COURSE PATTERN – M.Sc. BIOTECHNOLOGY

Sem	Category	Code	Course	Hrs	Crs.
I	Core 1	16PBT1101	Molecular Biology	6	5
	Core 2	16PBT1102	Biochemistry	6	5
	Core 3	16PBT1103	Cell Biology	6	5
	Core 4	16PBT1104	Lab course 1 (Molecular biology & Cell biology)	4	3
	Core 5	16PBT1105	Lab course 2 (Biochemistry)	4	3
	Core 6	16PBT1106	Fundamentals of Genetics (Self-paced learning)	---	2
	C. Elect.1	16PBT1201A	Developmental Biology	4	4
		16PBT1201B	Stem Cell Biology		
	A. Core 1	16PBT1301	Industrial training (2 weeks, Optional)		(3)
Total for Semester I				**30**	**27+(3)**
II	Core 7	16PBT2107	Recombinant DNA technology	5	4
	Core 8	16PBT2108	Microbiology	5	4
	Core 9	16PBT2109	Immunology	4	3
	Core 10	16PBT2110	Lab course 3 (Recombinant DNA technology)	4	3
	Core 11	16PBT2111	Lab course 4 (Microbiology & Immunology)	4	3
	C. Elect.2	16PBT2202A	Cell signaling	4	4
		16PBT2202B	Molecular Diagnostics and Therapeutics		
	IDC 1	16PSS2401	IDC: Soft skills	4	4
	A. Core 2	16PBT2112	Internship (8 weeks)	--	(4)
Total for Semester II				**30**	**29**
III	Core 12	16PBT3113	Bioinstrumentation & Research Methodology	6	5
	Core 13	16PBT3114	Microbial Biotechnology	6	5
	Core 14	16PBT3115	Lab course 5 (Microbial Biotechnology)	3	2
	Core 15	16PBT3116	Lab course 6 (Bioinformatics & Biostatistics)	3	2
	C. Elect.3	16PBT3203A	Bioinformatics	4	4
		16PBT3203B	Drug discovery and development		
	IDC 2	16PBT3402	IDC – WS Bioprocess technology	4	4
	IDC 3	16PBT3403	IDC – BS Food Technology	4	4
Total for Semester III				**30**	**26**
IV	Core 16	16PBT4117	Environmental Biotechnology and Nanotechnology	6	5
	Core 17	16PBT4118	Plant & Animal Biotechnology	6	5
	Core 18	16PBT4119	Gene expression, Genomics and Proteomics	6	5
	Core 19	16PBT4120	Comprehensive Examination	--	2
	Core 20	16PBT4121	Project/Dissertation	12	6
Total for semester IV				**30**	**23**
SEM I – IV		16PBT4601	SHEPHERD		05
Total for all Semesters				**120**	**110 (3)**

MOLECULAR BIOLOGY
(Core 1)

SEM: I **Lecture/Week: 6**
16PBT1101 **Credits: 5**

Assurance of Learning

i. To understand the basic structure and functioning of the genetic materials.
ii. To understand the changes in the genetic material and the consequences in plants & humans.
iii. To compare and contrast the mechanisms of bacterial and eukaryotic DNA replication and, DNA repair.
iv. To compare and contrast the mechanisms of bacterial & eukaryotic transcription, and translation respectively.

Unit – I:

Experiments to prove DNA and RNA as the Genetic Material, Central Dogma, Viral genome – types, Structural organization of Prokaryotic and Eukaryotic cells. Components, types & Structure of nucleic acids, C value paradox. Types and basic structure of Chromosomes. Chromosomal Proteins – Histones and Protamines – Nucleosomes – levels in the organization of Metaphase Chromosome. Organization of prokaryotic DNA. Special types of Chromosome: Polytene and Lamp brush chromosomes.

Unit – II:

Transposons: Discovery and Classification, Transposons in Bacteria (Tn elements), Maize (Ac/Ds and Sp/Dsp elements), Drosophila (P elements) and Yeast (Ty elements). Extra chromosomal DNA: Maternal Inheritance, Structure, gene contents and functions of Chloroplast and Mitochondrial DNA - Interaction between cpDNA and nDNA, theory of prokaryotic endosymbionts.

Unit – III:

DNA replication: Models – Meselson & Stahl Experimental, Molecular mechanism of the replication of linear and circular (Rolling circle Model) DNA. DNA polymerases – structure and function. Recombinations: Homologous and non-homologous recombination- Site specific recombination

Unit – IV:

Central dogma, Transcription: RNA types, structure and functions. Transcription Mechanism in Prokaryotes and Eukaryotes – initiation, elongation and termination, Post transcriptional modifications. Antibiotic inhibitors of transcription. Translation: Genetic code and features. Wobbling hypothesis. Machinery, initiation, elongation and termination of translation in bacteria and eukaryotes. Translational proof reading, translational inhibitors, Post translational modifications, chaperones and protein targeting, protein degradation.

Unit – V: (Online)

Changes and consequences: Changes in the chromosome number: Euploidy and aneuploidy and related genetic disorders. Changes in the chromosome structure: addition, deletion, inversion and translocation and related genetic disorders. Mutation: Definition, chemical basis and types**.** Mutagens: Physical and chemical. DNA repair mechanism: Thymine dimer, Light activation, Excision, Recombinational, SOS and Mismatch repair.

Text Books for Study

1. Watson J. D., *et al.* 2006. Molecular Biology of the gene (Ed. 5) Pearson Education Inc. London.
2. Jeoffrey M. Cooper and Rober E. Hausman. 2000. The Cell: A Molecular Approach (Ed: 4). ASM Press, Washington D.C.

Reference

1. David Freifelder. 2008. Molecular Biology. (Ed: 2). Narosa Publications. NewDelhi.
2. De Robertis and De Robertis. 1990. Cell and Molecular Biology. Saunders College, Philadelphia.
3. Gerald Karp. 2008. Cell and Molecular Biology. (Ed: 5). John Wiley and Sons, New York.

BIOCHEMISTRY

(Core 2)

SEM – I **Lecture/Week: 6**

16PBT1102 **Credits: 5**

Objectives:

i. To understand enzymes and how they catalyze reactions as well as enzyme kinetics

ii. To study the structures of amino acids, their chemical properties and their organization into polypeptides and proteins.

iii. To study the structure of fundamental monosaccharides and polysaccharide

iv. To understand the structure and biological function of nucleotides and lipids.

Unit – I:

The molecular logic of life: Water - Physio-chemical properties of water. Biomolecular reactions. Macromolecules and their monomeric subunits, Bioenergetics – laws of thermodynamics, Gibb's Free energy, Activation energy, exergonic and endergonic reactions, Biological energy transductions. Enzymes – nomenclature, classification, Principle, regulation and mechanisms of enzyme catalysis, enzyme kinetics- MM equation, LB plot, Inhibition. Introduction to Metabolisms – Anabolism and Catabolism, Experimental approaches to study metabolism.

Unit – II:

Carbohydrates – Classification, Structure and Isomerism. Monosaccharides, Oligosaccharides, Polysaccharides– Structure and Properties. Metabolism of Carbohydrates- Glycolysis, Citric acid cycle, HMP shunt, Glucuronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle, Regulations of Glycolysis and Gluconeogenesis. Metabolism of Amino sugars, Sialic acids, Mucopolysaccharides and Glycoproteins.

Unit – III:

Aminoacids- structures, classification, properties. Biosynthesis of Aspartate, Pyruvate and Aromatic aminoacids families. Amphibolic activity of amino acids. Protein – classification, types, characteristics and structures, Functions. Methods for determining protein conformations. Symmetry and functional properties, Protein folding, Denaturation & Renaturation, Ramachandran plot, Solid state synthesis of peptides, Sequence determination. Degradation of Proteins and Aminoacids, Urea cycle and its significance.

Unit – IV:

Lipids – classification, sources and biological functions. Biosynthesis of fatty acids and its regulation, Hydroxy fattyacids, Acylglycerols. Membrane lipids- Phospholipids, Sphingolipids & Eicosanoids. Cholesterol biosynthesis and its regulation. Fatty acid degradation. Lipoproteins- types and functions. Methods of inter organ transport of fatty acids. Formation of ketone bodies.

Unit – V: (Online)

Nucleic acids- bases, nucleosides & nucleotides, Structure of RNAs and DNA, Forces stabilizing nucleic acid structures. Fractionation, sequencing and chemical synthesis of oligonucleotides. Denaturation and Hybridization. Synthesis of Purines and Pyrimidines, Synthesis of Deoxy ribonucleotides. Biosynthesis of nucleotide coenzymes, nucleotide degradation. Intermediary metabolism.

Text Books for study

1. Lehninger, A. L. *et al.,* 1993. Principles of Biochemistry, Worth Publishers. Inc. USA.
2. Stryer, I., 1988. Biochemistry (2nd Edition), W.H. Freeman & Co., New York.

References

1. Zubey, G L., 1998. Biochemistry, WCB Publishers.
2. Robert K. Murray *et al*., 2000. Harper's Biochemistry (25th ed), Appleton and Lange Stainford Publishers, Connecticut.
3. White, A. *et al*., 1959. Principles of Biochemistry, McGraw Hill Book Co., New York.

CELL BIOLOGY
(Core 03)

SEM: I **Lecture/Week: 6**
16PBT1103 **Credits: 5**

Assurance of Learning

i. *To understand the knowledge of basic concepts of cell biology and of those properties that are common to cells.*
ii. *To understand the ability to analyze and interpret the behavior of cells in their microenvironment in multi-cellular organisms with emphasis on cell-cell interactions, cell - extra cellular matrix interactions, and soluble signaling.*
iii. *evidence-based critical thinking in cell biology.*
iv. *To understand the appreciation of the depth and scope of the ever developing field of cell biology.*

Unit – I:

Historical origins of cell biology: The discovery of cell, development of the cell theory. Cell as a basic unit of living system. Biochemical composition of cell: protein, lipid, carbohydrate, nucleic acid. Diversity of cell size and shape. Structure of Prokaryotic and Eukaryotic cells- Isolation and growth of cells. Ultra structure of cell. Sub-cellular organization of eukaryotic cells - microscopy and cell architecture - purification of cells and their parts.

Unit – II:

Steps in cell cycle, yeast as model system, cell division control and regulation yeast cdc gene. Genes for social control of cell, Protooncogenes. Cell signalling: Exocrine, Endocrine, Paracrine and Synaptic strategies of Chemical signalling, surface receptor mediated transduction (DAG, Ca+2, c-AMP, G-Proteins)

Unit – III:

The structural and functional organizations of cell membrane, ionic transport (Passive and active transport) the extracellular matrix of eukaryotes, cell wall. Structure and functions of endoplasmic reticulum, golgi complex, ribosome lysosomes, peroxisomes (glyoxysomes), plastids and mitochondria. Biogenesis of mitochondria and chloroplast.

Unit – IV:

Cytoskeleton and cell motility: Microtubules, microfilaments and intermediate elements. Nuclear ingredients: Nuclear membrane Nature of the genetic material, Proteins associated with nuclei. Packaging of genetic material: nucleosome model, Organization of chromatin: chromosome structure.

Unit – V: (Online)

Cell cycle: Mitosis & Meiosis. Checkpoints in Cell Cycle Regulation**.** Cell-cell interaction, Cell locomotion (amoeboid, flagellar and ciliar). Muscle and Nerve cell, Cell senescence and death, Cell differentiation. Cellular basis of differentiation and development-mitosis, gametogenesis and fertilization.

Text Books for study

1. Robertis De, E.D.P. & E.M.F. De Robertis, 1987, Cell and Molecular Biology, Lea & Febiger.
2. Bruce Albert, Dannis Bray, Julian Lewis, Martin Raff. Keith Roberts, James D. Watson, 2000, Molecular Biology of Cell, 4th Edition, Garland Publishing Inc., New York, USA.

References

1. Harris,D (Ed.), Karp, G.1999. Cell and molecular biology - Concept and experiment. 2nd edn., John Wiley & sons, sons, New York.
2. Mclaughlin,S., Trost,K., Mac Elree,E.(eds)., Kleinsmith,L.J.& Kish, V.M., 1995. Principles of cell and molecular biology. 2nd edn., Harper Collins Publisher, New York.
3. Alberts,B., Bray,D., Lawis,J., Raff,M., Roberta, K., Watson, J.d(eds.), 1994. Molecular biology of the cell.3nd edn., Garland Publication, Inc., New York.

LAB COURSE I: MOLECULAR BIOLOGY & CELL BIOLOGY
(Core 4)

SEM: I **Practical/Week:4**
16PBT1104 **Credits: 3**

Molecular Biology

1. Calculations in Molecular biology – a) Calculating DNA in mM and conversion to picomoles b) Oligonucleotide Quantitation c) Calculating Molecular weight of a vector d) Calculations in Oligonucleotide synthesis. e) Calculating T_m and concentration of primers
2. Isolation of extracellular DNA from biofilm matrix.
3. Induced mutation by: (a) Chemical mutagen. (b) Ultraviolet light.
4. Total RNA isolation
5. Spectroscopic analysis of DNA/RNA and calculate dsDNA, ssDNA and RNA concentration.
6. Determination of size of Nucleic acids in Agarose gel electrophoresis.
7. Chromosome banding - G- Banding
8. SDS-PAGE and Native PAGE

Cell Biology

1. Observation of prokaryotic and eukaryotic cells – Living Cells/Temporary/Permanent Preparations.
2. Squash preparation of giant chromosome of salivary gland of Chironomous larva.
3. Squash preparation of onion root tip.
4. Preparation of buccal smear.
5. Cytochemical study of cells/cell types using specific dyes/reagents.

LAB COURSE -II BIOCHEMISTRY
(Core 5)

SEM: I **Practical/Week: 4**
16PBT1105 **Credits: 3**

BIOCHEMISTRY

1. Preparation of Standard solutions (Molar & Normal) and various buffers.
2. Preparation of Titration curve & determination of pKa values for aminoacids
3. Estimation of Amino acids
4. Estimation of reducing sugars
5. Estimation of lipids
6. Estimation of Proteins by Bradford method.
7. Estimation of Vitamin C (Titration)
8. Chromatography: Column Chromatography - Separation of Photosynthetic Pigments and recording their absorption spectra in the visible range.
9. Separation of amino acids / sugars by Ascending Paper Chromatography.
10. Separation of lipids/ sugars/amino acids by Thin Layer Chromatography.
11. Enzyme Kinetics

    (a) Phosphatase assay (chicken liver)
    - Assay of enzyme activity,
    - Effect of pH,
    - Temperature,
    - Enzyme concentration
    - Substrate concentration.

FUNDAMENTALS OF GENETICS
(Self Paced Learning)

SEM: I **Lecture/week: --**
16PBT1106 **Credits: 2**

Assurance of Learning

i. *To understand the basic concepts of genetics*
ii. *To understand the concepts on Linkage and genetic mapping*
iii. *To understand how traits are inherited and to use this understanding in analyses*
iv. *To understand the uses of population genetics techniques*

Unit – I:
History of Genetics - Mendelism – basic principles. Extensions of Mendelism, penetrance and expressivity of genes. Non-mendelian inheritance – cytoplasmic inheritance.

Unit – II:
Linkage and genetic mapping Linkage and Crossing over - Stern's hypothesis, Creighton and McClintock's experiments, single cross over, multiple cross over, two-point cross, three-point cross, map distances, gene order, interference and co-efficient of coincidence. Haploid mapping (*Neurospora*),

Unit – III:
Inheritance of traits in humans; pedigree analysis, determination of human genetic diseases by pedigree analysis, genetic mapping in human pedigrees. Quantitative genetics - Polygenic inheritance, QTL, effect of environmental factors and artificial selection on polygenic inheritance.

Unit – IV:
Population genetics Gene pool, allele and genotype frequency. Hardy-Weinberg law and its applications, estimation of Allele and Genotype frequency of dominant genes, codominant genes, sex-linked genes and multiple alleles.

Unit – V: (Online)
Genetic equilibrium, genetic polymorphism. Factors that alter allelic frequencies; Mutation Genetic drift - Bottle neck effect and Founder effect, migration, selection, nonrandom mating, inbreeding coefficient.

Text Books for Study

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

References:

1. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
2. Russell, P. J. (2009). Genetics3 A Molecular Approach. III Edition. Benjam in Cummings.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biot echnology3 Principles and Applications of recombinant DNA. ASM Press, Washington.

DEVELOPMENTAL BIOLOGY

(Core Elective - 1)

SEM: I **Lecture/week: 4**

16PBT1201A **Credits: 4**

Assurance of Learning

i. *To study the cellular basis of development.*
ii. *To understand the concepts in developmental biology related to gene regulation and epigenetics.*
iii. *To understand the concepts in developmental biology related to cell fate specification and patterning.*
iv. *To elucidate the early development process of humans.*

Unit – I:

Basic concepts: General concept of cellular development: Potency, commitment, specification, induction, competence, determination & differentiation; morphogenetic gradients; cell fate & cell lineages; genomic equivalence and cytoplasmic determinants; imprinting. General principles of cell-cell communication in development: cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, paracrine factors.

Unit – II:

Fertilization, development and sex determination in humans: Gametogenesis - Sperm & Egg formation; ultrastructure of sperm and ovum, egg types, egg membrane. Fertilization, cleavage, Morula, Implantation, blastulation, gastrulation, formation of germ layers, axis formation - anterior and posterior. Sex determination - chromosomes and environment.

Unit – III:

Organogenesis - I: Organogenesis: Central nervous system and the epidermis - Formation of neural tube, Differentiation of the neural tube, tissue architecture of the central nervous system, origin of cutaneous structures. Neural crest cells and axonal specificity - Specification, Trunk Neural Crest, Pattern generation in the nervous system.

Organogenesis - II: Plant meristem organization and differentiation - Organization of shoot apical meristem (SAM); Organization of root apical meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixes.

Unit – IV:

Organogenesis - III: Paraxial and intermediate mesoderm - Somites formation, Osteogenesis, Urogenital system. Lateral plate mesoderm and endoderm **-** Heart formation, digestive tube and its derivatives.

Unit – V:

Implications of developmental biology: Medical implications of developmental biology - genetic disorders in human development, environmental assaults on human development, Future therapies and Developmental biology, Environmental regulation of animal development - Environment as a part of normal development, Polyphenisms and plasticity, Learning system.

Text Books for study

1. Gilbert S.F. 2010. Developmental Biology, (Ed: 9) Sinauer Associates Inc. Pub., Sunderland, Massachusetts.

References

1. Alberts B. *et al.* 2002. Molecular Biology of the Cell, (Ed: 3). Garland Science, New York.
2. Lodish, H. *et al.* 2000. Molecular Cell Biology. (Ed: 4). W.H.Freeman, New York.

STEM CELL BIOLOGY
(Core Elective – 1)

SEM: I **Lecture/week: 4**
16PBT1201B **Credits: 4**

Assurance of Learning

i. *To understand the stem cell biology and biotech revolution;*
ii. *To realize the molecular mechanisms and applications associated with this technology.*
iii. *To compare and contrast tissue specific stem cell types and the basic mechanisms that regulate them.*
iv. *To study the ethical and political issues related to stem cell research*

Unit – I:

Basic concepts of Stem cells – definition; unique properties – proliferation and differentiation; Potency definitions: totipotent, pluripotent, multipotent and unipotent; basics of early human embryology; History and key stem cell research events. Stem-cell plasticity, Regulators of pluripotency and differentiation of stem cell. The isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells. The problem of differentiation of stem cells. Stem Cells and imprinted genes.

Unit – II:

Differentiation & Types of Stem cells: Isolation, culture, identification and assays. Types: unlimited and limited; Embryonic and adult stem cells – bone marrow, cord blood, neural, endothelial, hematopoietic, corneal, epithelial, pancreatic, hepatic, glandular, cardiac and gastrointestinal, leukemia and cancer stem cells.

Unit – III:

Stem cells and cloning; Induced Pluripotent stem cells (iPS), germ line stem cells; Recruiting Donors and Banking Hes Cells; IPRs and Hes Cells. Fate mapping of stem cells in experimental systems.

Unit – IV:

Genetically engineered stem cells and experimental therapies. Stem cell based therapies: stem cells and repair of heart and nervous system; regeneration strategies. Skin replacement, brain cell transplantation and stem cells in aging.

Unit – V:

Controversies and Guidelines for Hes cell research – Scientific background of Hes research; societal implications: women, low-income, Different religious views, Current Ethical Guidelines in India, Ethical views of other countries and how this affects advancement of science Policy. Current Regulation of Human Embryonic Stem Cell Research. Future of SC research.

Text Books for Study

1. Hossein Baharvand. 2009. Trends in stem cell biology and Technology. Humana Press, NY
2. Robert Paul Lanza. 2006. Essentials of Stem Cell biology**.** Elsevier Academic Press.

References

1. Verma IM and Gage FH. 2002. (Ed) Regenerative Medicine, Natl Acad Sci & Engg, USA
2. The Natl Academies, USA 2007 Understanding Stem Cells (Unit - II)
3. The Natl Academies, USA 2002 Stem Cells and the Future of Regenerative Medicine (Unit– IV & V)

RECOMBINANT DNA TECHNOLOGY
(Core 7)

SEM: II **Lecture/Week: 5**
16PBT2107 **Credits: 4**

Assurance of Learning

i. To study the various underlying principles of genetic engineering that forms the basis of rDNA technology.
ii. To study current applications of biotechnology and advances in different research areas.
iii. To study the methodologies, and in brief the applications and related issues of rDNA technology.
iv. To study bioethical issues related to this new technology

Unit – I:

Introduction to Recombinant DNA technology - Isolation (Mechanical, cDNA, Shot gun) & Purification of Nucleic acid, PCR; Enzymes in molecular biology – Restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, T_4 polynucleotide kinase; Linker, Adaptors, Homopolymers.

Unit – II:

Expression Cassette & Viral vectors: Promoters (Constitutive, Inducible, Tissue specific), Terminators, Reporters, Markers (Antibiotic resistant, Herbicide resistant, Antimetabolite); Vectors in gene cloning – Plasmids (pBR322, pUC), Bacteriophages (Phage λ, M13), Cosmids, Phagemids, Yeast plasmid vector, Viral vectors (Adenovirus, Adeno associated virus, Baculo virus, Herpes virus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus X), Transposons (Ac-Ds, P) Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector.

Unit – III:

Gene transfer Methods – Transformation – Physical method (Electroporation, Micro-injection, Particle bombardment, Liposome mediated transfer); Chemical method (PEG mediated, DEAE Dextran mediated, $CaPo_4$ mediated gene transfer); Biological method (*Agrobacterium* mediated gene transfer). Expression systems – Prokaryotes (Bacteria) and Eukaryotes (Yeast, Mammalian and, Insect cell lines).

Unit – IV:

Screening & Selection methods – Insertional inactivation, Blue-White selection, colony - *in situ* hybridization, *In vitro* selection, *In vitro* translation, Radioactive antibody test, Immunological techniques, DNA labelling, dot blot hybridization, Molecular beacons. Gene Silencing, RNA interference, antisense therapy, Gene Knockout
Blotting techniques – southern, northern, Western and South-western.

Unit – V: (Online)

Molecular Techniques – RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C-DNA library & its types; BAC library; YAC library; Methyl filtration libraries; COT fractionation based libraries. Bioethics & Biosafety in genetic engineering; IPR & Patenting.

Text Books for Study

1. Glick R. and J. J. Pasternak. 2002. Molecular Biotechnology(Ed:3). ASM Press, Washington.
2. Old RW and SB Primrose. 1989. Principles of gene manipulation(Ed:4). Blackwell scientific publications, London.

References

1. Brown T. A. 1988. Gene cloning –An introduction. VNR (UK) co. Ltd, England.
2. Ernst L Winnacker. 2002. From genes to clones - Introduction to gene technology. VCR Pub., Weinheim.
3. James D Watson *et al.,* 1992. Recombinant DNA (Ed:2) WH freeman and co., New York.

MICROBIOLOGY
(Core 8)

SEM: II **Lecture/Week: 5**
16PBT2108 **Credits: 4**

Assurance of Learning

i. *To study the microbial ecology and role of microbes in nutrient cycles.*
ii. *To develop a knowledge of microbial organisms and their relevance of infectious diseases;*
iii. *To study the applications of microbiology in various industries.*
iv. *To study the medical and practical uses for microorganisms*

Unit – I: General Microbiology

Introduction and scope of microbiology. Brief study of structure and organization of major groups of microorganisms - Archaebacteria, Cyanobacteria, Eubacteria, Fungi, Algae, Protozoa and Viruses. Culture of microorganisms – batch, continuous and pure cultures. Control of microorganisms – physical, chemical and chemotherapeutic agents. Preservation of microorganisms.

Unit – II: Environmental Microbiology

Microbiology of soil – soil microflora – role of soil microbes in biogeochemical cycles (C,N,S) - Marine and fresh water microbiology. Contamination of domestic and marine waters. Water purification and sewage treatment. Role of microbes in waste water treatments. Microbiology of air.

Unit – III: Industrial Microbiology

Selection of industrially useful microbes. Fermentors and fermentation technology. Industrial production of alcohol, vinegar, lactic acid, antibiotics, enzymes and amino acids. Microbiology of food – sources of contamination – food spoilage – food preservation methods.

Unit – IV: Clinical Microbiology

Epidemic, endemic, pandemic and sporadic diseases. Pathogenicity, virulence and infection. Epidemiology of infectious diseases. Bacterial diseases of human (Typhoid, Cholera, Syphilis, Gonorrhoea and Pertussis). Fungal diseases of human (superficial, cutaneous, subcutaneous and systemic mycoses). Viral diseases of human (AIDS, Hepatitis, Polio, Rabies and Measles). Mycoplasmal, Chlamydial, Rickettsial and protozoan diseases of human. Mycotoxins.

Unit – V: (Online) - Applied Microbiology

Role of microbes in the manufacture of antibiotics and vaccines. Microorganisms as biofertilizers. Microbes as foods - SCP production. Role of microbes in bio-gas production, petroleum industry and mining. Microbial degradation of lignin, cellulose and pesticides. Microbial immobilization. Microbes in biological warfare.

Text Books for study

1. Pelczar *et. al.* (1998): Microbiology. Tata McGraw-Hill, New Delhi
2. Prescott *et al* (1996): Microbiology (WMC Brown Publishers, USA)

References

1. Martin Alexander (1969): Introduction to soil microbiology. Wiley, New York
2. Wayne *et al* (1962): Modern microbiology
3. Adams and Moss: Food microbiology

IMMUNOLOGY
(Core 9)

SEM: II **Lecture/Week: 4**
16PBT2109 **Credits: 3**

Assurance of Learning

i. To understand the function of the major components of the immune system in health and disease
ii. To elucidate the immune response of humans to foreign substances.
v. To study the modern techniques that help determine human protection.
vi. To study the common immune diseases in terms of the underlying basic principles.

Unit – I: Basics of immunology:
Terminology - antigen, immunogen, hapten, antigenecity, immunogenicity, immunoglobulin, antibody, epitope, paratope, super antigen, allergen, tolerogen etc. Organs of immune system, tissues of immune system, cells of immune system & mediators of immune system. Natural & induced immunity.

Unit – II: Immunoglobulin:
Structure and Functions domains, classes, Organization and expression of Immunoglobulin Light and Heavy chain genes Principles of cell signaling; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation. Natural immunity - Complement, Natural killing, Phagocytosis, Pinocytosis.

Unit – III: Major Histocompatibility Complex (MHC):
General organization and inheritance of MHC; MHC Haplotypes. The structure of MHC class-I and class-II molecules; organization of MHC class I and class II genes, peptide binding of MHC molecules. Complement system-alternate and classical pathways. HLA typing. Polyclonal and Monoclonal antibody. Transplantation - Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy. Cell Mediated Immunity, Humoral immunity, T-Cell Receptor, B-Cell Receptor, Antigen Presenting Cell.

Unit – IV: Antigen-antibody interactions:
Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, Immunofluorescence, Flow cytometry and Immunoelectron Microscopy; Surface plasmon resonance, Biosensor assays for assessing ligand - receptor interaction, CMI techniques - lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

Unit – V: (Online): Clinical Immunology:
Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency - Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Text Books for study

1. Kuby R.A. Goldsby *et al.,* 2002. Osborne Immunology(Ed: 6) Freeman & Co., New York.
2. Roit M. Ivan. 1998. Essential Immunology (Ed: 7). Blackwell Scientific Publisher, England.

References

1. Donald M. Weir and John Steward. 1993. Immunology (Ed: 7). ELBS, London.
2. Murphy *et al*., 2008. Janeway's Immunology the immune system in health and disease. (Ed: 7). Garland Science Publisher, New York.

LAB COURSE III: RECOMBINANT DNA TECHNOLOGY
(Core -10)

SEM: II **Practical/Week: 4**
16PBT2110 **Credits: 3**

Recombinant DNA Technology

1. Agarose gel electrophoresis
2. Isolation of genomic and plasmid DNA from bacteria
3. Isolation of total RNA from plant tissue
4. Isolation of genomic DNA from Plant tissue
5. Restriction digestion
6. Ligation of DNA
7. Transformation of bacteria by Calcium chloride method
8. Blue-White screening method
9. GFP cloning
10. Gel elution of DNA
11. DNA fingerprinting
12. Bacterial gene expression

LAB COURSE IV: MICROBIOLOGY AND IMMUNOLOGY
(Core 11)

SEM: II **Practical/Week: 4**
16PBT2111 **Credits: 3**

MICROBIOLOGY

1. Study of Autoclaving of media.
2. Preparation of basal media – Solid, Liquid: Serial dilution, plating with microbial strain;
3. Isolation of single colonies.
4. Study of a compound microscope.
5. Identification of bacteria by gram staining
6. Sub-culturing of a strain using a synthetic liquid media.
7. Study of bacterial growth of *E.coli* by a Spectrophotometer.
8. Assay of an antibiotic by zone-inhibition method using antibiotic impregnated discs.
9. Estimation of antimicrobial activity using standard guidelines (NCCLS/CLSA)
10. Study of biochemical identification of microorganisms.
11. Bacterial biofilm formation by microtitre plate assay.

IMMUNOLOGY

1. Collection of body fluids, blood
2. Separation of serum and plasma
3. Precipitation – Agar Gel Diffusion, Counter current Immunoelectrophoresis, Single Radial Immunodiffusion, Rocket electrophoresis
4. Agglutination - blood grouping, latex agglutination, heme agglutination, WIDAL, VDRL
5. Labeled assays- ELISA, Radio Immuno Assay and Immunoblot.
6. Total count, Differential count (RBC & WBC)
7. Blood typing
8. Isolation of DNA from leukocytes

CELL SIGNALLING
(Core Elective – 2)

SEM-II **Lecture/week: 4**
16PBT2202A **Credits: 4**

Assurance of Learning

- *To understand the basic knowledge of the components of the main signalling pathways and their functional properties*
- *To understand the regulation of target cell responsiveness.*
- *To understand the different mechanisms for receptor activation and regulation.*
- *To understand intracellular signaling cascades and their impact on cellular activities, including cytoskeleton rearrangements, motility and changes in gene expression.*

Unit – I:
Extra Cellular Matrix (ECM) and Cell Surface: Molecules in the ECM in plant and animals. Transport across cell membrane, Ficks Law. Types of transport- simple, passive, facilitated. Active transport, primary and secondary active transport system. Ionophores, gated channels (Voltage and Ligand). Cell communication and type of signaling molecules. Types of receptors and their structure. GPCR, inhibitory and stimulatory and type of down steam effectors and signal termination. Monomeric G-proteins their role. Drugs targeting signaling molecules

Unit – II:
Cell Signaling: Cell division and differentiation. Autocrine, paracrine & endocrine systems. Growth factors – EGF, PDGF, VEGF, IGF. Second messengers – Ca, calmodulin, inositol, NO, cAMP, cGMP. Receptors tyrosine kinases (Insulin signaling), MAPK pathway, role in signaling. Role of post-translational modification of proteins in signaling – phosphorylation. Acylation, glycosylation, ADP ribosylation, myristoylation. Signal cascades, Inhibitors of signal cascades.

Unit – III:
Concept of transducers, effectors, GTP binding proteins - Gi, Gs, Gp, Gq, ras; adenylate cyclase, guanylate cyclase, phosphodiesterases, Protein kinase (PK) A, C and G, Calmodulin dependent PK, tyrosine kinase, stress activated PK, ribosomal S6 kinase; cross-talk between different signal transduction pathways. Endocytosis and exocytosis, receptor mediated endocytosis, nuclear transcription factors, angiogenesis, PKs associated with cell survival and death processes.

Unit – IV:
Signal Transduction and Cancer: Discovery of oncogenes, proto-oncogenes. Modes of action of oncogenes – G proteins – Ras. Growth factors – Erb, Sis. Transcription factors – Fos, Jun, AP1, V-erbA. Discovery of tumor suppressor genes. RB and retinoblastoma, APC and colon cancer. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN). p53 and cancer risk. Selected examples – c-Myc and leukemia. BRCA and breast cancer

Unit – V:
Signal Transduction in Bacteria and Plants: Introduction of signaling components in bacteria, Chemotaxis, Protein kinases in bacteria, His-kinases: structure and role, Plant signaling system an over view, Stress signaling in plants (biotic), Stress signaling in plants (abiotic). Plants hormones and their mechanism of action. Signaling in yeast: STAT pathway in yeast

Text Books for Study:

1. Michel Friedman and Brett Friedman. 2004. Cell communication: Understanding how information is stored and used in cells. Ingram International Inc.
2. John T Hancock. 2005. Cell signaling. Oxford University press

References:

1. Geoffery M Cooper and Robert E Hausman. 2009. The Cell and Molecular Approach. (Ed: 5). ASM Press and Sinauer Associates Inc.
2. Gomperts, Basten D, Ijbrand M Kramer and Peter ER Tatham. 2009. Signal transduction. (Ed:2). Academic Press.
3. Ernst JM Helmreich. 2001. The Biochemistry of cell signaling. Oxford Univ Press.

MOLECULAR DIAGNOSTICS
(Core Elective - 2)

SEM: II **Lecture/Week: 4**
16PBT2202B **Credits: 4**

Assurance of learning

i. To explore the molecular mechanisms of diseases
ii. To study the various diagnostic tools available for these diseases.
iii. To study the difference between conventional and molecular techniques
iv. To understand how genetic problems may lead to disease or lethality

Unit – I:

Molecular mechanisms of diseases: Detection of genetic defects, Detection of infectious agents, tumor diagnosis markers and grading. Molecular genetics of B - cell neoplasia. Liver specific expression of cloned human genes, technology of carrier erythrocytes: a tool for diagnosis and therapy. Diagnosis of single gene disorders - Spinal muscular atrophy, DMD and BMD, Fragile X syndrome.

Unit—II:

Use of Probes for diagnostics: Restriction Fragment Length Polymorphism (RFLP) - DNA probes detection of mutations and deletions in gene. Eg: thalassemia, haemophilia, sickle cell anemia, retinoblastoma. DNA finger printing. Genetic disease probes. Chromosomal DNA probes for prenatal diagnosis of X-linked Retinitis pigmentosa, prenatal sex determination.

Unit – III:

Hereditary persistence of fetal hemoglobin: model for abnormal development regulation. Apolipoprotein genes, DNA polymorphism and hyperlipidemia, cDNA of human protein C for diagnosis of protein C deficiency. Prenatal diagnosis and carrier detection of phenylketonuria by gene. Prenatal diagnosis - Fluorescent *in situ* hybridization (FISH) DNA probes - fluorescent labeling, chromosome painting and spectral karyotyping, peptide mapping.

Unit – IV:

Approaches in hybridoma technology: Hybridoma variants affecting isotype, antigen binding and idiotype: isolation of class and subclass switch variants by selection. The MHC locus, HLA polymorphisms, HLA nomenclature, molecular analysis of the MHC, serological analysis DNA-based typing, combining typing results, HLA test discrepancies, coordination of HLA test methods, additional recognition factors, Minor histocompatibility antigens, nonconventional MHC antigens, killer cell immunoglobulin-like receptors, MHC & its disease association.

Unit – V:

Polymerase Chain Reaction - Its applications in diagnosis of infectious diseases - eg: HIV, hepatitis B and tuberculosis. Identification of gene mutations and deletions - eg: p53 mutations. Use in solving paternity disputes and crime detection. Molecular Oncology-Classification of Neoplasms, Molecular Basis of Cancer, Analytical Targets of Molecular Testing- Gene and Chromosomal Mutations in Solid Tumors, Microsatellite Instability, Loss of Heterozygosity. Enzyme linked immunosorbent assay (ELISA) - Diagnosis of infectious diseases and cancer antigens, HIV detection.

Textbooks for study

1. Koporowski,H *et al.* 1985. Biotechnology in Diagnostics, Elsevier publishers.Vol-21.
2. Gath, D. D, 1994, PCR-based diagnostics in infectious diseases, Blackwell Scientific

References

1) Fazal Ahmed, 1984, Advances in Gene technology: human genetic disorders, ICSU Stanely, A *et al,* 1994, Vaccines, W. B. Saunders & Co.
2) Lela Buckingham, Maribeth L. Flaws, 2007, Molecular Diagnostics - Fundamentals, Methods, & Clinical Applications, F.A. Davis & Company, Philadelphia.

BIOINSTRUMENTATION & RESEARCH METHODOLOGY
(Core 12)

SEM: III **Lecture /Week: 6**
16PBT3113 **Credits: 5**

Assurance of Learning

i. *To understand the working principles, construction and applications of the instruments often used in the studies related to various disciplines of Biological Sciences.*
ii. *To understand the statistical concepts and applying them in data collection, analysis and interpretation.*
iii. *To understand different scientific research designs and methods*
iv. *To understand the importance and the concept of Research and learn the art of paper writing and publication.*

Unit – I:
Electrochemical techniques – principles, electrochemical cells and reaction – pH and buffers. Measurement of pH – glass electrode and titration curves. Ion selective and gas sensing electrodes, oxygen electrode, and their applications. Microscopy – Compound, Fluorescence, Phase contrast, Scanning, Transmission, Atomic force and Confocal Scanning Laser Microscopy.

Unit – II:
Separation techniques: Centrifuges - Principles, differential and analytical centrifugation, density gradient centrifugation; Ultracentrifuge and its application. Electrophoresis: Principles, electrophoretic mobility, paper, disc, slab gel electrophoresis. Isoelectric focussing, 2D PAGE, blotting techniques, capillary electrophoresis. Chromatographic techniques – adsorption and partition chromatography. Techniques and application of paper, column, thin layer**,** normal phase and reverse phase - ion-exchange, exclusion, affinity, GLC, GC, HPLC and HPTLC.

Unit – III:
Spectroscopy – Properties of EMR, absorption spectrum., Absorption vs Emision spectrophotometry, AAS & flame photometer, UV/VIS spectroscopy, IR, ESR, NMR, MS, GC-MS, spectrofluorimetry, CD spectroscopy, X-ray diffraction. Tracer technique: Nature of Radioactivity, Patterns of decay, half life and its application, Detection and measurement of radioactivity: Geiger Muller Counter- principle, construction, applications, advantages and disadvantages. Scintillation counter – Principle, types, construction and applications.

Unit – IV:
Biostatistics – Basics and uses of Measures of Central values (Mean, Median, Mode), Measures of Dispersion (Standard Deviation and coefficient of variation) in data analysis and presentation. Basic theoretical knowledge of Correlation and Probability - Sample Testing: Large samples (Z), small sample test: t, Chi-square, ANOVA - one way & two way. Experimental Design: Principles: Randomization, Replication, Local control, Size and shape of the plot. CRD and RBD.

Unit – V: (Online)
Research: Selection of research problems – hypothesis – definition and characteristics. Experimental approaches – biological, physical and chemical methods. Sources of information: Journals, e-journals, books, biological abstracts, Preparation of index cards, Review writing, Thesis writing, Article writing – structure of article (title, introduction, methods, specimens and techniques of statistics, results, discussion, acknowledgements, references, abstracts), Selection of journals for publication.

Text Books for study

1. Braun, R.P. 1987. Introduction to Instrumental Analysis (McGraw Hill).
2. West, E.S. and Todd, W.R., Mason, H.S. and Van Brugan, J.T.: Textbook of Biochemistry.

References

1. Edsall, J.T., Wymen , J. : Biological Chemistry- Vol. I and II (Academic Press).
2. Research methodology for biological sciences by N.Gurumani: MJP publications (2006).
3. Biophysical chemistry: Part I,part II and Part III by Cantor and Schimmel :2004 edition.
4. Biostatistics by Wayne W. Daniel: Seventh edition (2006).

MICROBIAL BIOTECHNOLOGY
(Core 13)

SEM: III **Lecture/Week: 6**
16PBT3114 **Credits: 5**

Assurance of Learning

i. To study the avenues of exploiting microbes.
ii. To study the structure and types of fermentor
iii. To understand Bioprocess control mechanisms
iv. To study the downstream processes for product recovery in fermentation.

UNIT I

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Media formulation and optimization. Basic concepts- batch, Continuous and fed batch culture, selection methods for industrially important microorganisms. Strain improvement, preservation, and properties of industrial strains.

UNIT II

Fermentor – Design & Types: Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a bioreactor, Impellers, baffles and sparger, sterilization. Types of reactor- submerged reactor – mechanically stirred draught- tube reactor- continuous flow stir type reactor – airlift reactor- jet loop reactor, surface reactor, packed bed reactor, Fluidized bed reactor.

UNIT III

Bioprocess control and monitoring variables – O_2 requirement and uptake, factors affecting K_La. Flow measurement and control, control system – manual and automatic. PID control. Application and the role of computers in bioprocess.

UNIT IV

Down-stream processing: Introduction, recovery of microbial cells, precipitation, filtration-theory of filtration, batch and continuous filters. Centrifugation. Cell disruption-physical and chemical methods. Extraction- liquid-liquid extraction and aqueous-two phase extraction. Chromatography, membrane processes, drying and crystallization.

UNIT V (Online)

Production strategies for industrial products: (Lactic acid and Ethanol), therapeutics (Insulin and Interferon), antibiotics (Cephalosporin), Microbial enzymes (Chitinase, Glucose Oxidase, Lipase), Exopolysaccharides (Pullulan). Use of immobilized cells / enzymes to produce protease, Use of fungi in industry including food industry: biosensors and fuel cells, Use of fungi in agriculture and environmental applications: Biofertilizers, Bioremediation and Biological control. Animal cell culture technology to produce recombinant vaccines

Text Books for study

1. Stanbury P.F. *et al.* 1999. Principles of Fermentation Technology, Butterworth-Heinemann, UK.
2. El-Mansi E.M.T *et al*. 2007. Fermentation microbiology & biotechnology. CRC / Taylor & Francis.

Reference

1. Bailey J and D.F. Ollis. 1986. Biochemical Engineering Fundamentals (Ed: 2): McGraw-Hill, NY
2. Cinar A *et al.* 2003. Batch Fermentation - Modeling, Monitoring and Control. Marcel Dekker. USA.

LAB COURSE V: MICROBIAL BIOTECHNOLOGY
(Core 14)

SEM: III **Practical/week: 3**
16PBT3115 **Credits: 2**

1. Bioassay and Chemical estimation of penicillin
2. Preparation of bioinoculants and cell count determination on time scale
3. Preparation of enzyme immobilized columns for biotransformation –e.g. yeast cells immobilized in calcium alginate beads
4. Parameter testing for immobilized enzyme columns:
    a. Comparative enzyme activity of free cells and immobilized cells
    b. Effect of gel concentration on enzyme activity
    c. Effect of cell concentration on enzyme activity
5. Laboratory scale production of microbial emulsifiers
6. Biosorption of Congo Red dye using dead biomass of *Aspergillus niger*.
7. Preparation and maintenance of plant callus culture, Extraction and estimation of bioactive (antimicrobial) principles from plants; and activity fractionation.
8. Fermentation Kinetics.
9. Microbial Production of amino acids.
10. Screening and isolation of Antibiotic producing organisms from soil.
11. Production of Cellulase by solid state fermentation.

LAB COURSE VI: BIOINFORMATICS AND BIOSTATISTICS
(Core 15)

SEM: III **Practical/week: 3**
16PBT3116 **Credits: 2**

BIOINFORMATICS:

1. Biological databases-file formats.
2. Data retrieval using ENTREZ
3. Sequence analysis: Pairwise alignment (BLAST)
4. Sequence analysis: Multiple alignment (Clustal W)
5. Motif and domain analysis
6. Phylogenetic analysis
7. Six frame translation
8. Primer designing
9. Gene finding
10. Molecular visualization using Rasmol

BIOSTATISTICS

1. Random sampling by Random Number Table (Tipett's) Method (Cluster Bean N= 500 → n= 50).
2. Data Collection on discrete and continuous variables.
3. Data classification: Discrete frequency distribution, Continuous frequency distribution and Cumulative frequency distribution.
4. Statistical Illustrations – Manual and Computer aided using Microsoft Excel.
5. Measure of Central values (Mean, Median and Mode) for the data collected in the earlier exercises.
6. Determining the correlation coefficient between pod length & pod weight and testing the relationship.
7. Training on the SPSS (Statistical Package for Social Sciences) for
8. Measure of central values: Minimum, Maximum, Mean, Median and Mode
9. Measure of Dispersion: Standard Deviation and coefficient of variation
10. Coefficient of correlation and regression
11. Testing the significance
12. Single Mean T test
13. Two mean T test
14. Paired T test
15. One way ANOVA
16. Two way ANOVA
17. DMRT in one way and two way ANOVA
18. Interpretation of the results obtained from SPSS

BIOINFORMATICS
(Core Elective – 3)

SEM-III **Lecture/week: 4**
16PBT3203A **Credits: 4**

Assurance of Learning

i. To study the meaning and structure of biological information available in the existing databases
ii. To understand the importance of various databases.
iii. To understand various dimension of bioinformatics.
iv. To study the applied areas of Bioinformatics like drug design, metabolic pathway engineering etc.

Unit – I:

History of Bioinformatics; Role of Bioinformatics in biological sciences; Scope of Bioinformatics; Types of biological databases; Data mining and its techniques; Data warehousing.

Unit – II:

Nucleic acid databases – Genbank, NCBI, EMBL, DDBJ; Primary protein databases – PIR, SWISSPROT, TrEMBL; Secondary protein databases – PROSITE, PROFILES, PRINTS, Pfam; Structural classification databases – SCOP, CATH; Literature databases – PubMed, Medline; Bibliographic databases – OMIM, PubMed.

Unit – III:

Sequence Annotation – Principles and tools; Sequence retrieval system – Entrez, SRS; Sequence submission tool – BANKIT, SEQUIN, WEBIN, SAKURA. Molecular phylogeny – Concepts of tree – rooted and unrooted trees; Molecular Clocks, Clustering and Phenetic method, Cladistic method; Steps in constructing phylogenetic analysis; Bootstrapping strategies. Molecular viewers - Rasmol, Chime and Spdb viewer

Unit – IV:

Sequence alignment – concepts in alignment, Local & Global; Pairwise & Multiple; Tools for sequence alignment – BLAST, FASTA, Clustal W; Substitution matrices; Scoring matrices – PAM & BLOSUM; Dot plot; EST Clustering and analyses, Computational methods of gene prediction.

Unit – V:

Genomics & Proteomics: Comparative, Structural & Functional genomics; Proteomics – Expression, Structural & Functional proteomics; Applications of Metabolomics & Transcriptomics; Concept of system biology.

Text Books for study

1. Arthur M Lesk. 2005. Introduction to Bioinformatics(Ed:2). Oxford university press, New York.
2. Attwood, T.K. and Parrysmith, D.J. 2001. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd., New Delhi.

References

1. Andreas D. Baxevanis and B. F. Francis Ouellette. 2005. Bioinformatics - A Practical guide to the analysis of Genes and Proteins (Ed:3). John Wiley & Sons, Inc., Publications, US.
2. David W Mount. 2004. Bioinformatics: sequence and Genome analysis(Ed:2). Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.

DRUG DISCOVERY AND DEVELOPMENT
(Core Elective - 3)

SEM III **Lecture/week: 4**
16PBT3203B **Credits: 4**

Assurance of Learning

i. *To make a detailed study of drugs, particularly their actions on living systems*
ii. *To understand the major aspects of the drug discovery process, starting with target selection, to compound screening to designing lead candidates.*
iii. *To Increase understanding of the various drug discovery tools and methods that are used for finding, identifying and designing a new drug.*
iv. *To know their chemotherapeutic value*

Unit – I:
Drugs – definition, source and nature, types of classification and nomenclature, dose response curve and LD50. Role of drugs, Drug – protein interactions, routes of drug administration.

Unit – II:
Drug targets – Enzymes, receptors, carrier proteins. Structural proteins, nucleic acids, lipids and carbohydrates. Forces in drug – receptor interaction, Receptor theories.

Unit – III:
Drug absorption, distribution, metabolism, excretion and dosing. Pharmacokinetic oriented drug design – Drug solubility and drug stability.

Unit – IV:
Biological testing and bioassays – testing drugs *in vitro* and *in vivo.* Drug discovery. Lead compounds – natural sources and synthetic sources.

Unit – V:
Drug development. Target – oriented drug design, computer aided drug design, Quantitative structure, activity relationship – binding interaction, Functional groups and Pharmacophore. High thoroughput screening and Molecular docking.

Text Books for Study:

1. Barar F S K (2004), Essentials of Pharmacotherapeutics, S Chand & Co,Ltd.New Delhi.
2. G.Patrick (2002) Medicinal Chemistry-, Instant notes series, Viva Books,

References:

1. Trends in Molecular Pharmacology, Elseiver Publications.
2. Molecular graphics in drug design, Marshall and Motoc.

BIOPROCESS TECHNOLOGY
IDC – 2 (WS)

SEM: III **Lecture/week: 4**
16PBT3402 **Credits: 4**

Assurance of Learning

i. To study the avenues of exploiting microbes in bioconversion technology.
ii. To understand Bioprocess control mechanisms
iii. To study the downstream processing for product recovery in fermentation.
iv. To study the Scale-up and scale-down – problems and solutions.

Unit – I:

Principles of fermentation process, Bioprocess *vs* Chemical process, Media formulation – Growth factors, Buffers, O_2, Antifoams and Media Optimization. Cell growth and quantitation – density, cell mass, growth pattern, yield factors and environmental conditions. Batch, Continuous and Fed batch culture.

Unit – II:

Bioreactor design, parts and functions, sterilization, impellers, baffles and sparger. Types of reactor – submerged reactor, mechanically stirred draught-tube reactor, continuous flow stir type reactor, airlift reactor, jet loop reactor, surface reactor and packed bed reactor.

Unit – III:

Bioprocess control and monitoring variables: O_2 requirement and uptake-factors affecting K_La-aeration, agitation, pressure and pH, medium rheology. Computers in bioprocess. Flow measurement and control, control system – manual and automatic PID control.

Unit – IV:

Bioconversion and biocatalysts: Immobilization of cells and enzymes – methods and advantages. Selection of industrially important microorganisms. Strain improvement preservation and properties of industrial strains. Production strategies for insulin, lactic acid and vinegar. Scale-up and scale-down – problems and solutions.

Unit – V:

Downstream processing: recovery of microbial cells and products – Precipitation. Filtration and Centrifugation. Cell disruption – physical and chemical methods. Extraction – liquid-liquid extraction and aqueous-two phase extraction. Chromatography. Membrane processes, drying and crystallization.

Text books for Study:

1. Stanbury, P F & Whitaker, A, 1995, *Principles of Fermentation Technology*, Pergamon.
2. Schuler ML & Fikret Kargi, 2002, *Bioprocess Engg: Basic Concepts*, Prentice Hall, NJ.

References

1. Wulf Crueger & Anneliese Cruger, 2004, *Biotechnology: A Textbook of Industrial Microbiology*, 2nd Edn., Panima Publishing Co.
2. E.MT. El-Mansi & C F A Bryce, 2002, *Fermentation Microbiology and Biotechnology*, Taylor & Francis Co., USA.
3. Bailley & Ollis, 1986, *Biochemical Engg Fundamentals*, McGraw Hill, New York.

FOOD TECHNOLOGY
IDC - 3 (BS)

SEM: III **Lecture/week: 4**
16PBT3403 **Credits: 4**

Assurance of Learning

i. *To understand the chemical nature and associated microbes of food.*
ii. *To study various microbes that contaminate and spoil the foods*
iii. *To understand the principles of food processing and preservation.*
iv. *To study the manufacturing of basic food products*

Unit – I: Food chemistry

Constituent of food – contribution to texture, flavour and organoleptic properties of food; food additives – intentional and non-intentional and their functions; enzymes in food processing.

Unit – II: Food Microbiology

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases – infections and intoxications, food spoilage – causes.

Unit – III: Food processing

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit – IV: Food preservation

Use of high temperatures – sterilization, pasteurization, blanching, canning – concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods

Unit – V: Manufacture of food products

Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

Text Books for Study:

1. Crosby,N.T.1981. Food packaging Materials Applied Science Publishers, London.
2. Sivasankar B. 2002. Food processing and preservation, Prentice Hall, New Delhi.

References:

1. Brenner J G Butters J R Cowell N D and Lilly A E V. 1979. Food engineering operations, 2nd ed., Applied Sciences Pub.ltd., London.
2. Desrosier, N.W. 1996. The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi.
3. Fennema O R 1976. Principles of food science: Part I, Food chemistry, Marcel Dekker, New York.

ENVIRONMENTAL BIOTECHNOLOGY AND NANOTECHNOLOGY
(Core 16)

SEM: IV **Lecture/Week: 6**
16PBT4117 **Credits: 5**

Assurance of learning

i. *To connect two different facets of Environmental Biotechnology, principles of Environmental Microbiology and Environmental Engineering.*
ii. *To teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society.*
iii. *To introduce the fundamental design, principles and practice of wastewater treatment.*
iv. To e*ncourage the development of Engineered Nanomaterials that is safer and more sustainable alternatives to nanoscale materials*

Unit – I:
Environmental Pollution: Classification of pollutants, Air pollution and their properties, Gaseous pollutants, water pollutants and their properties. Noise pollution, Soil pollution, thermal pollution, marine pollution, Bioremediation & Phytoremediation: Biofeasibility, applications of Bioremediation.

Unit – II:
Bioabsorption and bioleaching of heavy metals: cadmium, lead, mercury, metal binding targets and organisms, metal microbial interaction, biomethylation of elements (methylation of mercury and arsenic), commercial biosorbants, bioleaching - metal precipitation, advantages and disadvantages of bioleaching.

Unit – III:
Waste water Treatment: biological treatment system (oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), biological waste treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme for dairy, distillery, tannery, sugar, fertilizers, refinery, chemical and antibiotic wastes. Sewage treatment.

Unit – IV:
Solid waste pollution and its management: Types of solid waste, Treatment process for solid waste- Thermal conversion, Pyrolysis, composting systems, Vermi-composting.
Xenobiotics metabolism: biodegradation of hydrocarbons, surfactant, pesticides, lignin, tannin, synthetic dyes and use of cytochrome P450 systems.

Unit – V: (Online)
Nanotechnology: Emergence and Challenges in Nanotechnology, Types of nanomaterials and their classifications. Synthesis of nanoparticles from biological samples, Applications of Nanotechnology – in biological field (Peptide/DNA Coupled Nanoparticles , Lipid Nanoparticles For Drug Delivery and Metal/Metal Oxide Nanoparticles (antibacterial/antifungal/antiviral).

Text Books for Study:

1. Rittmann, B.E. and McCarty, P.L. (2001), Environmental Biotechnology: Principles and Applications, McGraw-Hill.
2. P.K. Sharma. 2011. An Introduction To Nanotechnology And Its Analysis. 2011. Gaurav Book Centre Pvt Ltd.

References:

1. Nazaroff, W.W. and Alvarez-Cohen, L. (2001), Environmental Engineering Science, John Wiley & Sons, Inc.
2. Grady, Jr., C.P.L. and Lim, H.C. (1980), Biological Wastewater Treatment: Theory and Applications, Marcel Dekker, Inc.

PLANT AND ANIMAL BIOTECHNOLOGY
(Core 17)

SEM: IV **Lecture/Week: 6**
16PBT4118 **Credits: 5**

Assurance of Learning

i. *To study the basic principles and techniques involved in plant and animal cell culture.*
ii. *To understand the concepts of transformation in Plant and Animal systems.*
iii. *To understand the achievements of biotechnology in Plant and Animal systems.*
iv. *To study the importance of animal models*

Unit – I:

Establishment of plant tissue culture: culture media (types of media), explants and its preparation, Types of culture (callus, suspension, Meristem, Embryo, Protoplast, Root cultures), Regeneration of plants (organogenesis and Somatic embryogenesis), Haploid plant production (androgenesis and gynogenesis). Isolation and fusion of Protoplast, Artificial seeds, Hardening of plants, Cryopreservation and Germplasm storage. Applications of plant tissue culture in Agriculture and Forestry.

Unit – II:

Introduction of genetic engineering of plants - Vector (Viral vectors and Ti & Ri plasmids) and Gene transfer methods (Electroporation, Particle bombardment, Microinjection). Chloroplast transformation. Transgenic plants - Biotic stress resistance (Pest, Viral, Bacterial & Fungal), Abiotic stress tolerance (Herbicide, Salt, Drought), Crop improvement (*Flavr Savr* tomato, Golden rice, Amino acid enrichment, Preventing discolouration, Improving flower pigmentation, Male sterility).

Unit – III:

Transgenic plant as bioreactors – Plantibodies, Therapeutic proteins and Edible vaccines. Introduction to animal tissue culture - culture media. Primary cell culture. Development and maintenance of cell lines. Infinite and finite cell lines, Suspension culture, Embryo culture, Organ and Histotypic cultures.

Unit – IV:

Lab based and large-scale culture. Cell synchronization. Cryobiology. Applications of animal cell culture. Stem cells - isolation, culture, manipulation and applications. Gene therapy-method, gene delivery systems and applications. Production and applications of monoclonal antibodies.

Unit – V: (Online)

Methods of animal cloning (Somatic nuclear transfer, Chromatin transfer, Embryo splitting) and its pros& cons. Methods of production of transgenic animals (Transfection, Retroviral vector, Microinjection, Embryonic stem cells, YAC, Gene trageting) and its applications (Human disease models, Gene knockout mice, Transgenic cattle, sheep, fish, Chickens). Transgenic animals as bioreactors - Therapeutic proteins, Vaccines, Recombinant Insulin.

Text Books for study

1. Adrian Slater *et al.* 2003. Plant Biotechnology – The genetic manipulation of plants. Oxford University press, USA.
2. Ranga M.M. 2010. Animal Biotechnology, Agrobios, India.

References

1. Butler M. 1987. Animal cell technology- Principles and procedures. Open University press, New York.
2. Ed. Martin Clynes. 1998. Animal Cell Culture Techniques. Springer, Heidelberg.
3. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.

GENE EXPRESSION, GENOMICS AND PROTEOMICS
(Core 18)

SEM: IV **Lecture/Week: 6**
16PBT4119 **Credits: 5**

Assurance of Learning

i. To understand thoroughly the concepts and importance of Genes and genomes.
ii. To understand the mechanism of gene control in prokaryotes and eukaryotes.
iii. To study the basic techniques and concepts in genomics and proteomics.
iv. To understand the applied fields of genomics and proteomics.

Unit – I:

Gene regulation in Prokaryotes: Gene Expression by regulatory proteins, Regulation by activators and repressors, Regulation of transcription initiation in Bacteria: Lac gene - Activator and repressor together control, Combined control of CAP on other genes. AraC and control of araBAD operon.

Unit – II:

Gene regulation in Eukayotes: Role of Transcription factors - Structure of transcription factors Processing level control - Translational level control: Control of mRNA translation, control of mRNA stability, Post translational control, Determining Protein stability. Transcriptional Regulation in Yeast & Mammals. Gene silencing by modification of Histones, RNAs in gene regulation.

Unit – III:

Comparative genomics: Bacteria, Organelles and Eukaryotes Genome Mapping-Types and uses. Human physical map. Sequencing strategies and automation: (Maxam and Gilbert, Sanger's method) advanced methods (Automated DNA sequencing, Pyrosequencing, MPSS, BAC end sequencing) Human Genome Project.

Unit – IV:

Functional genomics: Genetic interaction mapping, Transcriptome profiling: Microarray, ChIP, SAGE) RNAi -Studying gene function through protein-protein interaction. (Phage display, yeast two hybrid,) Loss of function techniques (mutagenesis and RNAi).-Functional annotation of genes.

Unit – V: (Online)

Proteomics: Protein sequencing, Protein expression analysis by 2-DE, 2D-MALDI- TOF MS, LC-MS/MS, Quantitative proteomics. Tandem Mass spectrometry, peptide mass fingerprinting. Mining the proteome, Protein expression profiling, Protein tags; protein arrays and antibody arrays.

Text Books for study

1. Daniel L. Hartl and Elizabeth W.Jones.2009.Genetics (Ed: 7) Jones and Barlett Publishers Inc,Subury.
2. Watson J.D. *et al*. 2006 Molecular Biology of the Gene (Ed.5),Pearson Education INC. London.

References

1. Jocelyn E Krebs *et al.* 2011. Lewin's Genes X (Ed:10).Jones and Barlett Publishers Inc, Subury.
2. Brown T.A. 2007. Genomes 3. Garland Science Publishing.
3. Cullis C.A. 2004. Plant Genomics and Proteomics. John Wiley & Sons, Inc., Hoboken, New Jersey

PROJECT

SEM: IV **Lecture/Week: 12**
16PBT4121 **Credit: 6**
