PG - Biotechnology

2017-18

Since 1951

PG & Research Department of Biotechnology
JAMAL MOHAMED COLLEGE (Autonomous)
College with Potential for Excellence
Reaccredited (3rd Cycle) with 'A' Grade by NAAC
(Affiliated to Bharathidasan University)
Tiruchirappalli – 620 020.

PG Biotechnology Course Pattern from 2017 - 2018

SEM	Course Code	Course	Course Title	Hrs / week	Credit	CIA Mark	SE Mark	Total Mark
I	17PBT1C1	Core - I	Cell Biology	6	5	25	75	100
	17PBT1C2	Core - II	Advanced Biochemistry	6	5	25	75	100
	17PBT1C3	Core - III	Immunology and Immunotechnology	6	4	25	75	100
	17PBT1C4P	Core IV	Cell Biology, Advanced Biochemistry, Immunology and Immunotechnology - Practical	6	4	20	80	100
	17PBT1CE1A/B	Elective – I#	-	6	4	25	75	100
TOTAL				**30**	**22**			**500**
II	17PBT2C5	Core - V	Applied Microbiology	6	5	25	75	100
	17PBT2C6	Core - VI	Molecular Biology and Microbial Genetics	6	5	25	75	100
	17PBT2C7	Core - VII	Recombinant DNA Technology	6	4	25	75	100
	17PBT2C8P	Core VIII	Applied Microbiology, Molecular Biology and Microbial Genetics, Recombinant DNA Technology - Practical	6	4	20	80	100
	17PBT2CE2A/B	Elective – II#	-	6	4	25	75	100
TOTAL				**30**	**22**			**500**
III	17PBT3C9	Core - IX	Plant Biotechnology	6	5	25	75	100
	17PBT3C10	Core - X	Animal Biotechnology	6	5	25	75	100
	17PBT3C11	Core - XI	Bioinformatics and Biostatistics	6	4	25	75	100
	17PBT3C12P	Core - XII	Plant Biotechnology, Animal Biotechnology, Bioinformatics and Biostatistics - Practical	6	4	20	80	100
	17PBT3CE3A/B	Elective– III#	-	6	4	25	75	100
	17PBT3EC1	Extra Credit – 1	Genetic Toxicology	-	5*	--	--	100*
TOTAL				**30**	**22**			**500**
IV	17PBT4C13	Core - XIII	Industrial Biotechnology	6	5	25	75	100
	17PBT4C14	Core - XIV	Environmental Biotechnology	6	5	25	75	100
	17PBT4C15	Core XV	Industrial Biotechnology and Environmental Biotechnology - Practical	6	5	20	80	100
	17PBT4PW	Project	Project	12	9	-	-	200
	17PBT4EC2	Extra Credit – II	Agricultural Biotechnology	-	5*	--	--	100*
TOTAL				**30**	**24**			**500**
GRAND TOTAL				**120**	**90**	-	-	**2000**

* Not Considered for Grand Total and CGPA

Core Based Electives

SEMESTER	COURSE CODE	COURSE TITLE
I	17PBT1CE1A	Bioinstrumentation
	17PBT1CE1B	Enzymology and Enzyme Technology
II	17PBT2CE2A	Biopharmaceuticals in Nanomedicine
	17PBT2CE2B	Stem Cell Biology
III	17PBT3CE3A	Research Methodology, IPR and Biosafety
	17PBT3CE3B	Genomics and Proteomics

- This PG – Biotechnology (2017 – 2018) syllabus covers CSIR Life science portions where ever applicable.

SEMESTER I: CORE - I

CELL BIOLOGY

Course Code: 17PBT1C1 **Max Marks: 100**
Hours/week: 6 **Internal Marks: 25**
Credit: 5 **External Marks: 75**

Objectives:

- To provide a thorough knowledge on structure and function of cells, cellular signaling, protein trafficking, bio molecules and cellular development.

Unit I: **18 Hours**

Structural organization of Cell: An overview of plant and Animal Cells. Structure and Organization of prokaryotic and eukaryotic cells. Structural organization and function of intracellular organelles (Nucleus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Lysosomes, Peroxisomes and vacuoles). Chromatin organization and packaging. Three dimensional organization and functions of Cytoskeletons (Microfilaments, Intermediate filaments, Microtubules and associated proteins).

Unit II: **18 Hours**

Cell organelles: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, and ion pumps. Intracellular protein sorting-mechanism and regulation of intracellular transport in mitochondria, chloroplast, endoplasmic reticulum and nucleus. Electrical properties of membranes. #Protein insertion and processing in Endoplasmic reticulum and protein trafficking from Endoplasmic reticulum to Golgi bodies#.

Unit III: **18 Hours**

Organization of Chromosomes, Cell Division & Cell Cycle: Specialized chromosomes, chromosomal abnormalities and qualitative inheritance. Cell Division: Mitosis, meiosis and Binary fission. Cell Cycle and Cell Growth Control: Overview of cell cycle; #molecular mechanisms for regulating mitotic events; check points in cell cycle regulation; meiosis; cell birth, lineage and death#.

Unit IV: **18 Hours**

Nuclear - Cytoplasm interactions. Cell fusion and its applications. Properties of cancer cells. Proteasome – structural organization and function. #Chaperons-Classification and cellular functions#. Necrosis and Apoptosis - Process and Mechanism.

Unit V: **18 Hours**

Cancer Biology: Oncogenes, tumor suppressor genes, cancer and the cell cycle. Theories regarding tumor formation - Mutation, Virus, Metabolic and Hormonal disturbance theory. Aging Theories – Cellular, Systemic, Pace maker, Biological clock and Mutation theory.

 # Self-study portion

Text Books:

T.B.1. Sadava, DE. Cell Biology: Organelle Structure and Function, Panima Publishing Corporation. New Delhi. 2014.

T.B.2. Lodish. H., Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. Molecular Cell Biology, W.H. Freeman and Company, New York. 2015.

Unit I Chapter I, T.B.1

Unit II Chapter III to XI, T.B.1

Unit III Chapter IX and X, T.B.1

Unit IV Chapter 23, T.B.2

Unit V Chapter 25, T.B.2

Books for References:

1. Roberties De., Cell and Molecular Biology (Eight Edition), E.M.F. B.I.Waverly Pvt.Ltd. New Delhi. (2005).
2. James Darnell., Molecular Cell Biology (6th Edition) W. H. Freeman & Co. Cell Biology. Pollard, T.D. and Earnshaw. Publ. W.C. Saunders. Updated Edition. 3rd Edition, (2007).
3. Alberts B., Johnson A., Lewis J., Raff M., Roberts K and Walter P., Molecular Biology of the Cell, 6th Edition, , Garland Publishing (Taylor & Francis Group), New York & London, (2014).

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SEMESTER I: CORE - II

ADVANCED BIOCHEMISTRY

Subject code:17PBT1C2 **Max Marks: 100**
Hrs/week: 6 **Internal Marks: 25**
Credit: 5 **External Marks: 75**

Objectives:

- To study the structure, properties and metabolism of different biomolecules, interrelationships between different metabolisms,
- To study the biochemical processes responsible for the formation, breakdown and interconversion of carbohydrates, metabolism of amino acids, fatty acids and nucleic acids.

UNIT I: **18 hours**

Bioenergetics and carbohydrate metabolism: concept of entropy, and free energy changes in biological reactions, Redox reactions, Role of high energy phosphates. #Thermodynamics (laws and quantities)#. Glycolysis and gluconeogenesis – pathway Mechanism of pyruvate dehydrogenase. The citric acid cycle and regulation.The pentose phosphate pathway. Metabolism of glycogen and regulation.

UNIT II: **18 hours**

Metabolism of amino acids and proteins: Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen– transamination, deamination, ammonia formation, urea cycle and regulation of ureogenesis. Catabolism of carbon skeletons of amino acids. Proteins: Peptide bond, Primary structure of proteins, structural comparison of secondary, tertiary levels (Ramchandran plot), quaternary and domain structure. #Protein sequencing strategies – chemical and enzymatic#.

UNIT III: **18 hours**

Lipid metabolism: Fatty acid biosynthesis. Regulation of biosynthesis of triacylglycerol, phospholipids and cholesterol. α, β, γ, Oxidation of unsaturated fatty acids and odd carbon fatty

acids – Role of carnitine cycle in the regulation of oxidation. Ketogenesis and its control. #Lipoprotein metabolism exogenous and endogenus pathways#.

UNIT IV: **18 hours**

Metabolism of purines and pyrimidines: Digestion and absorption of nucleoproteins, Metabolism of purines - de novo and salvage pathways for purine biosynthesis, regulation of biosynthesis of nucleotides. #Purine catabolic pathway#. Hyperuricemia. Metabolism of pyrimidines - biosynthesis and catabolism. Oroticaciduria.

UNIT V: **18 hours**

Inborn errors of metabolism: Disorders of carbohydrate metabolism - Glycogen storage disease. Disorders of amino acid metabolism - Phenylketonuria, maple syrup urine disease, Albinism and Alkaptonuria. Disorders of fatty acid oxidation and mitochondrial metabolism - Medium chain acyl-coenzyme-A dehydrogenase deficiency. Disorders of purine and pyrimidine metabolism – Lesch-Nyhansyndrome, Lysosomal storage disorders Gaucher's disease, #Niemann Pick disease#

 # Self-study portion

Text Books:

T.B.1. Voet, D. and Voet, JG. Biochemistry, 3rd Edition, John Wiley & Son. 2004.

Unit-I Chapter 17 – Page no 581-618 and Chapter 18 - Page no 626-651. T.B.1.
Unit-II Chapter 26 –Page no 985-1044. T.B.1.
Unit-III Chapter 25- Page no 909-969. T.B.1.
Unit-IV Chapter 28 - Page no 1069-1098. T.B.1.
Unit-V Chapter 12 - Page no 324-380. T.B.1.

Books for References:

1. Conn, EE. "Outlines of Biochemistry" 5th Edition, John Wiley & Sons. 1987.
2. Murray, RK. "Harper's Illustrated Biochemistry", 27th Edition, McGraw-Hill. 2006.
3. Nelson, DL and MM. Cox. "Lehninger's Principles of Biochemsitry", 4th Edition,W.H. Freemen & Co. 2005.

SEMESTER I: CORE - III

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Code: 17PBT1C3 **Max. Marks: 100**
Hours/week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Objectives:

On completion of this course, the student will be able

- To comprehend the different components and mechanisms involved in immune system and their contributions in elucidating different types of immune response.
- To understand the various advanced techniques and technologies associated with immunological reactions.

UNIT I: **18 hours**

Components of Immune system: Innate and acquired immunity, #Haematopoiesis#, Cells of the immune system - lymphoid cells (T and B lymphocytes, NK cells), Macrophages, Granulocytes, Organs of the immune system - Primary and secondary lymphoid organs, Antigens - Properties and Classes, Adjuvants.

UNIT II: **18 hours**

Immune response of B cells and T cells: B cell - Activation, humoral response, Immunoglobulins - structure, classes and functions, #Organization and Expression of genes#. T cell - Activation and Cell mediated response, T cell Receptors, Cytokines - Properties, Receptors and therapeutic uses, MHC, Antigen processing and presentation pathways.

UNIT III: **18 hours**

Immunodeficiencies, Autoimmunity and Transplantation Immunology: Immunodeficiency - Primary, AIDS and other Secondary Immunodeficiencies, Autoimmunity - Organ specific and systematic, Animal models, #Treatment#. Graft Rejection – Immunologic basis, Clinical manifestations, Immunosuppressive Therapy.

UNIT IV: **18 hours**

Cancer Immunology and Experimental systems: Cancer - Origin, Malignancy, Oncogenes and cancer induction, Tumors of Immune system, Tumor Antigens, Tumor Evasion of Immune system, Cancer Immunotherapy. Experimental systems - Inbred strains, SCID mice, cell culture systems, #Transgenic and Knockout mice#.

UNIT V: **18 hours**

Immunology based techniques and technology: RIA, ELISA, ELISPOT, Western Blotting, Immunoprecipitation, Immunofluorescence, Flow cytometry, FACS, #Immunoelectron Microscopy#, Microarray, Hybridoma technology - Monoclonal Antibodies (mAbs) and clinical uses of mAbs.

 # Self - study portion

Text Books:

T.B.1. Goldsby RA, Kindt TJ, Osborne BA, Kuby J. Immunology, 5th Edition, W.H. Freeman and Company, New York. 2003.

T.B.2. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology, 7th Edition, Elsevier Health Sciences. 2011.

T.B.3. Latha PM. A Text Book of Immunology, 1st Edition, S.Chand & Company Ltd, New Delhi. 2003.

Unit 1: TB.1, Part - I, Page No. 1-52. Part - II, Page No. 57-76.

Unit 2: TB.1, Part - II, Page No. 76-132. Part - II, Page no. 167-272. Part - III, Page No. 276-293, 319-333.

Unit 3: TB.1, Part - IV, Page No. 429-496.

Unit 4: TB.1, Part - IV, Page No. 499-527. Page No. 541 & 542.

Unit 5: TB.1, Part - II, Page No. 148-156. Page No. 99 & 100. Part - IV, Page No. 546 & 547.

Books for References:

1. Roitt I . Essential Immunology, 10th Edition. Blackwell Scientific Publication. 2002.
2. Pandian MR and Kumar BS. Immunology and Immunotechnology, Panima Publishing corporation, New Delhi. 2007.
3. Weir DM and Stewart J. Immunology, 10th Edition. Churchill Livingston, Newyork. 2000.

SEMESTER I: CORE - IV

CELL BIOLOGY, ADVANCED BIOCHEMISTRY, IMMUNOLOGY AND IMMUNOTECHNOLOGY - PRACTICAL

Course Code: 17PBT1C4P **Max. Marks: 100**
Hours/week: 6 **Internal Marks: 20**
Credit: 4 **External Marks: 80**

Objectives:

- To develop knowledge on various types of macromolecules, cells and cell division stages.
- To gain skill based knowledge on techniques associated with immunological reactions.

1. Observation of different types of plant cells - parenchyma, collenchyma, sclerenchyma, Columnar epithelium, squamous epithelium.
2. Blood smear by Leishman staining
3. Chromosome staining - Giemsa staining
4. Total (WBC, RBC) & differential count of human blood cells.
5. Observation of cell division – mitosis using onion root tip.
6. Observation of cell division – meiosis using Tradescantia pollen grains.
7. Polytene and diplotene chromosomes.
8. Estimation of reducing sugar by DNS method.
9. Quantitative estimation of amino acid using Ninhydrin reagent.
10. Protein estimation by Lowry et.al (1951).
11. Paper Chromatography of Amino Acids.
12. Blood grouping.
13. Latex agglutination – Rheumatoid Arthritis Test.
14. Counter current immunoelectrophoresis.
15. Rocket Immunoelectrophoresis.
16. ELISA.

Text Books:

1. Keith Wilson and John Walker, Biochemistry - Practical Approach. 1992.
2. Butterworth- Heinemann. Collins and Lyne's Microbiological methods. 7th ed. C.H. Collins. 1994.
3. Goldsby RA, Kindt TJ, Osborne BA, Kuby J, Immunology, 5th Edition. W.H. Freeman and Company, New York. 2003.

Books for References:

1. Jayaraman, J., Laboratory manual in Biochemistry. Wiley Eastern Ltd. 1992.
2. Robert L., Switzer and Liam Garrity. Experimental Biochemistry. W.H.Freeman and Company, New York. 1999.

SEMESTER I: ELECTIVE - I

BIOINSTRUMENTATION

Subject code: 17PBT1CE1A **Max Marks: 100**
Hrs/week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Objectives:

- To understand the working principle, types of microscope and centrifugation.
- To understand the process and application of different types of centrifuges and electrochemical methods.

UNIT I: **18 hours**

Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes - microscopy of living cells – bright field, dark field, phase contrast, fluorescent, scanning and transmission microscopes, different fixation and staining techniques for EM, #freeze-etch and freeze fracture methods for EM#, image processing methods in microscopy, confocal laser scanning microscopy (CLSM) and Atomic force electron microscopy.

UNIT II: **18 hours**

Centrifugation and Electrophysiological methods: Principles of centrifugation, concepts of RCF. Different types of Centrifuges and their uses, different type's rotors, differential and density gradient centrifugation, separation methods in Preparative and Analytical Ultra Centrifuges, applications of analytical ultracentrifuge. Electrophysiological methods: Single neuron recording, patch-clamp recording, #ECG#, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

UNIT III: **18 hours**

Separation Techniques: Chromatography – Principles of adsorption and partition chromatography, ion exchange, gel permeation chromatography, affinity chromatography, Gas liquid chromatography and HPLC. Electrophoretic techniques – Principles of Electrophoresis, Continuous, zonal and capillary electrophoresis, Electrophoresis of Proteins: SDS-PAGE, IEF, 2D-PAGE, #Agarose Gel Electrophoresis of DNA#.

UNIT IV: **18 hours**

Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR- its types and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and #surface plasma resonance methods#.

UNIT V: **18 hours**

Radiolabeling techniques and methods in field Biology: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, #sampling methods in the study of behavior#, habitat characterization: ground and remote sensing methods.

 # Self -study portion

Text Books:

T.B.1. Boyer, R.. Modern Experimental Biochemistry. 3rd ed. Addison Weslery Longman. 2000.

Unit I Chapter I, II, III, T.B-1

Unit II Chapter V, T.B-1

Unit III Chapter 7, T.B-1

Unit IV Chapter 3 T.B-1

Unit V Chapter 4 T.B-1

Books for Reference:

1. Wilson and Walker. Principles and techniques of Biochemistry and Molecular Biology. 6th ed. Cambridge University Press. 2005.

SEMESTER I: ELECTIVE - I

ENZYMOLOGY AND ENZYME TECHNOLOGY

Subject code: 17PBT1CE1B **Max Marks: 100**
Hrs/week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Objectives:

- To educate the students to understand the importance of biocatalysts.
- To impart the knowledge on enzyme inhibition, sources and applications of enzymes.

UNIT I: **18 hours**

Enzymes - General characteristics, classification and IUB nomenclature, methods of enzyme isolation and purification. Methods of enzyme assay, Enzyme Units, specific activities and turnover number. Active site, #non-protein enzymes - ribozymes#, DNA enzymes.

UNIT II: **18 hours**

Enzyme kinetics – Pre steady state and steady state kinetics. Effect of P^H, temperature, enzyme and substrate concentration. Michaelis - Menten plot, linear transformation Lineweaver - Burk plot.Eadie – Hofstee plot and #Hanes-Woolf equation#, Significance of Km and Vmax. Kinetics of allosteric enzymes and co-efficient.

UNIT III: **18 hours**

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

UNIT IV: **18 hours**

Enzyme inhibition- Irreversible and reversible, competitive, non-competitive, uncompetitive, #Clinical uses of competitive inhibition using methotrexate#, methanol poisoning and insecticide poisoning, allosteric inhibition.

UNIT V: **18 hours**

Enzyme Technology - Immobilized enzymes - methods of immobilization and its applications. Enzymes of industrial and clinical significance, #Sources and clinical applications of amylase#, protease and lipases, Therapeutic use of asparginase and streptokinase.

 # Self-study portion

Text Books:

T.B.1. Palmer. Understanding enzymes.Prentice Hall. 2004.

T.B.2. Principles of Biochemistry – Zubay 4th ed, William C.Brown Publ. 1998.

UNIT1:T.B.2-Chapter 6, T.B.1-Chapter 1.

UNIT 2:T.B.2-Chapter 6.

UNIT 3:T.B.2-Chapter 6.

UNIT 4:T.B.2-Chapter 6.

UNIT 5:T.B.1-Chapter 20

Books for References:

1. Klaus Buchholz, Volker Kasche, Uwe Theo Bornscheuer. Biocatalysts and Enzyme Technology. John Wiley & Sons. 2012.

SEMESTER II: CORE – V

APPLIED MICROBIOLOGY

Course code: 17PBT2C5 **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 5 **External Mark:75**

Objectives:

- To provide information on the applied aspects of soil microbes and its role in biogeochemical cycling, use of microbes as biofertilizers.
- To study the methods involved in food preservation, production of industrially important compounds and sterile pharmaceutical products.

Unit I: **18 Hours**

Soil Microbiology: Soil microbes: Bacteria, Fungi, Actinomycetes, Algae, Protozoa and Viruses. Interaction among soil microorganisms: neutral association, beneficial association, harmful association. Role of microorganisms in biogeochemical cycling - carbon cycle, nitrogen cycle and sulphur cycle. #Mycorrhiza - Role of Mycorrhizal fungi in plants#.

Unit II: **18 Hours**

Agricultural Microbiology: Sources of organic matter, formation of humus, decomposition of organic matter. Organic and inorganic nutrients in soil - phosphorous uptake, #nitrogen fixation#, microbes as biofertilizers: Steps in preparing biofertilizer, advantages of Blue green algal biofertilizers. Microbial insect pest control: bacterial insecticides – *Thirustella thomposonii, Nomurae arileyi,* Entomopathogenic fungi - *Metarhizium anisopli* and *Beauveria bassiana*.

Unit III: **18 Hours**

Food Microbiology: Sources of contamination of microorganisms in foods, factors influencing microbial growth in foods, Extrinsic and intrinsic. Principles and methods of food preservation - high temperature, low temperature, drying, #irradiation and chemical preservatives#. Spoilage of fruits, vegetables, meat, poultry, fish and sea food.

Unit IV: **18 Hours**

Industrial Microbiology: Production of yeast, ethyl alcohol, beer and vinegar. Citric acid production, lactic acid production, production of antibiotic – penicillin and streptomycin, vitamin production – riboflavin, #vitamin C and vitamin B12#.

Unit V: **18 Hours**

Pharmaceutical microbiology: Microbial spoilage, infection risk and contamination control – Spoilage chemical and physicochemical deterioration of pharmaceuticals, sources and control of contamination, preservation of medicines using antimicrobial agents. Types of sterile pharmaceutical products and its sterilization consideration, #quality control and quality assurance of sterile products#.

 # Self-study Portion

Text Books:

T.B.1. Moshrafuddin Ahmed, Basumatary S.K., Applied Microbiology, MJP Publishers. 2006.

T.B.2. Microbiology, L.M. Prescott, J.P. Harley and D.A. Klein, 7/e. McGraw Hill, Boston. 2007.

T.B.3. Patel, AH. Industrial Microbiology by Macmillan India Ltd. 2005.

T.B.4. Hugo and Russell's Pharmaceutical Microbiology, edited by Stephen P. Denyer, Norman A. Hodges, Sean P. Gorman, Brendan F. Gilmore. 8th edition. Wiley-Blackwell. 2008.

Unit I – Chapter 5, Page no: 80-102. T.B.1.

Unit I – Part VIII: Chapter 28, 30, Page no: 593-602, 645-670. T.B.2.

Unit II – Chapter 8, Page no: 151-180. T.B.1.

Unit III – Chapter 11, Page no: 285-301. T.B.1.

Unit III – Chapter 18, Page no: 188-200. T.B.3.

Unit IV – Chapter 9, Page no: 188-213. T.B.1.

Unit IV – Chapter 10, 11, 13, 15, Page No: 112 – 162. T.B.3.

Unit V – Chapter 18, Page no: 571-587. T.B.1.

Unit V – Part X: Chapter 34, 35, Page no: 761-796. T.B.2.

Unit V – Chapter 17 & 22. T.B.4.

Books for References:

1. Stainer RY, Ingra Ham J L, Wheelis ML & Painter PR. General Microbiology. Macmillan. 1992.
2. Bernard R. Glick & Jack J. Pasternak. Molecular Biotechnology. Indian edition. Panima Publishing Corporation. 2002.

SEMESTER II: CORE - VI

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Course Code: 17PBT2C6 **Max. Marks: 100**
Hours/week: 6 **nternal Marks: 25**
Credit: 5 **External Marks: 75**

Objectives:

On completion of this course, the student will be able,

- To gain the basic knowledge on genetic material, nucleic acids, central dogma of molecular biology and DNA repair mechanisms.
- To develop an in-depth knowledge on gene expression and variations involved with the regulation of gene expression in prokaryotic system.

UNIT I: **18 hours**

Nucleic acids and DNA replication: DNA - structure, different forms, denaturation, renaturation, #circular and superhelical structures#. RNA - structure, classes and functions. Replication - Process, Enzymology of replication**,** Semiconservative and Discontinuous replication, DNA Polymerases - Prokaryote and Eukaryote.

UNIT II: **18 hours**

Transcription and Translation: Transcription - Initiation, Elongation and Termination, Transcriptional factors, Transcription in Eukaryotes, alternative splicing, mRNA transport. Translation **-** Genetic code, Decoding system, Protein synthesis - Initiation, Elongation and Termination. Post-transcriptional and translational modification of proteins, #Translational control#.

UNIT III: **18 hours**

Protein Localization and DNA repair: Export of secretory proteins - signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxysomes and membrane, #Nuclear localization signals#. DNA Repair - DNA damage and repair mechanisms - Photoreactivation, excision repair, recombination repair and SOS repair.

UNIT IV: **18 hours**

Plasmids and Bacterial genetics: Plasmids - properties, types and replication. Bacterial Transformation - process and competency, #Conjugation#, Transduction – generalized transduction and specialized transduction, *Cis*-Trans complementation, Molecular biology of phages - T4 Phage and Lambda phage (Lytic and Lysogenic cycle).

UNIT V: **18 hours**

Regulation of gene expression and Transposable elements: Operon systems: Lactose operon - induction & repression. Tryptophan operon - Repression & attenuation, #Arabinose operon#. Mutations - biochemical basis, Spontaneous mutations, Isolation of mutants, Mutagenesis, Reversion and Suppression. Transposable elements - Insertions, Types of Bacterial Transposons, Transposition, Excision of Transposons.

 # Self-study Portion

Text Books:

T.B.1. Freifelder D, Molecular Biology, 2nd Edition, Jones and Barlett Publishers, USA. 2004.

T.B.2. Maloy SR, Cronan JE, Freifelder D. Microbial Genetics, 2nd Edition, Jones and Barlett Publishers,USA. 1994.

T.B.3. Snyder L, Champness W. Microbial genetics of bacteria, ASM Press, Washington DC. 2007.

Unit 1: TB.1, Chapter - 4, Page No. 79-112, Chapter - 12 & 13, Page No. 333-337, 379. TB.1, Chapter - 9, Page No. 223-273.

Unit 2: TB.1, Chapter - 12, 13, 14, Page No. 315-450.

Unit 3: TB.3, Chapter - 2, Page No. 106-114. TB.1, Chapter - 10, Page No. 277-292.

Unit 4: TB.1, Chapter - 19, Page No. 619-639. TB.3, Chapter - 5,6,7,8, Page No. 243- 375.

Unit 5: TB.1, Chapter - 15, Page No. 453-497. TB.2, Chapter - 10, Page No. 179-206. TB.2, Chapter - 12, Page No. 239-254.

Books for References:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. Molecular Biology of the gene, 5th Edition, Pearson Education, Inc. 2004.
2. Karp G. Cell and Molecular Biology: Concepts and Experiments, John Wiley and Sons, Inc. 2009.
3. Garrett RH and Gresham CM. Molecular aspects of Cell Biology, International edition, Saunders College Publishers. 1995.

SEMESTER II: CORE – VII

RECOMBINANT DNA TECHNOLOGY

Course code: 17PBT2C7 **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 4 **External Mark:75**

Objectives:

- To understand the role of enzymes, properties of vectors, methodologies and applications of Recombinant DNA technology.
- To discuss different types of PCR, its principle, applications and its sequencing methods.

Unit I: **18 Hours**

Enzymes and Techniques in genetic recombination – Outline to recombinant DNA technology, enzymes used in recombination: restriction endonucleases (type I, II, III), properties, nomenclature. DNA ligase: Properties and specificity, alkaline phosphatase, polynucleotide kinase, DNA polymerase, reverse transcriptase and its mode of action. Cohesive and blunt end ligation, linkers, adaptors and homopolymeric tailing. Labeling of DNA – nick translation, random priming, #radioactive and non-radioactive probes#.

Unit II: **18 Hours**

Plasmids - Properties, incompatibility, isolation and purification techniques#, plasmid vectors and their properties, P^{BR322} – its construction and derivatives, Bacteriophage lambda (λ) as a vector: essential features, organization of λ genome, λ EMBL vectors. Phagemids, insertion and replacement vectors, #cosmids#, animal virus derived vectors - SV40 & retroviral vectors. Expression vectors – pMal and pET based vectors.

Unit III: **18 Hours**

Cloning Methodologies - Insertion of foreign DNA into host cells, isolation of mRNA and total RNA, #cDNA and genomic libraries#, cDNA and genomic cloning, short gun cloning, directed cloning, phage display. Expression cloning and protein - protein interactive cloning. Yeast two hybrid system, phage display and principles in maximizing gene expression.

Unit IV: **18 Hours**

PCR and its Applications - Primer design, fidelity of thermostable enzymes, Types of PCR - multiplex, nested, reverse transcriptase, real time, touchdown, hot start and colony. Single-strand conformation polymorphism **(**SSCP), Denaturing gradient gel electrophoresis (DGGE), RAPD, RFLP, oligo ligation assay (OLA), Mismatch Chemical Cleavage (MCC), Allele-Specific Amplification (ASA) and #Protein Truncation Test (PTT)#.

Unit V: **18 Hours**

Sequencing Methods - DNA sequencing (Enzymatic, chemical & automated sequencing), Chemical synthesis of oligonucleotides, Gene silencing techniques - introduction to siRNA, siRNA technology, micro RNA, principle and application of gene silencing. Somatic and germ line therapy – *in-vivo* and *ex-vivo*, gene replacement and gene targeting. cDNA and intragenic arrays, #differential gene expression and protein array# and Next generation sequencing (NGS).

 # Self-study portion

Text Books:

T.B.1. Brown TA., Gene cloning and DNA Analysis. 6th edition, Wiley Blackwell Publishing. 2010.

T.B.2. Primrose S.B., R.M. Twyman.. Principles of Gene Manipulation and Genomics. S.B.University Press. 2013.

Unit I – Chapter 4, Page no: 45-69. T.B.1.

Unit II – Chapter 6 & 7, Page no: 88-124. T.B.1.

Unit II & III – Chapter 4, 5, 6, 14. T.B.2.

Unit III – Chapter 8, Page no: 131-138. T.B.1.

Unit IV – Chapter 9, Page no: 147-160. T.B.1.

Unit IV – Chapter 2. T.B.2.

Unit V – Chapter 10, Page no: 165-183. T.B.1.

Books for References:

1. Watson, JD. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc. 2007.
2. Watson, J.D., M.Gillman, J.Witknow Ski and M.Zoller. Recombinant DNA (2^{nd} Ed), Scientific Americans books, New York. 1992.
3. Innis, M.A., D.H. Gelfant&J.J.Sninskey.. PCR Strategies,. IRL Press. 1995.

SEMESTER II: CORE – VIII

APPLIED MICROBIOLOGY, MOLECULAR BIOLOGY AND MICROBIAL GENETICS & RECOMBINANT DNA TECHNOLOGY – PRACTICAL

Course code: 17PBT2C8P **Total Mark: 100**
Hrs/week: 6 **Internal Mark:20**
Credit: 4 **External Mark:80**

Objective: To give hands on experience in Applied microbiology, Molecular biology and Recombinant DNA technology techniques.

1. Detection of Bacteria in milk by Dye reduction test
2. Extracellular activities of microorganisms – amylase, cellulose and lipase
3. Antibiotic sensitivity test : Kirby Bauer's method
4. Wine production by Yeast
5. Preparation of *E.coli* competent cells and Transformation - Transduction – Conjugation.
6. Isolation of genomic DNA from Bacteria.
7. Isolation and purification of plasmid from Bacteria
8. Agarose gel electrophoresis, quantification of genomic and plasmid DNA
9. Restriction digestion and ligation.
10. Southern and Northern blot – Demonstration
11. Polymerase chain reaction (PCR)

Text Books:

1. James G. Cappuccino and Natalie Sherman. Microbiology: A laboratory Manual. 10th Edition. Benjamin Cummings. 2013.
2. Sambrook J and D.W. Russel. Molecular Cloning: A Laboratory Manual, Vols (1-3), CSHL. 2001.

SEMESTER II: ELECTIVE – II

BIOPHARMACEUTICALS IN NANOMEDICINE

Course code: 17PBT2CE2A **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 4 **External Mark:75**

Objectives:

1. To study the history, pharmaceutical products and sources of Biopharmaceuticals.
2. To gain an understanding in both scientific knowledge of designing, producing novel nano biologics and nanoethics.

UNIT I **18 Hours**

Pharmaceuticals, Biologics and Biopharmaceuticals – Pharmaceutical products, biopharmaceuticals and pharmaceutical Biotechnology, history of pharmaceutical industry, the age of Biopharmaceuticals, Biopharmaceuticals: current status and future prospects, traditional pharmaceuticals of biological origin, distinction between chemical drugs versus biopharmaceuticals, #sources and delivery of biopharmaceuticals#.

UNIT II **18 Hours**

Nanopharmaceuticals – Nanobiotechnology for drug discovery - gold nanoparticles and nanolasers for drug discovery. Nanobiotechnology based drug development – Dendrimers as drugs, fullerenes as drug candidates and nanobodies. Nanobiotechnology and drug delivery devices - coating of implants by ultrafine layers of polymers, delivery systems for cell therapy and #nanochips for drug delivery#.

UNIT III **18 Hours**

Regenerative medicine and tissue engineering – Targeted drug delivery, Nanobiotechnology in tissue engineering - three dimensional nanofilament based scaffolds. Nanobiotechnology for organ replacement and assisted function - Exosomes for drug free organ transplants, Nanotechnology based human nephron filter for renal failure and #Blood-compatible membranes for renal dialysis#.

UNIT IV **18 Hours**

Role of Nanotechnology in biological therapies – Nanobiotechnology for vaccine delivery, nanobiotechnology and cell transplantation, nanobiotechnology in stem cell based therapies, Nanoparticle mediated gene therapy and nanorod gene therapy, nanocarriers for simultaneous delivery of anticancer drugs, #dendrimers for antisense drug delivery#.

UNIT V **18 Hours**

Ethical, Safety and regulatory issues of Nanomedicine – Ethical, legal and social implications of Nanomedicine (Nanoethics), safety concerns about nanobiotechnology – toxicity of Nanoparticle, fate of Nanoparticle in the human body, measures to reduce toxicity of Nanoparticles, #public perception of safety and future potentials of Nanomedicine#.

 # Self-study Portion

Text Books:

T.B.1. Gary Walsh. Biopharmaceuticals – Biochemistry & Biotechnology. 2nd Edition, John Wiley & Sons. 2003.

T.B.2. Kewal K. Jain. The Handbook of Nanomedicine. Humana Press. 2008.

Unit I: Chapter 1, Page no: 1-40. T.B.1.

Unit II: Page no: 119-160. T.B.2

Unit III: Page no: 303-327. T.B.2

Unit IV: Page no: 161-181. T.B.2

Unit V: Page no: 329-352. T.B.2

Books for References:

1. Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor). Nanobiotechnology: Concepts, Applications and Perspectives. 1st edition. Wiley-VCH. 2004.

SEMESTER II: ELECTIVE – II

STEM CELL BIOLOGY

Course code: 17PBT2CE2B **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 4 **External Mark:75**

Objectives:

- To provide students with wide-range of topics related to stem cell
- To familiarize students with applications of stem cells in regenerative medicine.

UNIT I **18 Hours**

Stem cells: Introduction to stem cells, terminologies - pluripotent, toitopotent, multipotent, unipotent, etc – Classification- Embryonic and Adult stem cells – Sources - blood, bone marrow, umbilical cord blood, adipose tissue, menstrual blood, skin, teeth, #placental tissue#.

UNIT II **18 Hours**

Embryonic Stem Cells: Isolation, identification, characterization, maintenance and culture methods. #Methods for stem cell differentiation#.

UNIT III **18 Hours**

Adult Stem Cells: Sources, isolation, identification, characterization, maintenance and culture methods - Cloning of stem cells - Therapeutic cloning and #Reproductive cloning#.

UNIT IV **18 Hours**

Stem cells and Human diseases – Diagnosis, treatment and prevention. Transplantation, bone marrow replacement, treatment of neural diseases such as Parkinson's disease, Huntington's disease and #Alzheimer's disease#.

UNIT V **18 Hours**

Clinical applications of stem cells – #Tissue Engineering# – generation of scaffolds – regenerative medicine - treatment of type I Diabetes - repair of damaged organs such as the heart, liver and pancreas.

 # Self-study portions

Text Books:

T.B.1. AmitaSarkar, Embryonic stem cells. Discovery Publishing House Pvt. Ltd. 2009.

T.B.2. Eapen Cherian, Stem cells. Jaypee brothers Medical Publishers. 2011.

Unit I Chapter I & II, T.B-2

Unit II Chapter I, T.B-1

Unit III Chapter III, T.B-2

Unit IV Chapter V, T.B-2

Unit V Chapter V & VI, T.B-2

Books for References:

1. Paul Knoepfler, Stem Cells: An Insider's Guide. World Scientific. 2013.
2. Potten C. Stem cells, 1996. Elsevier.

SEMESTER III: CORE - IX

PLANT BIOTECHNOLOGY

Course Code:17PBT3C9 **Max Marks:100**
Hours/Week :6 **Internal Marks:25**
Credit:5 **External Marks:75**

Objectives:

- To study the principles and techniques involved in plant tissue culture
- To learn the concepts of transformation and other achievements in Plant Biotechnology.

UNIT I: **18 hours**

Plant Tissue Culture: History of Plant tissue culture **-** Tissue culture media (composition and preparation), Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis; Hardening and acclimatization; Embryo culture and embryo rescue; Artificial seeds; Protoplast isolation and culture, somatic hybridization; cybrids; haploid and triploids plant production; Cryopreservation and germplasm conservation; #Greenhouse technology#.

UNIT II: **18 hours**

Techniques in plant transformation: Gene transfer methods - Vector mediated gene transfer – Agrobacterium mediated gene transfer – crown gall disease and Ti plasmid – Hairy root disease of *A.rhizogenes* (Ri plasmid); Virus mediated gene transfer: Caulimovirus as vector and Geminivirus as vector, RNA plant virus as vector; Direct gene transfer: Physical and chemical method; Marker gene for Plant transformation: Antibiotic resistant gene – Herbicide resistant gene – #Reporter genes#.

UNIT III: **18 hours**

Transgenic plants: Herbicide resistance: phosphoinothricin, glyphosate-sulfonyl urea and atrazine. Insect resistance: *Bt* genes, non-*Bt* genes like protease inhibitors, alpha amylase inhibitor. Plant disease resistance: plant pathogen interaction, existing approaches to combating disease, Natural disease resistant pathways. Biotechnological approaches to disease resistant. Abiotic stress: Drought, cold and salt. #Post-harvest losses: long shelf life of fruits#.

UNIT IV: **18 hours**

Metabolic Engineering and Industrial Products: Plant secondary metabolites, controlmechanisms and manipulation of phenylproponoid pathway, shikimate pathway; alkaloids, industrial enzymes, bioplastics, #therapeutic proteins#, custom made antibodies, edible vaccines, nif and nod genes.

UNIT V: **18 hours**

MolecularMarker-aided plant breeding: Molecular markers – Basic principle of molecular marker detection – marker based on DNA hybridization – RFLP – Markers based on PCR amplification – RAPD – AFLP - STS – #Microsatellites#.

 # Self-study portion

Text Books:

T.B.1. Kalyankumar D. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. 2007.

T.B. 2. Adrian Slater, Nigel W. Scott and Mark R. Fowler., Plant Biotechnology (The genetic manipulation of plants). Oxford University press, UK. 2003.

Unit I Chapter I - XII, T.B.1

Unit II Chapter III, T.B. 2

Unit III Chapter IV, T.B.2

Unit IV Chapter XI, T.B.2

Unit V Chapter XIII, T.B.2

Books for References:

1. Donald Grierson and S.V. Convey.. Plant Molecular Biology. Blackie and Son Limited. New York. 1984.
2. Gilmartin and Bowler. Molecular Plant Biology: A practical approach (Vol. I and II), Oxford University press, UK. 2002.
3. M.J. Chrispeels and D.F. Sadava. Plants, genes and agriculture, The American Scientific Publishers, USA. 2000.

4. Mantell, S.H and Smith, H.. Plant Biotechnology by. Cambridge University press, UK. 1983.
5. Mathews and Mickee. An introduction to genetic engineering in plants, Blackwell Scientific Publishers. London. 1985.
6. Henry, RJ. Practical Application of Plant Molecular Biology. Chapmans and Hall. 1997.

SEMESTER III: CORE - X

ANIMAL BIOTECHNOLOGY

Subject code: 17PBT 3C10 **Max Marks: 100**
Hrs/week: 6 **Internal Marks: 25**
Credit: 5 **External Marks: 75**

Objectives:

- To study the techniques culture, concepts and achievements in animal systems.
- To study the developmental stages in animals and humans.

UNIT I: **18 hours**

Gametogenesis and Embryo development: Molecular biology of animal development - Oogenesis and fertilization- Blastula- gastrulation and morphogenesis. Genetic analysis of development in Drosophila - a model system, sex determination in Drosophila, maternal gene activity, zygotic gene activity and #vertebrate homologues of invertebrate genes#.

UNIT II: **18 hours**

Animal cell and tissue culture: Primary cell culture- Different types of cell lines - transformed cell lines- cell culture media – components and their function- serum- and serum free media; CO_2 incubator; Expression of culture efficiency, cell death and apoptosis. Organ culture methods of introducing of DNA into cell lines – microinjection- calcium phosphate transfection- lipofection- electroporation; Reporter gene systems – luciferase and green fluorescent protein-CAT assay. #Preservation of animal cells#, American type culture collection (animal cell line).

UNIT III: **18 hours**

***In vitro* fertilization, embryo transfer and stem cell biology**: Embryo technology, ICSI, Ingamete intrafallopian transfer. Development and use of transgenic animals – retroviral method- embryonic stem cell method- micro –injection method, molecular pharming. Generation of gene knockouts and insertional mutants in mice. Stem Cells – types- Gene therapy. Cloning of animals. Stem cell therapy – reproductive cloning. #Ethical issues in animal cloning#.

UNIT IV: **18 hours**

Hybridoma technology: Monoclonal antibody production, fusion methods, selection and screening methods for positive hybrids. Purification of monoclonal antibodies and application of monoclonal antibodies. Phage display technology for production of Abs, T cell cloning and applications, Cytokine technology, #Gene therapy#.

UNIT V: **18 hours**

Vaccine Production: Active and passive immunization- whole organism vaccines- purified macromolecules as vaccines- recombinant vector vaccines- DNA vaccines- multivalent subunit vaccines strategies for Malaria, Rabies, Hepatitis B, HIV and Cancer; Dendrites cells as therapeutic agents; #Multi- valent vaccines#.

 # Self-study portion

Text Books:

T.B.1. Butterworthh –Heineman. "*In vitro* cultivation of animal cells", 5th Edition, Butterworthh Heineman Ltd. 2004.

T.B.2. John R.W. Masters., "Animal cell culture", 3rd Edition, Oxford university press. 2004.

Unit-1 Chapter 5 Page no 118-150 T.B.1

Unit-2 Chapter 7 Page no 243-267 T.B.1

Unit-3 Chapter 6 Page no 222-245 T.B.1

Unit-4 Chapter 4 Page no 99-121 T.B.2

Unit-5 Chapter 5 Page no 413-425 T.B.2

Books for References:

1. Masters, J.R.W., "Animal Cell culture", Oxford University Press. 2000.
2. Ranga, M.M., "Animal Biotechnology", Student Edition- Jodhpur. 2003.
3. Springer, T. A., "Hybridoma Technology in Biosciences and Medicine" by Plenum Press- New York. 1985.

SEMESTER III: CORE - XI

BIOINFORMATICS AND BIOSTATISTICS

Subject code: 17PBT3C11 **Total Mark: 100**
Hrs/week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Objectives:

- To understand the basics of Bioinformatics and Biostatistics problems.
- To give an insight into the application of biological software's fields.

Unit I: **18 Hours**

Structural Biology: Bioinformatics scope and history, factors determining primary – secondary - tertiary and quaternary structures of proteins - protein information resources – biological databases, primary Sequence databases, secondary databases. #Composite protein sequence databases#.

Unit II: **18 Hours**

Databases: Introduction to databases - database management system - types of databases. Flat file database - relational databases - object oriented databases - database software: overview of sequence retrieval system. #oracle – mysql, database design: visualization of databases#.

Unit III: **18 Hours**

Biological Sequence analysis: Pair wise sequence alignment comparison - scoring matrix, dynamics programming, – FASTA, and BLAST. Multiple sequence alignments clustalW – global and local alignment. Phylogenetic alignment. Protein structure visualization tools. #RasMol, Swiss PDB Viewer, and #Protein identification programs - Mascot. Protein protein interaction#. Molecular docking.

Unit IV: **18 Hours**

Programming in C & Perl: C-language-Introduction-Operators- variables- input output statements- control statements- function- arrays- pointers- structures- file handling and case studies. Introduction to PERL- variables- strings and numbers- lists conditional loops- strings- pattern matching.# Applying PERL to Bioinformatics#.

Unit V: **18 Hours**

Biostatistics: Measures of central Tendency - mean arithmetic's- harmonic and geometric median and mode - measures of dispersion - standard deviation and standard error; correlation coefficient- simple linear regress- #Basic idea of significance student test – t- test ,chi square test hypothesis test#. SPSS Packages.

 # Self-study portion

Text Books:

T.B.1. Attwood TK- Parry Smith DJ, Introduction to bioinformatics- Pearson Education Asia. 2001.

T.B.2. Rastogi , S.C., Mendiratta, P.Rastogi., Bioinformatics Methods and Application Genomics , Proteoics and Drug Discovery. 2004.

T.B.3. Balaguruswamy, E. Programming in ANSI C- TataMcGraw Hill. 1992.

T.B.4. Rastogi. SC., Mendiratta .P. Rastogi. Bioinformatics methods and application Genomics, Proteomics and Drug Discovery. 2004.

T.B.5. Pillai, RSN., Bagavathi and Chand Statistics, 1984.

Unit I Chapter 3 Section 35-67. T.B-3

Unit II Chapter 3 Section 121, 228. T.B-4

Unit III Chapter 6, 7 Section 119,125,132,133 T.B-2

Unit IV Chapter 2, 3 Section 2.37, 3.1-9.2. T.B-1

Unit V Chapter 9 Section 121, 228. T.B-5

Books for Reference:

1. David W. Mount, Bioinformatics: Sequence and Genome Analysis. CSHL Press. 2004.

SEMESTER III: CORE - XII

PLANT BIOTECHNOLOGY, ANIMAL BIOTECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS – PRACTICAL

Course Code: 17PBT3C12P **Max. Marks: 100**
Hours/week: 6 **Internal Marks: 20**
Credit: 4 **External Marks: 80**

PLANT BIOTECHNOLOGY

1. Introduction to the laboratory and general Safety Practices for plant cell, Plant growth and development. Laboratory Report Guidelines (Theory & Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures.
3. Tissue culture media preparation: Preparation of stock solutions of Murashige & Skoog basal medium and plant growth regulator stocks.
4. Propagation of plantlets and rapid multiplication by direct organogenesis.
5. Propagation of plantlets and rapid multiplication by indirect organogenesis.
6. Haploid plant production - Anther and Pollen culture
7. Mechanical isolation of protoplast and enzymatic isolation of protoplast and culture.
8. Production of synthetic seeds.
9. Transformation of leaf discs with *Agrobacterium*.

ANIMAL BIOTECHNOLOGY

10. Preparation of tissue culture medium and membrane filtration.
11. Primary culture of fibroblast cells/ liver cells.
12. Trypsinization of monolayer and subculturing.
13. Isolation and culture of lymphocyte from human blood.
14. Assessment of viability and counting using Tryphan blue exclusion method.

BIOINFORMATICS AND BIOSTATISTICS

15. Study of Internet resources in Bioinformatics- eg. NCBI,
16. Sequence alignment by BLAST.
17. Homology modeling of a given protein sequence.
18. Phylogenetic analysis using web tools.

19. Pair wise Sequence Alignment.
20. Multiple alignments- using CLUSTAL W
21. Program to find the percentage of G and C in a DNA sequence.
22. Program to find the percentage of type of amino acid in a sequence.
23. Program to concatenate DNA fragments.
24. Program to convert DNA to RNA.
25. *Web Publishing*: Create a web page for your University / College using HTML. The opening page should provide hyperlinks to other pages (add animation and sound effects appropriately).

Text Books:

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. 2007.
2. Nigel Jenkins. "Animal cell biotechnology methods and protocols", 1st Edition 1, Humana press. 1997.
3. John R.W. Masters.. "Animal cell culture", 3rd Edition, Oxford University press. 2004.
4. Balaguruswamy, E. Programming in ANSI C- Tata McGraw Hill. 1992.
5. Attwood TK., Parry Smith DJ. Introduction to bioinformatics- Pearson Education Asia. 2001.
6. Rastogi SC., Nametag Mendiratta Parag Rastogi. Bioinformatics Concepts, Skills & Applications. 2003.

Books for References:

1. Andreas D.Baxevanis B.F.Francis Ouellette, 3rd Edition. Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins. 2006.
2. Baxevanis A., and B.F. Ouellette. Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, Wiley-Inter science, Hoboken, NJ. 1998.

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SEMESTER IV: ELECTIVE – III

RESEARCH METHODOLOGY, IPR AND BIOSAFETY

Course code: 17PBT3CE3A **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 4 **External Mark:75**

Objective:

- To give an understanding about research, IPR & Legal Protection.
- To study the process of Patent Filing, Infringement and Biosafety.

Unit I: **18 Hours**

Research: Meaning – purpose, types and significance of research in basic/applied sciences. Steps in research: identification, selection and formulation of research problem- research questions-research design- formulation of hypothesis- literature collection. Sampling technique: sampling theory-types of sampling-steps in sampling- sampling and non-sampling error - sample size –advantages and limitations of sampling. Data for research: primary data, secondary data, limitations and cautions.

Unit II: **18 Hours**

Processing Data: Checking- editing - coding- transcriptions and tabulation-data analysis-meaning and methods- quantitative and qualitative analysis. Structuring the report: chapter format- pagination- identification- using quotations- presenting foot notes – abbreviations-presentation of tables and figures- referencing- documentation-use and format of appendices-indexing. preparation of research report - thesis - dissertation - manuscript/research article – monograph/review.

Unit III: **18 Hours**

IPR and its different forms - Development of patent system in India, Indian Patent Act 1970, recent amendments, filing patent application, precautions before patenting – disclosure and non-disclosure. WIPO treaties, Patent Cooperation Treaty (PCT) and implications, role of a country

patent office and procedure for filing a PCT application. Types of IP - patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications and international framework for the protection of IP.

Unit IV: **18 Hours**

Rights - Introduction to history of GATT, WTO, TRIPS. Basic requirements of patentability, patentable subject matter, novelty and the public domain; non obviousness compulsory licensing, patent infringements and revocation special issues in Biotechnology patents: disclosure requirements, collaborative research, competitive research, patent litigation, Budapest treaty. PETA – history, philosophy and activism. PETA Asia-Pacific, PETA India.

Unit V: **18 Hours**

Biosafety- Introduction to biological safety cabinets, primary containment for biohazards, biosafety levels, biosafety levels of specific microorganisms, recommended biosafety. Roles of Institutional Biosafety Committee, Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Appraisal Committee (GEAC) for GMO's applications in food and agriculture. Environmental release of GMOs, overview of national regulations and relevant international agreements - Cartagena protocol.

 # Self – study portion

Text Books:

T.B.1.Kothari, CR. Research Methodology – methods and techniques. New age International Pvt.Ltd. 2004.

T.B.2.Deepa Goel and Shomini Parashar, IPR, Biosafety and Bioethics. Dorling Kindersley Pvt. Ltd. 2013.

Unit I - Chapter 1, 3, 6, Page no: 1-20, 31-39, 95-120. T.B.1.

Unit II – Chapter 14, Page no: 344-359. T.B.1.

Unit III & IV – Chapter 3, 5, Page no: 47-60, 84-100. T.B.2.

Unit IV - https://en.wikipedia.org/wiki/People_for_the_Ethical_Treatment_of_Animals

Unit V – Chapter 10, 11, Page no: 150-164, 164-172. T.B.2.

Books for References:

1. Martin. M.W. and Schinzinger.R. Ethics in engineering. 3rd Edition, Tata McGraw-Hill, New Delhi. 2003.
2. Sasson A. Biotechnologies and Development, UNESCO Publications. 2002.
3. Biosafety issues related to transgenic crops - DBT guidelines, Biotech Consortium India Limited, New Delhi.

SEMESTER III: ELECTIVE - III
GENOMICS AND PROTEOMICS

Subject code: 17PBT 3CE3B **Total Mark: 100**
Hrs/week: 6 **Internal Mark: 25**
Credit: 4 **External-Mark: 75**

Objectives:

- The students will be able to understand the various techniques in Genome analysis and to understand the applications of proteomics in different fields.

UNIT- I

Genome Structure: Genome sizes- microbial and organelle genomes - Centromeres and telomeres, tandem repeats- dispersed repeats (transposons). Basic Sanger sequencing - automated sequencing- sequencing simple genomes - Sequencing large genomes - finalizing sequences – resequencing and Next generation sequencing (NGS).

UNIT- II

Microarray: DNA Micro array, Protein Micro array Transcriptomics, Applications and advantages of Micro arrays- DNA chips and SAGE technology- Organization of genome projects- human, plant, animal and microbial genome.

UNIT- III

Human Genome: Important genes associated with each chromosomes - Mendelian and sexlinked traits in human inheritance. Genetic diseases due to defects in autosomal and sex linked genes. Whole genome sequencing – Human Genome Project.

UNIT- IV

Proteomics: Identifying proteins in complex mixtures: Protein profiling, quantitative 2D GE, multidimensional chromatography, quantitative mass spectrometry, MALDI – TOF, TOF analysis and analytical protein chips. Protein structure databanks- protein databank.

UNIT- V

Phamacogenomics and New Drug Design: Need for developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR.

Text Books:

1. Necia Grant Cooper; (Ed.). The Human Genome Project; Deciphering the blueprint of heredity University Science books, CA, USA. 1994.
2. Gary zweiger. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences.. Tata McGraw-Hill Publishers, New Delhi. 2003.
3. Branden, C and J.Troze. Introduction to Protein Structure. Second Edition.Garland Publishing, New Delhi. 1999.
4. Evans W.E. and Relling, M.V. Pharmacogenomics: translating functional genomics into rational therapeutics. *Science* 286:487. 1999.

Unit I, T.B.2.
Unit II, T.B.3.
Unit III, T.B.1.
Unit IV, T.B.3.
Unit V, T.B.4.

Books for References:

1. Baxevanis, A.D and Ouellette, B.F.F. Eds. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. New York. 2001.
2. Higgins, D and Taylor, W (Eds). Bioinformatics: Sequence, Structure and Databnks.Oxford University Press, Oxford. 2000.

SEMESTER III: EXTRA CREDIT - 1

GENETIC TOXICOLOGY

Subject code: 17PBT 3CE1 **Total Mark: 100**
Hrs/week: -- **Internal Mark: --**
Credit: 5* **External-Mark: --**

Objectives:

- To study the relationship of genetic toxicology as a subset within the field of toxicology.
- To describe the effects of radiation and chemical mutagens upon the environment and the possible effects on humans.

Unit-I: **18 Hours**

Principles of Toxicology - Mechanisms of Toxicity, ADME and Toxicokinetics, Pharmacokinetics, #pharmacodynamics# and toxicokinetics of xenobiotic chemicals through the mammalian body - metabolism, principles of Phase I metabolism, oxidation, reduction, hydrolysis and the enzymes involved.

Unit-II: **18 Hours**

Testing Methods in Genetic Toxicology - *In vitro* micronucleus assay, structural numerical changes, #centromere and kinetochore staining#, binucleate cell assay and measurement of non-disjunction.

Unit -III: **18 Hours**

Environmental Mutagenesis - *In vitro* gene mutation assays, #HPRT methods#, thymidine kinase (TK) mutations. Detection methods for gene and chromosome changes such as SSCP, RSM, FISH, CGH.

Unit-IV: **18 Hours**

DNA Lesions, Repair and Mutation - DNA modifications by ionising and non-ionising radiations, Chemically induced lesions, DNA adducts by the alkylating agents, Lesion and adduct detection methods, comet assay, mismatch repair, #Base excision repair#, Nucleotide excision repair, post-replication and double strand break repair, Repair defective mutations.

Unit-V: **18 Hours**

Epigenetic Mechanisms of Chemical Carcinogenesis: Biological characteristics for classification of genotoxic and nongenotoxic carcinogens, biological characteristics of the stages of carcinogenesis, role of cell proliferation in non-genotoxic carcinogenesis, role of apoptosis in epigenetic carcinogenesis, molecular toxicology and #toxicogenomics#**.**

#**Self-study portion**

Text Books:

T.B.1. Brusick, D., Principles of Genetic Toxicology. Springer Science & Business Media. 2013.

T.B.2. Hartl, D.L and E.W. Jones. Genetics- analysis of genes and genomes. 6th edition. Jones and Bartlett publishers. 2005.

Unit I – Chapter 1. T.B.1

Unit II – Chapter 6. T.B.1

Unit III – Chapter 10. T.B.1

Unit IV – Chapter 7,8 & 9. T.B.1

Unit V – Chapter 11. T.B.2

Books for References:

1. Albert P. Li, Robert H. Heflich, Genetic Toxicology. CRC Press. 1991.
2. Wai Nang Choy. Genetic Toxicology and Cancer Risk Assessment. CRC Press. 2001.
3. Daniel Hartland MaryellenRuvolo. Genetics. Jones & Bartlett Publishers. 2011.
4. Gardner, E.J., Simmons, M.J., and Snusted D.P., Principles of Genetics, John Wiley and Sons, New York. 1991.

SEMESTER IV: CORE - XIII

INDUSTRIAL BIOTECHNOLOGY

Course code: 17PBT4C13 **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 5 **External Mark:75**

Objectives:

1. To study the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
2. To study the bulk production of commercially important Bioproducts.

UNIT I: **18 hours**

Isolation and screening of industrially important microbes: Primary screening and secondary screening. Strain improvement: auxotrophic mutants, resistant mutants and revertant mutants, recombination: applications of parasexual cycle, protoplast fusion and rDNA techniques. Preservation of Micro-organisms: serial subculture, overlaying culture with mineral oil, #lyophilization and nitrogen storage#.

UNIT II: **18 hours**

Microbial growth kinetics, production media and fermenter: Batch, fed batch and continuous culture. Characteristics of ideal production medium, medium formulations: energy, carbon, nitrogen, mineral sources, growth factors, precursor, inducer and inhibitor, oxygen requirement and antifoam agents. Sterilization of equipment and production media: #batch, continuous and filter sterilization#.

UNIT III: **18 hours**

Design of a fermenter: Basic functions of a fermenter, body construction, agitator (impeller), stirrer glands and bearings, baffles, pH probe – DO, aeration system (sparger), valves: gate, globe, piston, needle, plug, ball, butterfly, pinch, check valves and diaphragm valves,

pressure control valves and steam traps. Fermentation vessels: Waldhof-type, tower, air-lift, deep-jet, cyclone column, #packed glass bead reactors and hollow fibre chambers#.

UNIT IV: **18 hours**

Downstream processing– Foam separation, precipitation, Filtration: batch and continuous filters, centrifugation: basket, tubular-bowl, solid-bowl scroll, multi-chamber and disc-bowl centrifuge. Cell disruption: physical - mechanical methods and chemical methods. Liquid - liquid extraction, solvent recovery, two-phase aqueous extraction, chromatography, membrane process, drying, #crystallization and whole broth processing#.

UNIT V: **18 hours**

Production of Bioproducts: Antibiotics: Penicillin and Streptomycin, Organic acids: Citric acid and acetic acid, Enzymes: amylase and protease, Solvents: ethyl alcohol, vinegar and 2,3-butanediol, Amino acids: glutamic acid and lysine, Vitamins: B_{12} and B_2. #Production of Single Cell proteins#.

#Self-study portion

Text Books:

T.B.1. Patel, A. H. Industrial Microbiology. Rajiv Beri for Macmillan India Ltd. 2005.

T.B.2. Stanbury, P.F. Whitaker and S.J.Hall, Principles of fermentation technology. 2nd Edition. Elsevier Science India. 2003.

Unit I and II Chapter 3, 5 & 6, p. no: 15-55. T.B.1.

Unit III Chapter 7, p.no: 167-209. T.B.2.

Unit IV Chapter 10, p. no: 277-307. T.B.2.

Unit V Chapter 10, 11, 12, 13, 14, 15, 17, p. n o: 112-187. T.B.1.

Books for References:

1. SalaTeh JR., Bacterial physiology and metabolism, Academic press- New York. 2001.
2. Mansi& CFA. Bryce. Fermentation Microbiology &Biotechnology,Taylor& Francis Ltd.. 2004.
3. Coulson, JM., and J.F. Richardson. Chemical Engineering, Pergamon Press. 1984.

SEMESTER IV: CORE - XIV

ENVIRONMENTAL BIOTECHNOLOGY

Course code: 17PBT4C14 **Total Mark: 100**
Hrs/week: 6 **Internal Mark:25**
Credit: 5 **External Mark:75**

Objectives:

- To study the principles of microbiological treatment to clean up polluted environments and to create valuable resources for the human society.

UNIT I: **18 hours**

Global Environmental Problems: Greenhouse effect and global warming: Greenhouse gases – Measures to control greenhouse effect, global warming and climate change. Problem of ozone: Depletion of ozone – ozone hole– effect of ozone depletion – Measures to control ozone depletion: #Acid rain: Development of acid rain –effect of acid rain# –Measures to control acid rain, El Nino-Southern oscillation and sea level rise.

UNIT II: **18 hours**

Environmental Pollution: Origin of pollution; Classification and nature of Environmental Pollutants; Industrial pollutions. Overview of Noise pollution.#Radiation Pollution - Types and possible hazards of radioactive substances; #Soil Pollution - Waste land formation. Impact of Dams, Loss of soil fertility#.

UNIT III: **18 hours**

Waste water management*:* Waste water treatment: waste water collection, #physico-chemical properties of waste water, physical, chemical and biological (primary, secondary and tertiary) treatment processes. Activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. #Anaerobic digestion, anaerobic filters#. Biotechnology in tannery, dairy, distillery, textile, pulp, paper and Antibiotic industries effluent treatment.

UNIT IV: **18 hours**

Xenobiotic: Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides[#]. [#]Bioplastics[#], Biopesticides; bioremediation of contaminated soils and wastelands. Phytoremediation: degradation of xenobiotic by plants.

UNIT V: **18 hours**

Environmental Quality Assessment and Monitoring: Quality of environment for life on earth and man - Deterioration of environmental quality with reference to anthropogenic impact. [#]Methods of assessment of environmental quality[#]; Impacts of genetically engineered microbes, plants and animals. Organization for environmental quality and Law of environmental protection.

[#] [#]**Self-study portion**

Text Books*:*

T.B. 1. Agrawal, KC. Environmental Biotechnology, Nidhi Publishers (India), Bikaner. 2004.

T.B. 2. Pradipta K. Mohapatra. Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd. 2008.

UNIT I Chapter I, T.B.1

UNIT II Chapter II and III, T.B.1

UNIT III Chapter VIII and IX, T.B.1

UNIT IV Chapter XIII, T.B.1

UNITV Chapter I, T.B.2

Books for References:

1. Abbasi S.A and E Ramaswami,. Biotechnological Methods of Pollution Control. Universities Press. 2004.
2. Allsopp D. and K.J. Seal.. Introduction to Biodeterioration by, ELBS/Edward Arnold. 2005.

SEMESTER IV: CORE - XV

INDUSTRIAL BIOTECHNOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY – PRACTICAL

Course code: 17PBT4C15 **Total Mark: 100**
Hrs/week: 6 **Internal Mark:20**
Credit: 5 **External Mark:80**

Objectives:

- To understand the concepts involved in production of biomass.
- To determine the physical and chemical parameters from water samples.

1. Media formulation - Sterilization of bioreactors.
2. Production of biomass – batch, continuous and fed batch fermentation and recovery of products.
3. Cell and enzyme immobilization.
4. Wine Production.
5. Estimation of dissolved oxygen in water.
6. Determination of total hardness in water.
7. Determination of chloride in water.
8. Analysis of turbidity in water.
9. Analysis of carbonate and bicarbonate in water.
10. Removal of solids using coagulation technique
11. Microbial assessment of air quality (open plate and air sample)
12. Portability test of water (MPN technique).
13. Degradation of phenols - Colorimetric assay

SEMESTER IV: PROJECT WORK

Course code: 17PBT4PW **Total Mark: 200**
Hrs/week: 12 **Internal Marks: --**
Credit: 9 **External Marks: --**

SEMESTER – IV: EXTRA CREDIT –II

AGRICULTURAL BIOTECHNOLOGY

Course Code: 17PBT4EC2 **Max. Marks: 100**
Hours/week: - **Internal Marks: --**
Credit: 5* **External Marks: 100**

Objective:

- To understand the importance of traditional and modern agricultural practice to the students.

UNIT I: **6 hours**

Conventional methods for crop improvement: vegetative propagation methods - Grafting – Rapid multiplication techniques. Bio-fertilizers - Bio-fungicides -Bio-Insecticides – Vermi-composting -Farm Pollutants and their Management.

UNIT II: **6 hours**

Commercial Agriculture: Mushroom Cultivation, Apiculture, Sericulture, Farm Forestry, Seed Production, Crop Breeding, Hybrid Seed Production.

UNIT III: **6 hours**

Genetic Engineering for biotic stress tolerance: insects, fungi, bacteria, viruses- Genetic engineering of abiotic stress tolerance -drought, salt and temperature.

UNIT IV: **6 hours**

Major pests of Agricultural Crops: Developing pest resistant species - Biocontrol methods - Bioengineered biocontrols – Biotechnology of weed control, Public acceptance of bioengineered GM foods and organisms.

UNIT V: **6 hours**

Integrated Livestock Farming (Animal Science) and Veterinary: Poultry Production Management, Dairy Production Management, Sheep and Goat Production and Management, Value Addition to Animal Products, Veterinary Care Practices. Agricultural biotechnology and Law – plant variety certification and protection- Farmers rights.

Text Books:

T.B. 1. Kumaresan, V. A Text Book of Biotechnology. Saras Publication. 2010.

T.B. 2. Rajmohan Joshi. Agriculture Biotechnology. Saras Publication. 2006.

T.B. 3.Veeresh, G.K., Organic Farming, Foundation Pvt.Ltd. 2006.

Unit I Chapter 39 T.B.1

Unit II Chapter 43, 35 T.B.2

Unit III Chapter 18, T.B.1

Unit IV Chapter 21T.B.1

Unit V Chapter 22 T.B.3

Books for References:

1. Altman, Arie. Agricultural Biotechnology. Marcel Dekker, Inc.New York. 1998.
2. Chrispeels, M.J. and David E. Sadava,. Plants, Genes, and Crop Biotechnology. Jones and Bartlett,Boston. 2003.
3. Erbish, F.H. and M. Maredia. Intellectual Property Rights in Agricultural Biotechnology. Universities Press, India. 1998.
4. Forbes, J.C and R D Watson. Plants in Agriculture, Cambridge Univ. Press, Great Britain. 1992.
5. Jones, L. Biotechnological innovation in Crop improvement. Butterworth-Hiemann, London. 1991.
6. Joshi, N K. Biotechnology in Agriculture. Aavishkar Pub., Jaipur, India. 2007.
7. Maarten J. Chrispeels and David E. Sadava. Plants, Genes and Agriculture, Jones & Barleft Publishers, London. 1994.
8. Ramniwas Sharma (Ed.). BiotechnologyIn Agriculture. Saujanya Books, New Delhi. 2005.

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