DEPARTMENT OF BIOCHEMISTRY & BIOTECHNOLOGY
M.Sc. INTEGRATED BIOTECHNOLOGY PROGRAMME (2016-2017)
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 Aware-ness and Health Science	3		3	25	75	100
IBTT 14	Cell Biology & Genetics	5		5	25	75	100
IBTA 15	Ancillary I (Biology) Paper I Animal Science	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	Microbiology	5		5	25	75	100
IBTP25	Practicals in Cell Biology , Genetics & Microbiology		15	5	40	60	100
IBTA 26	Ancillary -I (Biology) Paper II Plant Science	4		4	25	75	100
IBTP 27	Practicals in Ancillary -I (Biology)		6	2	40	60	100
Total Credits: 25							
Semester –III							
ITAC 31	Language III	3		3	25	75	100
IENC 32	English III	3		3	25	75	100
IBTT 33	Biomolecules	5		5	25	75	100
IBTP 34	Practicals in Biomolecules		9	3	40	60	100
IBTA 35	Ancillary-II Chemistry	4		4	25	75	100
Total Credits: 18							
Semester IV							
ITAC 41	Language IV	3		3	25	75	100
IENC 42	English IV	3		3	25	75	100
IBTT 43	Metabolism	4		4	25	75	100
IBTT 44	Enzyme Technology	4		4	25	75	100
IBTP 45	Practicals in Enzyme Technology		9	3	40	60	100
IBTA 46	Ancillary-II Chemistry	4		4	25	75	100
IBTP 47	Practicals in Ancillary -II Chemistry		6	2	40	60	100
Total Credits:23							

Semester-V							
IBTT 51	Analytical Techniques	5		5	25	75	100
IBTT 52	Molecular Biology	5		5	25	75	100
IBTT 53	Immunology & Immunotechnology	5		5	25	75	100
IBTT 54	Cell and Tissue Culture	5		5	25	75	100
IBTP 55	Practicals in Analytical Techniques & Molecular Biology		9	3	40	60	100
IBTP 56	Practicals in Immunology & Tissue Culture		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
IBTP 64	Practicals in Bioprocess Engg, Downstream Processing & Environ-mental Biotechnology		12	4	40	60	100
IBTP 65	Practicals in Genetic Engg.		9	3	40	60	100
IBTPJ 66	In-plant training/Dissertation			3	25	75	100
Total Credits: 25							
Semesters 1-6 Total credits 135							
Semester –VII							
IBTT 71	Advanced Cell & 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	Food Biotechnology	5		5	25	75	100
IBTT92	Medical Biotechnology	5		5	25	75	100
IBTT93	Biotechnology Management	5		5	25	75	100
IBTP 94	Practicals in Food and Medical Biotechnology		15	5	40	60	100
	Optional IV	4		4	25	75	100
Total Credits: 24							

Semester-X							
IBTT 101	Genomics and Proteomics	5		5	25	75	100
IBTT 102	Nanobiotechnology and Bioinformatics	5		5	25	75	100
IBTP 103	Practicals in Genomics, Proteomics, & Bioinformatics		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 Test I & II : 20 Assignment : 5 End-Semester Marks : 75 Total Marks per paper :100	Internal Assessment Marks : 40 Test-I& II : 30 Seminar : 5 Viva : 5 End-Semester Marks : 6 Total Marks per paper : 100

Optionals: Any 4 from the following:

1. Chemistry
2. Microbiology
3. Statistical Methods
4. Drug Design and Drug Action
5. Genetic Engineering
5. Structural Biology
6. Vermiculture & Sericulture
7. Marine Biotechnology
8. Biotechnology Management

9 Clinical Biochemistry

10. Yoga
11. Any other course offered by other departments from time to time.

IBTT 14: CELL BIOLOGY & GENETICS

Objective: To learn in detail about the organization of cells, subcellular organelles, intercellular communication and to acquire knowledge of the principles of genetics.

Unit–I Cell and Subcellular Organelles

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

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 (brief overview).

Unit–III Basic principles of 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.

Unit–IV Chromosomes and Population Genetics

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–V Linkage and Inheritance

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 inheritance. Brief outline of allosomal (Klinefelter syndrome), autosomal (Down syndrome) disorders. Brief outline of Non-Mendelian inheritance.

Text Books

1. Karp. Cell & Molecular Biology 7th ed 2013. Wiley.
2. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
3. Elrod S. Schaum's Outline of Genetics. 5th ed. McGraw Hill. 2010.
4. Fletcher et al. Instant Notes in Genetics. 4th ed. BIOS. 2012.

Reference Books

Lodish et al Molecular Cell biology 8th ed. Freeman, 2016.

Abouelmagd and Ageeley. Basic Genetics. 2nd ed. Univ Publ. 2013.

IBTT 24: 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. 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.

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. Cultivation of anaerobes, 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 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 14th ed. Prentice Hall, 2014.
2. Schaechter M ed. Encyclopedia of Microbiology - 3rd ed. Acad Press 2009.
3. Pelczar*et al*. Microbiology 5th ed. McGraw-Hill, 2000.

IBTP 25: PRACTICALS IN CELL BIOLOGY, GENETICS AND MICROBIOLOGY

1. Isolation of cells-lymphocytes.
2. Microscopic examination of epithelial cells, plant cells.
3. Distinguishing mutant phenotypes of *Drosophila melanogaster- wild type and cry^{b} mutant*.
4. Monohybrid inheritance in *Drosophila*.
5. Setting up a cross and verifying Mendelian laws of inheritance- *wild type and cry^{b} mutant*.
6. Preparation of polytene chromosomes from *Drosophila* larvae.
7. Buccal smear– Barr bodies.
8. Karyotype analysis: Onion and human.
9. Microscopic examination of bacteria, fungi, yeast.
10. 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

9. 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)
10. Isolation of pure cultures from soil and water.
    - Development of pure culture by serial dilution
    - Enrichment culture and plate count
    - Replica plating
11. Growth curve, enumeration of bacterial population by turbidimetry and serial dilution met*h*ods.
12. Effect of temperature, pH and carbon and nitrogen sources on growth.
13. Antibiotic sensitivity and resistance pattern of bacteria.

IBTT 32: BIOMOLECULES

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

Unit–I Proteins

Amino acids: 3-letter and 1-letter abbreviation, classification. Nonstandard amino acids. Biologically important peptides.

Proteins: classification, acid-base properties, denaturation. Orders of protein structure: Primary structure: Determination of the amino acid sequence of proteins. The peptide bond, Ramachandran plot. Secondary, supersecondary, tertiary and quaternary structures. The structure of collagen and hemoglobin.

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, the cot curve. Differences between DNA and RNA. Major classes of RNA-structure and biological functions. Minor classes of RNA (elementary details).

Unit–III Carbohydrates

Classification and general properties of carbohydrates. Biologically important monosaccharides and disaccharides. Homopolysaccharides- structure and biological functions of starch, glycogen, and cellulose. Heteropolysaccharides- structure and biological role of glycosaminoglycans.

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. 4th ed. Wiley. 2015.
3. Murray et al. Harper's Illustrated Biochemistry 30th ed. McGraw Hill, 2015.

Reference Books

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

IBTP 33: 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.
13. Thermal denaturation of DNA.
14. UV absorption spectrum of proteins and nucleic acids.

IBTT 43: METABOLISM

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- the chemiosmotic theory. Inhibitors of respiratory chain and oxidative phosphorylation- uncouplers, ionophores. Introduction to metabolism: anabolism and catabolism.

Unit–II Carbohydrate metabolism

Digestion and absorption of carbohydrates. Glycolysis- pathway and key enzymes. The citric acid cycle. Gluconeogenesis, Glycogenesis, and glycogenolysis. Glycogen storage disorders: von Gierke's disease only.

Unit–III Lipid metabolism

Digestion and absorption of lipids. Oxidation of fatty acids: β-oxidation. Metabolism of ketone bodies- formation, utilization, excretion and clinical significance. Biosynthesis of fatty acids. Metabolism of triglycerides, phospholipids, and cholesterol.

Unit–IV Metabolism of amino acids

Digestion and absorption of proteins. 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. Elementary details of phenylketonuria.

Unit–V Metabolism of purines, pyrimidines and minerals

Digestion and absorption of nucleic acids. De novo and salvage pathways of purine biosynthesis, purine catabolism. Biosynthesis and catabolism of pyrimidines. Brief account of gout. Minerals: sources, requirements, biological role and clinical significance of calcium, phosphate and iron.

Text Books

1. Nelson and Cox. Lehninger's Principles of Biochemistry. 6th ed. Freeman. 2012.
2. Murray *et al*. Harper's Illustrated Biochemistry. 30th ed. McGraw Hill, 2015.
3. Voet and Voet, Fundamentals of Biochemistry. Wiley, 4th ed. 2015.
4. Kuchel et al. Schaum's Outline of Biochemistry. McGraw Hill. 3rd ed. 2011.

IBTT 44: 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: IU and Specific activity. Active site. Coenzymes, multienzyme complexes, metal-dependent and metalloenzymes. Isoenzymes. Extremozymes. Elementary details of ribozymes, abzymes and DNA enzymes.

Unit–II

Enzyme kinetics: Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Pre-steady state and steady state kinetics. Michaelis-Menten plot, Lineweaver-Burk plot. Significance of Km and Vmax. Turnover number. Kinetics of allosteric enzymes-MWC and KNF models.

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. 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, binding methods, applications. Enzyme engineering with lysozyme as example. Enzyme production and purification: enzyme sources, processes to improve enzyme yield, downstream processing of enzymes and chromatographic purification (brief account). Enzyme electrodes. Biosensors: components, types and applications.

Unit–V

Use of enzymes in detergents, textiles, and leather industry, production of glucose syrup and cheese. Synzymes and solvent engineering. Soluble enzymes- 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 enzyme production and use.

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.

IBTT 45: PRACTICALS IN ENZYME TECHNOLOGY

1. Determination of total and specific activity of α-amylase.
2. 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. Enzyme immobilisation using alginate beads.
7. Production and estimation of alkaline protease.

IBTT 51: 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. Brief outline of the principles and biological applications of NMR and ESR.

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 Microscopy

Electrophoresis: General principles, support media. PAGE, SDS-PAGE, isoelectric focusing. Agarose gel electrophoresis. Pulsed field gel electrophoresis.

Microscopy- basic principles, and components of light, bright field, phase contrast, fluorescence, confocal and electron microscopy (TEM and SEM).

Unit–IV Chromatography

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

Unit–V Centrifugation

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuges. Analytical and preparative ultracentrifuge- instrumentation and applications. Subcellular fractionation by differential centrifugation. Density-gradient centrifugation- basic principles.

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. Friefelder and Friefelder.Physical Biochemistry- Applications to Biochemistry and Molecular Biology.WH Freeman & Co. 1994.
2. Pavia Intro to spectroscopy 2009
3. Boyer 3rd ed 2000 Prentice Hall.

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. Concept of gene. Definitions of the following: gene, cistron, coding region (ORF), transcription unit, untranslated region (UTR). 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: helicases, SSB, topoisomerases, DNA polymerases, DNA ligase. DNA replication in bacteria (θ and rolling circle model) and eukaryotes: initiation, elongation, termination. The end-replication problem and telomerase. Inhibitors of replication. DNA damage and repair (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

Post-transcriptional processing of mRNA, rRNA and tRNA. Alternative splicing. RNA interference (brief account). 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. Mechanism of protein synthesis in bacteria and eukaryotes: amino acid activation, initiation, elongation and termination. Inhibitors of protein synthesis. Post-translational modifications. Protein folding- models, molecular chaperones. Brief account of protein targeting and degradation.

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: 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 autoimmune disorders (systemic lupus erythematosus). 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. Flow cytometry.

Text Books

1. Goldsby*et al*. Kuby Immunology. WH Freeman & Co. 7th ed 2013.
2. Abbas *et al*.Cellular and Molecular Immunology. 8th ed.Elsevier 2014.
3. Janeway, C. (Ed), Paul Travers. Immunobiology 8th ed. Garland Publ. 2016.
4. Coico and Sunshine. Immunology: A short course. 7th ed.Wiley,2015.

Reference Books

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

IBTT 54: CELL AND TISSUE CULTURE

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

Unit–IIntroduction 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

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 55: PRACTICALS IN ANALYTICAL TECHNIQUES AND MOLECULAR BIOLOGY

1. Spectrophotometry: Analysis of standard curve, absorption spectrum of a given chromophore/oxidized and reduced forms (NAD,NADH).
2. Separation of lipids by thin layer chromatography.
3. Separation of proteins by gel filtration - Demonstration.
4. Separation of plant pigments by adsorption chromatography.
5. Separation of proteins by SDS-PAGE.
6. GC and HPLC-Demonstration.
7. Light, phase contrast and electron microscope demonstration and photographs for interpretation.
8. Cell fractionation- isolation and analysis of mitochondrial and chloroplast DNA.
9. Isolation of DNA and electrophoresis in agarose gel.
10. Isolation of RNA from yeast and electrophoresis.
11. Bacterial conjugation.
12. Bacterial transformation.

IBTP 56: PRACTICALS IN IMMUNOLOGY & TISSUE CULTURE

1. Identification of blood groups and Rh typing.
2. Radial immunodiffusion.
3. Double diffusion.
4. Agglutination, rosette formation, complement fixation.
5. Immunoelectrophoresis.
6. Preparation of antisera.
7. Tissue culture techniques: Surface sterilisation techniques, media preparation and storage, serum inactivation.
8. Staining of cell cultures and observations under microscope.
9. Cell count, protein estimation, mitotic index.
10. Effect of additives on various explant cultures.

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 and 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.

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,). 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. 8th ed. Blackwell Sci 2014.

References

1. Flickinger and Drew (eds). Encyclopedia of Industrial Biotechnology. 8 vol. set. John Wiley & Sons, 2010.
2. Singh BD. Encyclopedia of Molecular Biotechnology. AnmolPubl 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. and C.O.D. and BOD. 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. Oil spill clean up. Bioremediation of contaminated soils and waste land. Biofertilisers. Biopesticides- *Bacillus thuriengenesis*. 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. 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. 2nded 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. Type II Restriction endonucleases-nomenclature, and types of cleavage. Cloning vectors- plasmid (pBR322) and phage (λ phage) vectors.Cosmids. Brief introduction to BACs and YACs.

Unit–II Cloning and rDNA transfer

Methods of ligating DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation. Linkers and adaptors. 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), 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, and Western 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. 4thed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.
3. Primrose, Twyman and Old. Principles of gene manipulation. 8th ed. Wiley-Blackwell. 2014.

IBTP 64: PRACTICALS IN BIOPROCESS ENGINEERING, DOWNSTREAM PROCESSING AND ENVIRONMENTAL BIOTECHNOLOGY

1. Determination of growth curve of a microorganism and substrate degradation profile.
2. Computation of specific growth rate (m) and growth yield $Y_{x/s}$.
3. Comparative studies of ethanol production using different substrates.
4. Microbial production of citric acid using *Aspergillusniger*.

5. Determination of total dissolved solids in water.
6. Determination of D.O. concentration of water sample.
7. Determination B.O.D. of sewage sample.
8. Determination C.O.D. of sewage sample.
9. Estimation of nitrate in drinking water.
10. Efficiency of removal of air pollutants using fibrous air filter.
11. Isolation and enumeration of soil bacteria.
12. Isolation and enumeration of bacteriophages from raw sewage.
13. Identification of heavy metals from sewage water by atomic absorption spectrometry.

IBTP 65: PRACTICALS IN GENETIC ENGINEERING

1. Extraction of genomic DNA and electrophoresis.
2. Determination of molecular size of DNA.
3. Plasmid preparation.
4. Restriction enzyme digestion of DNA.
5. Phage titration.
6. GFP cloning
7. RNA isolation and cDNA construction.
8. PCR and analysis of PCR products.
9. Blotting techniques.

IBTT 71: ADVANCED CELL AND MOLECULAR BIOLOGY

Objective: To learn the molecular mechanisms of cellular processes and signalling and to comprehend advances in molecular biology and DNA-protein interactions.

Unit–I Cell division, Cell Differentiation, Cell cycle, Cell death

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.

Unit–II Cell signaling

Fundamental concepts and general features of cell signalling. Endocrine, paracrine, autocrine signaling and juxtacrine signalling. Types of receptors. Nuclear and cytosolic receptors. G-protein-coupled receptors. Second messengers: c-AMP, cGMP, diacylglycerol, inositol triphosphate and Ca^{2+}. Receptor tyrosine

kinases- insulin signalling, ras-raf-MAP kinase and JAK-STAT pathways.

Unit–III 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. Fundamental concepts of development, differentiation and morphogenesis. Development in *Drosophila*: homeotic genes, maternal genes, and segmentation genes.

Unit–IV Mutations and Recombination
Mutations: types. Point mutations, frameshift mutations, and Suppressor mutations. Recombination: Homologous recombination-the Holliday model. Site-specific recombination. Transposition-prokaryotic and eukaryotic transposons. McClintock's work. Consequences and applications of transposition.

Unit–V Regulation of gene expression
Levels of gene expression, definition of housekeeping genes, upregulation and downregulation. Regulation of gene expression in prokaryotes: the *trp* operon. Regulation of gene expression in eukaryotes: Transcriptional (steroid hormone receptors, STAT proteins). Translational regulation (globin). Epigenetic regulation: DNA methylation, HATs and HDACs. DNA-protein interactions: -helix-turn-helix, zinc finger, leucine zipper, and helix-loop-helix.

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. 6th ed. Garland Sci. 2014.
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. Cosmids. Cloning in BACs PACS and YACs. Genomic libraries: construction, evaluation, growing and storing a genomic library. cDNA libraries: mRNA isolation, cDNA synthesis, construction of a cDNA library.

Unit–II Expression of cloned genes

Factors affecting expression of cloned genes. Expression of eukaryotic genes in bacteria- expression vector, promoters, industrial protein production. Fusion proteins, strategies to enhance protein stability, secretion and metabolic load. Expression in eukaryotic cells: Expression in yeast- yeast vectors, GAL system. Baculovirus and Mammalian expression systems (brief account). Tagged proteins and secretion signals.

Unit–III Analysis of Gene Expression

Analysis of transcription: northern and *in situ* hybridization, RNase protection assay, RT-PCR. Reporter genes- types and uses. Techniques characterizing nucleic acid-protein interactions- gel retardation assay, DNase I footprinting. Analysis of translation: western hybridization, immunohisto(cyto)chemistry.

Unit–IV Techniques

Extraction and purification of nucleic acids. Probes: types and applications, methods of radiolabelling (nick translation, end labelling, primer extension), nonradioactive probes. PCR: basic principles, optimization, applications. Real-time quantitative PCR, RACE. Cloning PCR products. DNA sequencing-automated method, next-generation sequencing

Unit–V Site-directed mutagenesis, Protein & Metabolic engineering

SDM-Cassette, oligonucleotide-directed mutagenesis, PCR-based methods. Use of SDM for protein engineering. Protein engineering by directed evolution and DNA shuffling. Metabolic engineering: designed overproduction of phenylalanine. 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. 8thh ed. Wiley-Blackwell. 2014.

Reference Books

1. Winnacker EL. From Genes to clones. VCH Publ. 1987.
2. Primrose, and Twyman. Principles of gene manipulation and genomics. 8th ed. Wiley-Blackwell. 2014.
3. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3rd ed. Freeman 2006.

IBTP 73: PRACTICALS IN ADVANCED CELL AND 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 human genomic DNA, agarose gel electrophoresis and identification.
4. Apoptosis: DNA fragmentation, FACS analysis.
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 .

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

Totipotency of plant cells- dedifferentiation and redifferentiation. Sterilization. Nutrient medium. Use of growth regulators. Callus and suspension cultures. Single cells- isolation, culture techniques and applications. Anther, ovary, meristem culture. Somatic hybridization (Symmetric, Asymmetric, Cybrids). Embryo culture. Embryo rescue. 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, detection and uses of haploids in plant breeding. Selection of hybrid cells and regeneration of hybrid plants.

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, TMV), chloroplast transformation. Use of reporter genes in transformed plant cells. Selectable markers for plants (briefaccount). RFLPs, RAPDs, DNA fingerprinting- general principles and applications in plant biotechnology.

Unit–IV Transgenic plant technology-I

Insect resistant plants-*cry* genes of *B.t.,* their proteins and target insects, *cry* gene expression in plants, insect resistance to Cry proteins. 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). Cytoplasmic male sterility.

Unit–V Transgenic plant technology-II

Genetic modification of flower pigmentation. Terminator technology. Production of vaccines by transgenic plants. 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.PrimroseTwyman and Old. Principles of gene manipulation and Genomics.8th ed. BlackwellSci 2014.
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

Biology and characterization of cultured cells- cell adhesion, proliferation, differentiation, morphology of cells and identification. Basic technique of mammalian cell culture *in vitro*, Measuring parameters of growth in cultured cells, cell viability and cytotoxicity. Germplasm conservation and establishment of gene banks. Large-scale culture of cell lines- monolayer, suspension and immobilized cultures.

Unit–II Animal cell culture-II

Organ and histotypic culture- technique, advantages, limitations, applications. Biotransformation - Induction of cell line mutants and mutations. 3D cultures. Whole embryo culture. Somatic cell hybridization. Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture. Hazards and safety aspects of 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.

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, dihydrofolatereductase, 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. 8th ed. Blackwell Sci 2014.
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. 8th ed. Wiley-Blackwell. 2014.
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. Shoot tip and nodal sector culture.
4. Anther culture.
5. Protoplast isolation and culture.
6. Animal cell culture techniques: Surface sterilization techniques, media preparation and storage, membrane filtration, serum inactivation.
7. Preparation of single cell suspension from spleen and thymus.
8. Primary culture of cells.

9. Estimation of protein, DNA and RNA from cultured cells.
10. MTT assay for cell viability and growth.
11. Preparation of metaphase chromosomes from cultured cells, karyotyping.
12. Trypsinization of monolayer and subculturing.
13. Cell cloning by single cell dilution method, freeze storing and revival of cultured cells.
14. Isolation of DNA and demonstration of apoptosis.

IBTT 91: 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: changes during processing. Caramelisation. Gel formation and starch retrogradation. Pectins- occurrence and use in foods. Major food proteins- hydrolysis, changes during processing. Oils and fats: rancidity, flavour reversion, refining, hydrogenation, shortenings and spreads. Emulsifyingagents.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. 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 SocChem 2007.
3. Singh BD. Biotechnology. Kalyani Publ.
4. Borem et al Understanding Biotechnology. Pearson 2011.

IBTT 92: 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 glucose homeostasis. Diabetes mellitus: classification, diagnosis, management, complications.

Unit–II Molecular Basis of Diseases-II

Atherosclerosis: risk factors and management.

Cancer- differences between benign and malignant tuours. Growth characteristics of cancer cells, ultrastructural alterations in tumour cells. Agents causing cancer (radiation, viruses and chemicals). Functions of proto-oncogenes and tumor suppressor genes (brief account only).

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. Cell-free nucleic acids. RFLP and PCR in disease diagnosis. Histocompatibility testing: lymphocytotoxicity test, cross matching. 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 93: 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 94: PRACTICALS IN FOOD AND MEDICAL BIOTECHNOLOGY

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

IBTT 101: 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. Genome sequencing approaches- whole-genome shotgun, hierarchical shotgun. Identifying genes-sequence inspection, EST comparison, similarity searches.

Unit–II Genome projects, post-genome analysis

Genome projects: *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, ChIPs, knock-out analysis.

Unit–III Protein separation, identification and quantitation

Proteomics introduction.Protein separation- general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry:basic principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem MS, peptide mass fingerprinting (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. Protein-protein interactions: yeast 2-hybrid system.

Unit–V Protein arrays and applications of proteomics

Protein arrays and protein chips. surface plasmon resonance biosensors. 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 102: 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 (brief account).

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. Database- types. Database management systems- hierarchical, rational, and network. Biological databases: primary and secondary sequence databases, organism-specific databases, miscellaneous databases. Data submission and retrieval from databases.

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 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.

IBTP 103: 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.
17. Preparation of nanoparticles.
18. Atomic force microscopy- Demo

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. Electron transport chain: components. Oxidative phosphorylation- Chemiosmotic theory. Introduction to metabolism- anabolism and catabolism.

Unit–II

Enzymes: 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 and isoenzymes. Applications of enzymes in clinical diagnosis and therapy.

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, glycogen metabolism.

Unit–IV

Amino acids: classification. Biologically important peptides. Proteins–classification, functions, and denaturation. Orders of protein structure: Primary, secondary (α-helix, β-pleated sheet), supersecondary, tertiary, and quaternary structures. Urea cycle, catabolism of carbon skeletons (overview only). Conversion of amino acids to specialized products.

Unit–V

Classification of lipids. Structure and functions of cholesterol.Brief account of lipoproteins. Lipid metabolism: β-oxidation of fatty acids, biosynthesis of fatty acids. Biosynthesis of ketone bodies,

utilization and clinical significance. Membrane structure- lipid bilayer, integral and peripheral proteins, the fluid mosaic model.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 6th ed. 2012.
2. Schaum's Outlines Biochemistry 2nd ed. McGraw Hill.
3. Murray et al. Harper's Illustrated Biochemistry 30th ed. McGraw Hill, 2015.
4. Satyanarayana U. Biochemistry. Books and Allied Publishers, Latest ed.

Reference Books

Voet and Voet.Fundamentals of Biochemistry. 4th ed. Wiley. 2015.

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

Vitamins: 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. Biological functions and clinical significance of calcium, phosphate, and iron.

Unit–II

BMR. Essential amino acids and fatty acids. Protein quality. Protein energy malnutrition: marasmus and kwashiorkor. Obesity: causes and consequences. Inborn errors of metabolism (PKU only). Diabetes mellitus: classification, diagnosis, management. Atherosclerosis: risk factors, and management. Jaundice: classification, diagnosis and management.

Unit–III

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. DNA replication- enzymes, basic mechanism and inhibitors. DNA damage. 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. The lac operon model.

Recombinant DNA technology: Basic steps in cloning. Restriction endonucleases, cloning vectors (e.g. pBR322). Gene transfer methods (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 30th ed. McGraw Hill, 2015.
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. Estimation of protein by Biuret/Lowry et al method
5. Determination of acid number/iodine number/saponification value of a fat.
6. Separation of lipids by TLC.
7. Estimation of ascorbic acid in lemon.
8. Isolation of DNA from rat liver and estimation of DNA by diphenylamine method.
9. Thermal denaturation of DNA.
10. Estimation of RNA by orcinol method.
11. Analysis of normal and abnormal constituents of urine.
12. Estimation of blood glucose.
13. Estimation of serum cholesterol.
14. Assay of serum ALP.

Reference Books

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