors affecting catalysis (pH, temperature, pressure, enzyme and substrate concentration) 13. Chemicals to identify active site residues: Arg, Cys, Lys, His 14. Site–directed mutagenesis to identify active site residues 15. Triose Phosphate Isomerase
CREDIT 2	**Enzyme Kinetics (15h)**
	1. Single substrate assumptions, Quasi steady state approximation. Briggs – Haldane equation. 2. Steady state, Michaelis –Menten kinetics (derive equation and transformations) 3. Transformation of Michaelis – Menten equation. Lineweaver Burk plot, Eadie-Hofstee plot. 4. Bi-substrate reactions: ordered, random, sequential, Ping - Pong 5. Distinction between ordered and random addition of substrates and products release. 6. Inhibitors (competitive, uncompetitive, noncompetitive, suicide), effect on kinetic constants 7 Enzyme inhibitors as drugs: reverse transcriptase and protease inhibitors as anti– HIV drugs 8. Cooperativity in binding (oxygen binding to hemoglobin) 9. Multiple sites; Cooperativity: MWC model, KNF model 10. Slow transition and Hysteretic behavior in enzymes 11. Convergent and divergent evolution of enzymes 12. Enzymes in dairy (Rennin, lipases, lactases) ,brewing (amylases, proteases, glucanases), and Food processing technology (invertase, pectinases, papain) 13. Enzymes in detergent (lipases, cellulases, proteases), paper (cellulases), and tanning 14. Enzymes in bioremediation, biofuel industry (cellulases) 15. Enzyme engineering: Designing High –Through put enzyme assays
CREDIT 3	**Catalytic Mechanisms of Enzymes (15h)**
	1. Types of catalysis: acid - base catalysis, transition state. 2. Covalent catalysis 3. Metal ion catalysis 4. Reversible and irreversible activation of enzymes (pro-enzymes, phosphorylation) 5. Enzyme activation by ligand binding and dimerization 6. Protein tyrosine kinase receptors 7. Catalytic mechanism of RNase 8. Catalytic mechanism of trypsin and chymotrypsin

	9. Catalytic mechanism of lysozyme 10. Catalytic mechanism of subtilisin 11. Catalytic mechanism of carboxypeptidase 12. Allosteric regulation of aspartate transcarbamylase 13. Regulation of glutamine synthetase 14. Multi-enzyme complex: fatty acid synthase 15. Abzymes
PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Enzymes and Coenzymes (30 h)**
	1. Isolation of urease (horse gram /any source) 2. Assay of urease 3. Isolation of beta-amylase (sweet potato) 4. Assay of beta-amylase 5. Isolation and assay of catalase (liver / any source)
CREDIT 5	**Enzyme kinetics (30 h)**
	1. Determination of yield, total activity and specific activity at various stages of enzyme purification (beta amylase) 2. Study of the time course and effect of enzyme concentration 3. Effect of pH on enzyme activity 4. Effect of temperature on enzyme activity 5. Effect of [S] on enzyme activity; determination of K_m and V_{max}

References:

1. Fundamentals of Enzymology, Price.NC. And Stevens.L.,Oxford University Press

2. Enzymes - Biochemistry, Biotechnology, Clinical chemistry - Palmer,T.,Affiliated East-West press

3. Fundamentals of Enzyme Kinetics, Segel I H; Wiley Interscience,

4. Biochemical calculations, 2nd Edition By Irwin H. Segel. John Wiley & Sons,

5. Lehninger Principles of Biochemistry, David L. Nelson, Michael M.Cox Publisher: W.H. Freeman.

6 Introductory practical Biochemistry Editors S.K. Sawhney & Randhir Singh. Narosa publishing House.

7 Experimental Biochemistry : A student companion by Beedu Sashidhar Rao and Vijay Despande.

PAPER-III BI 203 :MOLECULAR BIOLOGY

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**DNA Replication and Repair (15 h)**
	1. Models of replication – random, conservative, semi conservative 2. Replication of circular chromosomes by theta model –φ X174, E.coli 3. Replication of circular chromosomes by rolling circle (lambda phage) Strand displacement models (mt-DNA) 4. Prokaryotic and eukaryotic DNA polymerases, helicases, ligases, topoisomerases 5. Initiation – primosome,ori - sequences, accessory proteins 6. Elongation –replisome, leading and lagging strands, Okazaki fragments 7. Termination, Inhibitors of replication 8. Replication of linear chromosomes, telomeres, telomerase 9. Amplification –Polytene and double minute chromosomes 10. Types of DNA damage –oxidation, deamination, alkylation, adducts, breaks 11. Direct repair – MGMT, photo - reactivation, AlkB 12. Base Excision Repair (Short and Long Patch) and NucleotideExcision Repair, Mismatch Repair 13. Mechanism of Recombination 14. Repair of DSBs by NHEJ and Homologous recombination 15. SOS repair
	Transcription and Translation (15 h)
	1. Prokaryotic and eukaryotic RNA polymerases 2. Initiation: prokaryotic and eukaryotic promoter sequences 3. Elongation, Termination – rho dependent and independent 4. Post – transcriptional modifications -capping, Poly A addition 5. RNA Splicing 6. RNA editing 7. Inhibitors of transcription 8. Structure of ribosome 9. Genetic code , Wobble hypothesis 10. Initiation of translation (role of cap, IRESIFs) 11. Elongation of translation (role of EFs) and Termination of translation (role of RFs) 12. Post translational modifications of proteins: Phosphorylation, Acetylation, Ubiquitylation, Methylation, Glycosylation 13. Post translational modifications of proteins: SUMOylation, Palmitoylation, Myristoylation, Prenylation, Sulfation 14. Protein splicing of inteins 15. Inhibitors of protein synthesis
CREDIT 3	**Protein Targeting and Degradation (15 h)**
	1. Post translational modifications of proteins, role in targeting (isoprenylation) 2. Signal peptide 3. Signal recognition particle(SRP) 4. Nuclear Localization Signal (NLS) 5. Mitochondrial and chloroplast localization signal 6. Chaperones and HSPs in protein folding 7. Vesicular trafficking 8. Lysosomal pathways : endocytosis and crinophagy

	9. Lysosomal pathways: macroautophagy and microautophagy 10. Lysosomal storage diseases 11. Ubiquitin – proteasome pathway 12. N-End Rule Pathway 13. Immuno proteasome, Misfolded proteins in neurodegenerative diseases 14. PEST sequences and proteolysis 15. Action of cytotoxic, hemotoxic, myotoxic &hemorrhagic venoms
PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**DNA replication and repair (30 h)**
	1. Isolation of DNA from plant source (Onion) 2. Isolation of DNA from animal source 3. Isolation of DNA from microbial source (Plasmid) 4. Agarose gel electrophoresis: separation of super coiled, linear and circular DNA 5. Isolation and demonstration of Polytene chromosomes
CREDIT 5	**Transcription, Translation and Protein targeting (30 h)**
	1. Determination of glycoproteins (Total sugar by Phenol Sulphuric acid and protein by Lowry method) 2. Determination of Tm of DNA 3. Cell fractionation: Isolation of cell organelles 4. Mitochondrial fraction (Identification using a Marker) 5. Nuclear fraction (Identification using a Marker)

References:

1. Lehninger Principles of Biochemistry, David L. Nelson, MichaelM. CoxPublisher: W.H.Freeman.

2. Molecular Biology of the Cell, 3rd edition.Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts,and James D Watson. Publisher New York: Garland Science

3. Biochemistry, 4th Edition – Donald Voet, Judith G. Voet – Publisher John Wiley & Sons

4. The Cell: A Molecular Approach, by Geoffrey M.Cooper and Robert E.Hausman,pub.ASM Press

5 Principles and techniques of Biochemistry and Molecular Biology. Edited by Keith Wilson & John Walker. Cambridge University. Press.

6 Molecular Cloning. A laboratory manual by T. Maniatis, E F Fritsch and J Sambrook. Cold Spring harbor Laboratory, New York, 1982, $48 ISBN 0-87969 - 136-0

PAPER-IV BI 204: BIOCHEMICAL GENETICS

(5 credits: theory credits= 3+ practical credits= 2)

THEORY	
CREDIT 1	**Mendelian Genetics (15h)**
	1. Mendel's laws of inheritance 2. Importance of meiosis in heredity 3. Non – Mendelian Inheritance: Cytoplasmic inheritance 4. Maternal effect, Maternal influence 5. Gene interactions - Epistasis, Expressivity, Penetrance 6. Polygenic inheritance 7. Sex linked, sex limited, and sex influenced inheritance 8. Mutations: spontaneous/ induced, somatic/ germinal 9. Forward/ reverse, transition/ transversion 10. Silent, missense, nonsense and frame shift mutations 11. Leaky and conditional mutations 12. Reversion and suppression of mutations 13. Detection, selection and isolation of microbial mutants, Estimation of mutation rates 14. Mutagens – physical, chemical 15. Transposon mutagenesis, site – directed mutagenesis
CREDIT 2	**Linkage and Mapping (15h)**
	1. Discovery of linkage, Morgan's experiments 2. Cytological proof of crossing over 3. 2 – and 3 – point crosses 4. Recombination and Interference 5. Tetrad analysis 6. Mapping human genes by pedigree analysis 7. Fundamentals of population genetics (HW Law) 8. Pedigrees of autosomal dominant and autosomal recessive inherited traits 9. Pedigrees of X-linked recessive and X-linked dominant traits 10. Mobile genetic elements – Discovery, 11. Structure of transposons, Zea Ac/ Ds and Spm elements 12. Mechanism of transposition replicative and conservative 13. *Drosophila* copia, Yeast Ty elements 14. CRISPR-Cas9 gene editing 15. Using recombination to make knockout cells / organisms
CREDIT 3	**Bacterial genetics and Model organisms (15h)**
	1. Discovery of conjugation 2. Mapping bacterial genes by conjugation 3. Discovery of transformation 4. Mapping bacterial genes by transformation 5. Discovery of transduction 6. Mapping bacterial genes by transduction 7. Mapping phage genes – Fine structure of rII locus: Complementation analysis 8. Fine structure of rII locus: Deletion mapping 9. *Dictyostelium* to study cell – cell communication and differentiation. 10. *Neurospora* to study one gene – one enzyme hypothesis 11. *Arabidopsis* to study flower development 12. *Drosophila* to study embryonic development (homeotic mutations)

	13. *Danio* to study vertebrate development 14. *Xenopus* to study embryogenesis 15. *Mus* inbred and knockout strains, NOD and nude mice
PRACTICAL (Each practical topic consists of 3 Experiments, Total 15 Expts)	
CREDIT 4	**Mendelian Genetics and Linkage and Mapping (30 h)**
	1. Problem solving: 2 and 3 point crosses 2. Problem solving: tetrad analysis 3. Problem solving: pedigree analysis 4. Problem solving: Hardy Weinberg equilibrium 5. Cytological proof of crossing over
CREDIT 5	**Bacterial genetics and Model organisms (30 h)**
	1. Demonstration of stages of mitosis (onion root tip) 2. Demonstration of stages of meiosis (anthers) 3. Demonstration of *Drosophila* life cycle 4. Study of flower development : *Arabidopsis* 5. Karyotyping

References:

1. Microbiology – Prescott L M, Harley JP. & Klein DA, McGraw - Hill

2. Principles of Genetics by Eldon John Gardner, Michael J.Simmons,D.Peter Snustad;John Wiley

3. Modern Genetic Analysis Anthony JF Griffiths, William M Gilbert, Jeffrey H Miller, and Richard C Lewontin. Pub.W.H.Freeman

4. Molecular cloning. A laboratory manual by T. maniatis, E F Fritsch and J. Sambrook. Cold Spring Laboratory. New York. 1982.

5. Principles and techniques of Biochemistry and Molecular Biology. Edited by Keith Wilson & John Walker. Cambridge University press.

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Biochemistry Syllabus

III - SEMESTER

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Dr. RAJU PADI
M.Sc.
Assistant Prof

Department of Biochemistry, University College of Science, Osmania University, Hyderabad
Approved M. Sc, CBCS Syllabus : Effective from 2023 – 2024 Batch

Semester - III

Theory

paper	Title	Credits	Teaching hrs/wk	Internal Marks	End Semester Exams	Total Marks
I	BI 301 : Core I Gene Expression and Advanced Bioanalytical Techniques	3	3	30	70	100
II	BI 302 : Core II Immunology and Immunotechnology	3	3	30	70	100
III	BI 303 : Elective I A : Nutrition and Clinical Biochemistry B : Nanobiochemistry	3	3	30	70	100
IV	BI 304 : Elective II A : Physiology and Reproductive Biology B : Evolution, Ecology and Developmental Biology	3	3	30	70	100
	Seminar	2	4			50
Total		14	16			450

Practicals

paper	Title	Credits	Teaching Hrs/wk	Total Marks
V	Gene Expression and Advanced Bioanalytical Techniques	2	4	50
VI	Immunology and Immunotechnology	2	4	50
VII	Elective I A : Nutrition and Clinical Biochemistry B : Nanobiochemistry	1	2	25
VIII	Elective II A : Physiology and Reproductive Biology B : Evolution, Ecology and Developmental Biology	1	2	25
Total		6	12	150

Total End Semester (Theory + Seminar + Practicals) = 600 Marks

20-12-2023

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(Effective from 2022-23 admitted batch)

SEMESTER-III

PAPER	TITLE	Credits*	hrs/ week	Internal marks (Theory)	Final exam marks (Theory)	Practical exam marks
I	BI301: Core I Gene expression and Advanced Bioanalytical Techniques	5 (3T+2P)	7	30	70	50
II	BI302: Core II Immunology and Immunotechnology	5 (3T+2P)	7	30	70	50
III	BI303: Elective I A: Nutrition and Clinical Biochemistry B: Nanobiochemistry	4 (3T+1P)	5	30	70	25
IV	BI 304: Elective II A: Physiology and Reproductive Biology B: Evolution, Ecology and Developmental Biology	4 (3T+1P)	5	30	70	25
	SEMINAR	2	4	50		
TOTAL		20	28	450		150

TOTAL MARKS: 600

***One credit means the standard methodology of calculating one hour of theory or one hour of tutorial or two hours of laboratory work, per week for a duration of a semester (13-15 weeks)**

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Paper I (BI 301) - CORE I

Gene Expression and Advanced Bioanalytical Techniques (100 marks)

(5 credits: theory credits= 3+ practical credits= 2)

Theory

Credit 1	Gene Regulation in Prokaryotes and Eukaryotes
	1. Operon concept for gene regulation. Positive (+ve) & Negative (-ve) control Lac operon 2. Trp operon 3. Dual promoters gal operon; Dual function of repressor ara operon 4. Lambda Phage: Lytic / lysogenic switch; anti-termination 5. Phase variation in Salmonella flagellar protein synthesis 6. Sporulation gene expression in Bacillus 7. Riboswitch, control of plasmid copy number 8. Chromatin structure in active and inactive regions DNA methylation. 9. Eu-chromatin, histone acetylation, H2AX foci, histone code 10. Transcriptional control cell specific expression promoters, enhancers, Transcription factors 11. RNA transport and stability; Translational feedback. 12. Gene silencing: regulation by siRNA (PTGS). 13. Gene silencing: inactivation of mammalian X chromosome. 14. Gal operon of yeast, Antigenic variation in Trypanosoma 15. MAT locus and mating type switch in yeast
Credit 2	**Recombinant DNA Technology and Genetic Engineering**
	1. Enzymes in rDNA technology: Restriction endonucleases (discovery, properties) 2. Enzymes in rDNA technology: DNA and RNA polymerases 3. Enzymes in rDNA technology: Nucleases, Kinases, Phosphatases and Ligases 4. Prokaryotic and Eukaryotic vectors (plasmids, cosmids, phage, phagemid, BAC,YAC) 5. Shuttle vectors, Targeting vectors, Expression vectors(insect, plant and mammalian cells) 6. Construction of cDNA andgenomic DNA libraries 7. Screening library (+ve) & (-ve) selection strategies, Preparation of probes 8. Creating KO cells, Cre Lox systems. 9. Yeast 2 hybrid assay 10. Phage display 11. Reporter genes GFP, beta- gal, luciferase 12 . Expression in heterologous systems: bacteria, yeast cells. 13. Expression in heterologous system: insect cells, mammalian cells 14. Molecular markers RFLP, AFLP and Random amplification of polymorphic DNA (RAPD). 15. Short tandem repeat, single-nucleotide polymorphism (SNP), Ribo-typing

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Credit 3	**Advanced Bioanalytical techniques**
	1. DNase – I hypersensitivity mapping 2. DNA – Foot printing 3. Chromatin IP methods (ChIP) 4. Bioanalyzer 5. Atomic force microscopy 6. Total Internal Reflection Fluorescence (TIRF) microscopy 7. Light Sheet Fluorescence Microscopy 8. Electron Microscope Tomography and Single-particle Reconstruction 9. NMR and ESR 10. X-ray Crystallography 11. Atomic absorption spectroscopy 12. Mass spectrometry – MALDI TOF, LC-MS, MS-MS, ICP-MS, ICP-OES 13. Dynamic and static light scattering 14. Zeta potential measurement – LASER Doppler Velocimetry Nanodrop: Principle and applications

Practicals (Each practical topic consists 3 experiments, Total 15 experiments)

Credit 4:	**Recombinant DNA Technology**
	1. Isolation of plasmid DNA 2. Restriction mapping of DNA (experiment and problems) 3. Overexpression of desired gene by IPTG 4. Purification of expressed protein by Affinity chromatography 5. Purity of expressed protein by SDS-PAGE and Western blotting
Credit 5:	**Advanced Bioanalytical techniques**
	1. Atomic absorption spectroscopy: Estimation of metal ions (ppm) 2. ICPMS: Estimation of metal ions (ppb and ppt) 3. Dynamic Light Scattering: Determination of zeta potential of macromolecules 4. Isolation of RNA and its characterization 5. Agarose gel electrophoresis of DNA and gel documentation

References:

1. Molecular Cloning (Lab manual) by Maniatis T, Fritsch EF, Sambrook J, Volume –I, CSH
2. Practical Clinical Biochemistry –Varley, H. CBS Publications
3. Practical Clinical Biochemistry-Methods and Interpretations – Ranjna Chawla- Jaypee
4. Lab Manual in Biochemistry, Immunology and Biotechnology – Arti Nigam and Archana Ayyagari – Tata McGraw-Hill New Delhi

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Paper-II (BI 302T) - CORE-II
Immunology and Immunotechnology (100 Marks)
(5 credits: theory credits= 3+ practical credits= 2)

Credit 1	**Components of Immune System and Immune response**
	1. Elements of Immune system - Natural & acquired immunity, Specific & non-specific immune response. 2. Cells & organs induced in immune system 3. Antigenic determinants, Epitopes, Concept of haptens. T-Cell and B-Cell epitopes, Super-antigens 4. Classification, structure, and biological properties of immunoglobulins 5. Isotypes, allotype, idiotypes variations 6. Mucosal and neonatal immunity 7. Theories of antibody formation, Generation of antibody diversity 8. Genomic rearrangements & genes involved in antibody production 9. Humoral& cell-mediated immune response 10. T cell& B cell activation. T cell and B cell receptors 11. Antigen processing & presentation 12. MHC proteins structure & functions 13. Regulation of immune response. 14. Assembly and secretion of Ig. Class switching regulation 15. Cytokines in immune response
Credit 2	**Complement system and Immune Disorders**
	1. Complement system –. Complement activation and types 2. Classical, Alternative and Mannan-binding lectin pathways and its regulation, 3. Biological functions of complement fixation, Complement fixation test 4. Transplantation immunology (Types of graft rejection, mechanism of graft rejection, 5. Graft vs host response 6. Immune response to tumours 7. Hypersensitivity – Gell& Coombs classification. Allergen 8.Type I, II, III and V Hypersensitivity and mechanism of activation 9.Tests for diagnosis of hypersensitivity, Tuberculin test 10. Auto immune diseases; classification 11. Mechanism and study of selected autoimmune diseases 12.Immuno- deficiency disorders – primary and secondary. AIDS 13. Immunosuppressive drugs/agents & their mechanism of action 14.ADA Deficiency 15.Microbial evasion of immune response

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Credit 3	Immunotechnology
	1. Adjuvants – types of and their applications 2. Production of polyclonal antibodies. Experimental animals models for production of antibodies 3.Methods of antibody purification (Salt precipitation, Affinity chromatography) 4. Hybridoma technology – production of monoclonal antibodies and their applications; antibody engineering 5. Antigen-antibody binding analysis - Equilibrium dialysis; Affinity and Avidity of antibodies 6. Antigen-antibody interactions , Agglutination reaction and visualization 7. Gel diffusion techniques (Ouchterlony, Mancini techniques), 8. Immune-electrophoresis (Rocket, counter-, 2-D), 9. Immuno-fluorescence, RIA, 10. Enzyme immune assay (ELISA) and their types 11. Western blotting 12. FACS techniques 13. Vaccines – Types, traditional vaccines and their applications 14. Newer vaccine strategies (DNA, recombinant DNA, RNA, peptide and anti-idiotypic vaccines) 15. Vaccination schedules. Benefits and adverse consequences of vaccination

References:

1. Kuby Immunology – Edited Thomas J. Kindt, Richard A Goldsby, Publisher WH Freeman & Co
2. Roitt's Essential Immunology, Tenth Edition, Ivan Roitt, Peter Delves
3. Veterinary Immunology: Ian R. Tizard, I.R. Thomson press
4. The Immune System. By Peter Parham Publisher Garland publishing

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Practicals (Each practical topic consists of 3 Experiments, Total 15 Expts)

Credit 4	**Immunology**
	1 Isolation of Ig from serum (human/bovine) by ammonium salt precipitation. 2. Purification of IgG by gel filtration. 3. Estimation of protein in all the fractions by Lowry's method 4. SDS PAGE of Ig fractions 5. Characterization of IgG by Western blot
Credit 5	**Immunotechnology**
	1.Agglutination: ABO and D Ag typing 2. RID 3. ODD 4. Rocket immunoelectrophoresis 5. ELISA, sandwich ELISA

References:

1. Experimental Biochemistry: A Student companion- Sashidhar Rao, B and Deshpande, V. IK International (P) Ltd

2 . An introduction to practical biochemistry. By: David T Plummer. Publisher Tata McGraw-Hill

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Paper-III: BI 303 T: Elective I
A: Nutrition and Clinical Biochemistry (100 marks)
(4 credits: theory credits= 3+ practical credits= 1)

Credit 1	**Nutrition and Food Science**
	1. Balanced diet, Macro & Micro Nutrients, Calorific values of foods. 2. Nutritional composition of cereals, pulses, nuts and fibre 3. Nutritional composition of fruits, vegetables, milk and milk products 4. BMR, BMI and factors affecting them. 5. Absorption; Control of food intake (leptin, ghrelin, peptide YY) 6. Malnutrition (PEM, Marasmus, Kwashiorkor), Obesity (BMI and other metrics) 7. Eating disorders; Anorexia and bulimia; Diet and longevity, ageing. 10. Food spoilage and preservation 11. Food adulteration and hygiene, Principles of quality control 12.Food contaminants (metals, pesticides and aflatoxins) and food additives 13. Pre-biotics, Probiotics and Dietary fibres 14. Nutraceuticals and Functional foods (Millets) 15.RDA for infants, children, adults and expectant / nursing mothers
Credit 2	**Clinical Biochemistry**
	1. Sample collection, serum, plasma and anticoagulants, factors affecting the sample collection – Place, time, temperature and posture, Deproteinization, Identification, transport and storage 2. Quality control and assurance in clinical biochemistry 3. Complete Blood picture, prothrombin time, ESR and Erythrocyte metabolic disorders 4. Composition (including formed elements) and Coagulation of blood 5. Haemoglobin determination, Types and Abnormal Hbs. 6. Hemoglobinopathies – Sickle cell Anaemia and Thalassemia 7. Thrombosis and Thrombolysis 8. Complete Urine Examination – Normal and abnormal constituents 9. Acid and Bases in the body; Plasma buffers and electrolytes; Mechanism of acid-base balance 10. Water and Electrolyte balance. Assessment of Na^+, K^+ and Cl^- levels in the body 11. Respiratory and renal regulation of pH, Acidosis and alkalosis (both metabolic and respiratory). 12. Hormone tests – Thyroid function tests, Pregnancy test 13. Glucocorticoids- Cortisol, DHEA, Estrogen, Progesterone, 14. Glucocorticoids- FSH, Testosterone and Prostate Specific Antigen (PSA) 15. Enzymes as Tumor markers

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Credit 3	**Liver and Xenobiotics**
	1. Structure and anatomy of liver, Liver functions, Fatty liver. 2.Pharmacopeia drug deposition and mechanisms of drug detoxification 3. Cytochrome P450 enzymes, molecular biology, catalytic cycle, isozymes, inhibitors 4. Dose response relationship, drug-receptor interactions 5.Pharmacodynamics; pharmacokinetics 6. Phase I reactions - modifications 7. Phase II reactions - conjugation 8. Phase III reactions - modifications and elimination, 9. Environmental factors influencing drug metabolism 10. Effects and metabolism of model toxins: aflatoxins, bacterial exotoxins (types I, II, and III) 11. Serum enzymes in liver diseases- SGPT, GGT, SGOT, ALT 12. Alkaline phosphatase, Leucine amino peptidase 13. Liver function tests- conjugated and total bilurubin in serum, albumin: globulin ratio, Hippuric acid and bromsulphthalein tests. 14. Bile pigments in urine/faeces, carbohydrate tolerance 15. Nutrient drug interactions

References:

1 Nutritive value of Indian foods by C. Gopalan, B.V. Rama Sastri and S.C. Balasubramanian. National Institute of Nutrition, ICMR.

2 Essentials of Food and Nutrition –Swaminathan M. Bangalore Press

3Manual of Nutritional Therapeutics, 2nd edition, Alpers (1991), Little Brown Publications, Washington.

4 Textbook of Medical Biochemistry by MN Chatterjea and Rana Shinde, Jaypee Brothers

5 Teitz Fundamentals of Clinical Biochemistry by Carl A. Burtis, Edward R. Ashwood and David E. Bruns. Saunders, Elsevier

6 Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3rd Ed by Allan Gaw, Michael Murphy,Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Churchill Livingstone.

7 Davidson's Principles and Practice of Medicine: A Textbook for Students and Doctors (Hardcover) 15th Ed by LSP Davidson, J MacLeod and CRW Edwards. Publisher: Churchill Livingstone.

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Practicals: Each practical topic consists of 3 Experiments, Total 15 Expts

Credit 4:	Nutrition and Clinical Biochemistry
1. 2. 3. 4. 5.	1. Nutritional assessment by clinical testing; Anthropometric and Biochemical testing. Proximate analysis of common foods Determination of total carbohydrate and lipid content in a food item Detection of adulterants in Milk, Adulterants in oils and food stuffs 2. Sample collection: Blood sample collection, Separation of serum and plasma, Lipid profile: HDL/LDL cholesterol. Determination of PCV, ESR, differential count, osmotic fragility of RBC 3. Determination of blood hemoglobin (Drabkins) and glycosylated haemoglobin (Hb1Ac), Determination of blood urea, Determination of blood glucose (GOD-POD method, enzymatic method). 4. Qualitative analysis of abnormal constituents in urine. Determination of urinary glucose. 5. Pregnancy detection test: hcG test,

B: Nanobiochemistry

Credit 1	Concept of Nanomaterials
	1. Introduction to nanoscale. 2. Chronological development of Nano science 3. Classification of nanomaterial based on dimension (1D, 2D, 3D and QD) 4. Classification of nanomaterial based on composition (Carbon, metal, semiconductor, dendrimer, composite, hybrid) 5. Biological (cellular) nanostructures 6. Biomolecular motors 7. Thin films 8. Colloidal structure 9. Vesicular structure: nanovesicle, nanosphere, nanocapsule. 10. Asymmetric nanostructures: Nanorod, nanocube, nanotube, nanoprism, nanowire. 11. Nanopore: Sequencing 12. Self-assembly properties 13. Catalytic property and applications 14. Plasmonic (Noble metal) and fluorescence (QD, nanoclusters) properties 15. Bio-inspired nanomaterials (Ceramic scaffold: Alumina, Titinium dioxide)

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Credit 2	**Synthesis and Characterization Method**
	1. Top down and Bottom up approach 2. Top down approach: Solid phase methods (Grinding, Ball milling, mechanical alloying) 3. Bottom up approach: Solid phase methods (Chemical methods: Chemical Vapour Deposition (CVD), plasma, thermal decomposition) 4. Bottom up approach: Solid phase methods (Physiical methods: Vapour Deposition(PVD), flame hydrolysis, LASER, plasma, molecular beam epitaxy (MBE)) 5. Bottom up approach: Liquid phase methods (Liquid/liquid type: Chemical reduction, pyrolysis, solvothermal synthesis) 6. Bottom up approach: Liquid phase methods (Sedimentation type: Sol-gel, co-precipitation, alkaline precipitation, hydrolysis, colloidal synthesis) 7. Nanolithography 8. Size and morphology:TEM and SEM 9. Finer structural details: Atomic force microscopy 10. Crystal plane alignment:X-ray diffraction 11. Elemental study: EDX, XPS 12. Hydrodynamic size: Dynamic light scattering 13. Molecular weight and solvent association: Static light scattering 14. Solution stability: Zeta potential measurement – LASER Doppler Velocimetry 15. Nanodrop
Credit 3	**Applications of Nanobiochemistry**
	1. Drug delivery: Classification of candidates, structure, example (nanotubes, quantum dots, polymeric conjugates, Dendritic nanostructure) 2. Drug delivery mechanism: active targeting and passive targeting 3. Factors influencing drug delivery route; balancing pharmacokinetics and pharmacodynamics. 4. Chemodynamic therapy (CDT) 5. Tumour starving therapy (TST) 6. Tumour targeted imaging: hybrid nanostructure (Fe/Au nanoshell) 7. Moleular nanosubmarine and its anti-cancer application 8. Nanobiosensor: principle and classification 9. Sugar biosensing using FRET (Fluorescence resonance energy transfer) and ECL (electro chemiluminescence) 10. DNA biosensing using Silica Nanowire (SiNW) 11. Nanomaterials for Photoablation and hyperthermia 12. Nanoengineered hydrogel 13. Nanozymes: Nanomaterial based artificial enzyme 14. Nanotoxicity: Developing genotoxicity and ecotoxicity 15. Nanotoxicity: Containment strategies

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Practicals (Each practical topic consists of 3 Experiments, Total 15 Expts)

Credit 4	Synthesis and characterization of nanomaterials
	Chemical synthesis of nanoparticles (gold, silver nanoparticles). 3. Natural or green synthesis of metal nanoparticles. 3. Characterization of nanoparticles. using UV-vis spectroscopy. 4. Quantitation of nanoparticles by ICPMS (CFRD, OU) 5. Estimation of aqueous stability of various nanoparticles using DLS and Zeta potential. (One day demonstration for this 2.5 no experiment can be arranged for other colleges if anyone opts for the course.)

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Paper IV BI 304 - Elective II
A: Physiology and Reproductive Biology (100 marks)
(4 credits: theory credits= 3+ practical credits= 1)

Credit 1	**Neurophysiology**
	1. Structure of Brain and typical nerve cells. 2. Division of vertebrate nervous system: CNS, PNS, 3. ANS, regions of the brain 4. Functioning of the sensory and motor nerves 5. Types of neuronal cells – Neuroglia, microglia, astrocytes, 6. Oligodendrocytes, Schwann, satellite and epididymal cells 7. Nerves: regeneration of nerve fibers, generation of nerve impulse, all or none principle. 8. Mechanism of synaptic transmission, transmission of nerve impulse. 9. Types of neurotransmitters and their receptors, mode of signaling 10. Electrical synapse and giant neurons 11. Sensory organs – eye, ear, Sensory organs: skin, tongue 12. Vision: visual system, 13. Rhodopsin and classical GPCR mechanism, termination of visual signal 14. Cone cells, specialization in color vision, physiology of colour blindness 15. Similarity between vision, olfaction and gustation
Credit 2	**Structure and Physiology of Muscle**
	1. Basic structure of muscle 2. Various types of muscle: striated, cardiac, smooth, fast twitch, slow twitch 3. Mechanism of muscle contraction, 4. Regulation of muscle contraction 5. Role of actin and myosin in non-muscle cells. 6. Role of Cytochalasins 7. Cytokinesis. 8. Muscle gene expression, regulation at transcriptional and posttranscriptional level. 9. Role of muscle proteins in cell locomotion 10. Neuro-muscular transmission 11. Electromyography, Sherrington starling Kymograph (recording drum) 12. Disorders of muscle: dystrophy, myopathy, 13. Monocytosis, myotonia, 14. Paralysis, Myasthenia gravis 15. Detection and treatment of muscle disorders

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Credit 3	Human Reproductive Biology
	1. Anatomy of Female reproductive system 2. Endocrinology of Female reproductive system 3. Anatomy of male reproductive system 4. Endocrinology of male reproductive system 5. Gametogenesis 6. Menstrual cycle 7. Fertilization 8. Implantation 9. Endocrinology of pregnancy 10. Endocrinology of parturition 11. Female infertility causes and treatment 12. Male infertility causes and treatment 13. Reproductive aging (menopause and andropause) 14. Methods of Birth control 15. Placenta as source of stem cells, cord banking

Practical (Each practical topic consists of 3 Experiments, Total 15 Expts)

Credit 4	Physiology and Reproductive Biology
	1. Sample collection: Blood sample collection, Separation of serum and plasma, Determine PCV, ESR, differential count Determine osmotic fragility of RBC Determine blood hemoglobin (Drabkins) and glycosylated hemoglobin (Hb1Ac). 2. Determination of blood urea. Determination of A:G ratio in serum, Assay serum alkaline phosphatase, Assay serum ALT (SGPT),Assay of serum AST (SGOT) Assay serum LDH. 3. Pregnancy test, Detection of hcG, Histopathology of Uterus, Ovary, Oviduct and Placenta, Histopathology of Testes. 4. Qualitative analysis of abnormal constituents in urine Determination of Urinary Titrable acidity, Urea and Insulin clearance tests, phenol red test, Acute and chronic kidney failure – Creatinine, Determination of urinary glucose. 5. Histopathology: Techniques for tissue processing and slide staining. Estimation of dopamine (Spectrophotometric method)

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B:Evolution, Ecology and Developmental Biology

Credit 1	Evolution
	1. Origin of life 2. Evolution of life forms – a theory 3. Evidences for evolution 4. Theories of evolution 5. Selection in action 6. Adaptive radiation 7. Biological evolution 8. Population and genetic evolution 9. Mechanism of evolution 10. Hardy-weinberg principle 11. Evolution above species level 12. Isolation 13. Speciation 14. A brief account of evolution 15. Origin and evolution of man
Credit 2	**Ecology**
	1. Ecosystem structure and function, energy dynamics, 2. Distribution of Flora and Fauna 3. Types of ecology, 4. Mineral cycling—(carbon and nitrogen) primary production and methods of measurement of primary productivity. 5. Population Ecology: Concept and Characteristics of a population, Population growth curves, 6. Species interactions: Types of interactions, Positive interactions- Mutualism, symbiosis, 7. Commensalism, protocooperation, Herbivory, carnivory, antibiosis and competition 8. Community Ecology: Characteristics of communities, 9. Analytical, Quantitative- Frequency ,density, abundance ,cover and basal area 10. Qualitative—Physiognomy, phenology, 11. Stratification, sociability, vitality and life forms, 12. Raunkiaer concept, Ecotones. 13. Concept of climax- Monoclimax and Polyclimax theories 14. Environmental toxicology: Effects of Toxic chemicals, Pollutants, Natural contaminants. 15. Biodiversity: Levels of Biodiversity-Species, Ecosystem and Genetic Diversities,

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Credit 3	Developmental biology
	1. Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation 2. Morphogenetic gradients 3. Cell fate and cell lineages 4. Stem cells 5. Genomic equivalence and the cytoplasmic determinants 6. 6 Imprinting 7. Gametogenesis 8. Fertilization and early development 9. Embryo sac development and double fertilization in plants 10. Embryogenesis in plants, symmetry, seed formation and germination. 11. Embryogenesis in animals, Zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. 12. Morphogenesis and organogenesis in animals 13. Axes and pattern formation in Drosophila, amphibia and chick; limb development and regeneration in vertebrates. 14. Differentiation of neurons, post embryonic development 15. Morphogenesis and organogenesis in plants

Practical (Each practical topic consists of 3 Experiments, Total 15 Expts)

Credit 4	Evolution, Ecology and Developmental Biology
	1. Determination of quantitative characters by random quadrat method - Abundance, Density, Frequency and Dominance To determine the important value index(IVI) of plant species in the campus 2. Similarity and Dissimilarity Index Estimation of Carbonates, Bicarbonates, Chlorides & Fluorine. 3. Estimation of Dissolved Oxygen, BOD, COD. Preparation of biological spectrum IUCN threatened categories: Rare, and Endangered 4. Vulnerable categories of plant species from Telangana. Mapping of in situ plant conservation in India. Ex situ conservation: Seeds of crop plants. 5. Histology of embryogenesis in plants Histology of embryogenesis in animals, Development of zebra fish

Reference Books

1. Fundamentals of Ecology, 2nd Edition, (2001) By MC Dash, Tata Graw Hill.
Cell Biology, Genetics, Molecular Biology and Ecology (2005) by P.S Verma and V.K. Agarwal, SS Chand and Company.

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IV - SEMESTER

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Dr. RAJU PAD
M.Sc.,
Assistant Prof

Department of Biochemistry, University College of Science, Osmania University, Hyderabad
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Semester - IV

Theory

paper	Title	Credits	Teaching hrs/wk	Internal Marks	End Semester Exams	Total Marks
I	BI 401 : Core I Bioststistics and Bioinformatics	3	3	30	70	100
II	BI 402 : Core II Cell – Cell Communication and Signalling	3	3	30	70	100
III	BI 403 : Elective III A : General Microbiology, Bacteriology and Virology B : Biotechnology	3	3	30	70	100
Total		9	9			300

SEMESTER – IV (Practicals)

paper	Title	Credits	Teaching Hrs/wk	Total Marks
IV	Project	5	7	150
V	Bioststistics and Bioinformatics	2	4	50
VI	Cell – Cell Communication and Signalling	2	4	50
VII	A : General Microbiology, Bacteriology and Virology Eelective III B :Biotechnology	2	4	50
Total		11	19	300

Total End Semester (Theory + Project Work + Practicals) = 600 Marks

20-12-2023

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Approved MSc. Biochemistry CBCS Syllabus

(Effective from 2022-23 admitted batch)

SEMESTER-IV

PAPER	TITLE	Credits*	hrs/ week	Internal marks(Theory)	Final exam marks(Theory)	Practical exam marks
I	**BI401:** Core I **Biostatistics & Bioinformatics**	5 (3T+2P)	7	30	70	50
II	**BI402:** Core II **Cell-Cell communication and Signalling**	5 (3T+2P)	7	30	70	50
III	**BI403:** Elective III **A: General Microbiology, Bacteriology and Virology** **B: Biotechnology**	3T 2P	7	30	70	50
IV	**BI 404: PROJECT WORK**	5	7			150
TOTAL		20	28	300		300

*3 credits @ 1 hour each for literature search. 3 credits @ 2 hours each for practical / laboratory work

For BI 401: Students may use only basic / Non scientific calculator .

TOTAL MARKS: 600

*One credit means the standard methodology of calculating one hour of theory or one hour of tutorial or two hours of laboratory work, per week for a duration of a semester (13-15 weeks)

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Paper-I (BI 401T) - CORE I
Biostatistics and Bioinformatics Credits; (100 Marks)
5 credits: theory credits= 3 + practical credits= 2

Credit 1	Biostatistics
	1. Biostatistics fundamentals (sample, population, variable); Types of variables, Measurement and measurement scales 2. Measures of central tendency (mean, median, mode) 3. Measurement of dispersion (range, variance, standard distribution) 4. Study of bivariate data: correlation and regression; Regression to calculate concentration of DNA/protein, molecular weight of DNA/protein 5. Graphical methods to depict data (histograms, bar-plots, pie charts, line graphs) 6. Probability in biology, Laws of Probability, Bayesian probability 7. Normal distribution, Binominal distribution and Poisson distribution 8. Student's t – test 9. F – test , Chi – square test; Contingency tests 10. CRD: Completely Randomized Design; 1-way ANOVA 11. RCBD: Randomized Complete Block Design; 2-way ANOVA 12. Non-parametric tests: sign test, Wilcoxon signed rank test 13. Non-parametric tests: Mann-Whitney test, Kruskal-Wallis test, and Friedman tests 14. Design of experiments: factorial experiments 15. Quality control in biochemistry
Credit 2	**Bioinformatics**
	1. Introduction of Bioinformatics: scope, history 2. Bioinformatics web portals- NCBI, EBI, ExPASy 3. DNA sequence databases-GenBank, EMBL, DDBJ 4. Protein sequence databases- UniProt, SWISSPROT, PIR, TeMMBL 5. Protein structure databases- PDB, SCOP, CATH, DSSP, CCDC 6. Functional database- KEGG, SWISS 2D-PAGE, COGS, PROSITE 7. Secondary or sequence cluster database - ProDom, SYSTERS, ProtoMap. 8. Sequence alignment: Dot matrix, match, mismatch, scoring method, gap penalty. 9. Comparing DNA/ protein sequences: pairwise local and global alignment 10. BLAST and FASTA- principle, classification and variation. 11. Scoring matrices- PAM and BLOSUM matrices 12. Multiple sequence alignments- Clustal-W, COBALT 13. Proteins motifs and MS profiles databases 14. Comparing protein sequences, alignment methods 15. Predicting secondary structure-ab initio, Homology folding, threading
Credit 3	**Genomics and Proteomics**
	1. Genomics and its branches 2. HGP and Strategies for sequencing genomes (shotgun and hierarchical sequencing) 3. 1st generation sequencing methods (Maxam and Gilbert Method; Sanger's method) 4. 2nd and 3rd Generation DNA sequencing methods (Next Generation

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	Sequencing: Pyrosequencing, Solexa, SoLiD, Helicos, SMaRT, IonTorrent) 5. Genetic and Physical maps of the genome, EST, STS 6. Genome annotation, re-sequence mapping and GWAS 7. Gene and genome duplications, and transposable elements 8. Epigenomics 9. Metagenomics 10. Paleogenomics and synthetic genomics 11. Relation of proteome to genome and transcriptome 12. Post-translational modification (kinome, glycosylation) 13. HUPO goals and accomplishments 14. Methods for sequencing proteins: Edman degradation 15. 2D gels and peptide maps

Practicals (Each practical topic consists of 3 Experiments, Total 15 Expts.)

Credit 4	**Applications of Bioinformatics databases**
	1.OMIM database and human genetic disorders 2. Retrieve DNA sequence from database (NCBI) 3. Retrieve protein sequence from database (NCBI) 4. Retrieve protein structure from database (PDB) 5. KEGG database for pathways
Credit 5	**Sequence alignment techniques and *in silico* processes**
	1. Local and global alignment of DNA, protein 2. Multiple sequence alignments 3. Primer design for PCR and *in silico* PCR 4. *In silico* restriction mapping 5. *In silico* translation, R programming.

References:

1. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India
2. Biostatistics –Arora & Malhan, Himalaya Publishing House
3. Introduction to Bioinformatics- Attwood T K and parry –smith, D.J. Pearson Education
4. Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH
5. Discovering Genomics, Proteomics and Bioinformatics – Campell&Heyer, Benjamin / Cummings pub

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Paper-I (BI 402T) – CORE II
Cell-Cell communication and Signalling (100 marks)
5 credits: theory credits= 3+ practical credits= 2

Credit 1	Extracellular matrix (ECM), cytoskeleton and cancer biology
	1. Molecules in ECM of animal tissue, Collagen, Elastin, Fibronectin. 2. ECM remodeling 3. Cell-Cell junctions and cadherin's 4. Functions and origin of cytoskeleton 5. Myosin and actin 6. Microtubules, Intermediate filaments and septins 7. Cell polarization and cell migration 8. Transport across cell membrane, Ficks Law. 9. Types of transport - simple, passive, facilitated. 10. Active transport system: primary and secondary active 11. Ionophores, gated channels (Voltage and Ligand). 12. Regulation of Cell cycle 13. Proto – oncogenes, Modes of action.of oncogenes – monomeric G – proteins, 14. Ras, c-Myc and leukemia 15. Tumor suppressor genes p53, RB and retinoblastoma, BRCA and breast cancer
Credit 2	**Cell Signaling and Signal Transduction**
	1. Cell communication and type of signaling molecules. 2. Types of receptors and their structure. 3. Signal cascades their importance 4. GPCR, mechanism of signal transduction; inhibitory and stimulatory G alpha (one eg each) 5. GPCR signal termination 6. Tyrosine kinase receptors mediated signaling 7. Insulin, growth factors EGF, VEGF signaling mediated 8. MAPK pathway, role in signaling 9. JAK-STAT pathway 10. Second messengers – Ca and calmodulin 11. Phosphoinositides 12. NO, cAMP, cGMP 13. Important signaling enzymes and their regulation: PKC, CAM-kinases 14. PI3-kinase 15. Phospholipases and Phosphatases

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Credit 3	Signal Transduction in Bacteria and Plants
	1. Introduction of signaling components in bacteria 2. Chemotaxis, Protein kinases in bacteria 3. His - kinases: structure and role 4. Plant signaling system : an overview 5. Response of plants to light, temperature and environmental factors 6. Cell surface Receptors in plants 7. Phytochromes and Cryptochromes 8. Stress signaling in plants (biotic) 9. Stress signaling in plants (abiotic) 10. Role of growth regulators in plants: Ethylene, auxins 11. Role of Cytokinins, Giberrelins and Abscissic acid 12. Signaling in yeast 13. STAT pathway in yeast 14. Protein - Protein interactions in signaling 15. Drugs: targeting signaling molecules

Practicals (Each practical topic consists of 3 Experiments, Total 15 Expts)

Credit 4	Basic experiments: Cell-cell communications
	1. Cell line assays: Preparation of suspension and adherent cells 2. Trypan blue and MTT assays, 3. Analysis of phosphoproteins 4. Chemotaxis assay-eukaryotes 5. Egg experiments – Osmosis, Diffusion
Credit 5	**Basic experiments : Signal transduction in Bacteria and Yeast**
	1. Sterilization methods: autoclaving & surface sterilization Preparation of culture media 2. Isolation of pure cultures, Bacterial growth curve 3. Gram Staining, Differential staining: Acid fast staining, Giemsa 4. Chemotaxis-bacteria 5. Yeast budding experiment

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References:

Theory:

1. The Biochemistry of Cell Signaling, Helmreich JM, Oxford Press
2. Cell signaling – John T Hancock, Oxford University press
3. Cell biology. Second edition: Edited by C A Smith and E J Wood. Chapman & Hall publ.
4. Molecular Cell Biology, 4th edition. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H Freeman.
5. 5. Molecular Cell Biology, 4th edition. Alberts B, Johnson A, Lewis J, et al New York: Garland Science; 2002.

Practicals:

1 Practical Medical Microbiology by R Panjarathinam. Jaypee Brothers Medical Publishers (P) Ltd.

2 Practical Medical Microbiology by Mackie &Mc Cartney. Elsevier

3 Microbiology – A Laboratory Manual by Cappuccino and Sherman. Pearson Education India.

4 Practical Medical Microbiology by Chandra Prakash Bhatt. A.K. Books and Educational Enterprises

5. A Practical guide to Clinical Virology by L. R. Haaheem, John R. Pattison and Richard J. Whitley

5 Virology Methods Manual by *Brian WJ Mahy and Hillar O Kangro. Elsevier*

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Paper-III (BI 403T) - ELECTIVE III
A: General Microbiology, Bacteriology and Virology (100 marks)
3 Credits (theory)

Credit 1	General and Applied Microbiology
	1. Introduction and Classification of Microorganisms 2. General Characteristics and structure of Bacteria 3. General Characteristics and structure of Archae 4. General Characteristics and structure of Fungi 5. General Characteristics and structure of Algae 6. Sub viral agents: viroids, virusoids and prions 7. Type of media for Bacterial cultures– Selective and Enriched media 8. Methods of sterilization - Physical and chemical methods 9. Isolation of pure cultures 10. Bacterial growth curve and kinetics of growth. 11. Batch, Continuous and synchronous cultures 12. Isolation and purification of viruses by filtration, ultracentrifugation and affinity chromatography 13. Cultivation and propagation of viruses 14. Viruses: One step growth, single burst and eclipse experiments 15. Viral assay methods – Plaque assays, pock assay, hemagglutination assay, transformation assay.
Credit 2	**Bacteriology**
	1. Classification of Bacteria 2. Bacterial Photosynthesis 3. Introduction to medical bacteriology. Infections – Types and transmission 4. Gram positive pathogens, Morphology , Reproduction and pathogenesis – *Staphylococcus* 5. Gram negative pathogens Morphology , Reproduction and pathogenesis – *E.*coli and *Salmonella* 6. Morphology , Reproduction and pathogenesis of *Mycobacterium tuberculosis* 7. Analysis of air, water and milk borne bacteria 8. Probiotic bacteria and their relevance to health 9. Domestic, municipal and industrial wastes Disposal. Microorganisms in the recycling process 10. Biodegradation of lignocellulosic waste, phenolic compounds and hydrocarbons. 11. Biotransformation of antibiotics and steroids. 12. Bioremediation of pollutants, metals and metallothioneins 13. Microbial metabolism – Autotrophs and Heterotrophs 14. Industrial uses of Bacteria 15. Antibacterial agents

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Credit 3	Virology (Prokaryotic and Eukaryotic viruses)
	1. Classification of viruses (Bacteriophages, plant and animal viruses): 2. Baltimore & ICTV systems, Genome diversity 3. Structure and composition of bacteriophages 4. Life cycle of model bacteriophages infecting *E coli* – λ (lytic lysogenic) 5. Life cycle of ϕ X 174, M13 6. Life cycle of T4, T7 7. Life cycle of Qß, Mu 8. Applications of phages - therapy; Concern over phage contamination in industry (dairy) 9. Eukaryotic viruses Host – virus interactions, permissive/non - permissive hosts; Cytopathic effects 10. Structure, life cycle and pathogenicity of Geminivirus 11. Structure, life cycle and pathogenicity of TMV 12. Structure, life cycle and pathogenicity of Adenovirus and SV 40 virus 13. Structure, life cycle and pathogenicity of Rotavirus and Rubella, 14. Structure, life cycle and pathogenicity of Influenza and Measles viruses 15. Structure, life cycle and pathogenicity of HIV and Hepatitis B Virus

References:

1. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.
2. Microbiology by Gerard J. Tortora, Berdell Ra. Funke and Christine L. Case. Publ: Pearson Education Inc
3. Medical Microbiology-David Green wood
4. Jawetz-Medical Microbiology-Geo F.Brooks,Janet S Butel.
5. Principles of Virology, (Vol I & II) Flint SJ, Enquist LW, Racaniello VR, Skalka AM Pub ASN Press
6. Introduction to Modern Virology – Dimmock
7. Basic Virology – Wagner
8. Virology – Saravanan
9. Virology – Maharajan
10. Molecular Virology – A. J. Cann
11. An introduction to Viruses – Biswas

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B Biotechnology
3 Credits (theory)

Credit 1	Microbial Biotechnology
	1. Large scale cultivation of microbes; Fermenter design and control of growth 2. Downstream processing, Production of biomass, single cell protein 3. Production of low molecular weight primary and secondary metabolites, 4. Microbial insecticides 5. Production of enzymes for research (restriction enzymes) 6. Production of enzymes for industry (high fructose corn syrup, cheese, food processing) 7. Microbial polysaccharides-Xanthan gum, Dextran, Pullulan, 8. Mannan, Curdlan, Alginate 9. Microbial mining (heavy metal mining, mineral leaching, Sulfur cycle) 10. Microbial production of human insulin, human growth hormone 11. Microbial production of interferon, tissue plasminogen activator 12. Superbug and microbial degradation of oil (bioremediation) 13. Methods and applications of immobilized cells 14. Methods and applications of immobilized enzymes 15. Protoplast isolation and applications
Credit 2	**Plant Biotechnology**
	1. Plant cell culture: callus, , differentiation into plantlets 2. Isolation of protoplasts and protoplast fusion 3. Plant vectors, 4. Agrobacterium tumefaciens and Ti plasmids 5. Transgenic technology 6. GM plants, GM foods, GEAC 7. Terminator technology 8. Antisense RNA 9. Antisense DNA 10. Plantibodies (example dental caries) 11. Case studies (genes involved, commercial value, problems) of StarLink corn, 12. Bt cotton 13. Case studies of Zeneca tomato paste, FlavrSavr tomato 14. Case studies of Golden rice, Herbicide resistant plants (Roundup Ready) 15. Virus resistant plants (papaya)

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Credit 3	Animal Biotechnology and Protein engineering
	1. Development, maintenance and growth of animal cell lines 2. Cloning of mammalian and non-mammalian species (Polly, Molly, and Dolly) 3. Production of viral vaccines 4. Production high value therapeutics, interferon, PEGylated interferon 5. Plasminogen activator, urokinase 6. Chimeric antibodies and antibody engineering 7. Immunotoxins as therapeutic agents 8. Gene knockouts 9. Human gene therapy 10. "Humanized" animals as organ farms 11. Large-scale and site-directed mutagenesis, high throughput screening tools in protein engineering 12. Natural and recombinant fusion proteins, tags for protein purification 13. Altering kinetic properties and pH dependence of enzymes 14. Increasing stability, enhancing specific activity of enzymes 15. Methods of drug design and delivery

Practicals: 2 Credits (Each practical topic consists of 3 experiments, Total 15 experiments)

Note: The practical experiments in Credit 4 and 5 as mentioned below are to be conducted irrespective of the Elective paper chosen by the students.

Credit 4	General Microbiology
	1.Methods of isolation and Identification of Fungi (Soil fungi) 2. Antibiotic sensitivity: Well Disc diffusion assay 3.Broth dilution assay-Determination of MIC 4. Widal test, 5. VDRL test
Credit 5	**Biotechnology**
	1. Biotransformation of Antibiotics and Steroids 2. Biodegradation of phenolic compounds hydrocarbons, Dye decolourization by microorganisms 3. Isolation of protoplasts, regeneration and protoplast fusion 4. Production of industrially important enzymes 5. Isolation of industrially important enzymes

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References:

1. Introduction to Biotechnology, William J. Thieman, Michael A. Palladino, Benjamin Cummings Publ
2. Biotechnology- Arora, Himalaya pub. House
3. Principles of Gene Manipulation, by R.W. Old, S.B. Primrose, Wiley-Blackwell Publications
4. Biotechnology, Applying the genetic revolution. David P Clark and Nanette J. Pazdernik.Academic Press.
5. Culture of animal cells. 6th Edition. A manual of Basic technique and specialized applications, By R Ian Freshney. Wiley Blackwell publishers.

BI 404: PROJECT (5 Credits) (150marks)

Internal Assessment		
Credit 1	Research Design Seminar	25 marks
Credit 2	Progress Seminar 1	25 marks
Semester end Assessment		
Credit 3	Dissertation	25 marks
Credit 4	Final presentation	50 marks
Credit 5	Viva Voce during final presentation	25 marks

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