

**Department of Biochemistry, UCS&I,
Mahatma Gandhi University, Nalgonda. Approved MSc. CBCS Syllabus
(Effective for 2016-17 admitted batch onwards)**

SEMESTER I						
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI101T:Chemistry and Metabolism of Proteins and Lipids and Porphyrins (core)	4	4	4	20	80
2	BI102T:Chemistry and Metabolism of Carbohydrates, NucleicAcids and Vitamins (core)	4	4	4	20	80
3	BI 103T: Bio-AnalyticalTechniques (core)	4	4	4	20	80
4	BI104T:Bioenergetics and CellBiology (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	Add on paper	2	2	2	10	40
5	BI105P:Biomolecules	9	6	4	--	100
6	BI106P:BioanalyticalTechniques	9	6	4	--	100
	<i>Total</i>	38	32	27	90	585
SEMESTER II						
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI201T:Enzymology (core)	4	4	4	20	80
2	BI202T:Molecular Biology (core)	4	4	4	20	80
3	BI203T:BiochemicalGenetics and Model Organisms (core)	4	4	4	20	80
4	BI 204T: Endocrinology and Metabolic Disorders (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	Add on paper	2	2	2	10	40
5	BI205P:Enzymology and Biochemical preparations	9	6	4	--	100
6	BI206P:Molecular Biology and Endocrinology	9	6	4	--	100
	<i>Total</i>	38	32	27	90	585
SEMESTER III						
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI301T:Gene Regulation and GeneticEngineering (core)	4	4	4	20	80
2	BI302T:ImmunologyandImmunotechnology (core)	4	4	4	20	80
3	BI303T: clinical Biochemistry/Nutrition (Elective)	4	4	4	20	80
4	BI304T: Human physiology and xenobiotics (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	#Inter Disciplinary paper-I (ID paper-I) Chemistry of Biomolecules and Methods of study	4	4	4	20	80
5	BI305P:RecombinantDNA and Immunotechnology	9	6	4	--	100
6	BI306P:Nutrition and ClinicalBiochemistry	9	6	4	--	100
	<i>Total</i>	40	34	29	100	625
SEMESTER IV						
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI401T: Biostatistics and Bioinformatics (core)	4	4	4	20	80
2	BI402T: Cell-Cell Communication and SignalTransduction (core)	4	4	4	20	80
3	BI403T: Microbiology (core)	4	4	4	20	80
4	BI404T: Biotechnology (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	#ID paper-II: Health and Immune System	4	4	4	20	80
5	BI405P:Bioinformatics, Biostatistics and Biotechnology	9	6	4	--	100
6	BI 406 P: Project	9	6	4	--	100
	<i>Total</i>	40	34	29	100	625

	Sem-I	Sem-II	Sem-III	Sem-IV	Total
No. of credits	4+4+4+4+1+2+4+4=27	4+4+4+4+1+2+4+4=27	4+4+4+4+1+4+4+4=29	4+4+4+4+1+4+4+4=29	112
Marks	675	675	725	725	2800
	Total work load of (Sem-I, Sem-III)				*56
	Total work load of (Sem-II, Sem-IV)				*56

*Note: work load without add on paper, ID papers and seminars
#ID papers: for other than M.Sc. Biochemistry course students

Semester I

Paper-I: BI 101T: Chemistry and Metabolism of Proteins and Lipids & Porphyrins (4Credits; 100 Marks)

Unit-I: Chemistry of Amino Acids, & Proteins

1. Classification and structure of 20aa, essential, non-essential, unusual and non-protein
2. General properties of aa, acid-base titrations, pKa
3. Peptide bond-stability and formation, Primary structure, GN Ramachandran plots
4. Secondary structure and motifs, α helix, β sheet, 3-10helix
5. Leucine zipper, Zinc finger, Trans-membrane regions, β LHL
6. Tertiary & Quaternary structure (myoglobin, hemoglobin)
7. Protein-protein interactions (actin, tubulin)
8. Small peptides (glutathione, peptide hormones), Cyclic peptides (Gramicidin)
9. Classification of proteins-globular, fibrous, membrane, metallo-proteins, SCOP, CATH
10. Denaturation (pH, temperature, chaotropic agents), refolding, Role of chaperones in folding

Unit-II: Metabolism of Amino Acids, & Proteins

1. Metabolic fate of dietary proteins and amino acids
2. Degradations to glucose and ketone bodies
3. Amino acids degraded to Pyruvate, Oxaloacetate
4. Amino acids degraded to Acetyl-CoA, Succinyl-CoA
5. Metabolism of branched chain amino acids
6. Role of glutamate cycle in formation & circulation of ammonia
7. Glucose alanine cycle, urea cycle
8. Linking of citric acid and urea cycles, regulation of urea cycle
9. Genetic defects in metabolism of amino acids (albinism, Phenylketonuria, maple syrup urine disease, homocystinuria, alkaptonuria, methyl malonic Acidemia)
10. Genetic defects in metabolism of urea (Argininemia, Arginosuccinic Acidemia, Carbamoyl Phosphate Synthetase-I deficiency)

Unit-III: Chemistry of Lipids & Porphyrins

1. Classification & biological significance of lipids & fatty acids
2. Steroids, Sterols, relation to vitamin D and steroid hormones
3. Bile acids and salts, Phospholipids
4. Oils, waxes, isoprene units
5. Lipoproteins
6. Glycolipids, Sphingolipids
7. Structure & function of porphyrins (e.g. Heme, Chlorophyll)
8. Cerebrosides, Gangliosides
9. Prostaglandins, Prostacyclins
10. Thromboxanes, Leukotrienes

Unit-IV: Metabolism of Lipids & Porphyrins

1. Fate of dietary lipids and Apo-lipoproteins
2. Fatty acid biosynthesis, Desaturation of fatty acids
3. Beta-oxidation, breakdown of odd chain fatty acids, energy yields
4. Regulation of β -oxidation, ω -oxidation & α -oxidation
5. Metabolism of phospholipids & Sphingolipids
6. Regulation and Biosynthesis of cholesterol and other steroids
7. Fate of acetyl CoA, formation of ketone bodies and ketosis
8. Biosynthesis of prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes
9. Role of HDL, LDL, and Very-low-density lipoprotein (VLDL) and cholesterol levels in body
10. Catabolism of Porphyrins, Genetic defects in lipid and nucleotide metabolism, Medium chain acyl coenzyme A dehydrogenase deficiency MCAD, Long-chain 3-hydroxyacyl-CoA dehydrogenase (LCHAD) deficiency, Familial hypercholesterolemia, Gout

References:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W.H. Freeman.
2. Biochemistry- Jeremy M Berg, John L Tymoczko, and Lubert Stryer.: WH Freeman
3. Biochemistry, 4th Edition- Donald Voet, Judith G. Voet.- Publisher John Wiley & Sons.

PaperII BI102T:Chemistry Metabolism of Carbohydrates, NucleicAcids and Vitamins.(4Credits;100Marks)

Unit–I: Chemistry of Carbohydrates

- 1 Classification, monosaccharides (aldoses & ketoses)
- 2 Configuration and conformation of monosaccharides (pyranose & furanose, chair & boat)
- 3 Reducing and optical properties of sugars
- 4 Stability of glycosidic bond disaccharides, oligosaccharides
- 5 Structural polysaccharides—cellulose, hemicellulose, pectin, lignin, chitin, chitosan
- 6 Storage polysaccharides: starch, glycogen, inulin
- 7 Steric factors in polysaccharides folding, sugar code and lectin
- 8 Glycosaminoglycans, mucopolysaccharides, hyaluronic acid
- 9 Chondroitin sulfate, keratan sulfate, dermatan sulfate
- 10 Bacterial cell wall—proteoglycans and peptidoglycans

Unit–II: Metabolism of Carbohydrates

- 1 Reactions and energy balance in Glycolysis
- 2 Reactions and energy balance in Gluconeogenesis
- 3 Reactions and energy balance in TCA cycle
- 4 Pentose phosphate, Pasteur and Crabtree effect
- 5 Anapleurotic reactions
- 6 Glyoxylate cycle
- 7 Glucuronic acid cycle
- 8 Glycogen metabolism
- 9 Photosynthesis reactions for biosynthesis of glucose
- 10 C₃ and C₄ cycle in plants

Unit–III: Chemistry and Metabolism of Nucleic Acids

- 1 Purines, pyrimidines, nucleosides, nucleotides, unusual bases
- 2 Structure of DNA—Watson Crick Model, A- and Z-forms
- 3 Supercoiling of DNA—negative and positive, linking number
- 4 Structure of RNA, tRNA, rRNA, siRNA/miRNA
- 5 Properties of NA—denaturation and renaturation
- 6 T_m (factors affecting T_m) and C₀t curves
- 7 Heteroduplex mapping—D loops and R loops
- 8 Biosynthesis of purines and pyrimidines
- 9 Degradation of purines and pyrimidines
- 10 Regulation: *denovo*, salvage, nucleotide analogs

Unit–IV: Chemistry and Metabolism of Vitamins

- 1 Discovery of vitamins, classification, RDA
- 2 Vitamin A—source, biological role, deficiency
- 3 Vitamin B₁—Thiamine—source, biological role, deficiency
- 4 Vitamin B₂—Riboflavin—source, biological role, deficiency
- 5 Vitamin B₃—Niacin and B₅—Pantothenic acid—sources, biological role, deficiency
- 6 Vitamin B₆—Pyridoxamine and B₇—Biotin—source, biological role, deficiency
- 7 Vitamin B₉—Folic acid and B₁₂—Cobalamin—source, biological role, deficiency
- 8 Vitamin C—Ascorbic acid—source, biological role, deficiency
- 9 Vitamin D—Calciferol—source, biological role, deficiency
- 10 Vitamin E, Vitamin K—source, biological role, deficiency

References:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
2. Biochemistry—Jeremy M Berg, John L Tymoczko, and Lubert Stryer.: WH Freeman
3. Biochemistry, 4th Edition—Donald Voet, Judith G. Voet—Publisher John Wiley & Sons
4. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, ... White A, McGraw Hill

Paper III BI103T: Bioanalytical Techniques.(4Credits;100Marks)

Unit-I:Spectroscopy

- 1 Beer Lambert's Law, Molar extinction coefficient, Absorption maximum
- 2 UV-Vis: Spectroscopy, Colorimetry—principle, instrumentation, application
- 3 Fluorescence Spectroscopy—principle, instrumentation, application
- 4 Atomic Absorption Spectrometry—principle, instrumentation, application
- 5 NMR—principle, instrumentation application
- 6 ESR—principle, instrumentation application
- 7 CD—principle, instrumentation, application
- 8 ORD—principle, instrumentation, application
- 9 Mass spectroscopy principle, instrumentation, application
- 10 X-ray crystallography

Unit-II:Chromatography

- 1 Partitioning and countercurrent distribution
- 2 PC—principle, instrumentation, application
- 3 TLC—principle, instrumentation, application
- 4 GC—principle, instrumentation, application
- 5 Ion-exchange—principle, instrumentation, application
- 6 Gel filtration (Gel exclusion chromatography)—principle, application
- 7 Affinity chromatography—principle instrumentation, application; immunoprecipitation
- 8 HPLC and RP-HPLC—principle, instrumentation, application
- 9 FPLC, LC—principle, instrumentation, application
- 10 Peptide mapping and N-terminal sequencing of proteins

Unit-III:CentrifugationandElectrophoresis

- 1 Centrifugation, RCF and types of rotors
- 2 Ultra centrifugation—principle, instrumentation, application
- 3 CsCl density gradient and sucrose gradient centrifugation—principle, application
- 4 Electrophoresis—moving boundary and zonal electrophoresis
- 5 Native and SDS PAGE, IEF and 2D PAGE
- 6 Agarose Gels, PFGE
- 7 Zymography, PAGE for DNA sequencing
- 8 DNase-I hypersensitivity mapping
- 9 DNA-Foot-printing and Chromatin IP methods
- 10 Denaturing gels for RNA, Southern and Northern Blots

Unit-IV: Tracer Techniques

- 1 Stable and radioactive isotopes, Radioactivity theory, half-life and emission spectra of
Half-life of biologically useful isotopes- ^2H , ^3H , ^{14}C , ^{18}O , ^{32}P , ^{35}S , ^{125}I
- 2 Isotopes used for labeling proteins (^3H , ^{14}C , ^{35}S , ^{125}I) and nucleic acids (^3H , ^{32}P)
- 3 Detection of radioactivity by Scintillation counting
- 4 Autoradiography, Fluorography, Phosphor-imaging, applications
- 5 GM counter, gamma counter
- 6 Radiation hazards and safe disposal of radioactivity waste;
Luxometry and chemiluminescence as alternative to radioactivity
- 7 Isotope dilution method—pulse chase
- 8 Historic examples- ^{14}C and ^{18}O to study photosynthesis
- 9 Historic examples- ^{31}P and ^{32}S to study viral replication (Hershey-Chase experiment)
- 10 Historic examples- ^{14}N and ^{15}N in DNA replication (Meselson and Stahl experiment)

References:

1. Principles and Techniques of Practical Biochemistry-
Wilson. K. And Walker. J. Pub: Cambridge Press
2. Physical Biochemistry-Friefelder, Publisher D. W. H. Freeman Press
3. Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay
and N. Nath. Himalaya Publishing House, Delhi.
4. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman
5. The Tools of Biochemistry, Cooper TG, John Wiley and Sons

Paper IV: BI104T: Bioenergetics and Cell Biology. (4 Credits; 100 Marks)

Unit-I: Bioenergetics

- 1 Elementsofimportanceinbiochemistry(H,C,N,O,P,S),typesandenergy of bonds and interactions(ionic,covalent,coordinate,H-bonds,vanderWaals,hydrophobicinteractions)
- 2 Laws of thermodynamics,Gibbs free energy,relevance of entropy and Enthalpy in biological systems and reactions; First and second-order reactions
- 3 **Log** and **ln** scales in biological processes (exponential growth curves,radio active decay)
- 4 Biological oxidation,high energy compounds
- 5 High energy bonds, redox and phosphate potential
- 6 Structure of membrane,forces stabilizing membranes
- 7 Formation of iongradients across a membrane(protongradientsinorganelles),role of transporters and channels
- 8 ETC in mitochondria and chloroplasts,un-couplers and inhibitors of energy transfer
- 9 Polarization of cell,resting potential,action potential,propagation of impulse
- 10 Biological fluorescence (GFPandderivatives),Bioluminescence

Unit-II: Structure of Prokaryotic cells

- 1 Classification of prokaryotes(systems of classification)
- 2 Ultra-structure of eubacteria,cyanobacteria,mycoplasma
- 3 Motility of bacteria,bacterial films,isolation of bacteria from natural sources
- 4 Sterilization of materials (autoclaving,dryheat,filtration,chemical disinfection,irradiation) and commonly-used media(minimal,enriched,selective)for bacterial growth
- 5 Staining methods for bacteria;maintenance,and preservation of bacterial cultures
- 6 Growthcurve,Doubling time,Factors effecting growth-pH,temperature,oxygen,agitation
- 7 Batch and continuous growth of bacteria,chemostat,synchronized cultures
- 8 Industrial(large-scale)growth of bacteria,fermenter design
- 9 Bacteria of industrial importance,development of commercially valuable strains
- 10 Discovery of antibiotics,mode of action of various classes of antibiotics,antibiotic resistance

Unit-III: Structure of Eukaryotic cells

- 1 Ultra-structure of animalcells
- 2 Ultra-structure of plantcells
- 3 Composition of cytoskeleton-microfilaments,microtubules,intermediate filaments
- 4 Nuclear skeleton-lamina,scaffold
- 5 Vesicle trafficking (endocytosis,exocytosis),role of Rabs and Rab GTPases
- 6 Structure of chromatin and chromosomes (centromere,telomere,kinetochore)
- 7 Mitosis, meiosis, and interaction of chromatin with cytoskeleton (attachment of spindle fibers).
- 8 Formation and structure of special chromosomes (polytene,lampbrush)
- 9 Celleycle
- 10 Apoptosis

Unit-IV: Methods of Cell Study

- 1 Simple and compound microscope.
- 2 Phase contrast,dark field and polarization microscopy.
- 3 Electron microscopy,SEM,TEM;freeze fracture.
- 4 Fluorescence and Confocal microscopy;imaging live cells.
- 5 FRET and FRAP.
- 6 Atomic force microscopy.
- 7 Flow-Cytometry and cellsorting(FACS).
- 8 Plant tissue culture.
- 9 Animal and insect tissue culture.
- 10 Methods of cell disruption and fractionation,isolation of organelles.

References:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: 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. The Cell: A Molecular Approach, Fifth Edition, by Geoffrey M. Cooper and Robert E. Hausman, published by ASM Press

Semester I:Practicals
(Note:Each topic corresponds one practical session)

PaperV:BI105P:Biomolecules	PaperVI:BI106P:BioanalyticalTechniques
1 Lab safety, GLP, calculations and preparation of standard solutions 2 Preparation of buffers, use of balance and pH meter 3 Qualitative analysis of amino acids 4 Determine pKa and pI of acidic, basic, and neutral amino acids 5 Estimate amino acids by Ninhydrin methods 6 Quantify glycine by formal titration 7 Estimate tryptophan by Spies and Chambers method 8 Qualitative analysis of carbohydrates 9 Estimate total sugars by phenol sulfuric acid method 10 Estimate reducing sugars by DNS 11 Estimate fructose by Roe's method 12 Qualitative analysis of lipids 13 Saponification value of fats 14 Iodine number of oil 15 Peroxide value of fats 16 Acid value of fats 17 Estimate DNA by DPA 18 Estimate RNA by Orcinol- Method 19 SDS PAGE for proteins 20 Agarose gel for DNA	1 Absorption spectrum of tyrosine, determination of molar extinction coefficient, calculations based on Beer Lambert's Law 2 Estimate inorganic phosphate by Fiske-Subbarow method 3 Estimate protein by Biuret method 4 Estimate protein by Lowry method 5 Titrate calcium in milk 6 Titrate vitamin C 7 Photometric analysis of iron 8 AAS analysis of metals 9 Anion-exchange capacity of resin 10 Cation-exchange capacity of resin 11 Separate amino acids by ion-exchange chromatography 12 Separate purines and pyrimidines by paper chromatography 13 1-D PC of amino acids 14 2-D PC of amino acids 15 PC of plant pigments 16 TLC of plant pigments 17 TLC of lipids 18 Desalting proteins by dialysis 19 Gel filtration (size exclusion) 20 Cell fractionation (centrifuge)

Project ideas:

- 1 Compare pigments in different plant parts, different flowers, plants and algae
- 2 Compare unsaturation of various oils and fats
- 3 Determine sugar /vitamin C content in various fruits and soft drinks, calcium content in various milk brands

References:

1. An introduction to practical biochemistry. By: David T Plummer. Publisher Tata McGraw- Hill
2. Biochemical Calculations—Segel, I.H. John Wiley & sons
3. Experimental Biochemistry: A Student companion- Sashidhar Rao, B and Deshpande, V. IK International (P) Ltd
4. Experiments And Techniques In Biochemistry: by Sheel Sharma, Galgotia publications.

Semester II

Paper-I: BI 201T:Enzymology. (4 Credits; 100 Marks)

Unit-I:Enzymes, Coenzymes and catalysis

- 1 Thermodynamics of catalysis,Energy of activation,Relation of ΔG and K_{eq}
- 2 Coupled reactions(endergonicandexergonic)in biochemical pathways
- 3 Methods to isolate and purify enzymes,Assays,Activity Units,Specificactivity
- 4 Nomenclature and classification of enzymes:EC,SCOP,CATH
- 5 Metal,co-factor,and co-enzyme requirements
- 6 Vitamin cofactors:TPP,FMN/FAD,NAD/NADP,Pantothenicacid
- 7 Vitamin cofactors:PLP,Biotin,Folate,Cobalamine,Phylloquinone
- 8 Factors affecting catalysis(pH,temperature,pressure,enzyme and substrate concentration)
- 9 Chemicals to identify active site residues:Arg,Cys,Lys,His
- 10 Site-directedmutagenesis to identify active site residues:Triose Phosphate Isomerase

Unit-II: Enzyme Kinetics

- 1 Single substrate assumptions,Briggs-Haldane equation.
- 2 Steady state,Michaelis-Mentonkinetics(derive equation and transformations)
- 3 Transformation of Michaelis-Menton equation.
- 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:RT and Protease inhibitors as anti-HIVdrugs
- 8 Cooperativity in binding(oxygen binding to hemoglobin)
- 9 Multiple sites;Cooperativity:MWCmodel,KNFmodel
- 10 Slow transition and Hysteretic behavior in enzymes

Unit-III:CatalyticMechanisms

- 1 Types of catalysis:acid-base,transition state,covalent intermediates
- 2 Reversible and irreversible activation of enzymes (pro-enzymes,phosphorylation)
- 3 Enzymes activation by ligand binding and dimerization(protein tyrosine kinase receptors)
- 4 Catalytic mechanism of RNase
- 5 Catalytic mechanism of Chymotrypsin, Trypsin
- 6 Catalytic mechanism of Lysozyme
- 7 Catalytic mechanism of Carboxy peptidase,Subtilisin
- 8 Allosteric regulation of Aspartate Transcarbamylase
- 9 Regulation of Glutamine Synthetase
- 10 Multi-enzyme Complex: fatty acid synthase

Unit-IV:Enzymes in Physiology and Biotechnology

- 1 Regulatory enzymes in carbohydrate metabolism (glycolysis, TCAcycle)
- 2 Regulatory enzymes in nucleotide metabolism
- 3 Enzyme cascades (blood clotting,complement activation)
- 4 Enzyme cascades(cell division and apoptosis)
- 5 Convergent and divergent evolution of enzymes
- 6 Reporterenzymesforgeneexpression(β -gal, β -glucuronidases,CAT);
Restriction enzymes and ligases in recombinant DNATEchnology
- 7 Enzymes in dairy (Rennin,lipases,lactases),brewing(amylases,proteases,glucanases),
Foodprocessingtechnology(invertase,pectinases,papain)
- 8 Enzymes in detergent(lipases,cellulases,proteases), paper(cellulases),and tanning
- 9 Enzymes in bioremediation,biofuel industry(cellulases)
- 10 Enzyme engineering:Catalytic RNA and antibodies;Designing High-Through put enzyme assays

References:

- 1.Fundamentals of Enzymology,Price.NC.AndStevens.L.,OxfordUniversityPress
- 2.Enzymes-Biochemistry,Biotechnology,Clinicalchemistry-Palmer,T.,AffiliatedEast-Westpress
- 3.Fundamentals of Enzyme Kinetics,SegelI.H.;WileyInterscience,

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!

Paper II: BI202T: Molecular Biology. (4 Credits; 100 Marks)

Unit-I: DNA Replication

- 1 Models of replication—random, conservative, semi conservative
- 2 Prokaryotic and eukaryotic DNA polymerases, helicases, ligases, topoisomerases
- 3 Initiation—primosome, ori-sequences, accessory proteins
- 4 Elongation—replisome, leading and lagging strands, Okazaki fragments
- 5 Termination, Inhibitors of replication
- 6 Replication of circular chromosomes by theta model- ϕ X174, E. coli
- 7 Replication of circular chromosomes by rolling circle (lambda phage) and Strand displacement models (mt-DNA)
- 8 Replication of linear chromosomes, telomeres, telomerase
- 9 Amplification—Polytene and double minute chromosomes
- 10 *In vitro* replication-PCR

Unit-II: DNA Repair

- 1 Types of damage—oxidation, deamination, alkylation, adducts, breaks
- 2 Direct repair—MGMT, photo-reactivation, AlkB
- 3 Base Excision Repair (Short and Long Patch)
- 4 Nucleotide Excision Repair
- 5 Mismatch Repair
- 6 Repair of DSBs by NHEJ and Homologous recombination
- 7 Holliday junctions and repair of collapsed forks
- 8 SOS and bypass repair
- 9 Diseases due to defects in DNA repair
- 10 Roles of ATM, BRCA in DNA repair

Unit-III: Transcription and Translation

- 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, PolyA addition
- 5 Splicing, RNA editing; Inhibitors of transcription
- 6 Structure of ribosome, nature of genetic code
- 7 Initiation of translation (role of cap, IRESIFs)
- 8 Elongation of translation (role of EFs)
- 9 Termination of translation (role of RFs)
- 10 Inhibitors of protein synthesis

Unit-IV: Protein Sorting, Targeting and degradation

- 1 Post translational modifications of proteins, role in targeting (isoprenylation)
- 2 Signal peptide (ERLS), role of SRP in translation of secreted proteins
- 3 NLS, Mitochondrial & chloroplast LS
- 4 Chaperones, HSPs in protein folding
- 5 Lysosomal pathways (endocytosis, crinophagy, macroautophagy, Micro autophagy, direct translocation from cytosol)
- 6 Lysosomal storage diseases
- 7 Ubiquitin-proteasome pathway, N-end rule
- 8 Immuno-proteasomes, Misfolded proteins in neuro degenerative diseases,
- 9 PEST sequences and proteolysis
- 10 Action of cytotoxic, hemotoxic, myotoxic & hemorrhagic venoms

References:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: 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

Paper-III: BI 203T: Biochemical Genetics and Model Organisms.
(4 Credits; 100Marks)

Unit-I: Mendelian Genetics

- 1 Mendel's Laws, Importance of meiosis in heredity
- 2 Non-Mendelian Inheritance—Maternal effect, Maternal influence, Cytoplasmic inheritance
- 3 Gene interactions—Epistasis, Expressivity, Penetrance
- 4 Sexlinked, sexlimited, and sex influenced genes; Polygenic inheritance and polyploidy
- 5 Mutations (spontaneous/induced, somatic/germinal, forward/reverse, transition/transversions)
- 6 Mutations (Silent, missense, nonsense, and frameshift mutations, conditional, leaky)
- 7 Detection, selection & isolation of microbial mutants, Estimation of mutation rates
- 8 Reversion and suppression of mutations
- 9 Mutagens—physical, chemical
- 10 Transposon mutagenesis, site-directed mutagenesis

Unit-II: Linkage and Mapping

- 1 Discovery of linkage, Morgan's experiments
- 2 Cytological proof of crossing over
- 3 2- and 3-point crosses
- 4 Recombination, Interference
- 5 Tetrad analysis
- 6 Mapping human genes by pedigree analysis; Fundamentals of population genetics (HW Law)
- 7 Pedigrees of AR, AD, XR, and XD inherited traits
- 8 Mobile genetic elements—Zea Ac, Ds and Sp elements
- 9 *Drosophila* copia, Yeast Ty elements
- 10 Using recombination to make knockout cells/organisms

Unit-III: Bacterial Genetics

- 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 Discovery of transposition
- 8 Structure of transposons, replicative and conservative transposition, use as mutagens
- 9 Mapping phage genes—Fine structure of rII locus: Complementation analysis
- 10 Fine structure of rII locus: Deletion mapping

Unit-IV: Model Organisms

- 1 *Dictyostelium* to study cell–cell communication and differentiation.
- 2 *Saccharomyces* to study homologous recombination in mating type switch; site of formation of buds
- 3 *Neurospora* to study one gene–one enzyme hypothesis
- 4 *Drosophila* to study embryonic development (homeotic mutations)
- 5 *C. elegans* to study development and nervous system
- 6 *Danio* to study vertebrate development, GLO fish
- 7 *Xenopus* to study embryogenesis
- 8 *Mus* in bred and knockout strains, NOD and nude mice
- 9 *Zea* to demonstrate cytological proof of crossing over
- 10 *Arabidopsis* to study flower development

References:

1. Microbiology—Prescott LM, Harley JP. & Klein DA, McGraw-Hill
2. Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley & Sons
Modern Genetic Analysis Anthony J F Griffiths, William M Gilbert, Jeffrey H Miller, and Richard C Lewontin. Pub. W. H. Freeman;

Paper-IV: BI 204T: Endocrinology and Metabolic Disorders.(4 Credits; 100 Marks)

Unit-I:Hormones and Endocrine glands

- 1 History of endocrinology
- 2 Organization and classification of hormones and endocrine systems
- 3 Basic mechanism of action of peptide hormones and receptors
- 4 Basic mechanism of action of steroid hormones and receptors
- 5 Chemistry,physiology,and disorders related toHypothalamus-Pituitary axis
- 6 Chemistry,physiology,and disorders related to thyroid and parathyroidglands
- 7 Glycoprotein hormones(LSH,FSH,TH,hCG,POMC)
- 8 Growth hormone family(GH,hCS,Prolactin)
- 9 Adrenal hormones
- 10 Gonadal hormones

Unit-II:Endocrine regulation

- 1 Regulatory pathways (positive,negative,feedbackloops),Regulation of biosynthesis of steroid hormones by peptide hormones(LH,FSH,ACTH)
- 2 Endocrine regulation of growth
- 3 Endocrine regulation of stress
- 4 Endocrinology of Cahomeostasis
- 5 Endocrinology of blood sugar,hunger,digestion,andobesity
- 6 Endocrine regulation of renal function
- 7 Endocrine regulation of cardio vascular system (angiotensin,BNP,ET1)
- 8 Endocrinology of fertility (changesinmenstruation,pregnancy,andmenopause)
- 9 Medical uses of steroid hormones (contraception,HRT,hydrocortisone,anabolicsteroids)
- 10 Erythropoietin,Adipo-cytokines,Orexins

UnitIII:Disorders of AminoAcid and Carbohydrate Metabolism

- 1 Hyper phenyl alaninemia
- 2 Disorders of proline and hydroxyl proline metabolism
- 3 Alcaptonuria
- 4 Disorders of lysine metabolism
- 5 Disorders of tyrosine metabolism
6. Hemoglobinopathies;Thalassemia
- 7 Disorders of glycogen storage
- 8 Disorders of fructose metabolism
- 9 Disorders of Galactose metabolism
- 10 Pentosuria, Diabetes

Unit-IV:Disorders of Lipids and Nucleic Acids Metabolism

- 1 Disorders of acid Lipase deficiency
- 2 Farber'sdisease
- 3 Neeman-Picks disease
- 4 Goucher'sdisease
- 5 Krabbe disease
- 6 Sulphatide-lipidosis disease
- 7 Fabry disease
- 8 Downs andTurner's syndrome
- 9 Hyperuricemia and Gout
- 10 Hereditary Xanthine Urea and Lesch-Nyhan syndrome

References:

- 1.WilliamsTextbookofEndocrinology– Larsen,R.P.Korenberg,H.N.Melmed,S.andPolensky,K.S.Saunders.
- 2.HumanPhysiology–Chatterjee.C.C,MedicalAlliedAgency
- 3.PrinciplesofBiochemistry:MammalianBiochemistry:SmithEL,HillRL,... WhiteA,McGrawHill4.ThemetabolicbasisofInheriteddiseases(VolI&II)ScriverCR..ValleD,PubMcGrawHill

Semester II: Practicals
(Note: Each topic corresponds one practical Session)

Paper-V:BI205P:Enzymology and Biochemical preparations	Paper-VI:BI206P:Molecular biology and Endocrinology
<ol style="list-style-type: none"> 1 Assay urease (horse gram / any source) 2 Assay catalase (liver / any source) 3 Assay α amylase (saliva) 4 Assay β amylase (sweet potato) 5 Purify the enzyme; calculate yield, total activity and specific activity at each stage 6 Time course and enzyme concentration (salivary amylase) 7 Effect of pH on enzyme activity 8 Effect of temperature on enzyme activity 9 Effect of [S], determine K_m and V_{max} 10 Purify casein from milk, calculate yield at each step 11 Purify albumin from egg, calculate yield at each step 12 Fractionate BSA by salt precipitation 13 Isolation of starch from potato 14 Isolation of glycogen from liver 15 Isolation of lecithin and cholesterol from egg yolk 	<ol style="list-style-type: none"> 1 Isolate DNA (onion/thymus/other source), 2 Absorption spectrum to assess purity (A260/A280 ratio) 3 Determine T_m of DNA 4 Prepare RNA (yeast/other source) 5 Agarose gel for RNA, DNA 6 Over expression of a cloned protein 7 Purification of a cloned protein 8 Absorption spectrum, molar extinction coefficient of purine/pyrimidine 9 Estimation of h HCG 10 Estimation of FSH 11. Estimation of LH 12. Estimation of Estrogen, Estradiol 13. T3, T4, TSH Tests (demonstration) 14. Pregnancy Test (strip method) 15. Estimation of C Peptide

Project ideas:

- 1 Compare abundance of an enzyme in various sources
- 2 Compare sensitivity and/or specificity of different assays for the same enzyme
- 3 Find the effect of some treatment (drug) on your model organism
- 4 Screen natural sources for biodiversity (bacteria, phage, algae, antibiotic-resistant bacteria)

References:

1. Enzyme assays-A Practical Approach, Eisenthal, R and Dawson, M.J, IRL press
2. Practical Biochemistry-Rameshwar. A, Kalyani Publisher
3. Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley
4. Modern Genetic Analysis Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin. Pub. W.H. Freeman;
5. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India
6. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W.H. Freeman.

Paper-I: BI 301T: Gene Regulation and Genetic engineering (Core 4 Credits; 100Marks)

Unit – I: Gene Regulation in Prokaryotes and Viruses

- 1 Operon concept for gene regulation
- 2 Positive (+ve)&Negative (-ve) control – Lac operon
- 3 Attenuation – Trp operon
- 4 Dual promoters – gal operon: Dual function of repressor – ara operon
- 5 Phase variation in *Salmonella* flagellar protein synthesis
- 6 Sporulation gene expression in *Bacillus*
- 7 Riboswitch
- 8 Anti – termination in lambda phage
- 9 Lytic / lysogenic switch in lambda phage
- 10 Control of plasmid copy number

Unit – II: Gene Regulation in Eukaryotes

- 1 Chromatin structure in active and inactive regions – DNA methylation.
- 2 Euchromatin, histone acetylation, H2AX foci, histone code
- 3 Transcriptional control – cell specific expression – promoters, enhancers, Transcription factors
- 4 Posttranscriptional control – alternative splicing RNA editing.
- 5 RNA transport and stability.
- 6 Translational feedback.
- 7 Gene silencing – inactivation of mammalian X chromosome.
- 8 Regulation by siRNA
- 9 Gal operon of yeast.
- 10 MAT locus and mating type switch in yeast, Antigenic variation in *Trypanosoma*

Unit – III: Genetic Engineering-I

- 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, mammalian cells)
- 6 Construction of cDNA and genomic DNA libraries
- 7 Screening a library (+ve) & (-ve) selection strategies, Preparation of probes
- 8 Creating KO cells, Cre – Lox systems.
- 9 Sequencing DNA by Maxam-Gilbert and Sangar method.
- 10 Sequencing DNA by Pyrosequencing,

Unit – IV: Genetic Engineering-II

- 1 Yeast 2 hybrid
- 2 Phage display
- 3 Reporter genes – GFP, b – gal, luciferase
- 4 Expression in heterologous systems – bacteria
- 5 Expression in heterologous system – yeast cells
- 6 Expression in heterologous system – insect cells
- 7 Expression in heterologous system – mammalian cells
- 8 Molecular markers – RFLP, AFLP

- 9 Random amplification of polymorphic DNA (RAPD), Short tandem repeat, single nucleotide polymorphism (SNP),
- 10 Ribotyping

References:

1. Genes VIII, Lewin, B, Publish Oxford University Press
2. Principles of Gene Manipulation: An introduction to GE – Old, R. and Primrose, S.B. Blackwell Sci. Pub
3. Molecular Biotechnology Glick, BR and Paternak, JJ. Publish ASM Press
4. Molecular Biology of the Gene by Watson JD, Losick R. Pub Pearson Education

Paper-II: BI 302T: Immunology and Immunotechnology (Core 4 Credits; 100 Marks)

Unit – I: Components of the Immune System

- 1 History of immunology
- 2 Natural & acquired immunity, Specific & non-specific immune response.
- 3 Cells & organs of immune system
- 4 Antigenic determinants, Epitopes, Haptens, Properties of strong antigens
- 5 Adjuvants – types, mode of action, and applications.
- 6 Classification, structure, and biological properties of immunoglobulins
- 7 Isotypes, allotype, idiotypes.
- 8 Theories of antibody formation, Generation of antibody diversity
- 9 Genomic rearrangements of light and heavy – chain loci in B-cells
- 10 Genomic rearrangements in T-cell receptor, structure of CD3, CD4, CD8

Unit – II: Events in Immune Response

- 1 Humoral& cell-mediated immune response
- 2 Activation of T cells & B cells
- 3 Kinetics and regulation of primary and secondary immune response
- 4 MHC proteins structure & functions
- 5 Antigen processing & presentation
- 6 Transplantation immunology; Graft Versus Host Disease
- 7 Complement fixation: pathways and biological consequences
- 8 Discovery and action of Interferons
- 9 Cytokines; Inflammation; Role in obesity, cancer
- 10 Tumor immunology

Unit – III: Immune Disorders

- 1 Hypersensitivity; Coombs classification
- 2 Type I-V hypersensitivity
- 3 Tests for diagnosis of hypersensitivity (Coombs), Tuberculin test
- 4 Auto immune diseases; classification
- 5 Study of selected auto – immune disorders of types I – V
- 6 Immuno- deficiency disorders – primary and secondary deficiencies
- 7 Gene therapy for ADA deficiency
- 8 Immunology of AIDS
- 9 Immunosuppressive drugs/agents & their mechanism of action
- 10 Immune evasion by bacteria and viruses

Unit – IV: Immunotechnology

- 1 Production of polyclonal antibodies; Animals models for production of antibodies
- 2 Methods of antibody purification: Salt precipitation, Affinity chromatography
- 3 Antigen-antibody binding (Equilibrium dialysis, Surface Plasmon Resonance); Affinity, Avidity
- 4 Immunoprecipitation methods - gel diffusion (Ouchterlony; Mancini); Immune-electrophoresis (Rocket, counter-, 2-D)
- 5 Agglutination tests (Direct and indirect), Inhibition of Agglutination, Complement fixation test, Inhibition of complement fixation
- 6 ELISA, RIA Western Blots; use of antibody staining for FACS
- 7 Hybridoma technology – production of monoclonal antibodies; applications in research and immunotherapy; antibody engineering
- 8 History and types of Vaccines; Conventional vaccines - killed, attenuated, and subunit vaccines
- 9 Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines
- 10 Schedules of common vaccination, 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

Paper-III: BI 303T: Clinical Biochemistry-E1 (Elective –I) (4 Credits; 100 Marks)

Unit – I: Clinical Biochemistry-I

- 1 Free radical metabolism, ROS in disease
- 2 Neuro-endocrine regulation
3. Endocrine regulation of growth
- 4 Endocrine regulation of salt, electrolyte and water, Acid base balance and imbalance
- 5 Endocrine regulation of calcium & phosphate
- 6 Specimen collection. Automation and QA in clinical laboratories
- 7 Examination of Urine & Blood
- 8 Examination of Sputum & CSF
- 9 Pregnancy test, prenatal diagnosis & genetic counseling
- 10 Clinical importance of Enzymes and isoenzymes

Unit – II: Clinical Biochemistry-II

- 1Physiological Interrelationship between cardiovascular, respiratory and renal systems
- 2Normal values for different blood tests and clinical implications
- 3Diagnosis of anemia, thalassemia
- 4hyper cholesterolemia, atherosclerosis.
- 5Diagnostic enzymes: Principles of diagnostic enzymology.
- 6Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase
- 7Clinical significance of aldolase and lactate dehydrogenase.
- 8Enzyme tests in determination of myocardial infarction

- 9 Biochemical tests for the diagnosis of heart diseases- HDL/LDL cholesterol, SGOT, LDH, CK, C-reactive protein, cardiac troponins.
- 10 Diagnostic and therapeutic uses of radioisotopes

Unit – III: liver and Renal function tests

- 1 Structure and functions of the liver.
- 2 Liver diseases: jaundice, hepatitis, cirrhosis, Fatty liver
- 3 Liver function tests: conjugated and total bilirubin in serum, albumin: globulin ratio, hippuric acid and bromsulphthalein tests.
- 4 Serum enzymes in liver diseases: SGPT, GGT and alkaline phosphatase.
- 5 Kidneys-structure of nephron, urine formation
- 6 Normal and abnormal constituents of urine.
- 7 Normal values for different urine tests and clinical implications
- 8 Biological buffers.
- 9 Role of kidneys in maintaining acid-base and electrolyte balance in the body.
- 10 Renal function tests- creatinine and urea clearance tests, phenol red test.

Unit – IV: Clinical aspects of disorders of lipid metabolism and gastric, thyroid function tests

- 1 Physiology of lipids/lipoproteins.
- 2 Lipidosis.
- 3 Lipoproteins and apolipoproteins.
- 4 Disorders of lipid metabolism: lipoproteinemias
- 5 Clinical interrelationships of lipids (sphingo-lipidosis and multiple sclerosis)
- 6 Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders.
- 7 Fractional gastric analysis: Achylia gastric, Stimulation tests, Tube less gastric analysis
- 8 Tests based on primary function of thyroid, Tests measuring blood levels of thyroid hormones,
- 9 Tests based on metabolic effects of thyroid hormones,
- 10 Thyroid scanning, Immunological tests for thyroid functions

References:

1. Text book of Biochemistry and Human Biology –Talwar , G.P. and Srivastava. L.M., Printice Hall of india
2. Human Physiology –Chatterjee.C.C, Medical Allied Agency
3. Textbook of Medical Biochemistry By MN Chatterjea and Rana Shinde, Jaypee Brothers.
4. Lehninger Principles of Biochemistry 5th Ed By David L. Nelson and Michael M. Cox, WH Freeman and Company.
5. Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3rd Ed
By Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.
6. Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
7. Clinical Biochemistry By Richard Luxton. Scion Publishing Ltd.

Paper-III: BI 303T: Nutrition-E2 (Elective –II)
(4 Credits; 100 Marks)

Unit – I: Nutrition -I

- 1 Balanced diet
- 2 Calorific values of foods and their determination by bomb calorimeter.
- 3 Specific dynamic action of foods
- 4 Nutritional assessment by clinical testing; Anthropometric and Biochemical testing
- 5 BMR and RDA for infants, children, adults and expectant / nursing mothers; Food fortification; probiotics
- 6 Organs of digestive system; Enzymes (amylases, proteases, lipases)
- 7 Hormones in digestion (stomach, pancreas; gastrin, secretin, CCK);
- 8 Role of bile acids
- 9 Absorption; Control of food intake (leptin, ghrelin, peptide YY)
- 10 Cholesterol, sodium and blood pressure

Unit – II: Nutrition - II

- 1 Protein factor in nutrition
- 2 Role of carbohydrates in diet
- 3 Role of lipids in the diet
- 4 Malnutrition (PEM, Marasmus, Kwashiorkor), Obesity (BMI and other metrics)
- 5 Eating disorders; Anorexia and bulimia; Obesity and starvation.
- 6 Diet and longevity, ageing.
- 7 Diet in pregnancy and lactation
- 8 Composition and nutritive value of common foodstuffs
- 9 Electrolyte content of fluid compartments, Functions of electrolyte, Sodium, Potassium and Chloride, Absorption, Transport and balance
- 10 Factors effecting electrolyte balance and hydrogen ion balance.

Unit – III: Macrominerals and Microminerals

- 1 Macrominerals
- 2 Calcium Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA
- 3 Regulation of calcium concentration, Calcium interaction with other nutrients.
- 4 Phosphorus Distribution, Concentration in the body, Digestion, Absorption, Utilization, Transport, Storage, Excretion, Sources, Calcium: Phosphorus ratio.
- 5 Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia and hyperphosphataemia
- 6 Iron Distribution, Concentration in the body, Digestion, Absorption, Utilization, Transport, Storage, Excretion, Sources
- 7 RDA, interaction with other nutrients
- 8 Role of iron in prevention of anaemia.
- 9 Microminerals: Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Sources, distribution in the human body
- 10 Physiology, function, deficiency and toxicity of microminerals

Unit – IV: Food Microbiology

- 1 General principles underlying spoilage of food
- 2 fitness and unfitness of food for consumption, contamination and spoilage of non perishable and perishable foods.
- 3 food born diseases, food infection, intoxication
- 4 microbial toxins types, bacterial poisoning
- 5 Causative agents and sources, symptoms and prevention of Staphylococcal food poisoning, botulism, salmonella, bacillus infection, E.coli,
- 6 food poisoning of fungal origin ergotism, aflatoxin.
- 7 Control of microorganisms
- 8 Principles of preservation, Preservation by high and low temperature,
- 9 chemical preservatives, salt, sugar as preservative
- 10 new trends in preservation.

References:

1. Essentials of Food and Nutrition –Swaminathan M. Bangalore Press
2. Tietz textbook of clinical chemistry and molecular diagnostics edited by Carl. A. Burtis
3. Textbook of Medical physiology by Guyton and Hall
4. Text book of medical biochemistry by MN Chatterjea and Rana Shinde
5. Food microbiology -Adams, M.R. and Moss M.O.
6. Foundations in Microbiology -Kathleen Talaro and Arthur Talaro
7. Industrial Microbiology -Patel, H.P.
8. Industrial Microbiology –Casida
9. Industrial Microbiology -Prescott and Dunn
10. Microbiology -Concepts and Applications -Paul A. Ketchum
11. Microbiology Concepts and Applications -McKane and Kandel
12. Bergeys Manual of Determinative Bacteriology
IX edition
13. Elements of Biotechnology - Gupta
14. Elements of Biotechnology - Singh
15. Food Technology Latest Issues

Paper-IV: BI 304T: Human Physiology and Xenobiotics (Core, 4 Credits; 100 Marks)

Unit – I: Neurophysiology

- 1 Types of neuronal cells – Neuroglia, microglia, astrocytes, oligodendrocytes, Schwann, satellite and epididymal cells
- 2 Nerves: regeneration of nerve fibers, generation of nerve impulse, all or none principle.
- 3 Mechanism of synaptic transmission, transmission of nerve impulse.
- 4 Types of neurotransmitters and their receptors, mode of signaling
- 5 Electrical synapse and giant neurons
- 6 Division of vertebrate nervous system: CNS, PNS, ANS, regions of the brain
- 7 Sensory organs – eye, ear, skin, tongue
- 8 Vision: visual system, rhodopsin and classical GPCR mechanism, termination of visual signal

- 9 Cone cells, specialization in color vision, physiology of colour blindness
- 10 Similarity between vision, olfaction and gestation

Unit – II: Structure and Physiology of Muscle

- 1 Structure of various types of muscle: striated, cardiac, smooth, fast twitch, slow twitch
- 2 Mechanism of muscle contraction, regulation of contraction
- 3 Role of actin and myosin in non-muscle cells.
- 4 Cytochalasins and cytokinesis.
- 5 Muscle gene expression, regulation at transcriptional and posttranscriptional level.
- 6 Role of muscle proteins in cell locomotion
- 7 Neuro-muscular transmission
- 8 Electromyography, Sherrington starling Kymograph (recording drum)
- 9 Disorders of muscle (dystrophy, myopathy, monocytosis, myotonia, paralysis, Myasthenia gravis)
- 10 Detection and treatment of muscle disorders

Unit – III: Human Reproductive Biology

- 1 Female reproductive system: anatomy and endocrinology
- 2 Causes of female infertility (acquired and genetic), treatments
- 3 Male reproductive system: anatomy and endocrinology
- 4 Causes of male infertility (environmental and genetic), treatments
- 5 Puberty, reproductive aging (menopause and andropause)
- 6 Gametogenesis and fertilization (natural and assisted (*in vitro*)), implantation and placenta
- 7 Milestones in first trimester of pregnancy (<http://www.ehd.org/virtual-human-embryo/>)
- 8 Milestones in second trimester of pregnancy
- 9 Milestones in third trimester of pregnancy, child birth
- 10 Placenta as source of stem cells, cord banking

Unit – IV: Liver and Xenobiotics

- 1 Liver functions, pharmacopeia drug deposition and mechanisms of drug detoxification
- 2 Cytochrome P450 enzymes, molecular biology, catalytic cycle, isozymes, inhibitors
- 3 Dose response relationship, drug-receptors interactions
- 4 Pharmacodynamics; pharmacokinetics
- 5 Phase I reactions - modifications
- 6 Phase II reactions - conjugation
- 7 Phase III reactions - modifications and elimination,
- 8 Environmental factors influencing drug metabolism
- 9 Effects and metabolism of model toxins: aflatoxins, bacterial exotoxins (types I, II, and III)
- 10 Nutrient drug interactions – I and II

References:

1. Human Physiology by Guyton and Hall Press Pub Saunders
2. Biochemistry, 4th Edition - Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
3. Human reproductive Biology by Jones and Lopez Pub
4. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, ... White A, McGraw Hill

Semester III: Practicals

(Note: Each topic corresponds one Practical Session)

Paper-V: BI 305P: Recombinant DNA and Immunotechnology

- 1 Restriction digestion of DNA
- 2 Prepare competent cells
- 3 Transform competent cells
- 4 Blue-white complementation screening
- 5 Express heterologous protein in *E. coli*
- 6 Gene cloning (demonstration)
- 7 Purify IgG by gel filtration
- 8 Purify IgG by affinity chromatography
- 9 Characterize IgG by specific antibody (Western blot)
- 10 SDS PAGE of Ig fractions
- 11 Agglutination: ABO and D Ag typing
- 12 Radial Immuno diffusion
- 13 Ouchterlony double diffusion
- 14 Rocket immunoelectrophoresis
- 15 Dot ELISA
- 16 sandwich ELISA

References:

1. Molecular Cloning (Lab manual) by Maniatis T, Fritsch EF, Sambrook J, Volume –I, CSH
2. Lab Manual in Biochemistry, Immunology and Biotechnology – Arti Nigam and Archana Ayyagari –Tata McGraw-Hill New Delhi

Paper-VI: BI 306P: Nutrition and Clinical Biochemistry

1. Determine total protein content (Kjeldahl) in a food item
2. Determine total carbohydrate content in a food item
3. Determine lipid content in a food item
4. Qualitative analysis of abnormal constituents in urine
5. Determine PCV, ESR, differential count
6. Determine osmotic fragility of RBC
7. Laboratory test to measure coagulation
8. Determine urinary glucose
9. Determine urinary creatinine
10. Determine blood haemoglobin (Drabkins) and glycosylated hemoglobin
11. Determine blood urea
12. Determine blood glucose (POD-DOD method, enzymatic method)
13. Assay serum alkaline phosphatase
14. Assay serum ALT (SGPT)

15. Assay serum AST (SGOT)
16. Assay serum LDH

References:

1. Practical Clinical Biochemistry –Varley, H. CBS Publications
2. Practical Clinical Biochemistry-Methods and Interpretations – Ranjna Chawla- Jaypee
3. Manipal Manual of Clinical Biochemistry: For Medical Laboratory and MSc Students
By S. Nayak, Shivnanda Nayak B, JAPEE Brother Medical Publications, New Delhi

Paper-I: BI 401T: Biostatistics and Bioinformatics (Core, 4 Credits: 100 Marks)

Unit – I: Biostatistics-I

- 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
- 7 Bayesian probability
- 8 Normal distribution.
- 9 Binominal distribution.
- 10 Poisson distribution

Unit – II: Biostatistics-II

- 1 Design of experiments: factorial experiments
- 2 Student's t – test
- 3 F – test
- 4 Chi – square test; Contingency tests
- 5 CRD: Completely Randomized Design; 1-way ANOVA
- 6 RCBD: Randomized Complete Block Design; 2-way ANOVA
- 7 Non parametric tests: sign test
- 8 Wilcoxon signed rank test, Mann-Whitney test
- 9 Kruskal-Wallis test, and Friedman tests
- 10 Quality control in biochemistry

Unit – III: Genomics

- 1 Genomics and branches of genomics (Why study a genome?)
- 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 Sequencing)
- 5 Genetic and Physical maps of the genome, EST, STS
- 6 DNA sequence databases, Use of databases; data mining
- 7 Comparing DNA sequences, pairwise local and global alignment
- 8 BLAST, FASTA, PAM and BLOSUM matrices
- 9 Multiple sequence alignments (Phylogenetic trees, Clustal-W, COBALT)
- 10 Epigenomics and metagenomics

Unit – IV: Transcriptomics and Proteomics

- 1 Relation of transcriptome to genome and proteome (Why study a transcriptome?)
- 2 Tools of transcriptomics: Northern blots, RNase protection assays, RT-PCR and Q-PCR
- 3 HT tools of transcriptomics: Microarrays for expression profiling, alternate sequencing
- 4 HT RNA sequencing: SAGE, MPSS, RNA-Seq, GIGA
- 5 Identifying expressed sequences by ChIP-seq, DNase-seq
- 6 Transcriptome databases (ESTs, Transcriptome Shotgun Assembly, ArrayExpress)
- 7 Methods for sequencing proteins: Edman degradation
- 8 MS – MALDI. LC-MS, Tandem MS (MS-MS)
- 9 Micro-arrays for proteins, 2D gels and peptide maps
- 10 Proteins structure databases; Peptide sequence and MS profiles databases, Comparing protein sequences, alignment

References:

1. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India
2. Biochemical Calculations –Segel, I.H. John Wiley & Sons.
3. Math's from Scratch for Biologists Alan J, Cann, John Wiley & Sons
4. Calculus for Biology and Medicine, Claudida Neuhauser (third edition) Publications Prentice Hall
5. Biostatistics –Arora & Malhan, Himalaya Publishing House
6. Introduction to Bioinformatics- Attwood T K and parry –smith, D.J. Pearson Education
7. Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH
8. Discovering Genomics, Proteomics and Bioinformatics – Campell & Heyer, Benjamin / Cummings pub

Paper-II: 402T: Cell-Cell Communication and Signal Transduction (Core, 4Credits:100 Marks)

Unit – I: Extra Cellular Matrix (ECM) and Cell Surface

1. Molecules in the ECM in plant and animals.
2. Transport across cell membrane, Ficks Law.
- 3 .Types of transport- simple, passive, facilitated.
4. Active transport, primary and secondary active transport system.
5. Ionophores, gated channels (Voltage and Ligand).
6. Cell communication and type of signaling molecules.
7. Types of receptors and their structure.
8. GPCR, inhibitory and stimulatory and type of down steam effectors and signal termination.
9. Monomeric G-proteins their role.
10. Drugs targeting signaling molecules

Unit – II: Cell Signaling

1. Cell division and differentiation.
2. Autocrine, paracrine & endocrine systems
3. Growth factors – EGF, PDGF

4. VEGF, IGF
5. Second messengers – Ca, calmodulin, inositol, NO, cAMP, cGMP
6. Receptors tyrosine kinases (Insulin signaling)
7. MAPK pathway, role in signaling.
8. Role of post-translational modification of proteins in signaling – phosphorylation.
9. Acylation, glycosylation, ADP ribosylation, myristoylation.
10. Signal cascades, Inhibitors of signal cascades.

Unit – III: Signal Transduction and Cancer

1. Discovery of oncogenes, proto-oncogenes
2. Modes of action of oncogenes – G proteins – Ras
3. Growth factors – Erb, Sis
4. Transcription factors – Fos, Jun, AP1, V-erbA
5. Discovery of tumor suppressor genes
6. RB and retinoblastoma, APC and colon cancer.
7. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN)
8. p53 and cancer risk
9. Selected examples – c-Myc and leukemia
10. BRCA and breast cancer

Unit – IV: Signal Transduction in Bacteria and Plants

1. Introduction of signaling components in bacteria
2. Chemotaxis
3. Protein kinases in bacteria
4. His-kinases: structure and role
5. Plant signaling system an over view
6. Stress signaling in plants (biotic)
7. Stress signaling in plants (abiotic)
8. Plants hormones and their mechanism of action
9. Signaling in yeast
10. STAT pathway in yeast

References:

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

Paper-III: BI 403T: Microbiology (Core, 4Credits:100 Marks)

Unit I: Bacteriology

1. Classification of prokaryotes,
2. Staining methods,
3. Common culture methods (minimal, enriched, selective).
4. Structure of bacterial cell.
5. Motility of bacteria, bacterial films,
6. Sterilization methods (autoclaving, dry heat, filtration, chemical disinfectants, irradiation),
7. Maintenance and preservation of microbial cultures.
8. Bacterial culture growth conditions, growth curve, doubling time.
9. Factors affecting growth – pH, temperature, oxygen and agitation.
10. Chemostat, continuous and synchronous cultures

Unit II: Mycology

1. Classification: classification of Fungi (Ainsworth, 1973) upto sub-division with diagnostic characters and examples.
2. Hyphal forms,
3. Fungal spore forms and mode of liberation,
4. Sexual reproduction and degeneration of sex,
5. Homothallism and heterothallism, life cycle patterns,
6. Anamorphic fungi and parasexuality
7. Life history of synchytrium,
8. Life history of Rhizopus, Ascobolus,
9. Life history of Agaricus, Micorrhiza types with salient features,
10. Role in agriculture and forestry.

Unit III: Prokaryotic viruses

1. Discovery of bacteriophages
2. Structure and composition of bacteriophages; classification
3. Genome diversity and host-specific interactions
4. Isolation and purification by filtration, ultracentrifugation and affinity chromatography
5. Plaque assay and other assay methods
6. One step growth, single burst and eclipse experiments
7. Life cycle of model bacteriophages infecting E.coli – lambda phage (lytic and lysogenic)
8. Φ x174, Q β , M13
9. T4, T7
10. Phages in therapy

Unit-IV: Eukaryotic viruses

1. Classification of animal viruses, Virioids and virusoids
2. Structure of naked and enveloped viruses
3. Host-virus interactions, permissive/non-permissive hosts; cytopathic effects
4. Isolation and purification of viruses
5. Assay methods-Pock assay, hemagglutination assay, transformation assay

6. Cultivation of viruses in animals and tissue culture
7. Life cycle of animal viruses – SV40
8. Adenovirus, Poliovirus
9. Retroviruses – RSV/HIV
10. Plant viruses – TMV, CaMV

References:

1. The Fundamentals of Bacteriology by Charles Bradfield Morrey
2. Bacteriology Textbook by Charles P. Davis, Gail Woods and David Niese
3. Basic Bacteriology by C.C. Chen, Ph.D., D.D.S
4. Fungi Their Nature and Uses by Mordecai Cubitt Cooke
5. Biology of Fungi by Chet Cooper
6. An Introduction To The Study of Fungi by E. F. Legner
7. Basic Virology by Elliott J. Blumenthal by Elliott J. Blumenthal
8. Veterinary Virology by Dr. M. A. Oyekunle, Dr O. E. Ojo and Dr. M. Agbaje
9. Molecular Virology by Moses P. Adoga
10. Viruses of Prokaryotes by Hans-Wolfgang Ackermann, Michael S. Dubow
11. Viruses of Fungi and Simple Eukaryotes by Y. Koltin

Paper-IV: BI 404T: Biotechnology. (Core, 4 Credits: 100 Marks)

Unit – I: Microbial Biotechnology

- 1 Large scale cultivation of microbes; Fermenter design and control of growth
- 2 Downstream processing
- 3 Production of biomass, single cell protein
- 4 Production of low molecular weight primary and secondary metabolites
- 5 Microbial insecticides
- 6 Production of enzymes for industry (high fructose corn syrup, cheese, food processing)
- 7 Microbial polysaccharides-Xanthan gum, Dextran, Pullulan, Mannan, Curdlan, Alginate
- 8 Microbial mining (mineral leaching)
- 9 Microbial production of interferon, tissue plasminogen activator
- 10 Microbial degradation of oil (bioremediation)

Unit – II: Plant Biotechnology

- 1 Plant cell culture: callus, protoplast fusion, differentiation into plantlets
- 2 Plant vectors, Ti plasmids
- 3 GM plants, GM foods
4. IPR and farmers' rights in GM plants
- 5 Anti sense RNA and DNA
- 6 Plantibodies
- 7 Case studies (genes involved, commercial value, problems) of StarLink corn, Bt cotton
- 8 Case studies of Zeneca tomato paste, FlavrSavr tomato
- 9 Case studies of Golden rice, Herbicide resistant plants
- 10 Virus resistant plants

Unit – III: Animal Biotechnology

- 1 Development, maintenance and growth of animal cell lines

- 2 Cloning of mammalian species (Dolly)
- 3 Production of viral vaccines
- 4 Production high value therapeutics, interferon
- 5 Plasminogen activator, urokinase
- 6 Monoclonal antibodies, chimeric antibodies
- 7 Immunotoxins as therapeutic agents
- 8 Gene knockouts and transgenic animals
- 9 Human gene therapy
- 10 "Humanized" animals as organ farms

Unit – IV: Protein Engineering

- 1 Methods and applications of immobilized cells
- 2 Methods and applications of immobilized enzymes
- 3 Large-scale and site-directed mutagenesis,
- 4 Natural and recombinant fusion proteins, tags for protein purification
- 5 Altering kinetic properties and pH dependence of enzymes
- 6 Increasing stability, enhancing specific activity of enzymes
- 7 Directed enzyme evolution
- 8 PEGylated interferon
- 9 Macro-modifications
- 10 Methods of drug design and delivery

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

Semester IV: Practicals

(Note: Each topic corresponds one practical session)

Paper-V: BI 405P: Bioinformatics, Biostatistics and Biotechnology

- 1 OMIM database and human genetic disorders
- 2 Retrieve DNA, protein sequence from database (NCBI)
3. Retrieve protein structure from database (PDB)
4. KEGG database for pathways
5. Local, Global alignment of DNA, protein
6. Multiple sequence alignments
7. Descriptive statistics (mean, median, mode, range, variance, standard deviation)
8. Correlation and regression
9. Binomial, Poisson and Normal distribution
10. Z , T ,F and Chi-square tests
11. Polymerase chain reaction
12. Isolation of plasmid DNA
13. Production of alcohol by *saccharomyces cerevisiaceae*
14. Production of any microbial enzyme

15. Culturing of plant animal cell or tissue
16. Immobilization of cells

References:

1. Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH
2. Biostatistics by con and conum
3. Biostatistics –Arora & Malhan, Himalaya Publishing House
4. Methods In Biotechnology, edited by Hans-Peter Schmauder. Taylor & Francis

Paper-VI: BI 406P: Project

Department of Biochemistry, UCS&I, MGU, Nalgonda
Semester – III, Interdisciplinary paper-I (C.B.C.S)
w.e.f 2015-16 admitted Batch

Subject: Chemistry of Biomolecules and Methods of Study

Unit-I: Chemistry of Biomolecules and Metabolism

Introduction of Biochemistry and evolution (outline only). Water properties, interactions, pH scale, buffers. Biomolecules (amino acids, proteins, polysaccharides, lipids and nucleic acids) classification, chemical nature, structure and functions. Peptide bond. Outlines of metabolism of proteins, polysaccharides, lipids and nucleic acids.

Unit-II: Biocatalysis and Bioenergetics

Introduction to enzymes. Nomenclature and classification of enzymes, Difference between chemical and biological catalysis. Specific activity, Metal and cofactor requirements, Factors effecting rate of reaction: pH, Temperature, Pressure, Michaelis Menten Kinetics, Types of enzyme inhibitors, Allosteric proteins and cooperativity. Laws of thermodynamics, Gibbs free energy, Entropy, Enthalpy. High energy compounds, ETC in mitochondria, Bioluminescence

Unit-III: Instrumental Methods-I

Beer Lamberts Law, Molar extinction coefficient, Colorimetry-Principle, instrumentation, application, UV-Vis spectroscopy -principle, instrumentation, application, NMR, ESR-principle, instrumentation, application, Mass spectrometry -Principle, instrumentation, application. Fluorescence spectroscopy -principle, instrumentation, application, X-Ray crystallography.

Unit-IV: Instrumental Methods-II

Partitioning and counter current distribution, PC- principle, instrumentation, application, TLC-principle, instrumentation, application, Affinity chromatography-principle, instrumentation, application, Gel filtration (gel exclusion chromatography)-principle, instrumentation, application, Ion exchange chromatography-principle, instrumentation, application, GC- principle, instrumentation, application, HPLC-principle, instrumentation, application.

Department of Biochemistry, UCS&I, MGU, Nalgonda
Semester – IV, Interdisciplinary paper-II (C.B.C.S)
w.e.f 2015-16 admitted Batch

Subject: Clinical Biochemistry, Nutrition and Immunology

Unit-I: Clinical Biochemistry

Clinical importance of Enzymes and isoenzymes
Normal values for different blood tests and clinical implications
Clinical diagnosis of human diseases: anaemia, thalassemia
hyper cholesterolemia, atherosclerosis, diabetes, Pregnancy test.
Liver function tests: conjugated and total bilirubin in serum, albumin: globulin ratio,
Liver diseases: jaundice, hepatitis.

Unit-II: Nutrition

Biological buffers. Acid base balance
Balanced diet, Calorific values of foods and their determination by bomb calorimeter.
Specific dynamic action of foods, BMR, RDA for infants, children, adults and expectant /
nursing mothers, Malnutrition (PEM, Marasmus, Kwashiorkor), Eating disorders; Anorexia
and bulimia; Obesity and Starvation.

Unit-III: Immunology-I

History of immunology, Classification, structure, and biological properties of
immunoglobulins, Isotypes, allotype, idiotypes.
Natural & acquired immunity, Specific & non-specific immune response. Cells & organs of
immune system, Antigenic determinants, Epitopes, Haptens, Properties of strong antigens,
Adjuvants – types, mode of action and applications.

Unit-IV: Immunology-II

Humoral & cell-mediated immune response
Activation of T cells & B cells. MHC proteins structure & functions
Antigen processing & presentation, Hypersensitivity, Auto immune diseases; classification
Production of monoclonal antibodies
Immunoprecipitation methods - gel diffusion (Ouchterlony; Mancini);
Immune-electrophoresis (Rocket), Agglutination tests, ELISA, RIA, Western Blots;