DEPARTMENT OF BIOCHEMISTRY AND BIOTECHNOLOGY
M.Sc. BIOCHEMISTRY
Choice Based Credit System (CBCS)– 2 year Programme (2014 – 2015)
Revised Scheme of Examinations and Syllabus

Subject Code	Theory & Practical	Credit			Internal Assessment Marks	End Semester Examination Marks	Total Marks
		L	P	C			
SEMESTER-I							
BIO C 101	Biomolecules	5	-	5	25	75	100
BIO C 102	Genetics and Cell Biology	4	-	4	25	75	100
BIO C 103	Physiology	4	-	4	25	75	100
BIO P 104	Practical – I	-	10	3	40	60	100
Total Credits: 16							
SEMESTER-II							
BIO C 201	Enzymes	4	-	4	25	75	100
BIO C 202	Metabolism and Regulation	5	-	5	25	75	100
BIO C 203	Molecular Endocrinology and Signaling	4	-	4	25	75	100
BIO C 204	Molecular Biology	5	-	5	25	75	100
BIO P 205	Practical – II	-	10	3	40	60	100
STA O 215	Optional I	4	-	4	25	75	100
Total Credits: 25							
SEMESTER –III							
BIO C 301	Analytical Techniques	4	-	4	25	75	100
BIO C 302	Immunology	4	-	4	25	75	100
BIO C 303	Biotechnology	4	-	4	25	75	100
BIO P 304	Practical III	-	6	2	40	60	100
BIO P 305	Practical IV	-	6	2	40	60	100
CHE O 315	Optional II	4	-	4	25	75	100
MBO O 315	Optional III	4	-	4	25	75	100
ENG C 316	Soft Skills	4	-	4	25	75	100
Total Credits: 28							
SEMESTER IV							
BIO C 401	Clinical Biochemistry	5	-	5	25	75	100
BIO C 402	Genomics, Proteomics and Bioinformatics	4	-	4	25	75	100
BIO P 403	Practical V	-	10	3	40	60	100
PHARM O 415	Optional IV	4	-	4	25	75	100
BIOPJ 404	Project	-	-	5	25	75	100
Total Credits: 21							

Distribution of Credits

Core Courses and Project**: 70 credits**
Soft Skills and Optionals**: 20 credits**

Total: 90 credits

M.Sc. BIOCHEMISTRY (CBCS)

BIO C 101: BIOMOLECULES

Objective: To understand the structure and functions of biomolecules.

Unit-I Proteins I

Amino acids- structure and properties. The peptide bond: The Ramachandran plot.Orders of protein structure. Primary structure- Determination of amino acid sequence of proteins.

Secondary structures- α-helix, β-sheet and β-turns. Pauling and Corey model for fibrous proteins. Collagen triple helix.

Supersecondary structure- helix-loop-helix, hairpin β motif, Greek key motif and β-α-β motif. Structural classification of proteins based on protein motifs.

Unit-II Proteins II

Tertiary structure- All α, all β, α/β, $\alpha+\beta$ domains. Structural motifs- protein family and superfamily. Quaternary structure– protomers, multimers– rotational and helical symmetry.

The structure of haemoglobin. Binding of oxygen to haemoglobin, Hill equation, Bohr effect, changes in conformation on O_2 binding. Role of 2, 3-BPG. Models for haemoglobin allostery. Methods for characterization and purification of proteins. Criteria for purity of proteins.

Unit–III Nucleic Acids

DNA double helical structure - Watson and Crick model. A, B and Z forms of DNA. Unusual structures– palindrome, inverted repeats, cruciform and hairpins. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA: buoyant density, viscosity, UV absorption, hypochromic effect, denaturation and renaturation, the cot curve. Differences between DNA and RNA.Major classes of RNA- mRNA, rRNA, tRNA: structure and biological functions. Minor classes of RNA [snRNA, miRNA and siRNA].

Nucleic acid-binding proteins - DNA and RNA binding motifs in proteins. HTH, HLH, zinc finger motif, leucine zipper motif.

Unit–IV Glycosaminoglycans and Glycoconjugates

Glycosaminoglycans- structure, location and biological role of hyaluronic acid, chondroitin sulphate, keratin sulfate, heparin sulfate, dermatan sulfate and heparin. Sialic acid- structure and significance. Proteoglycans.

Glycoproteins and their biological importance. Principal sugars in human glycoproteins. Lectins- structure, function, applications. Lectin-carbohydrate interaction. Major classes of glycoproteins-O-linked, N-linked, GPI linked oligosaccharides. Blood group antigens and bacterial cell wall polysaccharides.

Unit–V Lipids

Fatty acids-saturated, unsaturated and hydroxy fatty acids. Eicosanoids-structure and biological actions of prostaglandins, prostacyclins, thromboxanes, leukotrienes and lipoxins. Phospholipids and glycosphingolipids- structure and biological functions. Steroids- plant and animal sterols. Structure, properties and functions of cholesterol.

Lipoproteins-classification and composition. Amphipathic lipids (membranes, micelles, emulsions and liposomes). Lipid and protein composition of biomembranes.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Voet and Voet. Fundamentals of Biochemistry. 3rd ed. Wiley. 2010.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
4. Berg, Tymoczko. Stryer Biochemistry 7th ed. Freeman 2010.

Reference Books

Blackburn et al. Nucleic acids in Chemistry and Biology. Royal Soc Chem 2006.

BIO C 102: GENETICS AND CELL BIOLOGY

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

Unit-I Genetics

Definitions of some common terms in genetics- phenotype, genotype, heterozygous, homozygous, allele (dominant, recessive, wild-type, mutant), character, gene, gene locus, pure line, hybrid. Mendel's laws. Monohybrid cross, multiple alleles, dihybrid cross, test cross, backcross, epistasis.

Chromosome structure. Polytene and lampbrush chromosomes. Types of chromosomes on the basis of centromere position. Karyotyping. Variation in chromosome number (euploidy, aneuploidy), arrangement (translocation, inversion), number of segments (deletion, duplication). Population genetics-The Hardy-Weinberg law (basic concept).

Unit – II Cell and Tissue organization

Molecular organization of prokaryotic and eukaryotic cells. Structure and functions of subcellular organelles. The cytoskeleton-microtubules, microfilaments and intermediate filaments. Types of tissues. Epithelium- organization and types. The basement membrane. Connective tissue.

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

Unit – III Membrane composition and transport

Composition of membranes- the lipid bilayer, peripheral and integral proteins. The fluid mosaic model. Brief account of membrane rafts. Endocytosis and exocytosis.

Membrane transport: types. Diffusion- passive and facilitated. General classes of transport systems- uniport, symport, antiport. Active transport- primary and secondary. The P-type ATPases (Na^+K^+-ATPase), F-type ATPases (ATP synthases), ABC transporters, ionophores, aquaporins, ion channels (ligand-gated and voltage-gated).

Unit– IV Cell division, cell differentiation, cell cycle, and cell death

Molecular events in mitosis and meiosis. Brief account of cell differentiation. Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues.

The cell cycle: phases, regulation by cyclins and cyclin-dependent kinases. Checkpoints.

Cell death- types. Necrosis- causes and mechanism. Apoptosis: morphology, mitochondrial and death receptor pathways. Differences between apoptosis and necrosis.

Unit–V Cell Culture Techniques

Cell and tissue culture- merits and demerits, aseptic techniques, substrates, culture media, freeze storing, transport, contamination. Growth and development of plant cells and tissues *in vitro*. Callus, suspension, and protoplast culture. Somatic hybridization. Applications of plant cell and tissue culture in breeding and industry.

Animal cell culture: Primary cell culture: disaggregation, separation of viable cells. Secondary culture-maintenance of cell lines. Cancer cell lines. Large-scale cell cultures. Tissue culture: slide, flask, and test tube. Commercial applications of animal tissue culture.

Text Books

1. Elrod S. Schaum's Outline of Genetics. 5th ed. McGraw Hill. 2010.
2. Fletcher et al. Instant Notes in Genetics. 4th ed. BIOS. 2012.
3. Karp. Cell & Molecular Biology 7th ed 2013. Wiley.
4. Lodish et al Molecular Cell Biology 7th ed. Freeman, 2012.
5. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
6. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
7. Martin BM. Tissue Culture Techniques- An Introduction. 1994. Birkhauser.

Reference Books

1. De Robertis and De Robertis. Cell and Molecular Biology. Lippincott Williams and Williams 8th edition 2001.
2. Alberts *et al*. Molecular Biology of the cell 5th ed. Garland Sci. 2007.
3. Freshney RI. Culture of animal cells: A manual of basic technique. 6th ed. Wiley - Liss, 2010.
4. Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.
5. Abouelmagd and Ageeley. Basic Genetics. 2nd ed. Univ Publ. 2013.

BIO C 103: PHYSIOLOGY

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

Unit–I Neuromuscular system

Structure of neuron. Propagation of action potential. Neurotransmitters-examples, release and cycling of neurotransmitters. The neuromuscular junction. The acetylcholine receptor.

Structure of skeletal muscle. Muscle proteins- myosin, actin, troponin and tropomyosin and other proteins. Sequence of events in contraction and relaxation of skeletal muscle. Brief account on cardiac and smooth muscle.

Unit–II Digestive and Excretory System

Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.

Structure of nephron. Formation of urine- glomerular filtration, tubular reabsorption of glucose, water and electrolytes. Tubular secretion. Normal and abnormal constituents of urine.

Unit–III Blood, Lymph and CSF

Composition and functions of blood. Plasma proteins in health and disease. Red blood cells- formation and destruction. Composition and functions of WBCs. Blood coagulation-mechanism. Fibrinolysis. Anticoagulants. Transport of blood gases: oxygen and carbon dioxide. Role of 2,3 BPG.Lymph- composition and functions. CSF-composition and clinical significance.

Unit–IV Hydrogen ion and fluid electrolyte homeostasis

Hydrogen ion homeostasis: Factors regulating blood pH- buffers, respiratory and renal regulation. Acid-base balance-causes, biochemical findings and management of metabolic and respiratoryacidosis and alkalosis.

Unit–V Water, sodium and potassium homeostasis

Distribution of water and electrolytes in the ECF and ICF. Water balance- role of ADH. Sodium balance- the renin-angiotensin-aldosterone system. Potassium balance. Hypo- and hypernatremia. Hypo and hyperkalemia.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Lodish et al Molecular Cell Biology 7th ed. Freeman, 2012.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
4. Smith *et* al. Principles of Biochemistry. Mammalian Biochemistry. McGraw Hill 7th ed.

Reference Books

1. Barrett et al. Ganong's Review of Medical Physiology. 24th ed. Lange 2012.
2. Graaf & Rees. Schaum's Easy Outline of Human Anatomy & Physiology.2nd ed.2010.

BIOP 104: PRACTICAL – I

BIOMOLECULES, GENETICS, CELL BIOLOGY AND PHYSIOLOGY

1. Estimation of glucose by anthrone method.
2. Qualitative analysis of amino acids
3. Estimation of protein by Lowry *et al* method.
4. Estimation of DNA by diphenylamine method.
5. Estimation of RNA by orcinol method
6. Thermal denaturation of DNA.
7. Enumeration of RBCs, WBCs (Total & differential)
8. Estimation of bleeding time and clotting time.
9. Blood hemoglobin.
10. Microscopic examination of epithelial cells, plant cells.
11. Tissue culture techniques: Surface sterilisation techniques, media preparation and storage, serum inactivation.
12. Staining of cell cultures and observations under microscope.
13. Cell count, protein estimation, mitotic index.
14. Distinguishing mutant phenotypes of *Drosophilamelanogaster* - eye color mutant (white), eyesurface/shape mutant (glazed), wing shape (curly) and body shape (tubby).
15. Preparation of polytene chromosomes from *Drosophila* larvae.

BIO C 201: ENZYMES

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

Unit–I

Enzymes- general characteristics, classification and IUB nomenclature, methods of enzyme isolation and purification. Methods of enzyme assay, Enzyme units, specific activities and turnover number. Active site- investigation of active site structure. A brief account of non-protein enzymes- ribozymes, DNA enzymes and extremozymes.

Unit–II

Enzyme kinetics– pre steady state and steady state kinetics.Fast kinetics to elucidate the intermediates and rate limiting steps (flow and relaxation methods) effect of pH, temperature, enzyme and substrate concentration. Michaelis-Menten plot, linear transformation Lineweaver-Burk plot. Eadie-Hofstee plot, and Hanes-Woolf equation. Significance of K_m and V_{max}.

Kinetics of allosteric enzymes, positive and negative cooperativity MWC and KNF models. Hill's equation and co-efficient. K and V series enzymes. Sequential and non sequential bisubstrate reactions.

Unit–III

Enzyme inhibition- irrerversible and reversible, competitive, non competitive, uncompetitive, mixed inhibition (derivation not required). Kinetic differentiation and graphical methods. Clinical uses of competitive inhibition using methotrexate, methanol and insecticide poisoning.

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

Unit–IV

Coenzymes- coenzymic role of NAD, FAD, CoQ, biotin, cobalamine, thiamine pyrophosphate, pyridoxal phosphate and folic acid. Multienzyme complexes. Metal-dependent and metalloenzymes.

Enzyme regulation: General mechanism of enzyme regulation, feedback inhibition and feedforward stimulation. Enzyme repression, induction and degradation, control of enzymic activity by

products and substrates. Zymogens. Covalent modification of enzymes. Compartmentation.

Unit–V

Immobilized enzymes- methods of immobilization, applications. Enzyme Engineering with reference to T4 lysozyme- Abzymes- Enzyme electrode.

Industrial and Clinical Enzymology: Enzymes of industrial and clinical significance, sources and applications of amylases, protease and lipases. Therapeutic use of asparginase. Streptokinase. Enzymes and isoenzymes of diagnostic importance. LD, CK, transaminases, phosphatases, amylase and cholinesterase. Enzyme patterns in diseases- liver disease and myocardial infarction.

Text Books

1. Palmer T. Understanding enzymes. Prentice Hall. 2004.
2. Buchholz et al Biocatalysts and Enzyme Technology. 2nd ed Wiley-Blackwell. 2012.
3. Pandey et al. Enzyme Technology. 2010, Springer.
4. Nelson, Cox. Lehninger Biochemistry. 6th ed. Freeman 2012.
5. Balasubramanian et al. Concepts in Biotechnology. Univ Press 2004.

Reference Books

Dixon and Webb. Enzymes 3rd ed. Longmans 1979.

BIO C 202: METABOLISM AND REGULATION

Objective: The objective of this course is to understand metabolic pathways, their interrelationship and the mechanisms of regulation.

Unit–I Bioenergetics and Biological Oxidation

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

Oxidative phosphorylation- electron transfer reactions in mitochondria. F_1F_0 ATPase- structure and mechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and oxidative phosphorylation- poisons, uncouplers and ionophores. Regulation of oxidative phosphorylation.Mitochondrial transport systems- ATP/ADP exchange, malate/ glycerophosphate shuttle, creatine-phosphate shuttle.

Unit–II Carbohydrate metabolism

Overview of glycolysis and gluconeogenesis- Regulation. The citric acid cycle and regulation. The pentose phosphate pathway and uronic acid pathway. Significance. Metabolism of glycogen and regulation. Glycogen storage diseases. Galactosemia. Fructose intolerance and fructosuria. The glyoxylate cycle. Cori cycle.

Photosynthesis- photosynthetic apparatus, light reaction, cyclic and noncyclic photophosphorylation. Dark reaction- Calvin cycle, Hatch-Slack pathway. Photorespiration. Starch biosynthesis and degradation. Bioluminescence.

Unit–III Lipid metabolism

Oxidation of fatty acids- role of carnitine in fatty acid transport, α, β and ω-oxidation. Metabolism of ketone bodies. Biosynthesis of fatty acids– Fatty acid synthase complex– regulation of lipogenesis. Metabolism of triglycerides, phospholipids and sphingolipids. Cholesterol- biosynthesis, regulation, transport and excretion. Metabolism of lipoproteins and lipoproteinemias. Metabolism of prostaglandins– COX and LOX pathways. Lipid storage diseases and fatty liver.

Unit–IV Amino acid, purine and pyrimidine metabolism

Biosynthesis of 20 amino acids found in proteins (overview only). Catabolism of amino acid nitrogen- transamination, deamination, ammonia formation and the urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to special products. Disorders of amino acid metabolism- phenylketonuria, alkaptonuria, albinism, and maple syrup urine disease.

Metabolism of purines- de novo and salvage pathways for biosynthesis. Purine catabolism. Biosynthesis and catabolism of pyrimidines. Regulation of purine and pyrimidine metabolism. Hyperuricemia and gout. Hypouricemia. Orotic aciduria.

Unit–V Porphyrins, minerals and metabolic integration

Biosynthesis and degradation of porphyrins and heme. Porphyrias. Minerals- sources, daily allowance, absorption, metabolism, biological roles and clinical significance of calcium, phosphate and magnesium trace elements- metabolism of iron- absorption, storage, transport and excretion. Iron deficiency and overload. Copper, zinc, selenium, cobalt, manganese and fluoride.

Integration of metabolism– interconversion of major food stuffs. Metabolic profile of the liver, adipose tissue and brain. Altered metabolism in starvation.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Voet and Voet. Fundamentals of Biochemistry. 3rd ed. Wiley. 2010.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
4. Berg, Tymoczko. Stryer Biochemistry 7th ed. Freeman 2010.
5. Kuchel et al. Schaum's Outline of Biochemistry. Mc Graw Hill. 3rd ed. 2011.

BIO C 203: MOLECULAR ENDOCRINOLOGY AND SIGNALING

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

Unit–I Hypothalamic and Pituitary hormones

Classification of hormones and mechanism of action. Hypothalamic and pituitary hormones. Hypothalamic releasing factors. Anterior pituitary hormones: biological actions, regulation and disorders of growth hormone, ACTH, gonadotropins and prolactin. Leptin.

Posterior pituitary hormones- biological actions of vasopressin. Diabetes insipidus and syndrome of inappropriate ADH secretion (SIADH) Oxytocin. Hypopituitarism.

Unit–II Thyroid and Parathyroid hormones

Thyroid hormones- synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid function tests. Hyper and hypothyroidism. Hormonal regulation of calcium and phosphate metabolism. Secretion and biological actions of PTH, calcitonin and calcitriol. Hypercalcemia and hypocalcemia Rickets and osteomalacia.

Unit–III Adrenal hormones

Adrenal cortical hormones. Synthesis, regulation, transport, metabolism and biological effects. Hypo and hyper function - Cushing's syndrome, aldosteronism, CAH, aderenal cortical insufficiency, Addison's disease.

Adrenal medullary hormones- synthesis, secretion, metabolism, regulation and biological effects of catecholamines. Phaeochromocytoma.

Unit–IV Gonadal, Gastrointestinal and Pancreatic hormones

Gonadal hormones: Biosynthesis, regulation, transport, metabolism and biological actions of androgens. Hypogonadism and gynecomastia. Biosynthesis, regulation, transport, metabolism and biological effects of oestrogen and progesterone. The menstrual cycle. Pancreatic hormones- synthesis, regulation, biological effects and mechanism of action of glucagon, somatostatin and insulin. Insulin receptor. Brief account of gastrointestinal hormones.

Unit–V Signal transduction

Cell signaling– Modes of cell-cell signaling– endocrine, paracrine, autocrine.Steroid hormones and nuclear receptor superfamily.Peptide hormones and growth factors. Nitric oxide. Functions of cell surface receptors– GPCR, receptor protein/tyrosine kinase, cytokine receptors and non receptor protein–tyrosine kinase, receptor linked to protein tyrosine phosphatase, ser/thr kinases guanyl cyclase.

Signal transduction- cAMP pathway, cGMP, phospholipids and calcium, MAP kinase pathway, PI3K-Akt and JAK/STAT pathway.

Text Books

1. Williams Text Book of Endocrinology, S. Melmed et al., 12th edition, Saunders (2011)
2. Murray et al. Harper's Illustrated Biochemistry. 29th ed. McGraw Hill, 2012.
3. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
4. Clinical Chemistry in diagnosis and treatment Mayne ELBS. (1999)
5. Clinical Chemistry 6th edition W. J. Marshall, M. Lapsley, S. K. Bangert 6th editionMosby. (2008).

BIO C 204: MOLECULAR BIOLOGY

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

Unit–I Chromatin and Genome

Molecular structure of the bacterial nucleoid- The *E.coli* chromosome and DNA-binding proteins. Plasmids- classification and properties.The eukaryotic chromatin- nucleosomes, 30 nm fiber and chromatin loops. Organization of chromatin structure.Genome complexity- genome size, C-value paradox,coding and non coding DNA,typical structure of protein-coding genes in prokaryotes and eukaryotes.Introns and exons and repetitive DNA (SINES, LINES,

simple sequence repeats- satellite, minisatellite and microsatellite). Organelle genomes- mitochondria and chloroplast.

Unit–II Replication, Repair and Recombination

Enzymes and proteins involved in replication in prokaryotes and eukaryotes (helicases, SSB, topoisomerases, DNA polymerases and DNA ligase).Mechanism of DNA replication in virus (T4 DNA), bacteria and eukaryotes.Telomeres, telomerase and end replication. Regulation of replication. Inhibitors of replication.

Mechanisms of DNA repair- excision repair, mismatch repair, SOS response, double-strand break repair and recombination repair.Molecular mechanism of homologous and site specific recombination. Transposons and mechanism of transposition (elementary details).

Unit–III Prokaryotic Transcription and Regulation

E. coli RNA polymerase subunit structure. The promoter sequence in *E. coli*.Initiation, elongation and termination. Rho-dependent and rho-independent termination. Inhibitors of transcription. Post-transcriptional processing of rRNA and tRNA.Regulation of transcription in prokaryotes- the lac operon and trp operon.Antitermination.

Unit–IV Eukaryotic Transcription and Regulation

Eukaryotic RNA polymerases– structure. RNA pol I, II and III– promoters, transcription factors, transcription complex assembly and mechanism of transcription. Post-transcriptional processing of mRNA, rRNA and tRNA. Catalytic RNA (ribozymes). RNA editing. Transcriptional regulation in eukaryotes–steroid hormone receptors and phosphorylation. Alternative splicing. Antisense RNA. MicroRNAs and RNA interference. Epigenetic regulation: DNA methylation and histone acetylation.

Unit–V Protein biosynthesis and sorting

The genetic code- general features, Mitochondrial genetic code. Mutations– point mutations and frameshift mutations. Suppressor mutations– nonsense and missense suppression.

Mechanism of protein synthesis in bacteria, and eukaryotes- amino acid activation, initiation, elongation and termination. Regulation of protein synthesis. Inhibition of protein synthesis. Co- and post-translational modifications. Protein targeting to membranes, nucleus and Mitochondria and lysosome.The signal sequence hypothesis. Protein degradation-the ubiquitin pathway. Protein folding- (elementary details).

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2012.
3. Alberts et al Molecular biology of the cell. 5th ed. Garland Sci. 2007.
4. Watson. Molecular Biology of the Gene. 7th ed. Pearson Education, 2013.

Reference Books

1. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.
2. Twyman. Advanced Molecular Biology. BIOS Sci Publ. 2000

BIO P 205: PRACTICAL–II

ENZYMES, ENDOCRINOLOGY, AND MOLECULAR BIOLOGY

1. Activity, specific activity, effect of pH, temperature and substrate concentration, Km value of any one enzyme.
2. Estimation of activity of the following serum enzymes: Transaminases, ALP
3. Enzyme immobilization using alginate beads.
4. Hormone assay.
5. Extraction of genomic DNA, electrophoresis in agarose gel, determination of molecular weight.
6. Isolation of RNA from yeast.
7. Plasmid preparation, characterization by electrophoresis.
8. Bacterial conjugation
9. Transformation.

BIO C 301: ANALYTICAL TECHNIQUES

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

Unit–I Spectroscopy

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible, FT-IR spectroscopy and spectrofluorimetry. Principle, instrumentation and applications of luminometry. Atomic spectroscopy. Flame and flameless spectrophotometry.

Basic principles of NMR, ESR and mass spectrometry and their biological applications. X-ray diffraction, ORD and CD-elementary details.

Unit–II Radioisotope techniques and Microscopy

Nature and units of radioactivity. Stable and radioisotopes. Detection and measurement of radioactivity- Geiger-Muller counter, solid and liquid scintillation counting, quenching and quench correction, scintillation cocktails and sample preparation Cerenkov counting. Autoradiography. Applications of radioisotopes in biology-Radiation hazards.

Microscopy– Basic principles and components of light, bright field, phase contrast and fluorescence microscopy. Electron microscopy– principle, preparation of specimens for TEM and SEM. Microtomy. Fixation and staining.

Unit–III Electrophoresis and blotting techniques

Electrophoresis: General principles, support media. Electrophoresis of proteins- SDS-PAGE, native gels, gradient gel, isoelectric focusing, 2-D PAGE. Cellulose acetate electrophoresis. Detection, estimation and recovery of proteins in gels. Electrophoresis of nucleic acids - agarose gel electrophoresis, PAGE, pulsed-field gel electrophoresis. Blotting techniques: Southern, Northern and Western blotting techniques. DNA fingerprinting and foot printing.

Unit–IV Chromatography

Principle, instrumentation and applications of thin layer, gas, ion-exchange chromatography. Chromato-focusing. Molecular exclusion and affinity chromatography- principle, gel preparation, operation and application.

HPLC-principle, instrumentation and applications. Capillary electro-chromatography. HPTLC– principle and application.

Unit–V Centrifugation & Tissue fractionation

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuge: analytical and preparative ultracentrifuge- instrumentation and applications. Molecular weight determination by centrifugation. Subcellular fractionation by differential centrifugation. Density-gradient centrifugation- rate zonal and isopycnic. Cell disruption, homogenization and extraction of membrane bound proteins-cell disruption methods– organ and tissue slice techniques.

Text Books

1. Wilson and Walker. Principles and techniques of Biochemistry and Molecular Biology. 7th ed. Cambridge University Press 2012.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ. 2010.
3. Boyer, R.Modern Experimental Biochemistry.3rd ed.Addison Weslery Longman, 2000.

Reference Books

1. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 4th ed 2012.
2. Friefelder and Friefelder. Physical Biochemistry - Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1994.
3. Pavia Intro to spectroscopy 2009
4. Boyer 3rd ed 2000 Prentice Hall.

BIO C 302: IMMUNOLOGY

Objective*:* To acquire comprehensive knowledge of immunology and immunochemical techniques

Unit–I

Central and peripheral lymphoid organs. Bone marrow, thymus. Lymph node, spleen and mucosal associated lymphoid tissue. Cells of the lymphoreticular system. T-Cells, B-Cells, mononuclear phagocytes, dendritic cells, granulocytes, NK cells, mast cells. Antigens definition antigenicity, antigenic determinants, haptens and epitopes. Antibodies- structure, classification, functions, Isotypes, allotypes and idiotypes.Complement system- components, nomenclature, activation of complement, classical pathway and alternate pathway. Biological functions of complement.

Unit–II

Types of immunity- innate and acquired immunity, antitoxic, antibacterial and antiviral immunity. Immune response- primary and secondary- Humoral and cell mediated immunity. Antigen

recognition- T-cell and B-cell receptor complexes, antigen processing and presentation. Interaction of T and B-cells, cytokines. Immunological memory, Effector mechanisms: phagocytosis, cell mediated cytotoxicity, antibody dependent CMC. Immunotolerance.

Vaccines-killed, attenuated organisms, toxoids, recombinant vaccines, subunit vaccines, DNA vaccines, synthetic peptide vaccines, antiidiotypic vaccines. Immunization practices.

Unit–III

Immunochemical techniques- production of antibodies- polyclonal and monoclonal antibodies. Applications of Mab. Immunodiffusion techniques, Immunoprecipitation, RIA, ELISA, fluorescence immune-assay, avidin-biotin mediated assay, immunohisto-chemistry, immunoelectrophoresis, immunoblotting. Complement fixation test. Flow cytometry.

Unit–IV

Antibody diversity- mechanisms contributing to diversity- somatic recombination, rearrangement and generation of antibody diversity. Class switching. MHC complex- gene organisation- HLA genes class I and II antigens. Structure and function histocompatibility testing - lymphocytotoxicity test- cross matching. MHC & disease association.Transplantation-types-Graft versus host reactions. Immunosuppressive agents.

Unit–V

Hypersensitivity - definition and classification - type I to type V (brief account only). Autoimmunity and autoimmune disease - SLE and RA only. Immunodeficiency disorders– primary and secondary immunodeficiency diseases - pathogenesis, diagnosis and treatment of AIDS. Mabs, growth factors and interferons as therapeutic agents. Tumor immunology– immune surveillance, tumor antigens, Tumor viruses, immune response to tumors, cancer immunotherapy.

Text Books

1. Goldsby *et al*. Kuby Immunology. WH Freeman & Co. 7th ed 2013.
2. Abbas *et al*. Cellular and Molecular Immunology. Elsevier 2011.
3. Janeway, C. (Ed), Travers. Immunobiology 8th ed. Garland Publ. 2011.
4. Coico and Sunshine. Immunology: A short course. 6th ed. Wiley-Liss, 2009.

Reference Books

Roitt et al. Roitt's Essential Immunology. 12th ed Wiley-Blackwell Sci. 2011.

BIO C 303: BIOTECHNOLOGY

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

Unit–I

Bioprocess engineering: Isolation and screening of industrially important microbes. Maintenance and improvement of strains. Bioreactors-types, design, parts and their function. Media for industrial fermentation, air and media sterilization. Antifoaming devices. Types of fermentation processes: Analysis of batch, fed-batch and continuous bioreactions, analysis of mixed microbial population, specialized bioreactors (pulsed, fluidized, photobioreactors).

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

Unit–II

Industrial production of ethanol, lactic acid, butanol, penicillin and phenylalanine. Commercial production of fructose. Wastewater treatment-physical, chemical and biological treatment processes. Effluent treatment. Bioremediation, oil spill clean up. Microbial mining. Biofertilizers-bacteria and blue green algae. Biopesticides in integrated pest management-*Bacillus* and *Pseudomonas* as biocontrol agents.

Single cell protein-microorganisms and steps in SCP production, biomass recovery, nutritional and safety evaluation, advantages. Soil microbiota. Bio-geochemical role of soil microorganisms. Microbial degradation of xenobiotics in the environment.

Unit–III

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

Gene transfer methods-calcium phosphate coprecipitation, electroporation, lipofection, viral vectors, microinjection. Host organisms for cloning. Recombinant screening-marker inactivation (antibiotic resistance and blue-white selection), colony hybridization, immunological screening and *in vitro* translation.

Unit–IV

Cloning strategies: Construction of genomic and cDNA libraries. Difference between genomic and cDNA libraries. Cloning of insulin gene. Expression vectors- baculovirus and mammalian expression systems (brief outline).

Transgenic plant technology: Development of insect resistance, virus resistance, herbicide resistance and stress tolerant plants. Delayed fruit ripening. Terminator technology. Production of vaccines and antibodies in plants. Ethics of genetically engineered crops. Transgenic animal technology: Methods of producing transgenic animals (retroviral, microinjection, engineered stem cell). Application of transgenic animals. Transgenic animals as models of human disease.

Unit–V

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

Text books

1. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.
2. Gupta PK. Elements of Biotechnology, Rastogi Publication, 2005.
3. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience. 2011.
4. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
5. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
6. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.

References

1. Winnacker EL. From Genes to clones. 4th ed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
3. Primrose, Twyman and Old. Principles of gene manipulation. 7th ed. Wiley-Blackwell. 2006.

BIO P 304: PRACTICAL– III
MICROBIOLOGY AND IMMUNOLOGY

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

BIO P 305: PRACTICAL – IV
ANALYTICAL TECHNIQUES AND BIOTECHNOLOGY

1. UV-Absorption spectrum of proteins and nucleic acids.
2. Separation of lipids by TLC
3. Separation of plant pigments by adsorption chromatography.
4. Separation of proteins by SDS-PAGE and Western blotting.
5. HPLC - Demonstration.
6. Subcellular fractionation - isolation and analysis of nuclear and mitochondrial fractions.
7. Restriction enzyme digestion of DNA.
8. Phage titration.
9. PCR and analysis of PCR products.
10. Real-time qPCR - Demonstration.
11. Determination of D.O. concentration of water sample.
12. Determination B.O.D. of sewage sample.
13. Determination C.O.D. of sewage sample.

BIO C 401:CLINICAL BIOCHEMISTRY

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

Unit–I Molecular Basis of Diseases-I

Genetic diseases. Elementary details of chromosomal disorders (Down syndrome, Klinefelter's syndrome), monogenic disorders (autosomal dominant, autosomal recessive, sex-linked). Multifactorial diseases.

Role of tissues and hormones in blood glucose homeostasis. Diabetes mellitus: classification, metabolic abnormalities, diagnosis, acute complications (hypoglycemia, diabetic ketoacidosis, HONK coma) and long term (nephropathy, neuropathy, retinopathy, diabetic foot) complications, management. Atherosclerosis: risk factors, biochemical findings and management.

Unit–II Molecular Basis of Diseases-II

Cancer-Differences between benign and malignant tumours. Growth characteristics of cancer cells. Morphological and biochemical changes in tumour cells. Tumor markers- oncofetal proteins, hormones, enzymes, tumor-associated antigens. Agents causing cancer (radiation, viruses & chemicals). Multistage carcinogenesis. Mechanisms of protooncogene activation. Functions of protooncogenes and tumor suppressor genes. Role of p53.

Neuropsychiatric disorders- mutations in mitochondrial genes. Alzheimers disease- the amyloid cascade and genes involved.

Unit–III Liver and Gastrointestinal disorders

Structure and function of the liver. metabolism of bilirubin. Liver function tests: excretory, synthetic, detoxification and metabolic. Plasma enzymes in liver disease. Jaundice-retention, regurgitation, neonatal. Inherited hyperbilirubinemias. Causes, consequences, biochemical findings and management of hepatitis, cirrhosis and gallstones.

Gastric function tests. Pathogenesis, biochemical findings and management of peptic ulcer and gastritis. Pancreatic and intestinal function tests. Causes, biochemical findings and consequences of pancreatitis, cystic fibrosis and malabsorption.

Unit–IV Kidney and Nutritional disorders

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

Protein energy malnutrition- marasmus and kwashiorkor. Sources, daily requirement, deficiency manifestations of fat and water soluble vitamins. Metabolism and clinical significance of calcium, phosphorous and trace elements.

Unit–V Molecular Diagnosis and Molecular Therapeutics

Diagnostic kits. Prenatal & neonatal screening for genetic disorders. DNA diagnostic systems- hybridization probes, nonradioactive probes. RFLP and PCR in disease diagnosis. DNA profiling using VNTRs, STRs, mitochondrial DNA variants. Viral diagnostics: immunodiagnosis, molecular diagnosis. SNP-based diagnosis.

Therapeutic agents from nonrecombinant and recombinant organisms. Antivirals & antiretrovirals. Drug delivery and targeting. Gene therapy: gene delivery systems, *ex vivo* and *in vivo* strategies, gene therapy for single-gene disorders, cancer and AIDS. Antisense and siRNA therapy. Nanotherapy. Stem cell therapy.

Text Books

1. Practical Clinical Biochemistry Varley 4th and 6th editions. CBS Publishers (2006)
2. Clinical chemistry in diagnosis and treatment Mayne ELBS. (1999)
3. Clinical Chemistry W.J. Marshall, S. K. Bengert, M. Lapsley7thedition Mosby (2012)
4. Harper's Biochemistry 29th edition McGraw-Hill (2012).
5. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
6. Borem et al Understanding Biotechnology. Pearson 2011.

Reference Books

1. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics – 5thedition Saunders (2012).
2. Principles of Internal Medicine. Harrison's vol 1 & 2, 18th edition Mc Graw Hill (2011).

BIO C 402: GENOMICS, PROTEOMICS AND BIOINFORMATICS

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

Unit–I Genome mapping and sequencing

Genome mapping-rationale. Types of gene map- genetic, cytogenetic and physical. Molecular markers for mapping- RFLPs, microsatellites and SNPs. Assembling a physical map of the genome- chromosome walking and jumping. Restriction enzyme fingerprinting. STS, ESTs, radiation hybrid mapping. Genome sequencing approaches- clone contigs, whole-genome shotgun,

hierarchical shotgun. Identifying genes- sequence inspection, cDNA (EST) comparison, similarity searches.

Unit–II Genome projects, post-genome analysis

Genome projects: genome sequence data of model organisms- *E.coli, D.melanogaster*, and mouse. The human genome project: goals, mapping strategies, markers, sequencing technologies, results, potential benefits and risks, ELSI. Post-genome analysis- differential display, microarrays, SAGE and cluster analysis. ChIPs, knock-out analysis, genome-wide two-hybrid screens.

Unit–III Protein separation, identification and quantitation

Proteomics-introduction. Protein separation - general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry-basic principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem mass spectrometry, and FTICR mass (elementary details).

Unit–IV Structural & functional proteomics and applications of proteomics

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

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

Unit–V Bioinformatics

Useful search engines. File formats. PubMed. Bioinformatics workstation, Unix. Scripting languages-Perl and Python, markup languages- HTML, XML. Biological databases (primary, secondary, organism-specific, miscellaneous). Data submission and retrieval- *Entrez* and SRS.

Sequence alignment: substitution scores and gap penalties. Database similarity searching: BLAST, FASTA. Multiple sequence alignments: CLUSTAL. Gene discovery and prediction. Molecular phylogenetics: phylogenetic tree construction and analysis. Identification of orthologs and paralogs. Protein structure database- protein structure visualization, comparison and classification. Protein motifs and domain prediction.

Text Books

1. Lesk A. Introduction to Genomics. 4th ed. Oxford Univ Press. 2013.
2. Primrose. Principles of genome analysis. Wiley 2006.
3. Brown. Genomes. 2006 5th ed Wiley.
4. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience. 2011.
5. Lovrik Introducing Proteomics. Wiley-Blackwell. 2011.
6. Twyman. Principles of Proteomics. 2nd ed. 2013
7. Liebler DC. Introduction to proteomics. Humana Press. 2nd ed. 2007.
8. Hodgman et al. Instant Notes in Bioinformatics. 2nd ed. Taylor and Francis, 2009.

Reference Books

1. Gibas and Per Jambeck. Developing bioinformatics computer skills. 2nd ed. O'Reilly Associates, 2013.
2. Baxevanis, Ouellette. Bioinformatics. A practical guide to the analysis of genes and proteins. 3rd ed. Wiley Interscience, 2004.

Web sites

http: //www.ensembl.org
http://www.ncbi.nlm.nih.gov/genbank
http://www.123genomics.com
http://www.expasy.ch

BIO P 403: Practical – V
Clinical Biochemistry & Bioinformatics

A. Qualitative analysis of urine– Normal and abnormal constituents

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

C. 1. Sequence alignment and searching
   2. Phylogenetic analysis
   3. Protein sequence analysis

DEPARTMENT OF BIOCHEMISTRY AND BIOTECHNOLOGY
M.Sc. BIOTECHNOLOGY
Choice Based Credit System (CBCS)– 2 year programme (2014-2015)
Revised Scheme of Examinations and Syllabus

Subject Code	Theory & Practical	Credit			Internal Assessment Marks	End Semester Examination Marks	Total Marks
		L	P	C			
SEMESTER-I							
BIT C 101	Basic Biochemistry	4	-	4	25	75	100
BIT C102	Cell Biology and Genetics	4	-	4	25	75	100
BIT C 103	Analytical Techniques	4	-	4	25	75	100
BIT P 104	Practical I	-	9	3	40	60	100
Total Credits: 15							
SEMESTER-II							
BIT C 201	Enzyme Technology	4	-	4	25	75	100
BIT C 202	Immunology & Immunotechnology	4	-	4	25	75	100
BIT C 203	Industrial and Environmental Biotechnology	4	-	4	25	75	100
BIT C 204	Molecular Biology	4		4	25	75	100
BIT P 205	Practical II	-	6	2	40	60	100
BIT P206	Practical III	-	6	2			
MB O 215	Optional-I	4	-	4	25	75	100
Total Credits: 24							
SEMESTER –III							
BIT C 301	Genetic Engineering and Nanobiotechnology	5	-	5	25	75	100
BIT C 302	Plant Biotechnology	5	-	5	25	75	100
BIT C 303	Animal Biotechnology	5	-	5	25	75	100
BIT P 304	Practical IV	-	10	3	40	60	100
STA O 315	Optional-II	4	-	4	25	75	100
CHE O 315	Optional-III	4	-	4	25	75	100
ENG C 316	Soft Skills	4	-	4	25	75	100
Total Credits: 30							
SEMESTER IV							
BIT C 401	Genomics , Proteomics and Bioinformatics	5	-	5	25	75	100
BIT C 402	Food and Medical Biotechnology	4	-	5	25	75	100
BIT P 403	Practical V	-	10	2	40	60	100
PHARM 0415	Optional –IV	4	-	4	25	75	100
BIT PJ 404	Project	-	-	5	25	75	100
Total Credits: 21							

Distribution of Credits

Core Courses and Project	**: 70 credits**
Soft Skills and Optional	**: 20 credits**
Total	**: 90 credits**

BIT C 101: BASIC BIOCHEMISTRY

Objective: To comprehend the structure-function relationships of various biomolecules and concepts of metabolism.

Unit–I Bioenergetics and Biological Oxidation

Laws of thermodynamics. Basic concepts of free energy, entropy and enthalpy. Standard free energy change. Exergonic and endergonic reactions. Bioenergetics: high energy phosphate compounds, the ATP/ADP cycle. Synthesis, utilization and breakdown of ATP. Biological oxidation: Redox reactions and oxidoreductases. Electron transport chain: components, role in energy capture, respiratory control. Oxidative phosphorylation-Chemiosmotic theory, inhibitors, uncouplers and ionophores. Introduction to metabolism - anabolism and catabolism.

Unit–II Carbohydrates and Lipids

Classification of carbohydrates. Biologically important monosaccharides and disaccharides. Structure and biological functions of homopolysaccharides and heteropolysaccharides. Carbohydrate metabolism (structures not required)- brief outline of glycolysis, citric acid cycle, gluconeogenesis, pentose phosphate pathway, glycogen metabolism.

Classification of lipids. Fatty acids. Biological functions of eicosanoids, phospholipids, sphingolipids, and cholesterol. Lipid metabolism (structures not required): brief outline of fatty acid oxidation and lipogenesis.

Unit–III Proteins-I

Amino acids: 3-letter and 1-letter abbreviation for amino acids. Classification and general properties. Peptides: The peptide bond, Ramachandran plot. Biologically important peptides. Proteins: classification, denaturation and renaturation. Orders of protein structure: Primary structure- determination of the amino acid sequence of proteins. Secondary structure: α-helix, β-sheet and β-turns. Pauling and Corey model.

Unit–IV Proteins-II

Supersecondary structure- helix-loop-helix, hairpin α motif, β-α-β motif. Tertiary structure- α and β-domains. Quaternary structure of proteins. The structure of hemoglobin.

Protein metabolism (structures not required): Catabolism of amino acid nitrogen- transamination, deamination, ammonia formation, urea cycle, catabolism of carbon skeletons (overview only). Conversion of amino acids to specialized products.

Unit–V Nucleic acids and Nucleic acid-binding proteins

Nitrogenous bases, nucleosides and nucleotides. Biologically important nucleotides.

DNA double helical structure- Watson and Crick model. A, B, and Z forms of DNA. Triple and quadruple structures. DNA supercoiling. Properties of DNA: buoyant density, viscosity, denaturation and renaturation- the cot curve. Differences between DNA and RNA. Major classes of RNA - structure and biological functions. Minor classes of RNA.

Nucleic acid recognition by proteins. DNA binding proteins- the helix-turn-helix motif, zinc finger, leucine zipper, and helix-loop-helix.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Voet and Voet. Fundamentals of Biochemistry. 3rd ed. Wiley. 2010.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
4. Berg, Tymoczko. Stryer Biochemistry 7th ed. Freeman 2010.

Reference Books

Blackburn et al. Nucleic acids in Chemistry and Biology. Royal Soc Chem 2006.

BIT C 102: CELL BIOLOGY AND GENETICS

Objective*:* To learn in detail about the molecular organization of cells and cellular processes and the principles of genetics.

Unit–I Cell and tissue organization

Molecular organization of prokaryotic and eukaryotic cells. Structure and functions of subcellular organelles. The cytoskeleton-microtubules, microfilaments and intermediate filaments. Types of tissues. Epithelium- organization and types. The basement membrane. Connective tissue.

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

Unit – II Membrane composition and transport

Composition of membranes- the lipid bilayer, peripheral and integral proteins. The fluid mosaic model. Brief account of membrane rafts. Endocytosis and exocytosis.

Membrane transport: types. Diffusion- passive and facilitated. General classes of transport systems- uniport, symport, antiport. Active transport- primary and secondary. The P-type ATPases (Na^+K^+-ATPase), F-type ATPases (ATP synthases), ABC transporters, ionophores, aquaporins, ion channels (ligand-gated and voltage-gated).

Unit–III Cell division, cell cycle, cell death and cancer

Molecular events in mitosis and meiosis. Brief account of cell differentiation.

The cell cycle: phases, regulation by cyclins and cyclin-dependent kinases. Checkpoints.

Cell death- types. Necrosis- causes and mechanism. Apoptosis: morphology, mitochondrial and death receptor pathways. Differences between apoptosis and necrosis.

Cancer- differences between benign and malignant tumours. Growth characteristics of malignant tumours. Ultrastructure of cancer cells. (brief account only).

Unit–IV Cell signaling

Fundamental concepts and definitions of signal, ligands and receptors. Endocrine, paracrine and autocrine signaling. Receptors and signaling pathways- cell surface receptors, ion channels, G-protein coupled receptors, receptor kinases. Signal transduction through cytoplasmic and nuclear receptors- the ras-raf-MAP kinase

cascade. Second messengers: cyclic nucleotides, lipids, and calcium ions. Crosstalk in signaling pathways.

Unit–V Genetics

Definitions of some common terms in genetics- phenotype, genotype, heterozygous, homozygous, allele (dominant, recessive, wild-type, mutant), character, gene, gene locus, pure line, hybrid. Mendel's laws. Monohybrid cross, multiple alleles, dihybrid cross, test cross, backcross, epistasis.

Chromosome structure. Polytene and lampbrush chromosomes. Types of chromosomes on the basis of centromere position. Karyotyping. Variation in chromosome number (euploidy, aneuploidy), arrangement (translocation, inversion), number of segments (deletion, duplication). Population genetics- The Hardy-Weinberg law (basic concept).

Text Books

1. Karp. Cell & Molecular Biology 7th ed 2013. Wiley.
2. Lodish et al Molecular Cell Biology 7th ed. Freeman, 2012 (Unit–I& 3).
3. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012 (Unit – II and 3).
4. Fletcher et al. Instant Notes in Genetics. 3rd ed. Taylor & Francis. 2006.
5. Abouelmagd and Ageely. Basic Genetics. Textbook and Activities. Universal Publ. 2009.
6. Elrod and Stansfield Schaum's Outline of Genetics. 5th ed. McGraw Hill. 2010.

Reference Books

Alberts et al Molecular biology of the Cell. 5th ed. Garland Sci. 2007 (Unit – I,3,4).

BIT C 103: ANALYTICAL TECHNIQUES

Objective: To learn the principle, operation, and applications of various techniques for analyzing biomolecules. This course will help students to understand the theoretical basis of separation and analysis of biomolecules which form the basic tools in research.

Unit–I Spectroscopy techniques

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible, spectrophotometry and spectrofluorimetry. Principle, instrumentation and applications of luminometry, atomic flame and flameless spectrophotometry. Brief outline of the principles and biological applications of NMR, ESR, ORD, and CD.

Unit–II Radioisotope Techniques and microscopy

Nature and units of radioactivity. Solid and liquid scintillation counting, quenching and quench correction, scintillation cocktails and sample preparation. Autoradiography. Applications of radioisotopes in biology. Radiation hazards.

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

Unit–III Electrophoresis

Electrophoresis: General principles. Support media. Electrophoresis of proteins- SDS-PAGE, native gels, gradient gels, isoelectric focusing. Cellulose acetate electrophoresis. Detection, estimation and recovery of proteins in gels. Electrophoresis of nucleic acids- agarose gel electrophoresis. pulsed field gel electrophoresis. Electrophoretic mobility shift assay.

Unit–IV Chromatography

Principle, instrumentation and applications of thin layer and gas chromatography. Column chromatography- packing, loading, eluting and detection. Ion-exchange chromatography- preparation of resins, procedure and applications. Molecular exclusion chromatography- principle, operation and applications. Affinity chromatography- principle, procedure and applications. HPLC- principle, instrumentation and applications. HPTLC- brief account only. Capillary electrochromatography.

Unit–V Centrifugation

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuges. Analytical and preparative ultracentrifuge-instrumentation and applications. Basic principle and technique of subcellular fractionation by differential centrifugation. Density-gradient centrifugation- rate zonal and isopycnic. Formation and choice of gradients.

Text Books

1. Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology. 7th ed. Cambridge University Press 2012.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ. 2010.
3. Boyer, R.Modern Experimental Biochemistry.3rd ed.Addison Weslery Longman, 2000.

Reference Books

1. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 4th ed 2012.
2. Friefelder and Friefelder. Physical Biochemistry - Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1994.
3. Pavia Intro to spectroscopy 2009
4. Boyer 3rd ed 2000 Prentice Hall

BIT P 104: PRACTICAL-I
Biochemistry, Cell Biology, Genetics and Analytical techniques

1. Quantitative estimation of amino acids by ninhydrin method.
2. Estimation of proteins by Lowry *et al* method.
3. Thermal denaturation of DNA
4. Estimation of DNA by diphenylamine method.
5. Estimation of RNA by orcinol method.
6. Separation of lipids by thin-layer chromatography
7. Separation of plant pigments by adsorption chromatography - Demonstration
8. Separation of proteins by SDS-PAGE- Demonstration.
9. UV-Absorption spectrum of proteins and nucleic acids - Demonstration.
10. HPLC- Demonstration.
11. Microscopic examination of epithelial cells, plant cells.
12. Distinguishing mutant phenotypes of *Drosophilamelanogaster* - eye color mutant (white), eye surface/shape mutant (glazed), wing shape (curly) and body shape (tubby).
13. Preparation of polytene chromosomes from *Drosophila* larvae.

BIT C 201: ENZYME TECHNOLOGY

Objective: To understand the basic aspects of enzyme action, kinetics, inhibition, and the applications of enzymes in industry.

Unit–I

Enzymes- classification and nomenclature. Methods of enzyme isolation and assay. Enzyme units. Specific activity and turnover number. Active site- investigation of active site structure. Coenzymes, multienzyme complexes, metal-dependent and metalloenzymes. Isoenzymes. Elementary details of ribozymes, extremozymes, abzymes.

Unit–II

Enzyme kinetics - pre-steady state and steady state kinetics. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Michaelis-Menten plot, linear transformations: Lineweaver-Burk plot. Significance of Km and Vmax. Kinetics of allosteric enzymes- MWC and KNF models. Sequential and nonsequential bisubstrate reactions.

Unit–III

Enzyme inhibition- irreversible and reversible competitive, noncompetitive, uncompetitive, mixed inhibition (derivation of rate equation not required). Mechanism of enzyme action- acid-base catalysis, covalent catalysis, strain, proximity and orientation effects. Mechanism of action of chymotrypsin. Enzyme regulation-feedback inhibition. Covalent modification of enzymes and compartmentation. Allosteric regulation. Enzyme repression, and induction.

Unit–IV

Enzyme reactors: types (stirred tank, continuous flow), Immobilization of enzymes: principles, parameters, carriers (inorganic, polysaccharides, polymers), binding methods (adsorption, covalent), applications.

Enzyme engineering: principles, steps, enzyme engineering with reference to lysozyme.

Enzyme production and purification: enzyme sources (plant, animal, wild type and recombinant microorganisms), processes to improve enzyme yield, downstream processing of enzymes and chromatographic purification (brief account). Enzyme electrodes. Biosensors: components, types, (calorimetric, potentiometric, amperometric), applications.

Unit–V

Enzymes of industrial significance: use of enzymes in detergents, textiles, and leather industry, production of glucose syrup, cheese production. Brief account of synzymes and solvent engineering. Soluble enzymes- introduction and applications in food, starch processing and detergents.

Elementary details of enzymes as diagnostic aids. Therapeutic uses of enzymes: as thrombolytic agents and digestive aids. Regulations and safety criteria for production of enzymes and their use. Regulations governing use of enzymes produced in wild-type or recombinant organisms.

Text Books

1. Palmer T. Understanding enzymes. Prentice Hall. 2004.
2. Buchholz et al Biocatalysts and Enzyme Technology. 2nd ed Wiley-Blackwell. 2012.
3. Pandey et al. Enzyme Technology. 2010, Springer.
4. Nelson, Cox. Lehninger Biochemistry. 6th ed. Freeman 2012.
5. Balasubramanian et al. Concepts in Biotechnology. Univ Press 2004.

Reference Books

Dixon and Webb. Enzymes 3rd ed. Longmans 1979.

BIT C 202: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Objective: To acquire knowledge on immunological mechanisms and immunotechniques.

Unit–I

Types of immunity- innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system- lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes. NK cells, mast cells, interleukins.

Antigens-definition, antigenicity and immunogenicity, antigenic determinants, epitopes, haptens. Immunoglobulins-structure, classification and functions.

Unit–II

T-cell, B-cell receptors. Antigen recognition - processing and presentation to T-cells. Interaction of T and B cells. Immunological memory. Effector mechanisms- macrophage activation. Cell mediated cytotoxicity, immunotolerance, immunosuppression. Complement activation. Clonal selection theory. Immunoglobulin rearrangements, class switching.

Unit–III

Transplantation types. MHC antigens in transplantation. Immunodeficiency disorders-AIDS: The HIV genome and life cycle. Autoimmunity and elementary details of autoimmune disorders (systemic lupus erythematosus, rheumatoid arthritis). Hypersensitivity - types (basic concepts only).

Unit–IV

Immunization practices-active and passive immunization. Vaccines-killed, attenuated-toxoids. Recombinant vector vaccines-DNA vaccines, synthetic peptide vaccines. Production and applications of polyclonal and monoclonal antibodies. Genetically engineered antibodies.

Unit–V

Agglutination and precipitation techniques. Immuno-electrophoresis, RIA, Immunoblotting, Avidin-biotin mediated immunoassay. Immunohistochemistry, immune-fluorescence. Complement fixation test. ELISA-principle and applications. Flow cytometry.

Text Books

1. Goldsby *et al*. Kuby Immunology. WH Freeman & Co. 7th ed 2013.
2. Abbas *et al*. Cellular and Molecular Immunology. Elsevier 2011.
3. Janeway, C. (Ed), Immunobiology 8th ed. Garland Publ. 2011.
4. Coico and Sunshine. Immunology: A short course. 6th ed. Wiley, 2009.

Reference Books

Roitt et al. Roitt's Essential Immunology. 12th ed Wiley-Blackwell Sci. 2011.

BIT C 203: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Objective: To learn the principles and techniques of bioprocess engineering and downstream processing as well as biotechnological approaches to environmental management.

Unit–I Bioprocessing and bioreactors

Isolation and screening of industrially important microbes. Maintenance of strains. Inoculum development. Strain improvement- mutant selection, recombination, metabolite production by rDNA technology. Process development. Advantage of bioprocess over chemical process. Kinetics of microbial growth and death.Bioreactors- design, function and types. Media for industrial fermentation. Antifoaming devices. Analysis of batch, fed-batch and continuous bioreactions, analysis of mixed microbial

population. Heat transfer and shear effects in culture. Mass transfer, effect of scale on mass transfer.

Unit–II Downstream processing

Downstream processing: Stages: solid-liquid separation, release of intracellular compartments, concentration of biological products, membrane filtration, precipitation, adsorption, dialysis, reverse osmosis, ultrafiltration, preservation and stabilization, purification. Crystallization and drying. Product formulation. Monitoring of downstream processing.

Industrial production of ethanol, citric acid, butanol, penicillin, lysine/aspartate, and fructose. Whole cell immobilization and industrial applications.

Unit–III Pollution and control

Environmental pollution- types, methods for measurement, biosensors to detect environmental pollutants, hazards from wastes and pollutants. Air pollution and its control through biotechnology. Water pollution and control. Wastewater treatment- physical, chemical and biological. Activated sludge- oxidation ditches and ponds, trickling filter, towers, rotating discs and drums. Anaerobic processes: anaerobic digestion and filters. Effluent treatment: B.O.D and C.O.D Treatment for wastewaters of distillery, dairy, and tannery industries.

Unit–IV Soil and agricultural biotechnology

Soil microbiota. Growth, ecological adaptations, interactions among soil microorganisms, biogeochemical role of soil microorganisms. Microbial degradation of xenobiotics in the environment. Oil spill clean up. Bioremediation of contaminated soil and waste land. Biofertilisers. Biopesticides in integrated pest management- *Bacillus* and baculoviruses as biocontrol agents. Biodegradable plastics. Biofilms.

Unit–V Alternative energy sources and green technology

Renewable sources of energy (solar, wind, biogas, energy crops, cellulose); hydrogen production using hydrogenase and nitrogenase. Conservation of energy. Bioleaching- use of microorganisms in mining of gold and uranium. Global environmental problems; Ozone depletion, greenhouse effect, impact and management. Reforestation through micropropagation- use of *Casuarina,* and mycorrhizae. Development of stress resistant plants. Biodiversity- Alpha and beta diversity. Extinction and endangered species. Conservation of biodiversity. *In situ* and *ex situ*- gene banks, species conservation.

Text Books

1. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.
2. Borem, Santos, Bowen. Understanding Biotechnology. Prentice Hall 2003.
3. Casida L.E. JR Industrial Microbiology. 3rd Wiley Eastern reprint. John Wiley and Sons Inc. 1987.
4. Smith JE. Biotechnology Cambridge University Press. 4th ed.
5. Gupta PK. Elements of Biotechnology, Rastogi Publication, 1998.
6. Scragg A. Environmental Microbiology 1st ed. Am Society for Microbiology 2005.
7. Ahmed N. Industrial and environmental Biotechnology. Horizon Scientific Press 2001.
8. Primrose Twyman and Old. Principles of gene manipulation. 6th ed. Blackwell Sci 2001.

References

Flickinger and Drew (eds). Encyclopedia of Bioprocess Technology. 5 vol. set. John Wiley & Sons, 1999.

BIT C 204: MOLECULAR BIOLOGY

Objective: To gain an insight into the molecular mechanisms of genetic information flow and regulation of gene expression.

Unit–I Chromatin and genome complexity

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

Unit–II Replication, Repair and Recombination

Messelson and Stahl experiment. Enzymes and proteins involved in replication in prokaryotes and eukaryotes: helicases, SSB, topoisomerases, DNA polymerases, DNA ligase. Mechanism of DNA replication in bacteria and eukaryotes: initiation, elongation, termination. The end-replication problem and telomerase. Inhibitors of replication.

DNA damage by physical and chemical agents. DNA repair- photoreactivation, excision repair, mismatch repair, SOS

response, double strand break repair.Recombination: Molecular biology of homologous and site-specific recombination. Transposons: mechanism of transposition and applications.

Unit–III Transcription and Post-transcriptional processing

Transcription in *E. coli:* RNA polymerase subunit structure, promoter sequence steps in transcription- template recognition, initiation, elongation and termination (intrinsic, rho-dependent). Transcription in eukaryotes: RNA pol I, II and III: subunit structure, transcription factors, promoters, inhibitors. Mechanism of RNA pol II transcription: preinitiation complex formation, transcription initiation (activator proteins, mediator, chromatin recruitment), elongation, termination.

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

Unit IV Genetic code and Translation

The genetic code: general features. Mitochondrial genetic code. Mutations: point mutations and frameshift mutations. Suppressor mutations- nonsense and missense suppression.

Mechanism of protein synthesis in bacteria and eukaryotes: amino acid activation, initiation, elongation and termination. Inhibitors of protein synthesis. Post-translational modifications. Protein targeting to subcellular organelles, secretory proteins (the signal sequence hypothesis). Protein degradation: the ubiquitin pathway. Protein folding- models, molecular chaperones.

Unit–V Regulation of Gene expression

Basic principles of gene regulation- levels of gene expression, definition of housekeeping genes, and inducible genes, upregulation, downregulation. Regulation of gene expression in prokaryotes: The *lac* operon. Attenuation and the *trp* operon. Translational control in bacteria (r-protein operons). Regulation of gene expression in eukaryotes: Transcriptional regulation by steroid hormone receptors, phosphorylation (STAT proteins), alternative splicing. Translational regulation. Antisense RNA and RNA interference. Epigenetic gene regulation: DNA methylation, histone acetylation and deacetylation.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2012.
3. Alberts et al Molecular biology of the cell. 5th ed. Garland Sci. 2007.
4. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.

Reference Books

1. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.
2. Twyman. Advanced Molecular Biology. BIOS Sci Publ. 2000.

BIT P 205:PRACTICAL-II

Enzyme technology, Microbiology and Immunology

1. Determination of achromatic point in α-amylase.
2. Determination of total and specific activity of α-amylase and assay of serum ALP/ACP.
3. Effect of pH on enzyme activity (lipase/cellulase).
4. Effect of temperature on enzyme activity (lipase/cellulase).
5. Effect of substrate concentration on enzyme activity (lipase/cellulase) and determination of Km value.
6. Microscopic examination of bacteria, fungi, yeast.
7. Staining of microorganisms: Gram staining, acid fast staining, cytological and organism-specific staining.
8. Culture of microorganisms: media preparation, Serial dilution, inoculation, Culture of bacteria in culture tubes, agar plates.
9. Antibiotic sensitivity and resistance pattern of bacteria.
10. Identification of blood groups and Rh typing.
11. Radial immunodiffusion.
12. Double diffusion.
13. Agglutination, rosette formation, complementfixation.
14. Immunoelectrophoresis.
15. Preparation of antisera.

BIT P 206:PRACTICAL-III

(Industrial and Environmental Biotechnology)

1. Preparation of immobilized cell/enzyme beads using alginate.
2. Determination of growth curve of a microorganism and substrate degradation profile.
3. Computation of specific growth rate (m) and growth yield $Y_{x/s}$.
4. Comparative studies of ethanol production with different substrates.
5. Microbial production of citric acid using *Aspergillus niger*.
6. Determination of total dissolved solids in water.
7. Determination of D.O. concentration of water sample.
8. Determination B.O.D. of sewage sample.
9. Determination C.O.D. of sewage sample.
10. Estimation of nitrate in drinking water.
11. Efficiency of removal of air pollutants using fibrous air filter.
12. Production and estimation of alkaline protease.
13. Isolation and enumeration of soil bacteria.
14. Isolation and enumeration of bacteriophages from raw sewage.
15. Identification of heavy metals from sewage water by AAS.

BIT C 301: GENETIC ENGINEERING AND NANOBIOTECHNOLOGY

Objective: To master the basic principles of genetic engineering, cloning strategies, and techniques. To learn the basics and applications of nanobiotechnology

Unit–I Restriction endonucleases, cloning vectors, and splicing
Basic steps in gene cloning. Restriction endonucleases-nomenclature and mechanism of action of type II restriction enzymes. Cloning vectors: plasmids (pBR322 and pUC), phage vectors (λ and M13), cosmids, BACs and YACs. Methods of ligation of insert and vector DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation, linkers and adapters.

Unit–II Gene transfer methods, cloning strategies & screening
Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, viruses, microinjection. Choice of host organisms for cloning. Cloning strategies- genomic cloning, cDNA cloning. Differences between genomic and cDNA libraries. Screening of recombinants: marker inactivation (antibiotic resistance, blue-white selection), nucleic acid hybridization, immunoscreening, screening for protein activity.

Unit–III Expression systems
Expression of cloned genes in *E.coli*: promoter efficiency, increasing protein production, (mRNA and protein stability), fusion proteins, unidirectional tandem gene arrays, translation expression vectors, plasmid copy number and stability. Cloning of insulin. Expression in yeast: Yeast vectors. The GAL system. Expression in insect cells: baculovirus transfer vector. Mammalian cell expression systems.

Unit–IV Techniques in gene manipulation
Preparation of probes. Blotting techniques: Southern, northern, western, and southwestern. DNA fingerprinting- principle and applications. PCR:Principle and applications. Brief account of the principle and applications of RT-PCR, real-time qPCR, RAPD. Sequencing: Chemical and enzymatic methods. Automated DNA sequencing. Site-directed mutagenesis (SDM): cassette and oligonucleotide-directed mutagenesis, PCR-based methods. Protein engineering by directed evolution and DNA shuffling. Hazards and safety aspects of genetic engineering.

Unit–V Nanobiotechnology

Techniques for visualization of biomolecules at nanoscale- atomic force microscopy, optical microscopy, magnetic resonance force microscopy, TEM, SEM, FRET. Nanoparticles- metal, and bimetallic nanoparticles, quantum dots, dendrimers, and fluorescent nanoparticles. Production of nanoparticles: Collision/Coalescence mechanism of primary particle formation, nanoparticles agglomerates and aerogels. Biological synthesis of nanoparticles by fungi, bacteria, yeast, and actinomycetes. Applications of nanotechnology in biology, medicine and environment.

Text Books

1. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
2. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
3. Reece. Analysis of Genes and Genomes. Wiley 2004.
4. Jain KK. Nanobiotechnology Molecular Diagnostics: Current Techniques and Applications. Taylor & Francis. 2006.
5. vo-Dinh (ed) Nanotechnology in Biology and Medicine: Methods, devices and applications. CRC Press. 2007.

Reference Books

1. Winnacker EL. From Genes to clones. 4th ed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
3. Primrose, Twyman and Old. Principles of gene manipulation. 7th ed. Wiley-Blackwell. 2006.

BIT C 302: PLANT BIOTECHNOLOGY

Objective: To acquire theoretical knowledge about plant tissue culture techniques, gene transfer methods, and transgenic plant technology.

Unit–I Plant tissue culture-I

Tissue culture as a technique to produce novel plants and hybrids. Sterilization. Nutrient medium. Use of growth regulators. Callus and suspension cultures. Techniques for culture of single cells. Regeneration. Organogenesis and somatic embryogenesis-techniques and applications.Anther, ovary, meristem culture. Somatic hybridization (Symmetric, Asymmetric, Cybrids). Embryo culture. Embryo rescue. *In vitro* pollination and fertilization. Synseed production.

Unit–II Plant tissue culture-II

Large-scale culture of plant cells. Production of biochemicals from cultured plant cells. Micropropagation. Somaclonal and Gametoclonal variation. Endosperm and nucellus cultures. Cryopreservation and *ex situ* conservation of germplasm. Production of haploid plants and homozygous lines. Detection and uses of haploids in plant breeding. Protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants. Phytochemicals from plant tissue culture.

Unit–III Cloning in plants

*A. tumefaciens*mediated transformation-Ti plasmids (cointegrate and binary vectors), direct nuclear transformation (protoplast transformation, particle bombardment), viral vectors (CaMV, TMV), chloroplast transformation. Use of reporter genes in transformed plant cells. Selectable markers for plants- drug resistance and herbicide resistance markers. RFLPs, RAPDs, DNA fingerprinting-general principles and applications in plant biotechnology.

Unit–IV Transgenic plant technology-I

Insect resistance plants- *cry* genes of *B.t.,* their proteins and target insects, *cry* gene expression in plants, insect resistance to Cry proteins. Strategies to obtain virus resistant transgenic plants. Herbicide resistance and stress - and senescence-tolerant plants. Modification of seed protein quality. Suppression of endogenous genes by antisense (delayed ripening) and ribozyme approaches. Cytoplasmic male sterility.

Unit–V Transgenic plant technology-II

Genetic modification of flower pigmentation. Terminator technology. Production of biochemicals and vaccines by transgenic plants. Modification of chloroplast and mitochondrial function. Problems in gene transfer in plants. Ethics of genetically engineered crops. Biotechnology and Intellectual Property Rights (IPR)-patents, trade secrets, copyright, trademark, TRIPS.

Text Books

1. Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.
2. Primrose Twyman and Old. Principles of gene manipulation and Genomics. 7th ed. BlackwellSci 2006.
3. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
4. Watson et al. Recombinant DNA: Genes and genomes- A short course. 3rd ed. Freeman 2006.

Reference Books

Slater A. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford Univ Press 2008.

BIT C 303: ANIMAL BIOTECHNOLOGY

Objective: To gain an insight into animal tissue culture techniques, gene transfer and gene manipulation methods, and transgenic animal technology.

Unit–I Animal cell culture-I

Animal cell and tissue culture- merits and demerits. Laboratory facilities, substrate, culture media. Culture procedures- preparation, sterilization, disaggregation of tissue (mechanical and enzymatic), subculture, contamination. Primary culture- cell lines, Secondary culture- transformed animal cells and continuous cell lines. Maintenance of cultures, cloning of cell lines, cancer cell lines. Large-scale culture of cell lines- monolayer, suspension and immobilized cultures.

Unit–II Animal cell culture-II

Tissue culture: slide, flask, and test tube culture. Organ culture-technique, advantages, limitations, applications. Whole embryo culture. Somatic cell hybridization, genetic analysis using cell hybridization and expression of cloned genes in cultured cells.

Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture.

Unit–III Manipulation of animal reproduction &characterization of animal genes

Manipulation of reproduction in animals. Artificial insemination, embryo transfer, *in vitro* fertilization. Embryo transfer in cattle and applications. Somatic cell cloning- cloning of Dolly. Ethical issues.

Characterizing and isolating animal genes- homologues, linked markers and linkage mapping, bulked segregant analysis, direct identification of novel genes. Production of recombinant vaccine for foot and mouth disease. Probiotics for disease control.

Unit–IV Gene transfer methods

Vectors for gene transfer in animals: adenovirus and retrovirus. Gene constructs- promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells-thymidine kinase, dihydrofolate reductase, CAT.

Transfection of animal cells- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, microinjection.

Unit–V Transgenic animal technology

Methods for producing transgenic animals- retroviral, microinjection, engineered stem cell. Targeted gene transfer. Transgene integration and identification methods. Transgenic cattle, sheep, fish and pigs. Uses of transgenic animals. Transgenic animals as models of human disease. Ethical issues in transgenesis.

Text Books

1. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
2. Primrose Twyman and Old. Principles of gene manipulation. 7th ed. Blackwell Sci 2006.
3. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
4. Wilson and Walker. Principles and techniques of Biochemistry and Molecular Biology. 7th ed. Cambridge University Press 2012.
5. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.

Reference Books

1. Primrose, and Twyman. Principles of gene manipulation and genomics. 7th ed. Wiley-Blackwell. 2006.
2. Freshney RI. Culture of animal cells: A manual of basic technique. 6th ed. Wiley-Liss, 2010.

BIT P 304: PRACTICAL–IV

(Cell and Molecular biology, Genetic Engineering, Plant and Animal Biotechnology)

1. Isolation of lymphocytes.
2. Microscopic examination of blood cells, epithelial cells, plant cells, tissue types.
3. Metaphase chromosome preparation.
4. Bacterial conjugation, transformation (Demonstration).
5. Isolation of DNA, DNA electrophoresis in agarose gel, determination of molecular weight.
6. Isolation of RNA from yeast.
7. Plasmid preparation, characterization by electrophoresis.
8. Restriction enzyme digestion of DNA.
9. PCR and analysis of PCR products
10. Blotting techniques - Western - Demonstration
11. GFP cloning. Demonstration
12. Protoplast isolation and culture.
13. Preparation of tissue culture medium and membrane filtration.
14. Preparation of single cell suspension, cell counting, viability of cells.
15. Trypsinization of monolayer and subculturing.
16. MTT assay for cytotoxicity testing

BIT C 401: GENOMICS, PROTEOMICS, AND BIOINFORMATICS

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

Unit–I Genome mapping and sequencing

Genome mapping-rationale. Types of gene map-genetic, cytogenetic and physical. Molecular markers for mapping-RFLPs, microsatellites and SNPs. Assembling a physical map of the genome - chromosome walking and jumping. Restriction enzyme fingerprinting. STS, ESTs, radiation hybrid mapping. Genome sequencing approaches-clone contigs, whole-genome shotgun, hierarchical shotgun. Identifying genes- sequence inspection, cDNA (EST) comparison, similarity searches.

Unit–II Genome projects, post-genome analysis

Genome projects: genome sequence data of model organisms-*E.coli, D.melanogaster*, and mouse. The Human Genome Project: goals, mapping strategies, markers, sequencing technologies, results of final sequence, potential benefits and risks, ELSI. Post-genome analysis-differential display, microarrays, SAGE and cluster analysis. ChIPs, knock-out analysis, genome-wide two-hybrid screens.

Unit–III Protein separation, identification and quantitation

Proteomics-introduction. Protein separation- general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry-basic principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem mass spectrometry, and FTICR mass (elementary details).

Unit–IV Structural & functional proteomics & applications

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

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

Unit–V Bioinformatics

Useful search engines. File formats. PubMed. Bioinformatics workstation, Unix. Scripting languages-Perl and Python, markup languages- HTML, XML. Biological databases (primary, secondary, organism-specific, miscellaneous). Data submission and retrieval-*Entrez* and SRS. Sequence alignment: substitution scores and gap penalties. Database similarity searching: BLAST, FASTA. Multiple sequence alignments: CLUSTAL. Gene discovery and prediction. Molecular phylogenetics: phylogenetic tree construction and analysis. Identification of orthologs and paralogs. Protein structure database-protein structure visualization, comparison and classification. Protein motifs and domain prediction.

Text Books

1. Lesk A. Introduction to Genomics. 4th ed. Oxford Univ Press. 2013.
2. Primrose. Principles of genome analysis. Wiley 2006.
3. Brown. Genomes. 2006 5th ed Wiley.
4. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience. 2011.
5. Lovrik Introducing Proteomics. Wiley-Blackwell. 2011.
6. Twyman. Principles of Proteomics. 2nd ed. 2013
7. Liebler DC. Introduction to proteomics. Humana Press. 2nd ed. 2007.
8. Hodgman et al. Instant Notes in Bioinformatics. 2nd ed. Taylor and Francis, 2009.

Reference Books

1. Gibas and Per Jambeck. Developing bioinformatics computer skills. 2nd ed. O'Reilly Associates, 2013.
2. Baxevanis, Ouellette. Bioinformatics. A practical guide to the analysis of genes and proteins. 3rd ed. Wiley Interscience, 2004.

Web sites

http: //www.ensembl.org

http://www.ncbi.nlm.nih.gov/genbank

http://www.123genomics.com

http://www.expasy.ch

BIT C 402: FOOD AND MEDICAL BIOTECHNOLOGY

Objective: To acquire knowledge in food biotechnology, molecular basis of diseases, molecular diagnostics & therapeutics.

Unit–I Food spoilage and preservation

Types and sources of microorganisms associated with food. Conditions influencing microbial growth in food. Estimating number and types of microorganisms in food. Composition and spoilage of food, meat, fish, cereals, pulses, nuts and oil seeds, fruits and fruit products, vegetable and vegetable products. Methods of food preservation. Control of microorganisms by retarding growth- low temperature, drying, intermediate moisture, chemicals. Control of microorganisms by destruction- gas treatments, heat, ionization radiation, ultraviolet radiation. canning and packing (Elementary idea).

Unit–II Fermented foods and enzymes in food industry

Basic principles of food fermentation. Fermented foods:fermented milk- yoghurt, cheese, bread; fermented vegetables- sauerkraut, olives. Fermented meats and fish. Production of beer, wine, and vinegar. Mushroom farming. Use of enzymes in food industry-proteases in food processing, enzymes in baking and dairy industry, enzymes in fruit juice and brewing industry. Pickling and curing.

Unit–III Molecular Basis of diabetes, atherosclerosis & cancer

Role of tissues and hormones in blood sugar homeostasis. Diabetes mellitus: classification, diagnosis, management, complications. Atherosclerosis: risk factors, biochemical findings and management. Cancer- growth characteristics of cancer cells, mechanism of radiation, virus and chemical carcinogenesis. Multistage carcinogenesis. Oncogenes and tumor suppressor genes (brief account).

Unit–IV Molecular Diagnosis

Diagnostic kits. Tumor markers- oncofetal proteins, hormones, enzymes, tumor-associated antigens. Prenatal & neonatal screening for genetic disorders. DNA diagnostic systems- hybridization probes, nonradioactive probes. RFLP & PCR in disease diagnosis. DNA profiling using VNTRs, STRs, mitochondrial DNA variants. Histocompatibility testing: lymphocytotoxicity test, cross matching. Graft versus host reaction. Viral diagnostics: immunodiagnosis, molecular diagnosis. SNP-based diagnosis.

Unit–V Molecular Therapeutics

Mabs, growth factors and interferons as therapeutic agents. Therapeutic agents from nonrecombinant and recombinant

organisms. Antivirals and antiretrovirals. Drug delivery and targeting. Gene therapy: gene delivery systems, *ex vivo* and *in vivo*strategies, gene therapy for single-gene disorders, cancer and AIDS. Antisense and siRNA therapy. Nanotherapy. Stem cell therapy. Bioethics- Food and drug safety. Ethical issues in human gene therapy, human genome analysis and human cloning.

Text Books

1. Montville et al. Food Microbiology: An introduction. 3rd ed. ASM Press. 2011.
2. Borem et al Understanding Biotechnology. Pearson 2011.
3. Adams and Moss. Food Microbiology. 3rd ed. Royal SocChem 2007.
4. Jay et al. Modern Food Microbiology 7th ed. Springer 2006.
5. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
6. Singh BD. Biotechnology. Kalyani Publ.

Reference Books

1. Ward OP. Fermentation Biotechnology. John Wiley 1991.
2. Maulik and Patel Molecular Biotechnology Wiley-Liss. 1997.
3. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.

BIT P 403: PRACTICAL V
Bioinformatics, Food and Medical Biotechnology

1. Sequence alignment and searching
2. Gene prediction
3. Multiple sequence alignment
4. Phylogenetic analysis
5. Protein sequence analysis, structure prediction
6. Primer design
7. SNP and ORF finding in DNA sequence
8. Visualization tools.
9. Microarray analysis
10. Isolation of microbes from spoiled vegetables.
11. Preparation of fruit juice concentrates and use of enzymes for clarity.
12. Identification & characterization of proteins resolved on 2D PAGE Demo.
13. HPTLC and GC-MS- Demonstration.
14. Structure determination of proteins and nucleic acids by NMR & XRD-Demo.
15. Molecular modeling.
16. Dehydration of fruits and vegetables.Preparation of fruit juice powders.
17. Aseptic packaging, freeze preservation, drying and dehydration, food fermentation, pickling and curing.
18. Preservation of food products using chemical preservatives.
19. Tissue collection, formalin fixation, sectioning, and staining.
20. Analysis of biochemical analytes by autoanalyser.
21. Biochemical analyses for diabetes and cardiovascular disease.
22. Use of ELISA for disease diagnosis- demonstration.

DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY
M.Sc. INTEGRATED BIOTECHNOLOGY PROGRAMME (2014-2015)
Scheme of Examinations

Subject Code	Theory & Practicals	Credits			Internal Assessment Marks	End Semester Examination Marks	Total Marks
		L	P	C			
Semester-I							
ITAC 11	Language I	3		3	25	75	100
IENC 12	English I	3		3	25	75	100
ICEC 13	Civics, Environmental Awareness and Health Science	3		3	25	75	100
IBTT 14	Biomolecules	5		5	25	75	100
IBTA 15	Ancillary-I Chemistry	4		4	25	75	100
Total Credits: 18							
Semester-II							
ITAC 21	Language II	3		3	25	75	100
IENC 22	English II	3		3	25	75	100
ICAC 23	Computer Applications	3		3	25	75	100
IBTT 24	Analytical Techniques	5		5	25	75	100
IBTA 25	Ancillary-II Chemistry	4		4	25	75	100
IBTP 26	Practicals in Chemistry		6	2	40	60	100
IBTP 27	Practicals in Biomolecules		6	2	40	60	100
Total Credits: 22							
Semester –III							
ITAC 31	Language III	3		3	25	75	100
IENC 32	English III	3		3	25	75	100
AAST 03	Ancillary -II (Biology) Paper I Animal Science	4		4	25	75	100
IBTT 32	Enzyme Technology	5		5	25	75	100
IBTP 33	Practicals in Analytical Techniques and Enzyme Technology		9	3	40	60	100
Total Credits: 18							
Semester IV							
ITAC 41	Language IV	3		3	25	75	100
IENC 42	English IV	3		3	25	75	100
APST 04	Ancillary -II (Biology) Paper II Plant Science	4		4	25	75	100
IBTT 43	Metabolism and Regulation	4		5	25	75	100
IBTT 44	Genetics and System Physiology	4		5	25	75	100
IBTP 45	Practicals in Genetics and System Physiology		9	3	40	60	100
ABIP 02	Practicals in Ancillary -II (Biology)		6	2	40	60	100
Total Credits: 25							

Semester-V							
IBTT 51	Cell Biology	5		5	25	75	100
IBTT 52	Molecular Biology	5		5	25	75	100
IBTT 53	Microbiology	5		5	25	75	100
IBTT 54	Immunology & Immunotechnology	5		5	25	75	100
IBTP 55	Practicals in Cell and Molecular Biology		9	3	40	60	100
IBTP 56	Practicals in Microbiology & Immunology		9	3	40	60	100
Total Credits: 26							
Semester-VI							
IBTT 61	Bioprocess Engineering & Downstream Processing	5		5	25	75	100
IBTT 62	Environmental Biotechnology	5		5	25	75	100
IBTT 63	Genetic Engineering	5		5	25	75	100
IBTT 64	Cell and Tissue Culture	5		5	25	75	100
IBTP 65	Practicals in Bioprocess Engg, Downstream Processing & Environ-mental Biotechnology		9	3	40	60	100
IBTP 66	Practicals in Genetic Engg & Tissue culture		9	3	40	60	100
Total Credits: 26							
Semesters 1-6 Total credits 135							
Semester –VII							
IBTT 71	Advanced Molecular Biology	5		5	25	75	100
IBTT 72	Advanced Genetic Engineering	5		5	25	75	100
IBTP 73	Practicals in Advanced Molecular Biology and Genetic Engineering		15	5	40	60	100
	Optional-I	4		4	25	75	100
ENGF	Optional-I Soft skills (English)	4		4	25	75	100
Total Credits: 23							
Semester VIII							
IBTT 81	Plant Biotechnology	5		5	25	75	100
IBTT 82	Animal Biotechnology	5		5	25	75	100
IBTP 83	Practicals in Plant and Animal Biotechnology		15	5	40	60	100
	Optional II	4		4	25	75	100
	Optional III	4		4	25	75	100

Total Credits:23							
Semester-IX							
IBTT 91	Genomics and Proteomics	5		5	25	75	100
IBTT 92	Nanobiotechnology and Bioinformatics	5		5	25	75	100
IBTT 93	Food Biotechnology	5		5	25	75	100
IBTP 94	Practicals in Genomics, Proteomics, & Bioinformatics		15	5	40	60	100
	Optional IV	4		4	25	75	100
Total Credits: 24							
Semester-X							
IBTT 101	Medical Biotechnology	5		5	25	75	100
IBTT 102	Biotechnology Management	5		5	25	75	100
IBTP 103	Practicals in Food and Medical Biotechnology		15	5	40	60	100
IBTPJ 104	Project/Dissertation			5	25	75	100
Total Credits: 20							
Semesters 7-10Total credits : 90							

L Lecture; P Practical; C Credit

OVERALL TOTAL CREDITS

Internal Assessment Marks

Theory	**Practicals**
Internal Assessment Marks : 25	Internal Assessment Marks : 40
Test I & II : 20	Test-I & II : 30
Assignment : 5	Seminar : 5
End-Semester Marks : 75	Viva : 5
Total Marks per paper :100	End-Semester Marks : 60
	Total Marks per paper : 100

IBTT 14: BIOMOLECULES

Objective: To gain a fundamental understanding of the structure-function relationships of various biomolecules.

Unit–I Proteins

Acids, bases, pH, buffers, the Henderson-Hasselbach equation.

Amino acids: 3-letter and 1-letter abbreviation, classification, stereoisomerism, and general properties. Nonstandard amino acids. The peptide bond, Ramachandran plot. Chemical synthesis of peptides (Merrifield method). Biologically important peptides.

Proteins: classification, properties, denaturation. Orders of protein structure: Primary, secondary, supersecondary, tertiary and quaternary structures. The structure of collagen and hemoglobin. Determination of the amino acid sequence of proteins.

Unit–II Nucleic acids

Structures of the major purine and pyrimidine bases, nucleosides and nucleotides. Biologically important nucleotides. DNA double helical structure- Watson and Crick model. A, B, and Z forms of DNA. Triple and quadruple structures. DNA supercoiling. DNA denaturation and renaturation, the cot curve.Differences between DNA and RNA. Major classes of RNA-structure and biological functions. Minor classes of RNA (snRNA, miRNA and siRNA).

Unit–III Carbohydrates

Classification and general properties of carbohydrates. Biologically important monosaccharides- structure and stereoisomeric forms. Disaccharides of biological importance. Homopolysaccharides-structure and biological functions of starch, glycogen, and cellulose. Heteropolysaccharides-structure and biological role of glycosaminoglycans. Brief account of blood group, and bacterial cell wall polysaccharides.

Unit–IV Lipids and Hormones

Classification of lipids. Fatty acids and triglycerides. Eicosanoids-structure and biological actions. Phospholipids and sphingolipids-structure and biological functions. Structure and functions of cholesterol. Brief account of lipoproteins.

Brief account of hormones- classification, mechanism of action and second messengers.

Unit–V Vitamins

Fat-soluble vitamins- structure, sources, requirements, biological actions and clinical significance of vitamins A, D, E, and K.Water-soluble vitamins-structure, sources, requirements, biological actions

and clinical significance of thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid and vitamin B_{12}.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Voet and Voet. Fundamentals of Biochemistry. 3rd ed. Wiley. 2010.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.

Reference Books

Blackburn et al. Nucleic acids in Chemistry and Biology. Royal Soc Chem 2006.

IBTT 24: ANALYTICAL TECHNIQUES

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

Unit–I Spectroscopic techniques

Laws of absorption. Absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, spectrofluorimetry and luminometry. Atomic spectroscopy- principle and applications of atomic flame and flameless spectrophotometry. Brief outline of the principles and biological applications of NMR, ESR, ORD, and CD.

Unit–II Radioisotope techniques

Nature and units of radioactivity. Detection and measurement of radioactivity- Geiger-Muller counter, solid and liquid scintillation counting. Autoradiography. Applications of radioisotopes in biology. Radiation hazards.

Unit–III Electrophoresis and blotting techniques

Electrophoresis: General principles. Paper electrophoresis. PAGE, SDS-PAGE, isoelectric focusing and 2-D PAGE. Agarose gel electrophoresis, Detection, estimation and recovery of proteins in gels. pulsed field gel electrophoresis.Hybridization techniques: Southern, Northern, Western and Southwestern.

Unit–IV Chromatography

General principles of partition and adsorption chromatography. Principle, instrumentation and applications of paper, thin layer and gas chromatography. Column chromatography- packing, loading, eluting and detection.Principle, procedure, and applications of ion-exchange, molecular exclusion, and affinity chromatography. HPLC- principle, instrumentation and applications.

Unit–V Centrifugation

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuges. Analytical and preparative ultracentrifuge- instrumentation and applications. Basic principle and technique of subcellular fractionation by differential centrifugation. Density-gradient centrifugation- rate zonal and isopycnic.

Text books

1. Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology. 7th ed. Cambridge University Press 2012.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ. 2010.

Reference books

1. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 4th ed 2012.
2. Sambrook and Russell. The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory, 2006.
3. Friefelder and Friefelder. Physical Biochemistry - Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1994.
4. Pavia Intro to spectroscopy 2009
5. Boyer 3rd ed 2000 Prentice Hall.

IBTP 27: PRACTICALS IN BIOMOLECULES

1. Preparation of buffers.
2. Qualitative analysis of amino acids.
3. Quantitative estimation of amino acids by ninhydrin method.
4. Estimation of proteins by Biuret method.
5. Estimation of DNA by diphenylamine method.
6. Estimation of RNA by orcinol method.
7. Qualitative analysis of carbohydrates.
8. Estimation of glucose by anthrone method.
9. Determination of acid number of a fat.
10. Determination of iodine number.
11. Determination of saponification value.
12. Estimation of ascorbic acid by titrimetric method.

IBTT 32: ENZYME TECHNOLOGY

Objective: To understand the basic aspects of enzyme action, kinetics, inhibition, and the applications of enzymes in industry.

Unit–I

Enzyme-classification and nomenclature. Methods of enzyme isolation and assay. Enzyme units. Specific activity and turnover number. Active site-investigation of active site structure. Coenzymes, multienzyme complexes, metal-dependent and metalloenzymes. Isoenzymes. Elementary details of ribozymes, extremozymes, abzymes.

Unit–II

Enzyme kinetics-pre-steady state and steady state kinetics. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Michaelis-Menten plot, linear transformations: Lineweaver-Burk plot. Significance of Km and Vmax. Kinetics of allosteric enzymes- MWC and KNF models. Sequential and nonsequential bisubstrate reactions.

Unit–III

Enzyme inhibition-irreversible and reversible competitive, noncompetitive, uncompetitive, mixed inhibition (derivation of rate equation not required). Mechanism of enzyme action - acid-base catalysis, covalent catalysis, strain, proximity and orientation effects. Mechanism of action of chymotrypsin. Enzyme regulation-feedback inhibition. Covalent modification of enzymes and compartmentation. Allosteric regulation. Enzyme repression, and induction.

Unit–IV

Enzyme reactors: types (stirred tank, continuous flow), Immobilization of enzymes: principles, parameters, carriers (inorganic, polysaccharides, polymers), binding methods (adsorption, covalent), applications. Enzyme engineering: principles, steps, enzyme engineering with reference to lysozyme. Enzyme production and purification: enzyme sources (plant, animal, wild type and recombinant microorganisms), processes to improve enzyme yield, downstream processing of enzymes and chromatographic purification (brief account). Enzyme electrodes. Biosensors: components, types, (calorimetric, potentiometric, amperometric), applications.

Unit–V

Enzymes of industrial significance: use of enzymes in detergents, textiles, and leather industry, production of glucose syrup, cheese production. Brief account of synzymes and solvent engineering. Soluble enzymes- introduction and applications in food, starch processing and detergents. Elementary details of enzymes as diagnostic aids. Therapeutic uses of enzymes: enzymes as thrombolytic agents and digestive aids. Regulations and safety criteria for production of enzymes and their use. Regulations governing use of enzymes produced in wild-type or recombinant organisms.

Text Books

1. Palmer T. Understanding enzymes. Prentice Hall. 2004.
2. Buchholz et al Biocatalysts and Enzyme Technology. 2nd ed Wiley-Blackwell. 2012.
3. Pandey et al. Enzyme Technology. 2010, Springer.
4. Nelson, Cox. Lehninger Biochemistry. 6th ed. Freeman 2012.
5. Balasubramanian et al. Concepts in Biotechnology. Univ Press 2004.

Reference Books

Dixon and Webb. Enzymes 3rd ed. Longmans 1979.

IBTP 33: PRACTICALS IN ANALYTICAL TECHNIQUES AND ENZYME TECHNOLOGY

1. Spectrophotometry: Analysis of standard curve, absorption spectrum of a given chromophore/oxidized and reduced forms (NAD,NADH).
2. Separation of amino acids by paper chromatography.
3. Separation of lipids by thin layer chromatography.
4. Separation of proteins by gel filtration - Demonstration.
5. Separation of plant pigments by adsorption chromatography.
6. Separation of proteins by SDS-PAGE.
7. GC and HPLC-Demonstration.
8. Subcellular fractionation.
9. Determination of achromatic point in α-amylase.
10. Determination of total and specific activity of α-amylase and assay of serum ALP/ACP.
11. Effect of pH on enzyme activity (lipase/cellulase).
12. Effect of temperature on enzyme activity (lipase/cellulase).
13. Effect of substrate concentration on enzyme activity (lipase/cellulase) and determination of Km value.

IBTT 43: METABOLISM AND REGULATION

Objective: To understand the bioenergetic principles, metabolic pathways and the regulatory mechanisms.

Unit–I Bioenergetics

Free energy and entropy. The ATP/ADP cycle. Enzymes involved in redox reactions. The electron transport chain. Oxidative phosphorylation- F_1F_0 ATPase, the chemiosmotic theory. Inhibitors of respiratory chain and oxidative phosphorylation- uncouplers, ionophores. Regulation of oxidative phosphorylation. Mitochondrial transport systems- ATP/ADP exchange, malate and glycerophosphate shuttle.

Unit–II Carbohydrate metabolism

Glycolysis- pathway, key enzymes and co-ordinate regulation. The citric acid cycle and regulation. Gluconeogenesis- pathway, reciprocal regulation of glycolysis and gluconeogenesis. The pentose phosphate pathway. Metabolism of glycogen- glycogenesis, glycogenolysis and their regulation. Glycogen storage disorders: von Gierke's disease only.

Unit–III Lipid metabolism

Oxidation of fatty acids: β-oxidation. Oxidation of unsaturated fatty acids, α- and ω-oxidation. Metabolism of ketone bodies- formation, utilization, excretion and clinical significance. Biosynthesis of fatty acids and regulation. Metabolism of triglycerides, phospholipids, and cholesterol. Regulation of cholesterol biosynthesis. Disorders of lipid metabolism (Tay-Sachs, Niemann-Pick only).

Unit–IV Metabolism of amino acids

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen- transamination, deamination, ammonia formation, the urea cycle. Overview of the catabolism of carbon skeletons of amino acids to amphibolic intermediates. Elementary details of the metabolism of phenylalanine and phenylketonuria.

Unit–V Metabolism of purines, pyrimidines & metabolic regulation

Denovo and salvage pathways of purine biosynthesis, purine catabolism. Biosynthesis and catabolism of pyrimidines. Regulation of purine, pyrimidine metabolism. Brief account of gout. General principles of metabolic regulation. Hormonal regulation of metabolism- role of epinephrine, glucagon, cortisol and insulin.

Text Books

1. Nelson and Cox. Lehninger's Principles of Biochemistry. 6th ed. Freeman. 2012.
2. Murray *et al*. Harper's Illustrated Biochemistry. 29th ed. Mc Graw Hill, 2012.
3. Voet and Voet, Fundamentals of Biochemistry. Wiley, 3rd ed. 2010.
4. Kuchel et al. Schaum's Outline of Biochemistry. Mc Graw Hill. 3rd ed. 2011.

IBTT 44: GENETICS AND SYSTEM PHYSIOLOGY

Objective: To acquire knowledge of the principles of genetics, and the physiology of different systems.

Unit–I

Definitions of some common terms in genetics- phenotype, genotype, heterozygous, homozygous, allele (dominant, recessive, wild-type, mutant), character, gene, gene locus, pure line, hybrid. Mendel's laws. Monohybrid cross, multiple alleles, dihybrid cross, test cross, backcross, epistasis. Basic concept of penetrance and expressivity.

Unit–II

Chromosome structure. Polytene and lampbrush chromosomes. Types of chromosomes on the basis of centromere position. Karyotyping. Variation in chromosome number (euploidy, aneuploidy), arrangement (translocation, inversion), number of chromosome segments (deletion, duplication). Population genetics- The Hardy-Weinberg law.

Unit–III

Linkage-definition, measurement, three factor crosses. Polygenic traits. Essential features of autosomal dominant, autosomal recessive, autosomal codominant, X-linked recessive, X-linked codominant and Y-linked. Brief outline of allosomal (Klinefelter syndrome), autosomal (Down syndrome) disorders. Brief outline of Non-Mendelian inheritance.

Unit–IV

Blood: Composition and functions of blood, RBCs, WBCs, platelets, and plasma proteins. Blood coagulation (brief outline).

The excretory system: structure of nephron. Formation and composition of urine.

Unit–V

Composition and functions of digestive secretions. Digestion and absorption of carbohydrates, lipids, and proteins (outline). Structure of neuron. Propagation of nerve impulse.Neurotransmitters (brief account). Structure of smooth, cardiac and skeletal muscle. Brief account of muscle proteins, muscle contraction and relaxation.

Text books

1. Elrod S. Schaum's Outline of Genetics. 5th ed. McGraw Hill. 2010.
2. Fletcher et al. Instant Notes in Genetics. 4th ed. BIOS. 2012.
3. Smith et al. Principles of Biochemistry. Mammalian Biochemistry. 7th ed. McGraw Hill (Unit – IV& 5).
4. Graaf & Rees. Schaum's Easy Outline of Human Anatomy & Physiology. 2nd ed. 2010.

Reference Books

1. Abouelmagd and Ageeley. Basic Genetics. 2nd ed. Univ Publ. 2013.
2. Barrett et al. Ganong's Review of Medical Physiology. 24th ed. Lange 2012.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012 (Unit – IV& 5).

IBTP 45: PRACTICALS IN GENETICS AND SYSTEM PHYSIOLOGY

1. Distinguishing mutant phenotypes of *Drosophilamelanogaster*-eye color mutant (white), eye surface/shape mutant (glazed), wing shape (curly) and body shape (tubby).
2. Monohybrid and dihybrid inheritance in *Drosophila*.
3. Setting up a cross and verifying Mendelian laws of inheritance-*w;wg^{Gla}/CyTb* cross.
4. Preparation of polytene chromosomes from *Drosophila* larvae.
5. Buccal smear–Barr bodies.
6. Karyotype analysis: Onion and human.
7. Enumeration of RBCs.
8. Enumeration of WBCs (total and differential count).
9. Estimation of bleeding time and clotting time.
10. Estimation of hemoglobin.
11. Qualitative analysis of urine and gastric juice.
12. Computer-based learning for physiological systems.

IBTT 51: CELL BIOLOGY

Objective: To learn in detail about the molecular organization of cells and the molecular mechanisms of cellular processes.

Unit–I Cell and tissue organization

Organization of prokaryotic and eukaryotic cells. Structure and functions of mitochondria, chloroplast, endoplasmic reticulum, ribosomes, Golgi, lysosomes, vacuoles, peroxisomes, glyoxisomes, cytoskeleton, nucleus, chromosomes. Types of tissues. Epithelium, connective tissue and extracellular matrix- proteoglycans, glycoproteins and glycosaminoglycans.

Unit–II Membranes and Intercellular communication

Composition of membranes. Fluid mosaic model. Endocytosis and exocytosis. Membrane transport: Diffusion (passive and facilitated). Uniport, symport, antiport systems. Active transport- $Na^{+}K^{+}$-ATPase, ionophores, and ion channels. Cell junctions- anchoring, tight and gap junctions. Cell adhesion molecules (CAMs)- cadherins and integrins (elementary details).

Unit–III Cell cycle, cell death, and cancer

Brief account of mitosis, meiosis, and cell differentiation.Fundamental concepts of cell cycle phases and regulation by cyclins and cyclin-dependent kinases. Basic principles of cell death by apoptosis and necrosis. Differences between benign and malignant tumors. Growth characteristics of malignant tumors. Morphological, ultrastructural, and metabolic alterations in tumor cells.

Unit–IV Cell signaling

Fundamental concepts and definitions of signal, ligands and receptors. General features of signal transduction. Endocrine, paracrine, and autocrine signaling. G-protein-coupled receptors. Second messengers: c-AMP, diacylglycerol, inositol triphosphate and Ca^{2+}. Receptor tyrosine kinases. The insulin receptor and protein phosphorylation cascade.

Unit–V Techniques in Cell Biology

Microtomy. Fixation and staining. Microscopy - basic principles, and components of light, bright field, phase contrast, and fluorescence microscopy Confocal microscopy (brief account) super resolution microscopy. Electron microscopy- principle, preparation of specimens for TEM and SEM. Flow cytometry.

Text Books

1. Karp. Cell & Mol Biol 7th ed 2013. Wiley.
2. Lodish et al Molecular Cell biology 7th ed. Freeman, 2012.
3. Wilson and Walker Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press 7th ed. 2012 (Unit– V).
4. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012 (Unit – II and III).

Reference Books

Alberts et al Molecular Biology of the Cell. 5th ed. Garland Sci. 2007.

IBTT 52: MOLECULAR BIOLOGY

Objective: To gain an insight into the molecular mechanisms of genetic information flow from DNA through RNA to protein.

Unit–I Chromatin

The central dogma of molecular biology. The *E.coli* chromosome and plasmids. Eukaryotic chromatin: nucleosomes, 30 nm fiber and higher order chromatin structure. Mitochondria and chloroplast genomes. Concept of gene. Definitions of the following: gene, cistron, coding region (ORF), transcription unit, untranslated region (UTR). Typical structure of protein-coding genes in prokaryotes and eukaryotes. Split genes-exons and introns.

Unit–II Replication

Messelson and Stahl experiment. Enzymes and proteins involved in replication in prokaryotes and eukaryotes: helicases, SSB, topoisomerases, DNA polymerases, DNA ligase. Mechanism of DNA replication in bacteria and eukaryotes: initiation, elongation, termination. The end-replication problem and telomerase. Inhibitors of replication. DNA damage and repair mechanisms (photoreactivation, excision and mismatch repair).

Unit–III Transcription

Transcription in *E.coli:* RNA polymerase, promoter sequence. Steps in transcription-template recognition, initiation, elongation and termination (intrinsic and rho-dependent). Transcription in eukaryotes: RNA polymerases-I, II and III. Promoters, transcription factors, transcription complex assembly, and mechanism of transcription. Inhibitors of transcription. Reverse transcription (elementary details).

Unit–IV RNA Processing and Regulation

Splicing and classes of introns. Post-transcriptional processing of mRNA, rRNA and tRNA. Alternative splicing. Ribozymes. Brief account of RNA editing, antisense RNA, and RNA interference.

Regulation of transcription in prokaryotes- The *lac* operon. Transcriptional regulation in eukaryotes (brief account).

Unit–V Genetic code and Translation

The genetic code: universal and mitochondrial. Mutations: point mutations and frameshift mutations. Mechanism of protein synthesis in bacteria and eukaryotes: amino acid activation, initiation, elongation and termination. Inhibitors of protein synthesis. Post-translational modifications. Protein targeting- the signal sequence hypothesis. Brief account of protein degradation. Translational regulation (brief account).

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Schaum's Outline of Molecular & Cell Biology. Stansfield et al. 2011

Reference Books

1. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2012.
2. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.
3. Twyman. Advanced Molecular Biology. BIOS Sci Publ. 2000.

IBTT 53: MICROBIOLOGY

Objective: To learn in detail about the various classes of microbes, microbial metabolism and recombination, microbial culture and food and medical microbiology.

Unit–I Bacteria

Classification of microbes, molecular taxonomy- Bacteria, eubacteria, cyanobacteria. archaebacteria. Ultrastructure of bacterial cell (Gram-positive and Gram-negative): Cell wall and cell membrane- structure and synthesis, flagella and motility, cell inclusions, endospore and capsule. Lactic acid bacteria, Pseudomonads, Mycobacteria, rickettsia. Staining- principle and types.

Unit–II Fungi, algae, protozoa and viruses

Fungi; classification and morphology of yeast and molds. Algae: occurrence, characteristics, classification, biologic and economic importance. Protozoa: occurrence, morphology, characteristics. Viruses: Classification and ultrastructure of bacterial, plant, and animal viruses. Lytic cycle and lysogeny. DNA and RNA viruses-replication (outline). Viroids and prions.

Unit–III Microbial culture and preservation

Microbial growth-growth curve, factors affecting growth. Culture media- types. Sterilization-physical, and chemical methods. Isolation of pure culture, incubation, streak, spread, pour-plate methods.

Enrichment techniques for aerobic and anaerobic bacteria, Isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microbes. Culture collection, preservation, lyophilization and freeze drying.

Unit–IV Microbial metabolism and Recombination

Microbial metabolism. Photosynthesis in microbes. Role of chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy; nitrate and sulfate reduction; methanogenesis and acetogenesis. Biogeocycle-carbon, sulfur, phosphorous, and nitrogen. Nitrogen metabolism, nitrogen fixation, hydrocarbon transformation. Recombination in bacteria- transformation, transduction and conjugation.

Unit–V Food and Medical Microbiology

Types and sources of microorganisms in food. Factors influencing microbial growth in food. Estimation of microorganisms in food. Fermented foods-yoghurt, cheese, sauerkraut. Production of beer, wine, vinegar. Probiotics and prebiotics.

Infectious diseases-methods of transmission. Antimicrobial agents- physical and chemical. Antibiotics and mode of action. Antibiotic resistance.

Text Books

1. Tortora *et al.* Microbiology: An introduction 11th ed. Benjamin Cummings, 2012.
2. Black JG. Microbiology: Principles and Explorations. Wiley 8th ed. 2012.

References

1. Madiagan *et al*. Brock Biology of microorganisms 13th ed. Prentice Hall, 2011.
2. Schaechter M ed. Encyclopedia of Microbiology - 3rdd ed. Acad Press 2009.
3. Pelczar *et al*. Microbiology 5th ed. Mc Graw-Hill, 2000.

IBTT 54: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Objective: To acquire knowledge on immunological mechanisms and immunotechniques.

Unit–I

Types of immunity-innate and acquired. Humoral & cell mediated immunity. Central & peripheral lymphoid organs. Cells of the immune system- lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes. NK cells, mast cells, interleukins.Antigens- definition, antigenicity and immunogenicity, antigenic determinants, epitopes, haptens. Immunoglobulins- structure, classification & functions.

Unit–II

T-cell, B-cell receptors. Antigen recognition- processing and presentation to T-cells. Interaction of T and B cells. Immunological memory. Effector mechanisms- macrophage activation. Cell mediated cytotoxicity, immunotolerance, immunosuppression. Complement activation. Clonal selection theory. Immunoglobulin rearrangements, class switching.

Unit–III

Transplantation types. MHC antigens in transplantation. Immunodeficiency disorders- AIDS: The HIV genome and life cycle. Autoimmunity and elementary details of autoimmune disorders (systemic lupus erythematosus, rheumatoid arthritis). Hypersensitivity- types (basic concepts only).

Unit–IV

Immunization practices-active and passive immunization. Vaccines-killed,attenuated, toxoids. Recombinant vector vaccines-DNA vaccines, synthetic peptide vaccines. Production and applications of polyclonal and monoclonal antibodies. Genetically engineered antibodies.

Unit–V

Agglutination and precipitation techniques. Immunoelectrophoresis, RIA, Immunoblotting, Avidin-biotin mediated immunoassay. Immunohistochemistry, immunofluorescence. Complement fixation test. ELISA-principle and applications. Chromatin immunoprecipitation.

Text Books

1. Goldsby *et al*. Kuby Immunology. WH Freeman & Co. 7th ed 2013.
2. Abbas *et al*. Cellular and Molecular Immunology. Elsevier 2011.
3. Janeway, C. (Ed), Paul Travers. Immunobiology 8th ed. Garland Publ. 2011.
4. Coico and Sunshine. Immunology: A short course. 6th ed.Wiley,2009.

Reference Books

Roitt et al. Roitt's Essential Immunology. 12th ed Wiley-Blackwell Sci. 2011.

IBTP 55: PRACTICALS IN CELL AND MOLECULAR BIOLOGY

1. Identification of tissue types, phases of cell division.
2. Isolation of cells-lymphocytes (Demonstration).
3. Light, phase contrast and electron microscope demonstration and photographs for interpretation.
4. Microscopic examination of epithelial cells, plant cells.
5. Separation of erythrocyte membrane and effect of detergents.
6. Metaphase chromosome preparation.

7. Cell fractionation- isolation and analysis of mitochondrial and chloroplast DNA.
8. Isolation of DNA.
9. Isolation of RNA from yeast.
10. Thermal denaturation of DNA.
11. UV absorption spectrum of proteins and nucleic acids- Demonstration.
12. Isolation of bacterial chromosomal and plasmid DNA and characterization by electrophoresis.
13. DNA electrophoresis in agarose gel.
14. Bacterial conjugation- Demonstration.
15. Bacterial transformation- Demonstration.

IBTP 56: PRACTICALS IN MICROBIOLOGY AND IMMUNOLOGY

1. Microscopic examination of bacteria, fungi, yeast.
2. Staining of microorganisms:
   - Simple, negative and differential (Gram) staining.
   - Acid-fast staining, Microchemical staining (Giemsa, crystal violet, Feulgen, acridine orange)
   - Cytological staining - endospore (malachite green), capsule (copper sulphate), flagella (Bailey's), cell wall (tannic acid/Congo red)
   - Organism-specific staining: staining for ova and cysts, milk bacteria, Mycoplasma, protozoa
3. Culture of microorganisms:
   - Preparation of liquid and solid media
   - Serial dilution, inoculation
   - Culture of bacteria in culture tubes, agar plates (streak plate, pour plate, lawn)
4. Isolation of pure cultures from soil and water.
   - Development of pure culture by serial dilution
   - Enrichment culture and plate count
   - Replica plating
5. Growth curve, enumeration of bacterial population by turbidimetry and serial dilution met*h*ods.
6. Effect of temperature, pH and carbon and nitrogen sources on growth.
7. Antibiotic sensitivity and resistance pattern of bacteria.
8. Identification of blood groups and Rh typing.
9. Radial immunodiffusion.
10. Double diffusion.
11. Agglutination, rosette formation, complement fixation.
12. Immunoelectrophoresis.
13. Preparation of antisera.

IBTT 61: BIOPROCESS ENGINEERING AND DOWNSTREAM PROCESSING

Objective: To learn the principles and techniques of bioprocess engineering and downstream processing.

Unit–I

Bioprocess engineering: Isolation and screening of industrially important microbes. Maintenance of strains. Inoculum development. Strain improvement- mutant selection, recombination, metabolite production by rDNA technology. Process development. Advantage of bioprocess over chemical process. Kinetics of microbial growth and death.

Unit–II

Bioreactors-design, parts and their function. Types of reactors. Media for industrial fermentation. Antifoaming devices. Types of fermentation processes: Analysis of batch, fed-batch and continuous bioreactions, analysis of mixed microbial population. Heat transfer and shear effects in culture. Mass transfer, effect of scale on mass transfer.

Unit–III

Downstream processing: Stages: solid-liquid separation, release of intracellular compartments, concentration of biological products, membrane filtration, precipitation, adsorption, dialysis, reverse osmosis, ultrafiltration, preservation and stabilization, purification by chromatography. Crystallization and drying. Product formulation. Monitoring of downstream processing.

Unit–IV

Industrial production of alcohol (ethanol), acids (citric acid, lactic acid), solvents (acetone, butanol), antibiotics (penicillin, cephalosporine), amino acids (lysine, aspartate,). Commercial production of fructose. Enzymes used for commercial purposes and their industrial production. Whole cell immobilization and industrial applications.

Unit–V

Biotransformation: general principles, biotransformation of D-sorbitol to L-sorbose, biotransformation of antibiotics, and steroids. Metabolic engineering: designed overproduction of phenylalanine. Single cell protein-microorganisms and substrates for SCP production, steps in SCP production and recovery, nutritional and safety evaluation, advantages.

Text Books

1. Smith. JE. Biotechnology. Cambridge Univ Press. 5th ed. 2012.
2. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.
3. Gupta PK. Elements of Biotechnology, Rastogi Publication, 2005.
4. Primrose Twyman and Old. Principles of gene manipulation and Genomics. 7th ed. Blackwell Sci 2006.

References

1. Flickinger and Drew (eds). Encyclopedia of Industrial Biotechnology. 8 vol. set. John Wiley & Sons, 2010.
2. Singh BD. Encyclopedia of Molecular Biotechnology. Anmol Publ 2011.
3. Casida Industrial Microbiology. 3rd Wiley Eastern reprint. John Wiley and Sons Inc. 1987.

IBTT 62: ENVIRONMENTAL BIOTECHNOLOGY

Objective: To comprehend the various biotechnological approaches to environmental management.

Unit–I

Environment- Basic concepts and issues. Environmental pollution, major types of wastes and pollutants, measurement of pollution, biosensors to detect environmental pollutants, hazards from wastes and pollutants. Methods of environmental management. Air pollution and its control through biotechnology.

Unit–II

Water pollution and its control. Sources and measurement of water pollution. Wastewater treatment-physical, chemical and biological processes. Activated sludge, oxidation ponds. Anaerobic processes: anaerobic digestion, anaerobic filters. Effluent treatment: D.O.C and C.O.D Treatment schemes for wastewaters of distillery, dairy, tannery, antibiotic industries.

Unit–III

Soil microbiota. Growth, ecological adaptations, interactions among soil microorganisms, biogeochemical role of soil microorganisms. Ecological considerations, decay behaviour and degradative plasmids. Microbial degradation of xenobiotics in the environment. Oil spill clean up. Bioremediation of contaminated soils and waste land. Biofertilisers. Biopesticides in integrated pest management- *Bacillus* and *Pseudomonas* as biocontrol agents. Biodegradable plastics. Biofilms.

Unit–IV

Renewable sources of energy (solar, wind, biogas, energy crops, cellulose); hydrogen production using hydrogenase and nitrogenase production. Conservation of energy. Bioleaching- use of microorganisms in mining of gold, uranium and copper. Global environmental problems: Ozone depletion, greenhouse effect, their impact and management.

Unit–V

Reforestation through micropropagation. Use of *Casuarina,* mycorrhizae in reforestation. Development of stress resistant plants.

Biodiversity- Alpha and beta diversity. Extinction and endangered species. Conservation of biodiversity. *In situ* and *ex situ* conservation- gene banks, species conservation.

Text Books

1. Smith. JE. Biotechnology. Cambridge Univ Press. 5th ed. 2012.
2. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.
3. Gupta PK. Elements of Biotechnology, Rastogi Publication, 2005.
4. Evans & Furlong. Environmental Biotechnology.Theory & Applications. 2nd ed 2010. Wiley-Blackwell.
5. Scragg A. Environmental Microbiology Oxford Univ Press. 2005.
6. Bhattacharya & Banerjee. Environmental Biotechnology. Oxford Univ Press 2009.

IBTT 63: GENETIC ENGINEERING

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

Unit–I Restriction enzymes and cloning vectors

Basic principles of rDNA technology. Restriction endonucleases-nomenclature and mechanism of action of type II restriction enzymes. Cloning vectors-essential features. Cloning in plasmid (pBR322) and phage (λ phage) vectors. Cosmids. Brief introduction to BACs and YACs. Expression vectors (brief outline).

Unit–II Cloning and rDNA transfer

Methods of splicing of DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation. Linkers and adaptors. Ligase-free joining. Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, viruses, microinjection. Host organisms for cloning- bacteria, plant, yeast and mammalian cells.

Unit–III rDNA Screening and Cloning strategies

Screening of recombinants: marker inactivation (antibiotic resistance, blue-white selection), restriction digestion, colony PCR, colony hybridization. Cloning strategies: Construction of genomic and cDNA libraries. Differences between genomic and cDNA libraries. Cloning of insulin.

Unit–IV Transgenic plants and animals

Methods of gene transfer in plants-*Agrobacterium*-mediated transformation and particle gun method. Transgenic plant technology-development of insect resistance plants. Applications of transgenic plants. Methods for producing transgenic animals-retroviral, microinjection, engineered stem cell. Uses of transgenic animals.

Unit–V Techniques

DNA sequencing. Chemical, and enzymatic methods. Southern, Northern, Western and Southwestern hybridization. DNA fingerprinting-principle and applications. PCR: principle and applications. Gene therapy-basic principles and applications. The human genome project (elementary details). Hazards and safety aspects of genetic engineering.

Text Books

1. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
2. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
3. Reece. Analysis of Genes and Genomes. Wiley 2004.

Reference Books

1. Winnacker EL. From Genes to clones. 4th ed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
3. Primrose, Twyman and Old. Principles of gene manipulation. 7th ed. Wiley-Blackwell. 2006.

IBTT 64: CELL AND TISSUE CULTURE

Objective: To acquire theoretical knowledge on cell and tissue culture techniques and the applications.

Unit–I Introduction to Cell and Tissue Culture Techniques

History and scope. Advantages and limitations of tissue culture. Laboratory facilities for tissue culture. Substrates, gas phase. Culture media: natural, defined media (with serum and serum free). Aseptic techniques-sterilization of glassware, media, workstation. Freeze storing of cells and transport of cultures. Biosafety.

Unit–II Primary culture, Cell lines, and Cloning

Primary cell culture: Disaggregation (enzymic, mechanical), separation of viable cells. Maintenance of cell lines. Advantages and disadvantages of finite and continuous cell lines. Cloning of cell lines and cell synchronization. Large scale cell cultures.

Unit–III Animal cell culture

Slide, flask, and test tube culture. Media components. Cell culture contamination-sources, consequences, prevention. Types of animal cell culture- primary, continuous and cancer cell lines. Subculturing, and cell quantitation. Whole embryo culture. Stem cell technology-basic principle and applications (brief outline).

Unit–IV Plant cell culture

Growth and development of plant cells and tissues *in vitro*. Laboratory requirements, aseptic techniques. Nutrient media: obligatory and optional constituents. Plant growth regulators: mode and mechanism of action. Explants for plant tissue culture. Callus culture, cell suspension culture, organ culture, protoplast culture.

Unit–V Applications of Tissue Culture

Applications of plant cell and tissue culture in breeding and industry: Mass propagation by organogenesis and embryogenesis, synthetic seeds, disease elimination. Commercial applications of animal tissue culture for diagnosis, development of vaccines. Production of biologically important compounds. Tissue engineering- basic concept.

Text Books

1. Martin BM. Tissue Culture Techniques- An Introduction. 1994. Birkhauser.
2. Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.
3. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.

Reference Books

1. Mather JP and Barnes D. Animal Cell Culture Methods. Vol 57, Elsevier.
2. Freshney RI. Culture of animal cells: A manual of basic technique. 6th ed. Wiley-Liss, 2010.

IBTP 65: PRACTICALS IN BIOPROCESS ENGINEERING, DOWNSTREAM PROCESSING AND ENVIRONMENTAL BIOTECHNOLOGY

1. Preparation of immobilized cell/enzyme beads using alginate.
2. Determination of growth curve of a microorganism and substrate degradation profile.
3. Computation of specific growth rate (m) and growth yield $Y_{x/s}$.
4. Comparative studies of ethanol production using different substrates.
5. Microbial production of citric acid using *Aspergillus niger*.
6. Determination of total dissolved solids in water.
7. Determination of D.O. concentration of water sample.
8. Determination B.O.D. of sewage sample.
9. Determination C.O.D. of sewage sample.
10. Estimation of nitrate in drinking water.
11. Efficiency of removal of air pollutants using fibrous air filter.
12. Production and estimation of alkaline protease.
13. Isolation and enumeration of soil bacteria.
14. Isolation and enumeration of bacteriophages from raw sewage.
15. Identification of heavy metals from sewage water by atomic absorption spectrometry.

IBTP 66: PRACTICALS IN GENETIC ENGINEERING AND TISSUE CULTURE

1. Extraction of genomic DNA.
2. Determination of molecular size of DNA.
3. Plasmid preparation.
4. Restriction enzyme digestion of DNA.
5. Phage titration.
6. Ligation of DNA fragments (GFP cloning - Demonstration)
7. PCR and analysis of PCR products.
8. Blotting techniques-Demonstration.
9. Tissue culture techniques: Surface sterilisation techniques, media preparation and storage, serum inactivation.
10. Staining of cell cultures and observations under microscope.
11. Cell count, protein estimation, mitotic index.
12. Role of additives on various explant cultures.

IBTT 71: ADVANCED MOLECULAR BIOLOGY

Objective: To comprehend advances in molecular biology and DNA-protein interactions.

Unit–I Genome complexity and Molecular Aspects of Development
DNA sequence elements: unique sequence DNA, repetitive DNA-SINEs, LINEs, satellite, minisatellite and microsatellite DNA. C-value paradox. Brief account of gene families, pseudogenes. Fundamental concepts of development, differentiation and morphogenesis. Development in *Drosophila*: homeotic genes, maternal genes, and segmentation genes.

Unit–II Mutations and Recombination
Mutations: types. Point mutations, frameshift mutations, and . Suppressor mutations-nonsense and missense suppression. Recombination: Homologous recombination-the Holliday model, molecular basis. Site-specific recombination-generation of immunoglobulin receptor diversity. Transposition- transposons. Mechanism of transposition in bacteria and eukaryotes. McClintock's work. Consequences and applications of transposition.

Unit–III Regulation of gene expression in prokaryotes
Basic principles of gene regulation-levels of gene expression, definition of housekeeping genes, upregulation and downregulation.

Regulation of gene expression in prokaryotes: The *lac* operon. Attenuation and the *trp* operon. Translational control in bacteria-regulation of r-protein operons. RNA regulation in *cis* and *trans*. Gene regulation by genetic recombination (phase variation in *Salmonella*).

Unit–IV Regulation of gene expression in eukaryotes
Transcriptional regulation by steroid hormone receptors, phosphorylation (STAT proteins). Translational regulation. Regulation of GAL genes transcription in yeast. Posttranscriptional gene silencing by RNA interference. Epigenetic regulation: DNA methylation, HATs and HDACs.

Unit–V Nucleic acid-Protein Interactions and Protein folding
Nucleic acid recognition by proteins. DNA-binding motifs in proteins-helix-turn-helix, zinc finger, leucine zipper, and helix-loop-helix. RNA-binding motifs in proteins. Techniques characterizing nucleic acid-protein interactions- gel retardation assay, DNaseI footprinting, modification protection and interference. Protein folding- models, molecular chaperones.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2012.
3. Alberts et al Molecular biology of the cell. 5th ed. Garland Sci. 2007.
4. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.

Reference Books

1. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.
2. Twyman. Advanced Molecular Biology. BIOS Sci Publ. 2000.

IBTT 72: ADVANCED GENETIC ENGINEERING

Objective: To learn cloning strategies, gene expression analysis, gene manipulation and genetic engineering techniques at an advanced level.

Unit–I Cloning strategies

Cloning vectors: Cloning in plasmid vectors (pBR322, pUC18). Bacteriophage lambda vectors-lambda biology, *in vitro packaging*, insertion and replacement vectors. M13 vectors. Cosmids. Expression vectors. BACs and YACs. Genomic libraries: construction, evaluation, growing and storing a genomic library. cDNA libraries: mRNA isolation, cDNA synthesis, construction of a cDNA library. Metagenomic, random, arrayed and ordered libraries.

Unit–II Expression of cloned genes

Factors affecting expression of cloned genes. Expression of cloned genes in bacteria. Fusion proteins, increasing protein stability and secretion. Expression in eukaryotic cells: Expression in yeast - yeast vectors. The GAL system, overexpression and secretion of heterologous proteins in yeast. Expression in insect cells: baculovirus system. Mammalian cell expression systems. Tagged proteins and secretion signals.

Unit–III Gene Expression Analysis

Analysis of transcription by northern, RNase protection, RT-PCR, *in situ* hybridization, and primer extension assays. Comparison of transcriptomes by differential screening, subtractive hybridization, differential display, array-based methods and microarray. Reporter genes- types and uses. Translational analysis by western, immunocytochemistry, immunohistochemistry, and 2-D electrophoresis.

Unit–IV Techniques

Extraction and purification of nucleic acids- cell lysis, extraction, precipitation, centrifugation, denaturation, purification, detection and

quantification. Probe preparation and screening libraries with gene probes, antibodies, rescreening, subcloning. PCR: basic principles, optimization, applications. Reverse Transcriptase (RT)-PCR, real-time PCR, RACE, RAPD, inverse PCR, ligase chain reaction. Gene knock-in and knock-out technology.

Unit–V Site-directed mutagenesis, Protein & Metabolic engineering
SDM-Cassette, oligonucleotide-directed mutagenesis, PCR-based methods. Use of SDM for protein engineering to improve enzymes and therapeutic proteins. Protein engineering by directed evolution and DNA shuffling. Metabolic engineering: designed overproduction of phenylalanine, novel routes to small molecules. Combinatorial biosynthesis. Hazards and safety aspects of genetic engineering.

Text Books

1. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
2. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience. 2011.
3. Primrose and Twyman and Old. Principles of gene manipulation. 6th ed. Wiley-Blackwell. 2006.

Reference Books

1. Winnacker EL. From Genes to clones. VCH Publ. 1987.
2. Primrose, and Twyman. Principles of gene manipulation and genomics. 7th ed. Wiley-Blackwell. 2006.
3. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.

IBTP 73: PRACTICALS IN ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING

1. Isolation of chromosomal and plasmid DNA from *E.coli*, agarose gel electrophoresis and identification.
2. Isolation of plant genomic DNA, agarose gel electrophoresis and identification.
3. Isolation of mammalian genomic DNA, agarose gel electrophoresis and identification.
4. DNA fragmentation by apoptosis.
5. Comet assay.
6. Restriction enzyme digestion and ligation.
7. Southern hybridization.
8. Electrophoresis of RNA and Northern hybridization.
9. SDS-PAGE of proteins and Western hybridization.
10. RNA isolation and cDNA synthesis.
11. RT-PCR
12. Real-time qPCR (Demonstration).

IBTT 81: PLANT BIOTECHNOLOGY

Objective: To acquire theoretical knowledge about plant tissue culture techniques, gene transfer methods, and transgenic plant technology.

Unit–I Plant tissue culture-I

Tissue culture as a technique to produce novel plants and hybrids. Sterilization. Nutrient medium. Use of growth regulators. Callus and suspension cultures. Techniques for culture of single cells. Regeneration. Organogenesis and somatic embryogenesis-techniques and applications. Anther, ovary, meristem culture. Somatic hybridization (Symmetric, Asymmetric, Cybrids). Embryo culture. Embryo rescue. *In vitro* pollination and fertilization. Synseed production.

Unit–II Plant tissue culture-II

Large-scale culture of plant cells. Production of biochemicals from cultured plant cells. Micropropagation. Somaclonal and Gametoclonal variation. Endosperm and nucellus cultures. Cryopreservation and *ex situ* conservation of germ plasm. Production of haploid plants and homozygous lines. Detection and uses of haploids in plant breeding. Protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants. Phytochemicals from plant tissue culture.

Unit–III Cloning in plants

Agrobacterium tumefaciens mediated transformation-Ti plasmids (cointegrate and binary vectors), direct nuclear transformation (protoplast transformation, particle bombardment), viral vectors (CaMV, gemini, TMV), chloroplast transformation. Use of reporter genes in transformed plant cells. Selectable markers for plants-drug resistance and herbicide resistance markers. RFLPs, RAPDs, DNA fingerprinting- general principles and applications in plant biotechnology.

Unit–IV Transgenic plant technology-I

Insect resistance plants-*cry* genes of *B.t.,* their proteins and target insects, *cry* gene expression in plants, insect resistance to Cry proteins. Strategies to obtain virus resistant transgenic plants. Herbicide resistance and stress- and senescence- tolerant plants. Modification of seed protein quality. Suppression of endogenous genes by antisense (delayed ripening) and ribozyme approaches. Cytoplasmic male sterility.

Unit–V Transgenic plant technology-II

Genetic modification of flower pigmentation. Terminator technology. Production of biochemicals and vaccines by transgenic plants. Modification of chloroplast and mitochondrial function. Problems in gene transfer in plants. Ethics of genetically engineered crops. Biotechnology and Intellectual Property Rights (IPR)- patents, trade secrets, copyright, trademark, TRIPS.

Text Books

1.Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.
2.Primrose Twyman and Old. Principles of gene manipulation and Genomics. 7th ed. BlackwellSci 2006.
3.Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
4.Watson et al. Recombinant DNA: Genes and genomes-A short course. 3rd ed. Freeman 2006.

Reference Books

Slater A. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford Univ Press 2008.

IBTT 82: ANIMAL BIOTECHNOLOGY

Objective: To gain an insight into animal tissue culture techniques, gene transfer and gene manipulation methods, and transgenic animal technology.

Unit–I Animal cell culture-I

Animal cell and tissue culture- merits and demerits. Laboratory facilities, substrate, culture media (natural and artificial). Culture procedures- preparation, sterilization, disaggregation of tissue (mechanical and enzymatic), subculture, contamination. Primary culture- cell lines, Secondary culture- transformed animal cells and continuous cell lines. Maintenance of cultures, cloning of cell lines, cancer cell lines. Large-scale culture of cell lines- monolayer, suspension and immobilized cultures.

Unit–II Animal cell culture-II

Tissue culture: slide, flask, and test tube culture. Organ culture-technique, advantages, limitations, applications. Whole embryo culture. Somatic cell hybridization, genetic analysis using cell hybridization and expression of cloned genes in cultured cells.

Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture.

Unit–III Manipulation of animal reproduction and characterization of animal genes

Manipulation of reproduction in animals. Artificial insemination, embryo transfer, *in vitro* fertilization. Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues.

Characterizing and isolating animal genes- homologues, linked markers and linkage mapping, bulked segregant analysis, direct identification of novel genes.

Production of recombinant vaccine for foot and mouth disease. Probiotics for disease control.

Unit–IV Gene transfer methods

Vectors for gene transfer in animals: retrovirus. Gene constructs-promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase, dihydrofolate reductase, CAT.

Transfection of animal cells- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, microinjection.

Unit–V Transgenic animal technology

Methods for producing transgenic animals- retroviral, microinjection, engineered stem cell. Targeted gene transfer. Transgene integration and identification methods. Transgenic cattle, sheep, fish and pigs. Uses of transgenic animals. Transgenic animals as models of human disease. Ethical issues in transgenesis.

Text Books

1. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
2. Primrose Twyman and Old. Principles of gene manipulation. 7th ed. Blackwell Sci 2006.
3. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
4. Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology. 7th ed. Cambridge University Press 2012.
5. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.

Reference Books

1. Primrose, and Twyman. Principles of gene manipulation and genomics. 7th ed. Wiley-Blackwell. 2006.
2. Freshney RI. Culture of animal cells: A manual of basic technique. 6th ed. Wiley-Liss, 2010.

IBTP 83: PRACTICALS IN PLANT AND ANIMAL BIOTECHNOLOGY

1. Plant tissue culture techniques: Surface sterilisation techniques, media preparation and storage.
2. Effect of plant growth regulators on various explants for callus induction, cell suspension culture, growth analysis, cell plating efficiency.
3. Organogenesis and somatic embryogenesis.
4. Shoot tip and nodal sector culture.
5. Anther culture.
6. Protoplast isolation and culture.
7. Animal cell culture techniques: Surface sterilization techniques, media preparation and storage, membrane filtration, serum inactivation.
8. Preparation of single cell suspension from spleen and thymus.
9. Primary culture of cells.
10. Estimation of protein, DNA and RNA from cultured cells.
11. MTT assay for cell viability and growth.
12. Preparation of metaphase chromosomes from cultured cells, karyotyping.
13. Trypsinization of monolayer and subculturing.
14. Cell cloning by single cell dilution method, freeze storing and revival of cultured cells.
15. Isolation of DNA and demonstration of apoptosis.

IBTT 91: GENOMICS AND PROTEOMICS

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

Unit–I Genome mapping and sequencing

Definition of genome and genomics. Types of gene map- genetic, cytogenetic and physical. Molecular markers for mapping- RFLPs, microsatellites and SNPs. Assembling a physical map of the genome- chromosome walking and jumping. Restriction enzyme fingerprinting. STS, ESTs, radiation hybrid mapping. Genome sequencing approaches- clone contigs, whole-genome shotgun, hierarchical shotgun. Identifying genes-sequence inspection, cDNA (EST) comparison, similarity searches.

Unit–II Genome projects, post-genome analysis

Genome projects: *E. coli*, *D. melanogaster*, *A. thaliana* and mouse. The human genome project: goals, mapping strategies, markers, sequencing technologies, results of final sequence, potential benefits and risks, ethical, legal and social issues (ELSI). Post-genome analysis-differential display, microarrays, SAGE and cluster analysis, ChIPs, knock-out analysis, genome-wide two-hybrid screens.

Unit–III Protein separation, identification and quantitation

Proteomics introduction. Protein separation- general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry:basic principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem mass spectrometry, and FTICR mass (elementary details).

Unit–IV Structural and functional proteomics

Structural proteomics: protein structure prediction, use of X-ray, NMR for structure analysis, comparative and homology modeling, secondary structure prediction, fold recognition and *ab initio* prediction. SCOP. Protein sequence analysis: evolutionary relationships, substitution score matrices, pairwise similarity search, pattern recognition. Determination of protein function: database search for homology, phylogenetic profile method, domain fusion. Protein-protein interactions: yeast 2-hybrid system, phage display.

Unit–V Protein arrays and applications of proteomics

Protein arrays and protein chips: protein expression mapping using antibody and antigen arrays, DNA array to study protein function, surface plasmon resonance biosensors. Manufacture, detection

and quantitation of proteins bound to protein chip. Bead and particle arrays in solution, cell and tissue arrays. Applications of proteomics-protein mining, protein expression profiling, mapping protein-network and protein modifications, drug diagnostics, and drug discovery.

Text Books

1. Lesk A. Introduction to Genomics. Oxford Univ Press. 2007.
2. Primrose. Principles of genome analysis. Wiley 2006.
3. Brown. Genomes. 2006 5th ed Wiley.
4. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience. 2011.
5. Lovrik Introducing Proteomics. Wiley-Blackwell. 2011.
6. Twyman. Principles of Proteomics. 2nd ed. 2013
7. Liebler DC. Introduction to proteomics. Humana Press. 2nd ed. 2007.
8. Campbell and Heyer. Discovering genomics, proteomics and bioinformatics. 2nd ed. 2006.

IBTT 92: NANOBIOTECHNOLOGY AND BIOINFORMATICS

Objective: To learn the basics and applications of nanobiotechnology and the importance of bioinformatics in storing, management and analyses of nucleic acid and protein data.

Unit–I

Basics of nanobiotechnology: Techniques for visualization of biomolecules at nanoscale- atomic force microscopy, optical microscopy, magnetic resonance force microscopy, TEM, SEM, FRET. Nanoparticles-metal, and bimetallic nanoparticles, quantum dots, dendrimers, and fluorescent nanoparticles. Production of nanoparticles: Collision/Coalescence mechanism of primary particle formation, nanoparticles agglomerates and aerogels. Biological synthesis of nanoparticles by fungi, bacteria, yeast, and actinomycetes.

Unit–II

Applications of nanotechnology in life sciences. Use of nanoparticles as biosensors. Nanoparticles for cleaning environment. Nanomolecular diagnostics- Use of nanoparticles as molecular imaging probes, nanoparticles for drug delivery, gene delivery. Clinical applications of nanotechnology- nanotechnology for detection of cancer and cardiovascular disease, infectious agents. Nanoparticles for *in vivo* molecular imaging (photodynamic therapy).

Unit–III

Scope, applications and limitations of bioinformatics. The world wide web. Useful search engines. File formats. PubMed. Bioinformatics workstation, Unix system. Scripting languages-Perl

and Python, markup languages- HTML, XML. Database- types. Database management systems- hierarchical, rational, and network. Biological databases: primary and secondary sequence databases, organism-specific databases, miscellaneous databases. Data submission. Information retrieval from databases- *Entrez,* DBGET and SRS.

Unit–IV

Sequence alignment: evolutionary basis, modular nature of proteins, optimal alignment methods, substitution scores and gap penalties, statistical significance of alignments.Database similarity searching: BLAST, FASTA, sequence filters, iterative database searches, PSI-BLAST. Multiple sequence alignments: rationale, and tools. Hidden Markov model. ESTs and gene discovery, gene prediction, and assessment of gene expression.

Unit–V

Molecular phylogenetics: terminology, phylogenetic tree construction methods, software programs and analysis. Identification of orthologs and paralogs. Structural bioinformatics: Gene, promoter and regulatory element prediction in prokaryotes and eukaryotes. RNA structure prediction methods, *ab initio*, comparative approach, performance evaluation. Protein structure database-protein structure visualization, comparison and classification. Protein motifs and domain prediction.

Text Books

1. Lesk AM. Introduction to bioinformatics. 4th ed. Oxford Univ Press 2013.
2. Campbell and Heyer. Discovering genomics, proteomics and bioinformatics. 2nd ed. Cold Spring Harbor Lab Press & Benjamin Cummings, 2006.
3. Hodgman et al. Instant Notes in Bioinformatics. 2nd ed. Taylor and Francis, 2009.
4. Krane et al Fundamental concepts of bioinformatics. Benjamin Cummings 2002.
5. Jain KK. Nanobiotechnology Molecular Diagnostics: Current Techniques and Applications. Taylor & Francis. 2006.
6. vo-Dinh (ed) Nanotechnology in Biology and Medicine: Methods, devices and applications. CRC Press. 2007.

Reference Books

1. Gibas and Per Jambeck. Developing bioinformatics computer skills. 2nd ed. O'Reilly Associates, 2013.
2. Baxevanis, Ouellette. Bioinformatics. A practical guide to the analysis of genes and proteins. 3rd ed. Wiley Interscience, 2004.

IBTT 93: FOOD BIOTECHNOLOGY

Objective: To acquire knowledge in the chemistry of foods, food microbiology, packaging and fermentation and food induustry.

Unit–I Chemistry of foods

Composition and factors affecting food composition. Moisture and minerals in foods.Plant pigments: occurrence, chemistry, functions and changes during processing. Flavonoids and tannins. Caramelisation. Gel formation and starch retrogradation.Pectins-occurrence and use in foods. Functional properties of proteins in foods, hydrolysis of proteins, major food proteins and their sources. Changes in proteins during processing. Oils and fats: rancidity, flavour reversion, refining, hydrogenation, shortenings and spreads.Emulsifying agents.Vitamins- changes during processing.

Unit–II Microorganisms in food and Food spoilage

Biotechnology in relation to the food industry. Nutritive value of food. Types and sources of microorganisms associated with food. Conditions that influence microbial growth in food- intrinsic and extrinsic factors. Estimating the number and types of microorganisms in food. Composition and spoilage of food, meat, fish, cereals, pulses, nuts and oil seeds, fruits and fruit products, vegetable and vegetable products.

Unit–III Food packaging and preservation

Food packaging: materials used for food packaging, shelf-life of packaged foods. Methods of food preservation. Control of microorganisms by retarding growth- low temperature, drying, intermediate moisture foods, chemicals. Control of microorganisms by destruction- gas treatments, heat, ionization radiation, ultraviolet radiation. Elementary idea of canning and packing.

Unit–IV Fermented foods and enzymes in food industry

Basic principles of food fermentation. Fermented foods- fermented milk- yoghurt, cheese, bread, fermented vegetables- sauerkraut, olives. Fermented meats and fish. Production of beer, wine, and vinegar. Mushroom farming. Use of enzymes in food industry-proteases in food processing, enzymes used in baking and dairy industry, enzymes in fruit juice and brewing industry.

Unit–V Food borne diseases

Food hazards, bacterial diseases, staphylococcal intoxication, botulism, C. perfringens food poisoning, Salmonellosis, Shigellosis, fungal illness, Mycotoxins, Aflatoxins. Food borne viruses. Detection of disease causing microorganisms.

Text Books

1. Montville et al. Food Microbiology: An introduction. 3rd ed. ASM Press. 2011.
2. Adams and Moss. Food Microbiology. 3rd ed. Royal Soc Chem 2007.
3. Singh BD. Biotechnology. Kalyani Publ.
4. Borem et al Understanding Biotechnology. Pearson 2011.

IBTP 94: PRACTICALS IN GENOMICS, PROTEOMICS, AND BIOINFORMATICS

1. Sequence alignment and searching
2. Gene prediction
3. Multiple sequence alignment
4. Phylogenetic analysis
5. Protein sequence analysis
6. Protein structure prediction
7. Protein structure alignment and comparison
8. Primer design
9. SNP finding in DNA sequence
10. ORF finding in DNA sequence
11. Visualization tools.
12. Microarray analysis.
13. Identification and characterization of proteins resolved on 2D PAGE (Demonstration).
14. HPTLC and GC-MS - Demonstration.
15. Structure determination of proteins and nucleic acids by NMR and X-ray crystallography (Demonstration).
16. Molecular modeling.

IBTT 101: MEDICAL BIOTECHNOLOGY

Objective: To acquire knowledge in food biotechnology, molecular basis of diseases, molecular diagnostics and therapeutics.

Unit–I Molecular Basis of Diseases-I

Genetic diseases. Chromosomal disorders (Down syndrome, Klinefelter's syndrome). Monogenic disorders (autosomal dominant, autosomal recessive, sex-linked). Multifactorial diseases. Role of tissues and hormones in blood sugar homeostasis. Diabetes mellitus: classification, diagnosis, management, complications. Atherosclerosis: risk factors, biochemical findings and management.

Unit–II Molecular Basis of Diseases-II

Cancer- growth characteristics of cancer cells, agents causing cancer (radiation, viruses and chemicals). Multistage carcinogenesis. Functions of proto-oncogenes and tumor suppressor genes. Brief account of role of epigenetics in cancer.

AIDS:The HIV genome and life cycle.Neuropsychiatric disorders:mutations in mitochondrial genes. Alzheimers disease-the amyloid cascade and genes involved.

Unit–III Molecular Diagnosis

Diagnostic kits. Tumor markers:oncofetal proteins, hormones, enzymes, tumor-associated antigens.Prenatal and neonatal screening for genetic disorders. DNA diagnostic systems:hybridization probes, nonradioactive probes. RFLP and PCR in disease diagnosis. DNA profiling using VNTRs, STRs, mitochondrial DNA variants. Histocompatibility testing: lymphocytotoxicity test, cross matching. Graft versus host reaction. Viral diagnostics: immunodiagnosis, molecular diagnosis. SNP-based diagnosis.

Unit–IV Molecular Therapeutics

Mabs, growth factors and interferons as therapeutic agents. Therapeutic agents from nonrecombinant and recombinant organisms. Antivirals and antiretrovirals. Drug delivery and targeting. Gene therapy: gene delivery systems, *ex vivo* and *in vivo* strategies, gene therapy for single-gene disorders, cancer and AIDS. Antisense and siRNA therapy. Nanotherapy. Stem cell therapy.

Unit–V Bioethics

Food and drug safety. Ethical issues in human gene therapy, human genome analysis and human cloning. Clinical trials: preclinical testing. Regulations for conducting clinical trials- Phase I, II, and III.

Text Books

1. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
2. Singh BD. Biotechnology. Kalyani Publ.
3. Borem et al Understanding Biotechnology. Pearson 2011.

Reference Books

1. Maulik and Patel Molecular Biotechnology Wiley-Liss. 1997.
2. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.

IBTT 102:BIOTECHNOLOGY MANAGEMENT

Objective: This course will enable students to understand different aspects of management pertaining to biotechnology industry in addition to principles of economics and accountancy.

Unit–I Principles of Management

Concepts of Management: Administrative Management (Planning, Organizing, Staffing, Directing and Controlling), policy formulation, Operative Management (Personnel, Materials, Production, Financial, Marketing, Time/space, Margin/Morale). Motivation, Communication, Decision-making, leadership, Innovation, Creativity, Delegation, Responsibility, Record keeping.

Unit–II Economics & Accountancy

Economics: Principles of economics with special reference to the laws of demand and supply, demand schedule, demand curves, labour welfare, general principles of insurance and inland and foreign trade, procedure of exporting and importing goods.

Accountancy: Principles of Accountancy, Ledger posting and book entries, preparation of trial balance, columns of a cash book, Bank reconciliation statement, rectification of errors, Profits and loss account, balance sheet. Structure of Indian financial systems.

Unit–III Portfolio and Project Management

Portfolio Management in the Biotechnology Industry:Balancing corporate need with product delivery to the market, impact of organizational size. Feasibility study. Project Management in Biotechnology Industry Sectors: objectives, sociotechnical considerations, insurance for projects, developing program strategy, risk assessment and management, tracking process, resources planning, management of uncertainty and safety issues. Clinical trials- introduction, organization, investigation, ethics. Regulatory affairs- Regulatory bodies for biotechnology products and compliance. Quality systems and control.

Unit–IV Production and Materials Management

Production Management: Concepts, Visible and Invisible inputs, Methodology of Activities, Performance Evaluation Technique, Process-Flow, Process Knowhow, Product development planning-rationale, targeted product profile, product development plan (clinical, project management, regulatory, nonclinical, quality control). Developing products with added value. Supply chain management- strategy, process.

Materials Management: Basic principles of materials management, major areas, scope, purchase, stores, inventory control and evaluation of materials management. TQM, quality systems and control.

Unit–V Marketing Management & Entrepreneurship

Principles of marketing, The Product Concept, Brand, Product positioning, Product strategy. Marketing communication, new product launching/development, Principles of advertising. Market Research: Measuring & Forecasting Market Demands, Estimating current demand, Estimating industry sales, Market share & Future demand. Distribution: Channels of distribution, wholesale, retail, departmental store, Chain stores. Transportation and storage. Copyrights, patents.

Entrepreneurship-Entrepreneurial traits, self appraisals, sources of funds. Business planning in Biotech.

Text Books

1. Harpum P. Portfolio, Program and Project Management in the pharmaceutical and biotechnology industries. 2010.
2. M.J. Roy. Biotechnology operations: Principles & Practices. CRC Press. 2011.
3. Biren N Shah, Bhavesh S Nayak, Vineet C Jain; Textbook Of Pharmaceutical Industrial Management; 2010; 1st edition; Elsevier India; ISBN: 9788131225394

IBTP 103: PRACTICALS IN FOOD AND MEDICAL BIOTECHNOLOGY

1. Isolation of microbes from spoiled vegetables.
2. Evaluation of milk quality.
3. Determination of ash, minerals, crude fiber, protein and carbohydrate content in foods.
4. Analysis of oils and fats by GLC.
5. Preparation of fruit juice concentrates and use of enzymes for clarity.
6. Dehydration of fruits and vegetables.Preparation of fruit juice powders.
7. Aseptic packaging, freeze preservation, drying and dehydration, food fermentation, pickling and curing.
8. Preservation of food products-using chemical preservatives.
9. Tissue collection, formalin fixation, sectioning, and staining.
10. Analysis of biochemical analytes by autoanalyser.
11. Use of ELISA for disease diagnosis.
12. PCR-based diagnosis.
13. Biochemical analyses for diabetes and cardiovascular disease.
14. Tumor marker analyses.

OPTIONALS OFFERED TO OTHER DEPARTMENTS
BIOO1: BASIC BIOCHEMISTRY

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

Unit–I

Classification and general properties of carbohydrates. Functions of biologically important monosaccharides, disaccharides, homopolysaccharides, and heteropolysaccharides. Carbohydrate metabolism:glycolysis, citric acid cycle, gluconeogenesis, pentose phosphate (HMP shunt) pathway, glycogen metabolism (overview only, structures not required). Diabetes mellitus (elementary details).

Unit–II

Amino acids: classification and general properties. The peptide bond. Biologically important peptides. Proteins–classification, functions, denaturation and renaturation. Orders of protein structure: Primary, secondary (α-helix, β-pleated sheet), supersecondary, tertiary, and quaternary structures. Protein metabolism: Catabolism of amino acid nitrogen- transamination, deamination, ammonia formation, urea cycle, (overview only, structures not required).

Unit–III

Classification of lipids. Fatty acids. Eicosanoids: biological functions of prostaglandins, thromboxanes and leucotrienes. Phospholipids and sphingolipids- biological functions. Structure and functions of cholesterol.Brief account of lipoproteins. Lipid metabolism: transport of fatty acids into mitochondria- role of carnitine, β-oxidation of fatty acids, biosynthesis of fatty acids (overview only, structures not required). Coronary heart disease (elementary details).

Unit–IV

Enzymes: Classification and nomenclature. Specificity, factors affecting enzyme activity- substrate, pH and temperature. Michaelis-Menten equation and Lineweaver Burk plot. Coenzymes and Isoenzymes (brief account only). Enzyme inhibition-competitive, non-competitive and uncompetitive (derivation of rate equation not required). Allosteric enzymes, feedback inhibition.

Unit–V

Nucleic acids: purine and pyrimidine bases, nucleosides and nucleotides. Biologically important nucleotides. DNA structure-Watson and Crick model. A, B, and Z forms of DNA. Triple and quadruple structures. DNA supercoiling. DNA

denaturation.Differences between DNA and RNA. Major classes of RNA- structure and biological functions. Minor classes of RNA.

Text books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th edition, 2012.
2. Murray et al. Harper's Illustrated Biochemistry 29th edition, McGraw Hill, 2012.
3. Satyanarayana U. Biochemistry. Books and Allied Publ, latest ed.

BIOO2: BASIC BIOTECHNOLOGY

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

Unit–I Bioprocess Engineering and Downstream Processing

Bioprocess engineering: Isolation and screening of industrially important microbes. Bioreactors- design, parts and their function. Types of reactors, media and fermentation processes. Downstream processing: solid-liquid separation, release of intracellular compartments, concentration of biological products, purification, preservation and stabilization, product formulation. Monitoring. Industrial production of ethanol and penicillin.

Unit–II Environmental and Energy Biotechnology

Wastewater treatment- physical, chemical and biological treatment processes. Effluent treatment. Bioremediation, oil spill clean up. Biodegradable plastics. Bioleaching- use of microorganisms in mining. Ozone depletion, UV-B, greenhouse effect, their impact and biotechnological approaches for management. Renewable sources of energy, biogas production.

Unit–III Enzyme and Food Technology

Immobilization of enzymes: methods, and applications. Biosensors: components, types,applications. Use of enzymes in detergents, textiles, leather and food industry. Production of glucose syrup and cheese. Methods of food preservation. Elementary idea of canning and packing. Basic principles of food fermentation. Production of beer.

Unit–IV Recombinant DNA Technology

Basic steps in cloning. Restriction endonucleases, cloning vectors (pBR322), phages (λ phage), cosmids and high-capacity cloning vectors (overview only). Introduction of rDNA into host cells by calcium phosphate coprecipitation, electroporation, lipofection, microinjection. Screening of recombinants by marker inactivation. Applications of rDNA technology.

Unit–V Plant, Animal, and Medical Biotechnology

Biofertilisers. Biopesticides (*Bacillus thuringiensis*).Transgenic plant technology: gene transfer by *Agrobacterium*-mediated method, development of insect resistant plants. Development and uses of transgenic animals. Gene therapy- basic principles.The human genome project (elementary details). Hazards and safety aspects of biotech.

Text Books

1. Smith. JE. Biotechnology. Cambridge Univ Press. 5th ed. 2012.
2. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.
3. Nicholls DTS. Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
4. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.

BIOO3: BIOCHEMICAL TECHNIQUES

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

Unit–I Spectroscopic techniques

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, and spectrofluorimetry. Atomic spectroscopy- principle and applications of atomic flame and flameless spectrophotometry. Basic principles of NMR, ESR and mass spectrometry and their biological applications.

Unit–II Radioisotope techniques

Nature and units of radioactivity. Detection and measurement of radioactivity- Geiger-Muller counter, solid and liquid scintillation counting. Quenching and quench correction. Autoradiography. Applications of radioisotopes in biology. Radiation hazards.

Unit–III Electrophoresis and blotting techniques

Electrophoresis: Factors influencing electrophoretic mobility. Principle, technique and applications of PAGE, SDS-PAGE, agarose gel electrophoresis, isoelectric focusing, 2-D PAGE, pulsed field gel electrophoresis. Detection, estimation and recovery of proteins in gels. DNA sequencing gels. Blotting techniques: Southern, Northern and Western.

Unit–IV Chromatography

General principles of partition and adsorption chromatography. Principle, instrumentation and applications of paper, thin layer, and

gas chromatography. Column chromatography-packing, loading, elution and detection. Principle, procedure, and applications of ion-exchange, molecular exclusion, and affinity chromatography. HPLC- principle, instrumentation and applications.

Unit–V Centrifugation

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuges. Analytical ultracentrifuge-molecular weight determination. Preparative ultracentrifuge-instrumentation and applications. Basic principle and technique of subcellular fractionation by differential centrifugation. Density-gradient centrifugation- rate zonal and isopycnic.

Text Books

1. Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology. 7th ed. Cambridge University Press 2012.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ. 2010.

BIOO4: IMMUNOLOGY

Objective: To acquire knowledge on immunological mechanisms and immunotechniques.

Unit–I

Types of immunity-innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system- lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes, NK cells and mast cells. Antigens- antigenicity, epitopes, haptens. Immunoglobulins- structure, classification and functions.

Unit–II

T-cell, B-cell receptors, Antigen recognition- processing and presentation to T-cells. Interaction of T and B cells. Immunological memory. Effector mechanisms- macrophage activation. Complement activation. Clonal selection theory. Organization and expression of immunoglobulin genes. Generation of antibody diversity.

Unit–III

Transplantation types. MHC antigens in transplantation. Immunodeficiency disorders - AIDS: The HIV genome and life cycle. Autoimmunity and elementary details of autoimmune disorders (systemic lupus erythematosus, rheumatoid arthritis). Hypersensitivity - types (basic concepts only).

Unit–IV

Immunization practices- active and passive immunization. Vaccines-killed, and attenuated. Recombinant vaccines- DNA vaccines, synthetic peptide vaccines. Production of polyclonal and monoclonal antibodies: principles, techniques and applications.

Unit–V

Agglutination and precipitation techniques. Immunoelectrophoresis, RIA, Immunoblotting, Avidin-biotin mediated immunoassay. Immunohistochemistry, immunofluorescence. Complement fixation test. ELISA-principle and applications.

Text Books

1. Goldsby *et al*. Kuby Immunology. WH Freeman & Co. 7th ed 2013.
2. Abbas *et al*. Cellular and Molecular Immunology. Elsevier 2011.
3. Janeway, C. (Ed), Paul Travers. Immunobiology 8th ed. Garland Publ. 2011.
4. Coico and Sunshine. Immunology: A short course. 6th ed. Wiley, 2009.

BIOO5: GENETIC ENGINEERING

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

Unit–I Restriction enzymes and cloning vectors

Basic principles of rDNA technology. Restriction endonucleases-nomenclature and mechanism of action of type II restriction enzymes. Cloning vectors-essential features. Mechanism of cloning in plasmid (pBR322) and phage (λ phage) vectors. Cosmids. Brief introduction to high-capacity cloning vectors - BACs and YACs. Expression vectors (brief outline).

Unit–II Ligation and rDNA transfer

Ligation of rDNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation. Linkers and adaptors. Ligase-free joining. Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, viruses, microinjection. Host organisms for cloning - bacteria, plant, yeast and mammalian cells.

Unit–III rDNA Screening and Cloning strategies

Screening of recombinants: marker inactivation (antibiotic resistance, blue-white selection), nucleic acid hybridization, *in vitro*translation. Cloning strategies: Construction of genomic and cDNA libraries. Differences between genomic and cDNA libraries. Cloning of insulin gene in *E. coli*

Unit–IV Transgenic plants and animals

Methods of gene transfer in plants-*Agrobacterium*-mediated transformation and particle gun method. Transgenic plant technology-development of insect resistance plants. Applications of transgenic plants. Methods for producing transgenic animals-retroviral, microinjection, engineered stem cell. Uses of transgenic animals.

Unit–V Techniques

DNA sequencing. Chemical, and enzymatic methods. Southern, Northern and Western hybridization. DNA fingerprinting- principle and applications. PCR: basic reaction, and applications. Gene therapy- basic principles. The human genome project (elementary details). Hazards and safety aspects of genetic engineering.

Text Books

1. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
2. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
3. Reece. Analysis of Genes and Genomes. Wiley 2004.

Reference Books

1. Winnacker EL. From Genes to clones. 4th ed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
3. Primrose, Twyman and Old. Principles of gene manipulation. 7th ed. Wiley-Blackwell. 2006.

BIOO6: CLINICAL BIOCHEMISTRY

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

Unit–I

Genetic diseases: Patterns of inheritance. Chromosomal disorders: Brief account of Down syndrome. Monogenic disorders (autosomal dominant, autosomal recessive, sex-linked). Screening for inborn errors: Prenatal and neonatal screening. Treatment strategies for inborn errors. Rationale for biochemical investigations in clinical practice. Collection of blood and urine samples for analysis: precautions and changes on keeping. Factors influencing biochemical analyses.

Unit–II

Structure and functions of the liver. Composition and functions of bile. Metabolism of bilirubin. Jaundice: classification, causes and biochemical findings.

Kidney: structure of nephron and formation of urine. Normal and abnormal constituents of urine. Pathogenesis, biochemical findings and management of glomerulonephritis, renal failure and nephrotic syndrome.

Unit–III

Blood glucose homeostasis: Role of tissues and hormones in the maintenance of blood glucose. Diabetes mellitus–classification, metabolic abnormalities, diagnosis and management. Acute complication–diabetic ketoacidosis. Long-term complications– retinopathy, neuropathy and nephropathy. Atherosclerosis: Risk factors, biochemical findings and management.

Unit–IV

Differences between benign and malignant tumors. Growth characteristics of cancer cells, Morphological and biochemical changes in tumor cells. Invasion and metastasis. Agents causing cancer–radiation, viruses, chemicals. Multistep carcinogenesis. Oncogenes and proto-oncogenes– mechanisms of proto-oncogene activation. Protein products of oncogenes and their mode of action. Tumor suppressor genes– p53.

Unit–V

AIDS-Incidence and clinical diagnosis. Molecular biology of HIV – tissue specificity, course of HIV infection. The HIV genome, HIV life cycle. Brief account of treatment strategies.

Nutritional disorders: Factors influencing BMR. Nitrogen balance. Protein Energy Malnutrition: classification, causes and management. Marasmus and Kwasiorkor: clinical features and biochemical findings. Obesity: Causes and consequences (brief account only).

Books Recommended

1. Harper's Biochemistry 29th edition McGraw-Hill (2012)
2. Practical Clinical Biochemistry Varley 4th and 6th editions. CBS Publ. (2006)
3. Clinical chemistry in diagnosis and treatment Mayne ELBS. (1999)
4. Clinical Chemistry. Marshall et al.7thedition Mosby (2012)
5. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics–5thed. Saunders (2012).
6. Principles of Internal Medicine. Harrison's vol 1 & 2, 18th edition Mc Graw Hill (2011).

ANCILLARY OFFERED TO OTHER DEPARTMENTS
BIOA1 Biochemistry-Paper I

Objective: This is an introductory course on the basic principles governing biological systems, structure-function relationships in biomolecules and metabolic pathways.

Unit–I

Laws of thermodynamics. Basic concepts of free energy, entropy and enthalpy. Standard free energy change. Exergonic and endergonic reactions. Bioenergetics: high energy phosphate compounds, the ATP/ADP cycle. Synthesis, utilization and breakdown of ATP. Biological oxidation: Redox reactions and oxidoreductases. Electron transport chain: components, role in energy capture, respiratory control. Oxidative phosphorylation-mechanism (Chemiosmotic theory), inhibitors, uncouplers and ionophores. Introduction to metabolism- anabolism and catabolism.

Unit–II

Enzymes: Definition, nomenclature and classification. Enzyme units. Factors affecting enzyme activity - substrate, pH, and temperature. Michaelis-Menten equation and Lineweaver Burk plot. Enzyme inhibition- competitive, non-competitive and uncompetitive (derivation of rate equation not required), allosteric enzymes, feedback inhibition. Coenzymes, multienzyme complexes, metalloenzymes and isoenzymes. Mechanism of enzyme action. Enzymes as diagnostic aids. Therapeutic uses of enzymes (thrombolytic agents and digestive aids). Elementary details of ribozymes, abzymes and extremozymes.

Unit–III

Classification and general properties of carbohydrates. Biologically important monosaccharides and disaccharides. Homopolysaccharides: structure and biological functions of starch, glycogen, and cellulose. Heteropolysaccharides:biological role of glycosaminoglycans. Carbohydrate metabolism- glycolysis, citric acid cycle, gluconeogenesis, pentose phosphate pathway, glycogen metabolism.

Unit–IV

Amino acids: classification and general properties. The peptide bond. Biologically important peptides. Proteins– classification, functions, acid-base properties and denaturation. Orders of protein structure: Primary, secondary (α-helix, β-pleated sheet), supersecondary, tertiary, and quaternary structures. Protein metabolism: Catabolism of amino acid nitrogen- transamination, deamination, ammonia

formation, urea cycle, catabolism of carbon skeletons (overview only). Conversion of amino acids to specialized products.

Unit–V

Classification of lipids. Fatty acids. Eicosanoids: biological functions of thromboxanes, prostaglandins, and leucotrienes. Phospholipids and sphingolipids- biological functions. Structure and functions of cholesterol.Brief account of lipoproteins. Lipid metabolism: β-oxidation of fatty acids, biosynthesis of saturated and unsaturated fatty acids, biosynthesis of ketone bodies and their utilization.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Schaum's Outlines Biochemistry 2nd ed. Mc Graw Hill.
3. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
4. Satyanarayana U. Biochemistry. Books and Allied Publishers, Latest ed.

Reference Books

Voet and Voet. Fundamentals of Biochemistry. 3rd ed. Wiley. 2010.

BIOA2 Biochemistry-Paper II

Objective: This is an introductory course on aspects of nutrition, biochemical basis of diseases and the basics of molecular biology and genetic engineering.

Unit–I

Elements of nutrition: Basal metabolic rate, nitrogen balance. Essential amino acids and essential fatty acids. Protein quality. Protein energy malnutrition: marasmus and kwashiorkor. Obesity: causes and consequences. Vitamins: classification. Sources, requirements, biological actions and clinical significance of fat-soluble (A, D, E, and K) and water- soluble (thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid and vitamin B_{12}) vitamins. Minerals: Distribution, biological functions and clinical significance of calcium, phosphate, magnesium, iron, zinc, copper, manganese, iodine, selenium and fluoride.

Unit–II

Biochemical basis of diseases: Inborn errors of metabolism-fundamental concepts with phenylketonuria as an example. Diabetes mellitus: classification, metabolic alterations, diagnosis, management, complications. Atherosclerosis: risk factors,

biochemical findings and management. Jaundice: Bilirubin metabolism, classification, diagnosis and management.

Unit–III

Nucleic acids: purine and pyrimidine bases, nucleosides and nucleotides. Biologically important nucleotides. Biosynthesis and catabolism of purines and pyrimidines. DNA structure- Watson and Crick model. A, B, and Z forms of DNA. DNA denaturation. Differences between DNA and RNA. Major classes of RNA-structure and biological functions. Minor classes of RNA.

Unit–IV

The central dogma of molecular biology.Organization of the prokaryotic and eukaryotic genome. Gene concept. DNA replication- enzymes, basic mechanism and inhibitors. DNA damage by physical and chemical mutagens. DNA repair-photoreactivation, excision repair. Transcription- RNA polymerase, overview of steps, inhibitors. Brief account of post-transcriptional modifications. Reverse transcription (concept only).

Unit–V

Genetic code-general features. Translation-steps. Inhibitors. Post-translational modifications. Regulation of gene expression-levels of regulation, constitutive and inducible genes. Jacob and Monod lac operon model.

Recombinant DNA technology: Basic steps in cloning. Restriction endonucleases, cloning vectors (pBR322), phages (λ phage), cosmids. Introduction of rDNA into host cells by calcium phosphate coprecipitation, electroporation, lipofection, microinjection. Screening of recombinants by marker inactivation. Applications of rDNA technology.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
3. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
4. Satyanarayana U. Biochemistry. Books and Allied Publishers, latest ed, 2

BIOAP1 BIOCHEMISTRY PRACTICAL (ANCILLARY)

1. Preparation of buffers.
2. Qualitative analysis of carbohydrates
3. Qualitative analysis of amino acids.
4. Separation of amino acids by paper chromatography.
5. Estimation of protein by Biuret/Lowry et al method
6. Separation of serum proteins by electrophoresis.
7. Determination of acid number/iodine number/saponification value of a fat.
8. Separation of lipids by TLC.
9. Determination of achromatic point in α-amylase.
10. Estimation of ascorbic acid in lemon.
11. Isolation of DNA from rat liver and estimation of DNA by diphenylamine method.
12. Thermal denaturation of DNA.
13. Estimation of RNA by orcinol method.
14. Analysis of normal and abnormal constituents of urine.
15. Estimation of blood glucose.
16. Estimation of serum cholesterol.
17. Estimation of serum bilirubin.
18. Assay of serum AST/ALT.

Reference Books

1. Practical Biochemistry by Plummer.
2. Practical Clinical Biochemistry by Varley.
3. Medical Lab Techniques by Todd & Stanford.

DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY
POSTGRADUATE DIPLOMA IN BIOTECHNOLOGY MANAGEMENT

Duration: One Year. Full time

Eligibility for Admission

Candidates for admission to PG Diploma in Biotechnology Management should have passed the B.Sc. Degree Examination in Biotechnology/Biochemistry/Microbiology,B.Tech. Biotechnology or equivalent thereof with not less than 50% of marks in Part-III.

Scheme of Examinations

Code No.	Course	L	P	C
BTM T101	Principles & Practice of Biotech Management	5	-	5
BTM T102	Plant and Animal Biotechnology	5	-	5
BTM T103	Industrial and Medical Biotechnology	5	-	5
BTM T 104	Project Management & Entrepreneurship	5	-	5
BTM P 105	Practicals in Biotechnology	-	15	5
BTM PJ 106	Project in Management			5
				Total 30

Theory	**Practicals**
Internal Assessment Marks : 25	Internal Assessment Marks : 40
Test I & II : 20	Test-I & II : 30
Assignment : 5	Seminar : 5
End-Semester Marks : 75	Viva : 5
Total Marks per paper : 100	End-Semester Marks : 60
	Total Marks per paper : 100

BTMT 101: PRINCIPLES AND PRACTICE OF MANAGEMENT

Objective: This course is intended to understand different aspects of management pertaining to biotechnology industry in addition to principles of economics and accountancy.

Unit I Principles of Management

Concepts of Management: Administrative Management (Planning, Organizing, Staffing, Directing and Controlling), policy formulation, Operative Management (Personnel, Materials, Production, Financial, Marketing, Time/space, Margin/Morale). Motivation, Communication, Decision-making, leadership, Innovation, Creativity, Delegation, Responsibility, Record keeping.

Unit–II Economics & Accountancy

Economics: Principles of economics with special reference to the laws of demand and supply, demand schedule, demand curves, labour welfare, general principles of insurance and inland and foreign trade, procedure of exporting and importing goods.

Accountancy: Principles of Accountancy, Ledger posting and book entries, preparation of trial balance, columns of a cash book, Bank reconciliation statement, rectification of errors, Profits and loss account, balance sheet. Structure of Indian financial systems.

Unit–III Portfolio and Project Management

Portfolio Management in the Biotechnology Industry- Balancing corporate need with product delivery to the market, impact of organizational size. Feasibility study. Project Management in Biotechnology Industry Sectors- objectives, sociotechnical considerations, insurance for projects, developing program strategy, risk assessment and management, tracking process, resources planning, management of uncertainty and safety issues. Clinical trials- introduction, organization, investigation, ethics. Regulatory affairs- Regulatory bodies for biotechnology products and compliance. Quality systems and control.

Unit–IV Production and Materials Management

Production Management: Concepts, Visible and Invisible inputs, Methodology of Activities, Performance Evaluation Technique, Process-Flow, Process Knowhow, Product development planning-rationale, targeted product profile, product development plan (clinical, project management, regulatory, nonclinical, quality control). Developing products with added value. Supply chain management - strategy, process.

Materials Management: Basic principles of materials management, major areas, scope, purchase, stores, inventory

control and evaluation of materials management. TQM, quality systems and control.

Unit–V Marketing Management & Entrepreneurship

Principles of marketing, The Product Concept, Brand, Product positioning, Product strategy. Marketing communication, new product launching/development, Principles of advertising. Market Research: Measuring & Forecasting Market Demands, Estimating current demand, Estimating industry sales, Market share & Future demand. Distribution: Channels of distribution, wholesale, retail, departmental store, Chain stores. Transportation and storage. Copyrights, patents. Entrepreneurship- Entrepreneurial traits, self appraisals, sources of funds. Business planning in Biotech.

Text Books

1. Harpum P. Portfolio, Program and Project Management in the pharmaceutical and biotechnology industries. 2010.
2. M.J. Roy. Biotechnology operations: Principles & Practices. CRC Press. 2011.
3. Biren N Shah, Bhavesh S Nayak, Vineet C Jain; Textbook Of Pharmaceutical Industrial Management; 2010; 1st edition; Elsevier India; ISBN: 9788131225394

BTMT102: PLANT AND ANIMAL BIOTECHNOLOGY

Objective: To acquire theoretical knowledge about tissue culture techniques, gene transfer methods, and transgenic plant and animal technology.

Unit–I Plant Cell and Tissue Culture

Laboratory facilities, sterilization, media for plant cell culture. Plant growth regulators: mode and mechanism of action. Explants for plant tissue culture. Callus and suspension culture, organ culture, protoplast culture. Somatic hybridization (Symmetric, Asymmetric, Cybrids). Embryo culture. *In vitro* pollination and fertilization. Synseed production. Large-scale culture of plant cells. Production of biochemicals from cultured plant cells. Micropropagation. Somaclonal and Gametoclonal variation.

Unit–II Animal Cell and Tissue Culture

Laboratory facilities, sterilization, media for animal cell culture. Slide, flask, and test tube culture. Cell culture contamination-sources, consequences, prevention. Types of animal cell culture: Primary cell culture - Isolation of tissue, disaggregation (enzymic, mechanical), separation of viable cells. Cell lines: Evolution and maintenance, advantages and disadvantages. Cloning of cell lines

and cell synchronization. Cancer cell lines. Subculturing, cell quantitation, maintenance, growth kinetics. Organ culture, whole embryo culture. Stem cell technology - basic principle and applications.

Unit–III Basic principles of rDNA technology

Restriction endonucleases- nomenclature and mechanism of action of type II restriction enzymes. Cloning vectors- Mechanism of cloning in plasmid (pBR322, pUC18) and phage (λ phage, M13) vectors. Cosmids. High-capacity cloning vectors- BACs, YACs and PACs. Expression vectors. Methods of splicing of DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation. Linkers and adaptors. Screening of recombinants: marker inactivation (antibiotic resistance, blue-white selection), nucleic acid hybridization, *in vitro* translation. Cloning strategies: Construction of genomic and cDNA libraries.

Unit–IV Transgenic Plant Technology

Methods of gene transfer: *Agrobacterium tumefaciens* mediated transformation- Ti plasmids (cointegrate and binary vectors), direct nuclear transformation (protoplast transformation, particle bombardment), viral vectors (CaMV, TMV). Use of reporter genes. Selectable markers for plants- drug resistance and herbicide resistance markers. RFLPs, RAPDs in plant genetic engineering. Transgenic plant technology: development of insect resistant, virus resistant herbicide resistance and stress-tolerant plants. Modification of seed protein quality. Suppression of endogenous genes by antisense (delayed ripening) and ribozyme approaches. Cytoplasmic male sterility. Terminator technology. Production of vaccines by transgenic plants. Ethics of genetically engineered crops.

Unit–V Transgenic Animal Technology

Transfection of animal cells:calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, microinjection. Viral vectors (SV40, adenovirus, retrovirus, baculovirus).Gene constructs- promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase, dihydrofolate reductase. Methods for producing transgenic animals- retroviral, microinjection, engineered stem cell. Transgenic cattle, sheep, fish and pigs. Uses of transgenic animals. Transgenic animals as models of human disease. Ethical issues in transgenesis. Gene knock-in and knock-out technology. The human genome project - goals, mapping strategies, results and ethical issues. Hazards and safety aspects of genetic engineering: Physical and biological containment. IPR.

Text Books

1. Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.
2. Primrose Twyman and Old. Principles of gene manipulation. 7th ed. Blackwell Sci 2006.
3. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
4. Watson et al. Recombinant DNA: Genes and genomes- A short course. 3rd ed. Freeman 2006.
5. Wilson and Walker. Principles & techniques of Biochemistry and Molecular biology. 7th ed. Cambridge University Press 2012.
6. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.

BTM T 103: INDUSTRIAL AND MEDICAL BIOTECHNOLOGY

Objective: To learn the principles and techniques of bioprocess engineering, downstream processing and biotechnological approaches to medical diagnostics and therapeutics.

Unit–I Bioprocess engineering

Isolation and screening of industrially important microbes. Maintenance of strains. Inoculum development. Strain improvement- mutant selection, recombination, metabolite production by rDNA technology. Process development. Advantage of bioprocess over chemical process. Kinetics of microbial growth and death.Bioreactors- Types. Media for industrial fermentation. Antifoaming devices. Types of fermentation processes: Analysis of batch, fed-batch and continuous bioreactions, analysis of mixed microbial population.

Unit–II Downstream processing

Stages in downstream processing: solid-liquid separation, release of intracellular compartments, concentration of biological products, membrane filtration, precipitation, adsorption, dialysis, reverse osmosis, ultrafiltration, preservation and stabilization, purification. Crystallization and drying. Product formulation. Monitoring of downstream processing. Industrial production of ethanol), citric acid, acetone, penicillin, lysine/aspartate, fructose and enzymes. Whole cell immobilization and industrial applications.

Unit–III Molecular Basis of Diseases

Genetic diseases: chromosomal disorders (Down syndrome). Monogenic disorders (autosomal dominant, autosomal recessive, sex-linked). Prenatal and neonatal screening for genetic disorders. Multifactorial diseases: Brief account of pathogenesis, diagnosis,

and management of diabetes mellitus and atherosclerosis. Cancer-growth characteristics of cancer cells, agents causing cancer. Functions of proto-oncogenes and tumor suppressor genes. Diagnostic kits. Tumor markers- oncofetal proteins, hormones, enzymes, tumor-associated antigens.

Unit–IV Molecular Diagnostics and Therapeutics

RFLP in disease diagnosis. PCR: principle and applications in medicine. DNA profiling using VNTRs. Histocompatibility testing: lymphocytotoxicity test, cross matching. Viral diagnostics: immunodiagnosis, molecular diagnosis. SNP-based diagnosis. Production and applications of monoclonal antibodies. Genetically engineered antibodies. Growth factors and interferons as therapeutic agents. Vaccines- killed, attenuated- toxoids. Recombinant vector vaccines- DNA vaccines, synthetic peptide vaccines. Antivirals and antiretrovirals. Gene therapy: gene delivery systems, *ex vivo* and *in vivo* strategies, target tissues, gene therapy for single-gene disorders, cancer and AIDS. Antisense and siRNA therapy. Nanotherapy. Stem cell therapy.

Unit–V Drug Design

Principles of drug development: lead discovery, lead modification, bioisosterism. Investigational new drugs: clinical trial phases. Bioinformatics in drug development- chemical diversity, computational screening. Pharmacogenomics (concept only). Quantitative structure-activity relationship: Physiochemical and electronic parameters used for quantifying drug action. Drug stereochemistry: basic concepts, chirality and drug action, influence of geometric isomerism on drug action. Conformational flexibility and multiple modes of action. Applications of NMR spectroscopyand X-ray crystallography in drug design.

Text Books

1. Smith. JE. Biotechnology. Cambridge Univ Press. 5th ed. 2012.
2. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.
3. Singh BD. Encyclopedia of Molecular Biotechnology.Anmol Publ 2011.
4. Pongracz et al. Medical biotechnology. Churchill Livingstone. 2009.
5. Khan FA. Medical Biotechnology. Academic Press. 2012.
6. Smith & Williams' Introduction to the principles of drug design and action, 4th ed, Taylor and Francis.
7. Goldsby *et al*. Kuby Immunology. WH Freeman & Co. 7th ed 2013.

References

1. Flickinger and Drew (eds). Encyclopedia of Industrial Biotechnology. John Wiley & Sons, 2010.

BTM T 104: PROJECT MANAGEMENT AND ENTREPRENEURSHIP

Objective: To learn the basics of project management and entrepreneurship.

Unit–I Introduction

Concepts of Project Management: Meaning and Definition of Project- Characteristics of a project- Project Life Cycle Phases- Role of a Project Manager- The Planning Process: Work Breakdown Structure- Cost Planning– tools & techniques, cost estimation- Time Planning– tools & techniques.

Unit–II

Project Appraisal: Technical Feasibility- Economic Feasibility- Financial Evaluation, Appraisal Under Risk and Uncertainty- Sensitivity Analysis- Social Cost Benefit Analysis: Rationale- Fundamentals of Shadow Pricing- Basic approaches to Social Cost Benefit Analysis.

Unit–III

Scheduling: Graphic representation of project activities- Network Analysis- Network Techniques: PERT and CPM. Resource Allocation- Overview of MS-Project 2000. Managerial and financial analysis– Resource survey– selection of plant layout- cost of capital

Unit–IV

Fundamentals of Entrepreneurship. Support mechanism for entrepreneurship in India- Role of knowledge centre and R&D- Knowledge centres like universities and research institutions- Role of technology and up gradation- Assessment of scale of development of Technology- Managing Technology Transfer- Regulations for transfer of foreign technologies- Technology transfer agencies.

Unit–V

Financial and economic feasibility- idea generation techniques– business plan preparation– project report– franchising– step by step approach for new venture creation– business enterprises– strategic approaches.

Text Books

1. Harvey Maylor, Project Management, Pearson Edu, New Delhi, 2nd ed.
2. Prasanna Chandra, Projects: Planning, Analysis, Selection, Implementation & Review, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 6th Edition.
3. United Nations Industrial Development Organisation, Guide to Practical Project Appraisal– Social Benefit Cost Analysis in Developing Countries, Oxford & IBH.
4. Jack R. Meredith, Project Management: A Managerial Approach, Wiley Publications, 1st Edition.

BTM P 105: PRACTICALS

1. Preparation of immobilized cell/enzyme beads using alginate.
2. Determination of growth curve of a microorganism and substrate degradation profile.
3. Comparative studies of ethanol production using different substrates.
4. Plant and animal tissue culture techniques: Surface sterilisation techniques, media preparation and storage.
5. Effect of plant growth regulators on various explants for callus induction, protoplast and cell suspension culture, growth analysis, cell plating efficiency.
6. Primary culture of animal cells, MTT assay for cell viability and growth. Subculturing.
7. Biochemical analyses for diabetes and cardiovascular disease.
8. Extraction of genomic DNA, plasmids, gel electrophoresis.
9. Restriction enzyme digestion, GFP cloning.
10. ELISA, Blotting techniques, PCR and real-time PCR-demonstration.

DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY

PG Diploma in Clinical Biochemistry
Add-On Programme

Eligibility

Degree in any branch of biology with a minimum of 50% of marks in the qualifying degree (for PH/SC/ST a mere pass in the qualifying examination). Candidates with a degree in Chemistry/Medicine/Chem Engg/Pharmacy may also apply. Candidates enrolled for on-campus 2-years M.Sc. [CBCS] programmes and fourth or fifth year of Integrated programmes of the University in the University are also eligible.

Duration of the Programme: One Year.

Hours of Instruction: Two hours a day for five days from 5.30 p.m. to 7.30 p.m.

Attendance: Minimum 75%

Maximum duration to complete the Programme: Two Years

Scheme of Examination

Code No.	Course	L	P	C
PGDCB T101	Physiology and Endocrinology	5	-	5
PGDCB T102	Clinical Biochemistry	5	-	5
PGDCB T103	Molecular Basis of Diseases	5	-	5
PGDCB P104	Practicals	-	15	5
Total 20				

Theory	**Practicals**
Internal Assessment Marks : 25	Internal Assessment Marks : 40
Test I & II : 20	Test-I & II : 30
Assignment : 5	Seminar : 5
End-Semester Marks : 75	Viva : 5
Total Marks per paper : 100	End-Semester Marks : 60
	Total Marks per paper : 100

PGDCB T101: PHYSIOLOGY AND ENDOCRINOLOGY

Objective: To understand system physiology,biological actions and regulation of hormone action.

Unit–I Neuromuscular System

Structure of neuron. Divisions of the nervous system- Central and Peripheral. Propagation of action potential. Neurotransmitters-examples and release. The neuromuscular junction. The acetylcholine receptor.Types of muscle. Structure of skeletal muscle. Muscle proteins– myosin, actin, troponin, tropomyosin and other proteins. Mechanism and regulation of contraction and relaxation of skeletal muscle.

Unit–II Blood

Composition and functions of blood. Separation of plasma and serum. Plasma proteins in health and disease. Red blood cells-formation and destruction. Composition and functions of WBCs. Blood coagulation: mechanism and regulation. Fibrinolysis. Anticoagulants.Transport of blood gases: oxygen and carbon dioxide. Role of 2,3 BPG.

Unit–III

Digestive system: Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Gastrointestinal hormones (brief account only).

Excretory system: Structure of nephron. Formation of urine: glomerular filtration, tubular reabsorption of glucose, water and electrolytes. Tubular secretion. Normal and abnormal constituents of urine.

Unit–IV Hormones-I

Classification and mechanism of action. The hypothalamus-pituitary axis. Anterior and posterior pituitary hormones: Biological functions and regulation.Thyroid hormones: synthesis (no structures), secretion, regulation and biological actions. Hyperthyroidism and Hypothyroidism.

Unit–V Hormones-II

Adrenal cortical hormones: synthesis (no structures), secretion, regulation and biological actions. Cushing's syndrome and Addison's disease. Adrenal medullary hormones: synthesis (no structures), secretion, regulation and biological actions of catecholamines.Pancreatic hormones: synthesis (no structures), regulation and biological actions of insulin and glucagon. Brief account of the biological actions of testosterone and estrogen.

Text Books

1. Murray et al. Harper's Illustrated Biochemistry 29th ed. McGraw Hill, 2012.
2. Smith et al. Principles of Biochemistry. Mammalian Biochemistry. 7th ed. McGraw Hill
3. Graaf & Rees. Schaum's Easy Outline of Human Anatomy & Physiology. 2nd ed. 2010.
4. Text Book of Medical Physiology, Guyton and Hall, 12th edition, Saunders (2007)
5. Williams Text Book of Endocrinology, S. Melmed et al., 12th edition, Saunders (2011)

PGDCB T102: CLINICAL BIOCHEMISTRY

Objective: To understand homeostatic mechanisms in biological systems, organ function tests and basics of nutrition with clinical correlations.

Unit–I

Rationale for biochemical investigations in clinical practice. Collection of blood and urine samples for analysis: precautions and changes on keeping. Factors influencing biochemical analyses.

Hydrogen ion homeostasis: Factors regulating blood pH– buffers, respiratory and renal regulation. Acid-base imbalance: Causes and biochemical findings in metabolic and respiratory acidosis and alkalosis.

Unit–II

Water, Sodium and potassium homeostasis: Fluid compartments of the body– distribution of water and electrolytes in ECF and ICF. Water balance– role of ADH. Sodium balance: the rennin-angiotensin-aldosterone system. Potassium balance. Hypo– and hypernatraemia. Hypo– and hyperkalemia.

Unit–III

Structure and functions of the liver. Composition and functions of bile. Metabolism of bilirubin. Liver function tests: measurement of bilirubin, prothrombin time, hippuric acid test, plasma enzymes. Jaundice: classification (retention and regurgitation), causes and biochemical findings. Neonatal jaundice. Causes, consequences and biochemical findings in hepatitis and cirrhosis. Gallstones.

Unit–IV

Kidney function tests: creatinine clearance, plasma levels of β_2–microglobulin, urea and creatinine. Tubular function tests– water load, concentration and acid excretion. Pathogenesis, biochemical

findings and management of glomerulonephritis, renal failure and nephrotic syndrome. Nephrolithiasis (brief account).

Unit–V

Factors influencing BMR. Nitrogen balance. Protein quality and essential amino acids. Protein Energy Malnutrition: classification, causes and management. Marasmus and Kwasiorkor: clinical features and biochemical findings. Brief account of causes and consequences of obesity. Sources, daily requirement, and deficiency manifestations of fat and water-soluble vitamins. Biochemical functions and clinical significance of minerals and trace elements.

Text Books

1. Practical Clinical Biochemistry Varley 4th and 6th editions. CBS Publishers (2006)
2. Clinical Chemistry in Diagnosis and Treatment Mayne ELBS. (1999)
3. Clinical chemistry W.J. Marshall, S. K. Bengert, M. Lapsley7thedition Mosby (2012)
4. Tietz textbook of Clinical Chemistry and Molecular Diagnostics – 5thedition Saunders (2012).
5. Principles of Internal Medicine. Harrison's vol 1 & 2, 18th edition Mc Graw Hill (2011)

PGDCB T103: MOLECULAR BASIS OF DISEASES

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

Unit–I

Genetic diseases: Patterns of inheritance. Chromosomal disorders: Brief account of Down syndrome and Klinefelter's syndrome. Monogenic disorders (autosomal dominant, autosomal recessive, sex-linked). Screening for inborn errors: Prenatal screening: amniocentesis and chorionic villus sampling. Neonatal screening. Treatment strategies for inborn errors.

Unit–II

Disorders of amino acid metabolism: Phenylketonuria, alkaptonuria. Disorders of carbohydrate metabolism: von Gierke's disease and galactosemia. Disorders of lipid metabolism: Gaucher's and Niemann Pick. Disorders of purine pyrimidine metabolism: Hyperuricemia and gout.

Unit–III

Blood sugar homeostasis: Role of tissues and hormones in the maintenance of blood sugar. Diabetes mellitus– classification, metabolic abnormalities, diagnosis and management. Acute complication– diabetic ketoacidosis. Long-term complications– retinopathy, neuropathy and nephropathy. Atherosclerosis: Risk factors, biochemical findings and management.

Unit–IV

Differences between benign and malignant tumors. Growth characteristics of cancer cells, Morphological and biochemical changes in tumor cells. Invasion and metastasis. Tumor markers: AFP, CEA and hCG only. Agents causing cancer: radiation, viruses, chemicals. Multistep carcinogenesis. Tests for mutagenicity– the Ames test. Oncogenes and proto-oncogenes: mechanisms of proto-oncogene activation. Protein products of oncogenes and their mode of action. Tumor suppressor genes– p53.

Unit–V

AIDS-Incidence and clinical diagnosis. Molecular biology of HIV: tissue specificity, course of HIV infection. The HIV genome, HIV life cycle. Treatment strategies: immunotherapy, drug therapy and gene therapy.Neuromuscular and neuropsychiatric disorders: Myasthenia gravis and Duchenne muscular dystrophy. Parkinson's disease: pathogenesis and therapy. Alzheimer's disease: the amyloid cascade hypothesis, genes and other factors involved.

Text Books

1. Harper's Biochemistry 29th edition McGraw-Hill (2012)
2. Biochemistry Zubay 4th edition 1998, William C. Brown Publication.
3. Clinical Chemistry in diagnosis and treatment Mayne ELBS. (1999)
4. Clinical Chemistry 6th edition W. J. Marshall, M. Lapsley, S. K. Bangert 6th editionMosby. (2008).
5. Tietz textbook of Clinical Chemistry and Molecular Diagnostics – 5thedition Saunders (2012).
6. Principles of Internal Medicine. Harrison's vol 1 & 2, 18th edition Mc Graw Hill (2011)
7. ImmunologyD. K. Male, J. Brostoff, D. Roth and I. M. Roitt 7th edition Mosby (2006)

PGDCB P104: PRACTICALS

1. Enumeration of RBCs, WBCs (Total & differential)
2. Blood hemoglobin.
3. Estimation of bleeding time and clotting time.
4. Hormone assay
5. Qualitative analysis of urine – Normal and abnormal constituents
6. Estimation of blood constituents
    i. Blood glucose
    ii. Blood urea.
    iii. Serum uric acid.
    iv. Serum creatinine.
    v. Serum cholesterol.
    vi. Serum HDL cholesterol.
    vii. Serum calcium.
    viii. Serum iron.
    ix. Serum inorganic phosphorus.
    x. Serum bilirubin
    xi. Serum protein - Biuret method – A/G ratio.
    xii. Serum protein – Bradford method.

DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY

PG DIPLOMA IN GENETIC ENGINEERING

Add-On Programme

Eligibility

Degree in any branch of biology with a minimum of 50% of marks in the qualifying degree(for PH/SC/ST a mere pass in the qualifying examination). Candidates with a degree in Chemistry/Medicine/ Chem Engg/Pharmacy may also apply. Candidates enrolled for on-campus 2-years M.Sc. [CBCS] programmes and fourth or fifth year of Integrated programmes of the University in the University are also eligible.

Duration of the Programme: One Year.

Hours of Instruction: Two hours a day for five days from 5.30 p.m. to 7.30 p.m.

Attendance: Minimum 75%

Maximum duration to complete the Programme: Two Years

Scheme of Examination

Code No.	Course	L	P	C
PGDGE T101	Recombinant DNA technology	5	-	5
PGDGE T102	Plant Genetic Engineering	5	-	5
PGDGE T103	Animal Genetic Engineering	5	-	5
PGDGE P104	Practicals	-	15	5
				Total 20

Theory	**Practicals**
Internal Assessment Marks : 25	Internal Assessment Marks : 40
Test I & II : 20	Test-I & II : 30
Assignment : 5	Seminar : 5
End-Semester Marks : 75	Viva : 5
Total Marks per paper :100	End-Semester Marks : 60
	Total Marks per paper : 100

PGDGE T101: RECOMBINANT DNA TECHNOLOGY

Objective: To learn the basic principles of rDNA technology, gene expression analysis, gene manipulation and genetic engineering techniques.

Unit–I Restriction enzymes and cloning vectors

Basic principles of rDNA technology. Restriction endonucleases: nomenclature and mechanism of action of type II restriction enzymes. Cloning vectors: Mechanism of cloning in plasmid vectors (pBR322, pUC18). Bacteriophage lambda vectors:lambda biology, *in vitro packaging*, insertion and replacement vectors. M13 vectors. Cosmids. Expression vectors. Supervectors:BACs and YACs.

Unit–II Ligation and rDNA transfer

Methods for ligating vector and insert: Cohesive end method, homopolymeric tailing, blunt-end ligation. Linkers and adaptors. Ligase-free joining. Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, viruses, microinjection. Host organisms for cloning:bacteria, plant, yeast and mammalian cells.

Unit–III rDNA Screening and Genomic Libraries

Screening of recombinants: marker inactivation (antibiotic resistance, blue-white selection), nucleic acid hybridization, *in vitro* translation. Genomic libraries: construction, evaluation, growing and storing a genomic library. cDNA libraries: mRNA isolation, cDNA synthesis, construction of a cDNA library. Metagenomic, random, arrayed and ordered libraries.

Unit–IV Expression of cloned genes

Factors affecting expression of cloned genes. Expression of cloned genes in bacteria- strong and regulatable promoters. Fusion proteins, increasing protein stability and secretion. Expression in eukaryotic host cells: Expression in yeast- yeast vectors. The GAL system, overexpression and secretion of heterologous proteins in yeast. Expression in insect cells: baculovirus system. Mammalian cell expression systems. Tagged proteins and secretion signals.

Unit–V Techniques

Extraction and purification of nucleic acids:cell lysis, extraction, precipitation, centrifugation, denaturation, purification, detection and quantification. Probe preparation and applications. PCR: basic reaction, optimization, applications. Reverse Transcriptase (RT-PCR), real-time PCR, RACE, RAPD, inverse PCR, ligase chain reaction. DNA sequencing. Chemical, and enzymatic methods. Southern,

Northern and Western hybridization. DNA fingerprinting- principle and applications. Hazards and safety aspects of genetic engineering.

Text Books

1. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
2. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
3. Reece. Analysis of Genes and Genomes. Wiley 2004.

Reference books

1. Winnacker EL. From Genes to clones. 4th ed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
3. Primrose, Twyman and Old. Principles of gene manipulation. 7th ed. Wiley-Blackwell. 2006.

PGDGE T102: PLANT GENETIC ENGINEERING

Objective: To acquire theoretical knowledge about plant tissue culture techniques, gene transfer methods, and transgenic plant technology.

Unit–I Plant tissue culture-I

Plasticity and totipotency. The culture environment. Plant cell culture medium and growth regulators. Culture types: Callus, cell suspension, protoplasts, roots, shoot tip and meristem, embryo culture, microspore culture. Plant Regeneration. Organogenesis and somatic embryogenesis- techniques and applications.Somatic hybridization (Symmetric, Asymmetric, Cybrids).

Unit–II Plant tissue culture-II

Large-scale culture of plant cells. Production of biochemicals from cultured plant cells. Micropropagation. Somaclonal and Gametoclonal variation. Endosperm and nucellus cultures. Cryopreservation and *ex situ* conservation of germplasm. Production of haploid plants and homozygous lines. Detection and uses of haploids in plant breeding. Protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants. Phytochemicals from plant tissue culture.

Unit–III Cloning in plants

Agrobacterium tumefaciens mediated transformation:Ti plasmids (cointegrate and binary vectors), direct nuclear transformation (protoplast transformation, particle bombardment), viral vectors (CaMV), chloroplast transformation. Use of reporter genes in transformed plant cells. Selectable markers for plants- drug

resistance and herbicide resistance markers. RFLPs, RAPDs, DNA fingerprinting- general principles and applications in plant biotechnology.

Unit–IV Transgenic plant technology-I

Insect resistance plants - *cry* genes of *B.t.,* their proteins and target insects, *cry* gene expression in plants, insect resistance to Cry proteins. Strategies to obtain virus resistant transgenic plants. Herbicide resistance and stress - and senescence-tolerant plants. Modification of seed protein quality. Golden rice. Suppression of endogenous genes by antisense (delayed ripening) and ribozyme approaches. Cytoplasmic male sterility.

Unit–V Transgenic plant technology-II

Genetic modification of flower pigmentation. Genetic manipulation of crop yield by enhancement of photosynthesis. Terminator technology. Molecular farming: Production of biochemicals and vaccines by transgenic plants. Modification of chloroplast and mitochondrial function. Problems in gene transfer in plants. Ethics of genetically engineered crops. Biotechnology and Intellectual Property Rights (IPR) - patents, trade secrets, copyright, trademark, TRIPS.

Text Books

1. Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.
2. Primrose Twyman and Old. Principles of gene manipulation and Genomics. 7th ed. BlackwellSci 2006.
3. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
4. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.

Reference Books

Slater A. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford Univ Press 2008.

PGDGE T103: ANIMAL GENETIC ENGINEERING

Objective: To gain an insight into animal cell culture techniques, gene manipulation methods in animals and transgenic animal technology.

Unit–I Animal cell culture-I

Animal cell and tissue culture- merits and demerits. Laboratory facilities, substrate, culture media (natural and artificial). Culture procedures:preparation, sterilization, diassgregation of tissue (mechanical, enzymatic), subculture, contamination. Primary culture:cell lines, Secondary culture:transformed animal cells and continuous cell lines. Maintenance of cultures, cloning of cell lines, cancer cell lines. Large-scale culture of cell lines:monolayer, suspension and immobilized cultures.

Unit–II Animal cell culture-II

Tissue culture: slide, flask, and test tube culture. Organ culture:technique, advantages, limitations, applications. Whole embryo culture. Somatic cell hybridization, genetic analysis using cell hybridization and expression of cloned genes in cultured cells.Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture.

Unit–III Manipulation of animal reproduction, SDM& Protein Engg

Manipulation of reproduction in animals. Artificial insemination, embryo transfer, *in vitro* fertilization. Embryo transfer in cattle and applications. Somatic cell cloning:cloning of Dolly. Probiotics for disease control.

Site-directed mutagenesis (SDM):Cassette, oligonucleotide-directed mutagenesis, PCR-based methods. Use of SDM for protein engineering to improve enzymes and therapeutic proteins. Protein engineering by directed evolution and DNA shuffling. Metabolic engineering: designed overproduction of phenylalanine, novel routes to small molecules. Combinatorial biosynthesis.

Unit–IV Gene transfer methods

Vectors for gene transfer in animals: SV40, retrovirus. Gene constructs- promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells:thymidine kinase, dihydrofolate reductase, CAT. Transfection of animal cells:calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, microinjection. Production of recombinant vaccine for foot and mouth disease.

Unit–V Transgenic animal technology

Methods for producing transgenic animals - retroviral, microinjection, engineered stem cell. Targeted gene transfer. Transgene integration and identification methods. Transgenic cattle, sheep, fish and pigs. Uses of transgenic animals. Transgenic animals as models of human disease. Ethical issues in transgenesis.

Text Books

1. Glick and Pasternak. Molecular Biotechnology.4th ed.ASM Press 2009.
2. Primrose Twyman and Old. Principles of gene manipulation. 7th ed. Blackwell Sci 2006.
3. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
4. Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology. 7th ed. Cambridge University Press 2012.
5. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.

Reference Books

1. Primrose and Twyman. Principles of gene manipulation and genomics. 7th ed. Wiley-Blackwell. 2006.
2. Freshney RI. Culture of animal cells: A manual of basic technique. 6th ed. Wiley-Liss, 2010.

PGDGE P103: PRACTICALS

1. Isolation of chromosomal and plasmid DNA from *E.coli*, agarose gel electrophoresis and identification.
2. Isolation of plant genomic DNA, agarose gel electrophoresis and identification.
3. Isolation of mammalian genomic DNA, agarose gel electrophoresis and identification.
4. Plant tissue culture techniques: Surface sterilisation techniques, media preparation and storage.
5. Effect of plant growth regulators on various explants for callus induction, cell suspension culture, growth analysis, cell plating efficiency.
6. Protoplast isolation and culture.
7. Animal cell culture techniques: Surface sterilization techniques, media preparation and storage, membrane filtration, serum inactivation.
8. Primary culture of cells, estimation of protein, DNA and RNA from cultured cells.
9. MTT assay for cell viability and growth.
10. Trypsinization of monolayer and subculturing.
11. Restriction enzyme digestion of DNA.
12. Southern, northern and western hybridization.
13. RNA isolation and cDNA synthesis.
14. RT-PCR
15. Real-time qPCR (Demonstration).

DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY
M.Phil. BIOCHEMISTRY/BIOTECHNOLOGY

Duration

The M.Phil.programme is for 1 year spread over two semesters.The programme including M.Phil.dissertation shall be completed within a maximum period of 2 years. In order to be eligible for the award of the Degree of Master of Philosophy, a candidate shall have to obtain 50 per cent of the maximum marks (or) equivalent grade point average in (1) each of the prescribed papers

(2) Dissertation and (3) viva-voce examination.

Course Work

All M.Phil.students shall take 3 courses of 6 credits spread over two semesters.

Course I: Research Methodology: This will be common to all the students of the department.

Course II: Core Subject: This will be common to all the students of the department.

Course III: Field of Specialization:

Examination for Paper I and II will be held at the end of the first semester and the examination for Paper III will be held at the end of the second semester.

Semester No.	Course	Credit	Internal Assessment Marks	End Semester Exam Marks	Total Marks
First	Paper-I	6	25	75	100
	Paper II	6	25	75	100
Second	Paper-III	6	25	75	100
	Dissertation	8	-	-	100
	Viva-voce	4	-	-	100
Total		**30**			**500**

M.Phil.BIOCHEMISTRY/BIOTECHNOLOGY

Paper I Research Methodology

Unit–I Scientific Research

Importance and need for research ethics and scientific research.Formulation of hypothesis. Types and characteristics– designing a research work.

Unit–II Scientific Writing

Scientific Writing Characteristics.Logical format for writing thesis and papers.Essential features of abstract, introduction, review of literature, materials and methods, and discussion.Effective illustration- tables and figures. Reference styles: Harvard and Vancouver systems.

Unit–III Bioinformatics

The scope of bioinformatics.The internet.The World Wide Web. File transfer protocol. Useful search engines. Entrez, File formats.Biological databases.Sequence and structure, NCBI, Data retrieval.Searching sequence database. Sequence similarity searches, amino acid substitution matrices. Database search-FASTA and BLAST, Protein multiple sequence alignments, CLUSTAL.

Unit–IV Biostatistics

Collection and classification of data-diagrammatic and graphic representation of data. Measurement of central tendency-standard deviation-normal distribution .Test of significance based on large samples, small samples. Student *t* test. Correlation and regression. Chi square test for independence of attributes.ANOVA.

Unit-V Bioethics And Patenting

Declaration of Bologna.Ethics in animal experimentation.CPCSEA guidelines.Animal care and technical personnel environment.Animal husbandry, feed, bedding, water, sanitation and cleanliness, waste disposal, anesthesia and euthanasia.

Composition of (Human) Institutional Ethical Committee (ICE)-General ethical issues.Specific principles for clinical evaluation of drugs, herbal remedies and human genetics research. Ethics in food and drug safety. Environmental release of microorganisms and genetically engineered organisms. Ethical issues in human gene therapy and human cloning.

Patenting– definition of patent.Product and process patents. Patenting multicellular organisms. Patenting and fundamental research.

BOOKS RECOMMENDED

1. R.A.Day. How to write a scientific paper.Cambridge University Press.
2. Cooray P.G. Guide to scientific and technical writing.
3. Carter V Good and Douglas E seats Methods of Research.
4. Alley, Michael. The craft of scientific writing. Englewood Cliffs. N.N. prentic 1987.
5. M.C. Sharma, Desk Top Publishing on PC, BPB Publications, 1997.
6. Lesk, A.M. Introduction to Bioinformatics Oxford 2002.
7. Krane et al Fundamental concepts of bioinformatics Benjamin Cummings.
8. SundarRao, Jesudian Richard – An introduction to Biostatistics.
9. S.P. Gupta – Fundamentals of statistics, Sultan Chand.
10. Ethics and the use of alternatives to animals in research and education. Shirance Pereira. CPCSEA.
11. CPCSEA guidelines for laboratory animal facility (CPCSEA) – No. 13 Seaward road, Valmiki Nagar Chennai-41.
12. Ethical guidelines for biomedical research on human subjects. ICMR, New Delhi, 2000.

Paper II- Analytical Methods

Unit–I Chromatography

Chromatography: Performance parameters (retention time, elution volume, capacity factor, plate height, and resolution). Low pressure liquid chromatography (LPLC) - principle, columns, matrix materials, procedure.HPLC-columns, matrix, mobile and stationary phases, sample application, pumps, detectors.HPTLC - principle, procedure, applications. Fast protein liquid chromatography. Reversed phase chromatography.

Unit–II Microscopy and cell culture techniques

Light microscopy-components, specimen preparation. Optical contrast, specimen stains. Fluorescence microscopy, fluorophores. Optical sectioning:confocal microscopes, multiple photon microscopes. Imaging living cells and tissues.Stereomicroscope. Electron microscopy:principle, specimen preparation for TEM and SEM.

Cell culture techniques: Equipment- hoods, CO_2 incubator. Safety considerations, aseptic techniques, eradication of infections. Animal cell cultures:primary cell cultures, cell lines, media and growth requirement, subcultures, cell quantification, cryopreservation, cell viability. Elementary details of bacterial and plant cell cultures.

Unit–III Immunochemical techniques

Antibody labeling: radiolabeling, labeling with fluorochromes and enzymes, biotinylation. Immunoblotting. Immunoassays: competitive binding, immunometric, solid-phase immunobinding, enhanced, peptide-based, fluorescence and photoluminescence-based. Immunohisto/cytochemistry. Immunofluorescence techniques. Immunoelectron microscopy. Chromatin immunoprecipitation. Flow cytometry.

Unit–IV Electrophoretic and Spectroscopy techniques

Electrophoresis of proteins.SDS-PAGE, isoelectric focusing, 2D-PAGE.Detection, estimation and recovery of proteins in gels. Electrophoresis of nucleic acids: agarose gel electrophoresis, DNA sequencing gels, pulsed field gel electrophoresis. Electrophoretic mobility shift assay. Southern, Northern and Western blotting.

Basic principle and biological applications of IR, NMR and ESR. Mass spectrometry: principle, instrumentation, ionization, mass analyzers, MALDI-TOF and tandem mass spectrometry (elementary details only).

Unit–V Molecular Biology Techniques

Probe preparation: end labeling, random primer labeling, nick translation, molecular beacon-based probes. RFLP, DNA fingerprinting, FISH. PCR-principle and applications.RT-PCR.Real-time quantitative PCR, differential display PCR, allele-specific oligonucleotide PCR. DNA sequencing:chemical and enzymatic methods, automated fluorescence method, pyrosequencing, cycle sequencing. DNA and protein microarrays:fabrication and applications.

Books recommended

1. Wilson and Walker.Principles and techniques of Biochemistry and Molecular biology.6th ed. Cambridge University Press 2005.
2. Boyer, R. Modern Experimental Biochemistry.3rd ed. Addison Weslery Longman, 2000.
3. Sambrook.Molecular Cloning.Cold Spring Harbor Laboratory, 2001.
4. Friefelder and Friefelder.Physical Biochemistry - Applications to Biochemistry and Molecular Biology.WH Freeman & Co. 1994.
5. Upadhyay, Upadhyay and Nath.Biophysical Chemistry Principles and Techniques.Himalaya Publ. 1997.

Paper-III Specialization Paper

This is prescribed by the respective Research Supervisor.

DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY
Ph.D. BIOCHEMISTRY/BIOTECHNOLOGY

All Ph.D. Research Scholars (Full-time and Part-time) shall undergo coursework and should write four papers. However, students with M.Phil.degree shall write two papers only.

The total marks for each question paper will be 100. The candidate shall secure not less than 50% in the course work examination(s), failing which he/she has to apply within six months after the first appearance. If a candidate does not pass the course work examination in the second appearance, his/her registration will be cancelled.

A student is deemed to have cleared any course only if he/she has more than 80% attendance, appeared in the each semester examination, and secured a weighted grade higher than 'F'.

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to Grade Point (GP). The sum total performance in each semester will be rated by Grade Point Average (GPA), while the continuous performance will be rated by Overall Grade Point (OGPA).

A student who has not secured a minimum of 50% of marks in a course is deemed to have failed in that course. A candidate who has scored a minimum of 50% in a course is deemed to have passed the course.

Course	Title	Credits	Total Marks
Course-I	Research Methodology	6	100
Course–II	Analytical Techniques	6	100
Course-III	Cell & Molecular Biology	6	100
Course-IV	Specialization Paper	6	100
		24	**400**

Ph.D. Biochemistry/Biotechnology Coursework

Paper I– Research Methodology

Unit–I Scientific Research and Scientific Writing

Importance and need for research ethics and scientific research. Formulation of hypothesis- Types and characteristics. Designing a research work. Scientific Writing:Characteristics. Logical format for writing thesis and papers. Essential features of abstract, introduction, review of literature, materials and methods, and discussion. Effective illustration:tables and figures. Reference styles:Harvard and Vancouver Systems.

Unit–II Biostatistics

Collection and classification of data- diagrammatic and graphic representation of data.Measurement of central tendency-standard deviation-normal distribution-test of significance based on large samples-small samples.Student *t* test. Correlation and regression. Chi square test for independence of attributes.ANOVA.

Unit–III Basic Concepts of Computers

History of Computers, Concept of Computer hardware, Concept of Computer languages, Concept of Computer Software. Computer applications in Biology

Spreadsheet tools: Introduction to spreadsheet applications, features, Using formulae and functions, Data storing, Features for Statistical data analysis, Generating charts/graph, and other features, Tools–Microsoft Excel or similar presentation tools: Introduction, features and functions, Power Point Presentation, Customizing and showing presentation. Introduction to Internet, Use of Internet and WWW, Use of search engines.

Unit–IV Bioethics and Patenting

Declaration of Bologna.Ethics in animal experimentation. CPCSEA guidelines:Animal care and technical personnel environment, animal husbandry, feed, bedding, water, sanitation and cleanliness, water disposal, anesthesia and euthanasia.

Composition of Human Institutional Ethical Committee. General ethical issues.Specific principles for clinical evaluation of drugs and human genetics research.Ethics in food and drug safety.Environmental release of microorganisms and genetically engineered organisms. Ethical issues in human gene therapy and human cloning. Patenting- definition of patent. Product and process patents.Patenting multicellular organisms.Patenting and fundamental research.

Unit–V Bioinformatics

Introduction.Biological databases. Biological databases: primary and secondary sequence databases, organism-specific databases, miscellaneous databases. Data submission. Information retrieval from databases- *Entrez* and SRS.Sequence alignment- sequence homology versus sequence similarity. Database similarity searching- FASTA, BLAST. Multiple sequencing alignments (CLUSTAL) Amino acid substitution matrices. Molecular phylogenetics: phylogenetic tree construction methods, software programs and analysis. Protein structure database- protein structure visualization, comparison and classification.Protein motifs and domain prediction.

Books recommended

1. R.A. Day. How to write a scientific paper. Cambridge University Press.
2. Lesk A.M. Introduction to Bioinformatics Oxford 2002.
3. Xiong J. Essential Bioinformatics. Cambridge University Press. 2006.
4. Krane et al. Fundamental concepts of bioinformatics. Benjamin Cummings.
5. S.P. Gupta. Fundamentals of Statistics, Sultan Chand.
6. Ethics and the use of alternatives to animals in research and education. Shiranee Pereira, CPCSEA.
7. Ethical guidelines for biomedical research on human subjects. ICMR, New Delhi, 2000.

Ph.D. Biochemistry / Biotechnology Coursework

Paper II- Analytical Techniques

Unit–I Chromatography Techniques

Performance parameters (retention time, elution volume, capacity factor, plate height, and resolution). Low pressure liquid chromatography (LPLC):principle, columns, matrix materials, procedure. HPLC-columns, matrix, mobile and stationary phases, sample application, pumps, detectors.HPTLC- principle, procedure, applications. Fast protein liquid chromatography. Reversed phase chromatography.

Unit–II Microscopy and Cell culture techniques

Light microscopy-components, specimen preparation. Optical contrast, specimen stains. Fluorescence microscopy, fluorophores. Optical sectioning:confocal microscopes, multiple photon microscopes. Imaging living cells and tissues.Stereomicroscope. Electron microscopy:principle, specimen preparation for TEM &SEM.

Cell culture techniques: Equipment- hoods, CO_2 incubator. Safety considerations, aseptic techniques, eradication of infections.

Animal cell cultures:primary cultures, cell lines, media and growth requirement, subcultures, cell quantification, cryopreservation, cell viability. Elementary details of bacterial and plant cell cultures.

Unit–III Immunochemical techniques

Antibody labeling: radiolabeling, labeling with fluorochromes and enzymes, biotinylation. Immunoblotting. Immunoassays: competitive binding, immunometric, solid-phase immunobinding, enhanced, peptide-based, fluorescence and photoluminescence-based. Immunohisto/cytochemistry. Immunofluorescence techniques. Immunoelectron microscopy. Chromatin immunoprecipitation. Flow cytometry.

Unit–IV Electrophoretic and Spectroscopy techniques

Electrophoresis of proteins.SDS-PAGE, isoelectric focusing, 2D-PAGE.Detection, estimation and recovery of proteins in gels. Electrophoresis of nucleic acids: agarose gel electrophoresis, DNA sequencing gels, pulsed field gel electrophoresis. Electrophoretic mobility shift assay. Southern, Northern, Western, and Southwestern blotting. Elementary details of mass spectrometry:principle, instrumentation, ionization, mass analyzers, MALDI-TOF and tandem mass spectrometry.Basic principle and biological applications of IR, NMR and ESR.

Unit–V Molecular Biology Techniques

Probe preparation: end labeling, random primer labeling, nick translation, molecular beacon-based probes. RFLP, DNA fingerprinting, FISH.PCR-principle and applications.RT-PCR.Real-time quantitative PCR, differential display PCR, allele-specific oligonucleotide PCR. DNA sequencing:chemical and enzymatic methods, automated fluorescence method, pyrosequencing, cycle sequencing. Whole-genome sequencing (shotgun and clone-by-clone approach). Microarrays: DNA and protein arrays.

Books recommended

1. Wilson and Walker.Principles and techniques of Biochemistry and Molecular biology.6th ed. Cambridge University Press 2005.
2. Boyer, R. Modern Experimental Biochemistry.3rd ed. Addison Weslery Longman, 2000.
3. Sambrook.Molecular Cloning.Cold Spring Harbor Laboratory, 2001.
4. Friefelder and Friefelder.Physical Biochemistry - Applications to Biochemistry and Molecular Biology.WH Freeman & Co. 1994.
5. Upadhyay, Upadhyay and Nath.Biophysical Chemistry Principles and Techniques.Himalaya Publ. 1997.

Ph.D. Biochemistry / Biotechnology Coursework

Paper III– Cell and Molecular Biology

Unit–I Intercellular communication, Cell cycle, and Cell death

Cell junctions- anchoring, tight and gap junctions. Cell adhesion molecules (CAMs): cadherins and integrins (elementary details).The cell cycle:phases and regulation by cyclins and cyclin-dependent kinases. Basic principles of cell death, apoptosis and necrosis. Death receptors and mitochondrial pathways.

Unit–II Cell Signaling

Fundamental concepts and definitions of signal, ligands and receptors. General features of signal transduction. Endocrine, paracrine, and autocrine signaling. G-protein-coupled receptors. Second messengers: c-AMP, diacylglycerol, inositol triphosphate and Ca^{2+}. Receptor tyrosine kinases. The insulin receptor and protein phosphorylation cascade.

Unit–III Genome Complexity

Eukaryotic chromatin: nucleosomes, higher order chromatin structure.DNA sequence elements: unique sequence DNA, repetitive DNA- SINEs, LINEs, satellite, minisatellite and microsatellite DNA. C-value paradox. Gene families, pseudogenes (brief account).

Unit–IV Regulation of Gene Expression

Regulation of gene expression in eukaryotes: Euchromatin, heterochromatin, DNase I sensitivity. Epigenetics.DNA methylation, Histone acetylation and deacetylation.Gene regulation by steroid hormone receptors, phosphorylation (STAT proteins).RNA interference (siRNA and miRNA).

Unit–V Nucleic acid-Protein Interactions and Protein folding

Nucleic acid recognition by proteins. DNA-binding motifs in proteins:helix-turn-helix, zinc finger, leucine zipper, and helix-loop-helix. RNA-binding motifs in proteins. Techniques characterizing nucleic acid-protein interactions:gel retardation assay, DNase I footprinting. Protein folding:models, molecular chaperones, chromatin immunopreciptation, yeast monohybrid system.

Text Books

1. Karp. Cell &MolBiol 7thed 2013. Wiley.
2. Nelson & Cox. Lehninger Principles of Biochemistry.Freeman,6th ed. 2012.
3. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2012.
4. Alberts et al Molecular biology of the cell. 5th ed. Garland Sci. 2007.
5. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.

6. Twyman. Advanced Molecular Biology.BIOSSci Publ. 2000.

Ph.D. Biochemistry/ Biotechnology Course work
Paper IV Diabetes Mellitus

Unit–I Insulin-Blood glucose homeostasis and diabetes

Blood glucose homeostasis: role of tissues and hormones. Insulin: structure, metabolic functions of insulin. Metabolic abnormalities in insulin deficiency.Diabetes-Definition and diagnostic criteria by ADA; WHO classification of diabetes. Etiology of type 1 and 2 diabetes. Complications of diabetes- acute complications: Hypoglycemia: causes, symptoms and prevention of hypoglycemia, Treatment of hypoglycemia; Diabetic ketoacidosis; HONK coma.

Unit–II Molecular mechanism of insulin action and regulation of metabolism

Insulin signaling pathways; Insulin receptor and its substrates, PI3K, Akt and downstream targets (GLUT, FOXO, GSK3β), Cbl pathway, Ras Mitogen– activated protein kinase cascade. Turning off the insulin signal by PTP1B and serine kinases.

Insulin resistance (IR) - definition; tissue sites of IR; defects in insulin signaling; genetic and acquired forms of IR; role of FFA and intracellular TG in IR, Role of cytokines secreted by adipose tissue - TNF–α, adiponectin, resistin, leptin, interleukin 6.

Unit–III Pathogenesis of Diabetes

Type 1 Diabetes Mellitus: Genetic factors-HLA genes and molecules; Environmental agents-autoantigens, chemicals, viruses, bacteria, vaccination, perinatal factors, food components, stress; gut dysfunction and diabetes; Islet histology in type 1 diabetes, immune mechanisms of beta-cell destruction; Animal models for type 1 diabetes-alloxan, streptozotocin, other β-cell toxins, spontaneous type 1 diabetes–BB rats.

Type 2 Diabetes Mellitus: Obesity and Nutritional factors. epidemiology, body mass index, sympathetic nervous system activation- role of hypothalamus, insulin resistance, beta cell defects; Animal syndromes resembling type 2 diabetes. Diabetic mice (db/db), desert rodents, sand rats and spiny mice, obese (ob/ob) mice -Diet induced type 2 diabetes.

Unit–IV Biochemistry and molecular cell biology of diabetic complications

Mechanisms of Diabetic complications: Hyperglycemia induced damage-Polyol pathway, advanced glycation end products (AGE) formation, protein kinase C pathway, hexosamine pathway;

Oxidative stress-Glucose induced production of free radicals, Free radicals and AGE, Nitric oxide.

Diabetic vascular disease: Risk factors for diabetic vasculopathy-hyperglycemia, dyslipidemia, hypertension and the renin angiotensin system. Micro and macrovascular damage, organ complications-molecular changes in nephropathy, neuropathy and retinopathy, diabetic foot disease.

Unit–V Therapeutics

Medical nutrition therapy: Glycemic index of common foods; Recommended nutrient composition of diet in diabetes; Macronutrients and Micronutrients.Nutritive and non nutritive sweeteners.

Pharmacotherapy: Antidiabetic agents, hypoglycemic agents, antihyperglycemic agents, Mode of action-Inhibitors of intestinal carbohydrate digestion and absorption (dietary fibre supplements, α glucosidase inhibitors), Rapid acting and long acting insulin analogues,Insulinsecretagogues, Potentiators of insulin secretion (sulphonylureas, meglitinides, GLP-1, exendin 4 and DPP4 inhibitors), insulin mimetics (vanadium), insulin sensitizers (thiazolidinediones, metformin), lipid lowering agents, fatty acid oxidation inhibitors, soluble amylin analogues.

Pancreas and islet transplantation. Stem cell therapy and gene therapy for diabetes (Elementary details).

References

1. Joslin's Diabetes Mellitus, 14th Ed., C. Ronald Kahn, Gordon C. Weir, George l. King, Aln M. Jacobson, Alan C. Moses, Robert J. Smith, Lippincott Williams and Wilkins Publ., 2006.
2. Diabetes Mellitus – A Fundamental and Clinical text, 3rd Ed., Derek Lerooith, Siemon I. Taylor, Jerrold M. Olefsky, Lippincott Williams and Wilkins Publ., 2004.
3. Textbook of Diabetes 1 & 2, 3rd Ed., John C. Pickup & Gareth Williams, Blackwell Science Publ., 2003.
4. International Textbook of Diabetes Mellitus Vol.1 & 2, 3rd Ed., R. A. Defronzo, E. Ferrannini, H. Keen, P. Zimmet, Wiley Publ., 2004.

Ph.D. Biochemistry/Biotechnology Coursework
Paper IV– Cancer Biology

Unit–I Introduction to Cancer

Types of growth– hyperplasia, metaplasia, dysplasia, anaplasia and neoplasia.Nomenclature of neoplasms. Differences between benign and malignant tumours. Epidemiology of cancer:types of epidemiological research. Methods of epidemiological investigation-cohort studies, case-control studies (elementary details only). Tumour assessment– grading and staging (elementary details only).

Unit–II Carcinogenesis

Growth characteristics of cancer cells. Morphological and ultrastructural properties of cancer cells.Metabolic alterations in neoplastic transformation.Tumour markers.Radiation and viral carcinogenesis. Chemical carcinogenesis: Activation of procarcinogens (benzo(a)-pyrene only). Stages in chemical carcinogenesis: Initiation, Promotion and Progression. Tumour promoters. Screening for chemical carcinogens: Ames test and whole animal bioassay.

Unit–III Genetic and Epigenetic Basis of Cancer

Oncogenes and Proto-oncogenes. Mechanisms of oncogene activation. Oncogenic proteins involved in signalingpathways: growth factors and their receptors, Ras oncogenes, nonreceptor cytoplasmic kinases, nuclear transcription factors, anti-apoptotic proteins. Tumour suppressor genes: loss of heterozygosity. *p53*, *Rb*, P*TEN*, *BRCA1* and *BRCA2*.The genetic model for colorectal cancer. Epigenetic alterations in cancer:DNA methylation, histone acetylation and deacetylation. HDAC inhibitors.MicroRNA and cancer.

Unit–IV Hallmarks of Cancer

Overview of hallmarks of cancer.Cell proliferation - overview of cell cycle, role of Myc and Ras in cell cycle control, deregulation of cell cycle in cancer. Apoptosis:overview, dysregulation of apoptosis in cancer. Cellular and molecular mechanisms of invasion and metastasis. Tumour angiogenesis.VEGF signaling. Role of inflammation in cancer (brief account).

Unit–V Tumour analysis and therapeutics

Identification of tumours by imaging and histological techniques (brief account). Molecular methods of analysis: genomic methods,*FISH*, comparative genomic hybridization, Microarrays and laser capture microdissection. Cancer chemotherapy: antimetabolites, antibiotics, platinum compounds, hormones. Basic concepts of radiotherapy, ADEPT, genetic prodrug activation therapy, biological therapy gene therapy and immunotherapy for cancer.Multidrug resistance.

References

1. The Cancer Handbook. M. R. Alison., Nature Publ. Group, latest ed.
2. Cancer Principles and Practice of Oncology. De Vita et al. latest ed.
3. Basic Science of Oncology.Tannock et al McGraw Hill latest ed.
4. Fundamentals of Oncology. H.C.Pitotlatest edition.

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Paper IV–Cardiovascular Biology

Unit–I Blood flow and Vasculature

Circulatory System. Macro versus microvasculature, structure of blood vessels, pressure and peripheral vascular resistance, conducting versus resistant vessels, blood flow and endothelial function, endothelial heterogeneity, neuronal, endocrine and autocrine regulation of vessel tone, autocoid production by haemodynamic forces, cardiovascular response to exercise, vascular permeability and diapedesis.

Unit–II Vasculogenesis and Angiogenesis

Vascular progenitors, concepts of sprouting and intussusceptive angiogenesis, vascular endothelial growth factors, pericytes and vessel maturation, integrins and extracellular matrices in angiogenesis, concepts in lymphangiogenesis, angiogenic and angiostatic factors, matrix metalloproteases in angiogenesis, hypoxia and angiogenesis.

Unit–III Cardiac Physiology, Myocardial Infarction and Ischemia-reperfusion Injury

Anatomy of the heart, valves, physiology and functions.Cardiac cycle. Electrocardiogram, ion channels in cardiac function, gap junctions and conductivity. Myocardial infarction-risk factors, etiology, metabolic abnormalities, animal models of MI. Introduction to Ischemia-reperfusion injury. Cellular and molecular mechanisms, clinical implications, Langendorff Heart: a model system to study ischemia-reperfusion injury.

Unit – IV Atherosclerosis and Hypertension

Atherosclerosis, causes, risk factors, atherosclerotic plaque, consequences, biochemical findings and treatment. Inflammation and atherosclerosis. Hypertension, classification, etiology, clinical features and pathogenesis.The Renin-Angiotensin system.Animal models of atherosclerosis and hypertension.

Unit–V Drugs in the management of cardiovascular diseases

Antihypertensive drugs- Diuretics, ACE inhibitors, angiotensin receptor blockers, calcium channel blockers, β-adrenergic blockers, α-adrenergic blockers, central sympatholytics, vasodilators. Cardiac glycosides, Antiarrhythmic drugs, nitrates, anticoagulants, antiplatelets, fibrinolytics.

References

1. Pathologic basis of disease-Cortran, Kumar, Collins (2009), 8th edition.
2. Text book of Medical Physiology-Guyton (2010) 12th edition.
3. Harper's Biochemistry. Murray et al., 2012, 29thed.
4. Harrison's Principles of Internal Medicine, Vol-1,2001, 15th edition.
5. Lehninger Principles of Biochemistry, 2008. 5th edition
6. Essentialsof Medical Pharmacology-Tripathi.K.D.-7th edition.
7. Cardiovascular Physiology - David E. Mohrman and Lois Jane Heller,McGraw-Hill, 8th Ed., 2013.

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Paper IV–Chronopharmacology and Chronotherapeutics

Unit–I Introduction

History of chronobiology, ubiquity of biological rhythms, types of biological rhythms, glossary of terms used in biological rhythm studies, fundamental properties of biological rhythms, selective advantages of biological rhythms in organisms, ultradian, infradian and circannual rhythms, measurement and analysis of rhythm data, cosinor analysis

Unit–II Anatomy and physiology of circadian clocks

Anatomy and physiology of biological clocks, circadian pacemakers in various organisms,suprachiasmatic nuclei– neuroanatomy and neurochemistry, pineal gland, afferent and efferent pathways of central biological clock, peripheral clocks, functional organization of circadian systems in eukaryotes.

Unit–III Chronoendocrinology

Endocrine rhythms in mammals, ultradian rhythms of hormones, normal rhythms of ACTH and alterations in disease states, 24h GH profile in men and women– alterations in disease states, 24h profile of prolactin in normal subjects – alterations in disease states.Diurnal and ultradian variations of leptin in normal subjects– alterations in obesity and weight loss, temporal pattern of release of prolactin and oxytocin, pineal gland and melatonin rhythm, diurnal and ultadian variations of glucose tolerance and insulin secretion, Abnormal circadian rhythms of adrenal hormones in Addison's disease and Cushing's syndrome

Unit–IV Chronopharmacology and chronotherapy

Basics of chronopharmacology. Clinicial chronopharmacology– circadian dependence of drug pharmacokinetics– chronoefficacy of doxorubicin, oxaliplatin and cisplatin– chronopharmacokinetics of antineoplatic drugs, chronotolerance, circadian rhythms and cancer chemotherapy, cancer chronotherapy, chronobiological concepts underlying the chronotherapy of cancer, chronotherapy of metastatic colorectal cancer, the relevance of circadian rhythms in human health, jet lag, shift work, chronobiology of asthma, human blood pressure and sleep disorders.

Unit–V Molecular chronobiology

Circadian clock genes in *Drosophila* (*per, tim, dbt, dclock*and *cycle*), regulation of expression of clock genes, autoregulatory transcriptional feedback loops, basic actions and interactions among clock gene products, circadian clock controlled genes, circadian clock genes in mammals, autoregulatory transcriptional feedback loops of clock genes in mammals, autonomous functions of clock genes in peripheral tissues, circadian clock genes in humans.

Reference Books

1. F.H. Columbus 2006 Trends in Chronobiology Nova Sci Pub Inc.
2. Refinetti 2005 Circadian Physiology 2nd ed. CRC Press, Boca Raton.
3. Sehgal 2004 Molecular biology of circadian rhythms Wiley-Liss, USA
4. J. C. Hall 2003Genetics and molecular biology of rhythms in Drosophila and other insects Elsevier Science, USA
5. Wilson and Foster, Williams Text book of Endocrinology, 9thed.
6. Touitou Y et al.2006 Handbook of Medical Chronobiology. Taylor & Francis
7. M. Smolensky and L. Lamberg 2001 The body clock guide to better health Henry Halt &Co. New York.

Ph.D. Biochemistry/Biotechnology Coursework

Paper IV-Radiation Biology

Unit–I

Electromagentic spectrum. Units of radiation and radiation absorbed dose (rad). Ionizing radiation– LET and non-LET radiation.Gamma radiation. Radiation effects on cellular system– direct and indirect action, radiolysis of water and radical formation. Time scale of radiation effects– acute radiation syndrome and chronic health effects.Bystander effect.Heritable radiation effects.Radiosensitivity of tissues.Ultraviolet radiation– Types and cellular effects.Cyclobutane thymidine and 6-4 photoproducts formation.Cellular photosensitizers. Ozone depletion- health effects of UV radiation and photocarcinogenisis.

Unit–II

Biomarkers of radiation exposure. Radiation induced DNA damage– Base damage and strand breaks. Multiple damaged sites and oxidative DNA damage. Chromosomal aberrations– dicentric aberration, dose response curve and biodosimetry. Chromosome translocation– Fluorescence in situ hybridization. Effect of radiation on actively dividing cells.Radiation sensitivity in different phases of cell cycle. Manifestations of radiation-induced cell death (apoptosis, necrosis, mitotic catastrophe and senescence).

Unit–III

Pathways of radiation–induced signal transduction processes. Mechanisms of DNA repair– BER, NER and DSBs repair. Radiation response elements– XRCC1, GAAD45a, ATM, P21 and TP53.Double strand breaks and histone H2AX phosphorylation. Critical regulators of the extracellular matrix– matrix metalloproteinases and MAPK/PI3K pathway. Low-dose radiation on Wnt/β-catenin signaling. Radiation induced inflammatory and immunosuppresionsignaling.

Unit–IV

Radiotherapy of tumors.Sparing normal issues from radiation effects– radioprotection. Characteristics of radioprotectors.Classical radioprotectors– amifostine. Free radical scavengers as radioprotectors. Natural products and dietary phytochemicals in radiation protection.Tumor hypoxia. Radioresistance. Hypoxic cell radiosensitizers. Chemotherapy– Chemotherapeutic agents,

multidrug resistance, chemosensitizers. ABC binding cassettes and drug efflux mechanism.

Unit–V

Methods in radiobiological research.Biomonitoring. Circulating lymphocytes as an experimental model. Assessment of radiation induced DNA damage– alkaline single cell gel electrophoresis, cytokinesis-blocked micronuclei cytome assay, γ-H2AX foci assay. Cytotoxicity assays– Clonogenic cell survival assay and MTT assay. Fluoresence based cellular assays– Intracellular ROS measurement, analysis of mitochondrial membrane potential**,** calcein-AM transport assay. Cell cycle analysis- BrdU label and Hoechst-propidium iodide staining.

References

1. Hall EJ, Giaccia AJ. Radiobiology for the Radiologist. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2006.
2. von Sonntag C.. The Chemical Basis of Radiation Biology. London: Taylor & Francis; 1987.

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Paper IV- Neurobiology

Unit–I Anatomy, Physiology of CNS

Anatomy of the brain, major anatomical subdivisions of the human brain; the surface anatomy and interior structures of cortical and subcortical regions; anatomical connectivity among the various regions; development of brain, blood supply to brain and the CSF system, Cytoarchitecture and modular organization in the brain.

Unit–II The Structure and Functions of the Nervous System

Basic features of the nervous system, meninges, ventricular system, CSF, blood brain barrier, peripheral nervous system: cranial nerves, spinal nerves, autonomous nervous system; major structures and functions, spinal cord, cells of the nervous system ,structure of neurons-types and functions, neural conduction, communication between neurons, Synaptic conduction, Neurotransmitters (adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors), neuromodulators, and hormones.

Unit–III Sleep and Biological Rhythms

Sleep: biological functions of sleep, rhythms of sleeping (ultradian, circadian, infradian), neural basis of biological clocks, Stages of sleep, slow-wave and REM sleep brain mechanisms of REM (paradoxical

sleep) sleep and dreaming, physiological basis of sleep and wakefulness, role of serotonin in sleep, physiologic effects of sleep, disorders of sleep, sleep deprivation.

Unit–IV Neurological and Psychiatric Disorders

Bipolar Disorder, Schizophrenia, Substance abuse disorders, Major affective disorders, Sleep Deprivation(SD), Obsessive Compulsive Disorder(OCD), Anxiety disorders, Synaptic plasticity, Dyslexia, Parkinson's and Alzheimer's diseases- types, epidemiology, classification, causes, pathophysiology and signs and symptoms.

Unit–V Neuropsychopharmacology

Principles of psychopharmacology (pharmacokinetics, drug effectiveness, effect of repeated administration); sites of drug action (effects on production, storage, release, receptors, reuptake and destruction), antipsychotic drugs and mood stabilizers (lithium, olanzapine, aripiprazole, carbamazepine, sodium valproate and chlorpromazine) -side effects of drugs.

References

1. Textbook of Medical Physiology. Guyton and Hall 12th ed. 2010.
2. Parkinson's Disease For Dummies.MicheleTagliatiet al. 2011
3. Alzheimer Disease: From Clinical Description to a Theory of Disease and Treatment, Armenian Medical Network, 2011.
4. Bipolar Disorder: Clinical and Neurobiological Foundations,Wiley2010.
5. Meyler's side effects of drugs -The international encyclopedia of adverse drug reaction and interactions. J.K Aronson, 2005.
6. Sleep Deprivation: Basic Science, PhysiologyandBehavior. Clete A. Kushida, Taylor & Francis, 2004.