

MASTER OF SCIENCE (BIOTECHNOLOGY)

REGULATIONS

ELIGIBILITY :

A pass in any one of the following Degree Courses of B.Sc. Biotechnology / Biology / Agriculture / Botany / Zoology / Plant Science / Microbiology / Animal Sciences / Biochemistry / Bioinformatics / Environmental Science / Food and Nutrition of any University in Tamil Nadu or an Examination accepted as equivalent thereto by the Academic Council, subject to such conditions as may be prescribed thereto are permitted to appear and qualify for the **M.Sc., Biotechnology Examination** of this College after a course study of two academic years.

PROGRAMME EDUCATIONAL OUTCOME

1. This programme will enable students to acquire knowledge on the fundamentals of Biochemistry, Cell biology, Microbiology and Molecular biology. It helps them to understand emerging and advanced concept in modern biology and guide them to take up their carrier in this field.
2. This programme will facilitate the students to acquire knowledge in fields such as Genetic Engineering, Protein Engineering and Molecular Therapeutic.
3. The programme will aid the students to learn the recent developments in the field of Genomics, Proteomics, Stem cell biology and Tissue Engineering approach

PROGRAM OUTCOMES

On the successful completion of the program, the following are the expected outcomes.

PO Number	PO Statement
PO1	Impart quality biotechnology education to students and to develop young minds as outstanding scholars/teachers/entrepreneurs and responsible citizens.
PO2	Apply their understanding of the commercialization processes to biotechnology products or services in future.
PO3	Graduates of the course will have strong background in the interface of biotechnology and be able to use the tools in industry and/or institutes wherever necessary.
PO4	Ability to design and carry out experiments (safely) and to interpret experimental data and apply the scientific method by developing valid hypotheses, designing experiments, gathering relevant data using current technology, and interpreting quantitative and qualitative data.
PO5	Develop an awareness of ethical issues in biochemical research and careers options along with understanding of the area of biotechnology chosen.

SCHEME OF EXAMINATIONS

Subject Code	Subject	Hrs of Instruction	Exam Duration (Hrs)	Max Marks			Credit Points
				CA	CE	Total	
First Semester							
17PBT13A	Cell and Molecular Biology	5	3	25	75	100	4
17PBT13B	Biochemistry	5	3	25	75	100	4
17PBT13C	Genetics	5	3	25	75	100	4
17PBT13D	Microbiology	5	3	25	75	100	4
17PBT13P	Core Practical- I: Basic Biotechnology	6	6	40	60	100	3
	Elective -I:	4	3	25	75	100	4
		30				600	23
Second Semester							
17PBT23A	Immunotechnology	5	3	25	75	100	4
17PBT23B	Genetic Engineering	5	3	25	75	100	4
17PBT23C	Microbial Biotechnology	5	3	25	75	100	4
17PBT23D	Genomics and Proteomics	5	3	25	75	100	4
17PBT23P	Core Practical- II: Applied Biotechnology - I	6	6	40	60	100	3
	Elective- II:	4	3	25	75	100	4
		30				600	23
Third Semester							
17PBT33A	Plant Biotechnology	5	3	25	75	100	5
17PBT33B	Animal Biotechnology	5	3	25	75	100	5
17PBT33C	Environmental Biotechnology	5	3	25	75	100	5
17PBT33D	Molecular Therapeutics	5	3	25	75	100	5

10/5/18
 BoS Chairman/HoD
 Department of Biotechnology
 Dr. N. G. P. Arts and Science College
 Coimbatore - 641 048

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 PRINCIPAL
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 Tamilnadu, India

M.Sc- Biotechnology (Students admitted from 2017-2018 onwards)

17PBT33P	Core Practical -III: Applied Biotechnology - II	6	6	40	60	100	3
17PBT33T	Internship *	--	--	--	--	50	2
	Elective- III:	4	3	25	75	100	4
		30				650	29
Fourth Semester							
17PBT43A	Research Methodology	5	3	25	75	100	5
17PBT43V	Project and Viva Voce	20	-	80	120	200	6
	Elective -IV:	5	3	25	75	100	4
		30				400	15
Grand Total						2250	90

* Student shall undergo Training for period of not less than 15 days during third Semester and report has to be submitted for Viva-voce examination (External Evaluation).

ELECTIVE - I

(Student shall select any one of the following **Course** as Elective-I in First semester)

S.No	Course Code	Name of the Course
1.	17PBT1EA	Biodiversity
2.	17PBT1EB	Protein Engineering

ELECTIVE - II

(Student shall select any one of the following **Course** as Elective-II in Second semester)

S.No	Course Code	Name of the Course
1.	17PBT2EA	Bioprospecting
2.	17PBT2EB	Principles of Clinical Trials

ELECTIVE - III

(Student shall select any one of the following **Course** as Elective-III in Third semester)

S.No	Course Code	Name of the Course
1.	17PBT3EA	Tissue Engineering and Bioimplant Technology
2.	17PBT3EB	Stem Cell Technology

ELECTIVE - IV

(Student shall select any one of the following **Course** as Elective-IV in Fourth semester)

S.No	Course Code	Name of the Course
1.	17PBT4EA	Bioentrepreneurship, IPR and Biosafety
2.	17PBT4EB	Organic farming

TOTAL CREDIT DISTRIBUTION

Subjects	Credits	Total Marks		Credits	Cumulative Total credits
Core Theory	4	8 X 100 =	800	32	74
Core Theory	5	5 X 100 =	500	25	
Core Lab	3	3 X 100 =	300	09	
Internship	2	1 X 50 =	50	02	
Project and Viva Voce	6	1 X 200 =	200	06	
Elective	4	4 X 100 =	400	16	16
Total			2250	90	90

FOR PROGRAMME COMPLETION

Students have to complete the following Subjects:

- Core papers in I, II, III and IV Semesters.
- Elective papers in the I, II, III and IV Semesters.
- Core practicals in I, II and III Semesters.
- Institutional/Industrial Training in III Semester
- Project and Viva - Voce in IV Semester

Earning Extra credits is not mandatory for course completion

Extra Credits

Subject	Credit	Total credits
Publication with ISSN Journal	1	1
Hindi /Other Foreign language	1	1
Paper Presented in Sponsored National/ International Seminar/conference/ workshop	1	1
Online Courses Prescribed By Department / Self study paper	1	1
Representation - Academic/Sports /Social Activities/ Extra Curricular Activities at University/ District/ State/ National/ International	1	1
Total		5

Rules:

The students can earn extra credit only if they complete the above during the course period (I to III semesters) and based on the following criteria. Proof of completion must be submitted in the beginning of IV semester. (Earning Extra credits is not mandatory for course completion)

1. Publication with ISSN Journal by a student and co-authored by staff member will be given one credit extra.
2. Student can opt Hindi/ French/ Other foreign Language approved by certified Institutions to earn one credit. The certificate (Hindi) must be obtained from **Dakshina Bharat Hindi Prachar Sabha** and he/ she has to enroll and complete during their course period (**first to Third semester**)

- Award winners in Paper Presentation in Sponsored International Seminar/conference/Participation in short term workshop (minimum 5 days) will be given one credit extra.
- Student can earn one credit, if they complete any one online certification courses / Self study paper prescribed by the concerned department.

Self study paper offered by Biotechnology Department

S. No.	Semester	Course Code	Course Title
1.	III Sem	17PBTSS1	Food Biotechnology
2.		17PBTSS2	Developmental Biology

- Award Winners in /Social Activities/ Extra Curricular /Co-Curricular Activities / Representation in Sports at University/ District/ State/ National/ International level can earn one credit extra.

17PBT13A	CELL AND MOLECULAR BIOLOGY	SEMESTER - I
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Total Credits: 4

5 Hours / Week

PREAMBLE:

1. To study the Basic components and functions of Cells and its organelles.
2. To learn gene expression and its regulation.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Review the process of cell architecture and cell division	K2, K3
CO2	Understand the membrane architecture and signaling molecules	K3, K4
CO3	Imparts knowledge on the mode of DNA replication and repair mechanisms	K3, K4, K5
CO4	Provide in-depth understanding of transcriptional events and its role in gene regulation	K4, K5
CO5	Focus on translational events and its role in gene expression	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	S	M	M
CO3	S	M	S	S	M
CO4	S	S	S	S	M
CO5	S	S	S	S	M

S-Strong; M-Medium; L-Low

17PBT13A	CELL AND MOLECULAR BIOLOGY	SEMESTER - I
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Total Credits: 4
5 Hours / Week

CONTENTS

UNIT - I

Cell Architecture and Cell Division

Discovery of Cell and Cell theory, Chemical composition of cell. Structural organization of prokaryotic and eukaryotic cells; membrane bound organelles and non-membrane bound organelles. Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle). Cancer and the cell cycle, oncogenes, tumor suppressor genes, apoptosis, therapeutic interventions of uncontrolled cell growth.

UNIT - II

Membrane Architecture and Transport

Cell membrane and chemical compositions. Structure of model membrane, lipid bilayer and membrane protein, diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Cell communication and its types -Extracellular and intracellular signaling molecules.

UNIT - III

DNA replication, repair and recombination

DNA replication - Experimental proof for Semiconservative method, Mechanism of DNA replication, Enzymes in replication. Differences between Prokaryotic and eukaryotic replication. Replication model -

Theta, Strand displacement and Rolling circle model. DNA Repair- Nucleotide excision, Base excision, Mismatch repair, Photo-reactivation, SOS and recombination repair. Homologous and site-specific recombination

UNIT - IV

Transcription and regulation

Features of promoters, enhancers, activators and repressors. RNA polymerases and Types; Transcription in prokaryotes and eukaryotes. Antisense RNA, RNA interference (RNAi), hn RNA, Si RNA, Sn RNA and Micro RNA. Post-transcriptional modifications; RNA Splicing, Polyadenylation and Capping, RNA editing. Control of gene expression at transcriptional level.

UNIT - V

Translation and regulation

Genetic code - codon and anticodon concepts, wobble hypothesis, translation in prokaryotes and eukaryotes. Post translational modifications - Phosphorylation, Deformylation, Glycosylation, Acetylation, Amidation, Lipid attachment, S - Nitrosylation and Disulfide bond formation. Translational inhibitors, Control of gene expression at translational level.

TEXT BOOKS:

1. *Bruce Alberts*. 1998. **Essential Cell Biology**. 1st edition. Garland Publishers.
2. *De Robertis*. 2003. **Cell and Molecular Biology**. 8th edition. EDP Lippincott Williams.

3. *Lodish, H. & Baltimore. D.* 1994. **Molecular cell Biology**. 2nd edition. American Scientific Books.
4. *Freifelder, D. and Malacinski, G. M.* 1996. **Essential of Molecular Biology**, 2nd edition. Panima Publishing Co., New Delhi.

REFERENCE BOOKS:

1. *Lewin, B.* 2004. **Genes V**. Oxford University press.
2. *Gerald Karp.* 2002. **Cell and Molecular Biology**. 3rd edition. John Wiley Sons.

17PBT13B	BIOCHEMISTRY	SEMESTER - I
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Total Credits: 4
5 Hours / Week

PREAMBLE:

1. To understand the Structure, function and interrelationship of various Biomolecules.
2. Integration of the various aspects of metabolism and their regulatory pathways.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the physical properties and kinetics of biochemical reactions.	K3, K4
CO2	Know the concepts of macromolecules and forces that stabilize biomolecules.	K3, K4
CO3	Structural understanding of enzymes and the factors affecting enzyme activity.	K3, K4, K5
CO4	Learning about intermediary metabolism and bioenergetics.	K3, K4
CO5	Concept and regulatory mechanism of different metabolic activities and their disorders.	K3, K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	M
CO2	S	M	S	M	M
CO3	S	M	S	S	M
CO4	S	M	S	S	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT13B	BIOCHEMISTRY	SEMESTER - I
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Total Credits: 4
Hours / Week : 5

UNIT - I

Principles of Biophysical Chemistry

Physical properties of water and their role in biology. pH, buffer, thermodynamics - Laws of thermodynamics. Concepts of ΔG , ΔH and ΔS , Colligative properties. Chemical kinetics: Concepts of order and molecularity of a chemical reaction. Derivation of first and second order rate equation, measurement of rate constants. Concept of activation energy.

UNIT - II

Biomolecular structure and function

Covalent structure and functions of Amino acids, proteins, nucleic acids, carbohydrates and lipids. Forces that stabilize biomolecules: electrostatic and van der Waal's interaction, hydrogen bonding. Protein Structure: Structural characteristics of α -helix, β -turn and β -sheet, Ramachandran plot. Protein domains and domain architecture. Quarternary structure of proteins. Conformation of Nucleic acids: Structural characteristics of A, B and Z-DNA. 3D structure of t-RNA, ribozymes and riboswitches.

UNIT - III

Enzymes and coenzymes

IUBMB classification and nomenclature of enzymes, Mechanism of enzyme catalysis, active site, Lock and key Model and induced fit hypothesis. Factors affecting enzyme activity. Enzyme kinetics- Michaelis - Menten (MM) equations, LB plot. Enzyme inhibition: Reversible - Competitive, Noncompetitive, Uncompetitive, Irreversible - inhibition,

Kinetics of Enzyme inhibition. Isoenzymes, allosteric enzymes, abzymes and artificial enzymes.

UNIT - IV **Bioenergetics**

ATP as energy source. Glycolysis, TCA Cycle, Electron Transport Chain, Oxidative Phosphorylation, Substrate Level Phosphorylation, coupled reaction, group transfer, biological energy transducers.

UNIT - V **Metabolism of Biomolecules**

Metabolism of carbohydrates - Glycogen synthesis, Gluconeogenesis, Interconversion of hexoses and pentoses (HMP Shunt). Lipids - Biosynthesis of Saturated fatty acids and Triglycerides, Catabolism of Fatty acids - Oxidation (α , β and ω). Nucleotides - Biosynthesis of Purines and Pyrimidines - Salvage pathway and De novo Synthesis. Catabolism of Purines and Pyrimidines. Disorders associated with various metabolic pathways.

TEXT BOOKS :

1. *Albert L. Lehninger, Michael M. Cox.* 2008. **Principles of Biochemistry.** 5th Edition. W H Freeman & Co.
2. *Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell.* 2006. **Harper's Illustrated Biochemistry.** 26th Edition. McGraw-Hill Medical Publishing Division.

REFERENCE BOOKS:

1. *Geoffrey L. Zubay.* 1998. **Biochemistry.** 4th Edition. Brown (William C.) Co,U.S.
2. *Donald Voet; Judith G Voet; Charlotte W Pratt.* 1999. **Fundamentals of Biochemistry.** Wiley & sons. Publications.

17PBT13C	GENETICS	SEMESTER - I
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Total Credits: 4**Hours / Week: 5****PREAMBLE:**

1. To recollect general concepts of genetics and genetic disorders.
2. To understand the Mendelian and Non Mendelian modes of inheritance that governs passage of genetic traits across generation.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	To gain knowledge about Mendelian factors and its extension	K3, K4
CO2	To understand extra chromosomal inheritance and to apply knowledge on gene mapping methods	K3, K4
CO3	To gain knowledge about microbial genetics and mutation	K3, K4
CO4	To comprehend Quantitative genetics and Transposons	K3, K4
CO5	Awareness on Human genetics, their disorders and population genetics	K3, K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	M
CO2	S	M	S	S	M
CO3	S	S	S	M	M
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT13C	GENETICS	SEMESTER - I
		Total Credits: 4 Hours / Week: 5

CONTENTS

UNIT - I

Mendelism and Non Mendelism

Brief overview of Mendel's work- monohybrid, dihybrid, back cross, test cross and related problems, Extension of Mendelism- incomplete dominance, codominance, Multiple alleles, Non Mendelism - epistasis, genome imprinting, complementary genes, lethal genes and related problems. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies, pleiotrophy.

UNIT - II

Gene mapping methods and Extrachromosomal inheritance

Linkage maps, Tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Inheritance of Mitochondrial and Chloroplast genes, maternal inheritance

UNIT - III

Microbial Genetics and Mutation

Methods of genetic transfer - Transformation, Conjugation, Transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes. Mutation - spontaneous, induced, lethal, conditional, reversion, mutagenic suppression, germinal and somatic mutation, insertion, deletion, duplication, translocation, transposition, ploidy.

UNIT - IV

Quantitative genetics and Transposons

Polygenic inheritance, heritability and its measurements, QTL mapping. DNA finger printing and its applications - DNA bar coding, marker assisted selection. Transposons and its types.

UNIT - V

Human Genetics and Population Genetics

Population studies and Hardy Weinberg Equilibrium. Pedigree studies: Symbols used in pedigree analysis, lod score for linkage testing, karyotypes. Pedigree analysis of important genetic diseases like Haemophilia, Color blindness, Duchenne Muscular Dystrophy (DMD). Prevention of disease: Prenatal diagnosis; Genetic counseling.

TEXT BOOKS:

1. *Phundan Singh*. 2012. **Principles of Genetics**. Kalyani Publishers.
2. *Peter J. Russell*. 1993. **Fundamentals of Genetics**. 3rd Revised edition. Longman Publisher.
3. *K.P. Singh*. 2016. **Concepts of Molecular Genetics**. Medtec Publisher.
4. *Pragya Khanna*. 2010. **Essentials of Genetics Paperback**. I K International Publishing House Pvt. Ltd.

REFERENCE BOOKS :

1. *Strickberger, M. W.* 2013. **Genetics**. 3rd edition. Prentice Hall College Division, New Delhi.
2. *Gardner, E.J.* 1991. **Principles of Genetics**. 8th edition. John Wiley and Sons Inc, New York.
3. *Winter, P.C., Hickey, G. I. and Fletcher, H.L.* 2000. **Genetics**. 1st edition. Viva Books Pvt Ltd.
4. *Brown, T. A.* 1999. **Genetics**. 3rd edition. Chapman and Hall.

17PBT13D	MICROBIOLOGY	SEMESTER - I
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Total Credits: 4
Hours / Week: 5

PREAMBLE:

1. To understand the microbial diversity and systematics.
2. To investigate microbial interactions and their applications.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	To gain knowledge about microbial biodiversity and systematics	K3, K4
CO2	To elucidate microbial growth and physiology	K4
CO3	To analyze microbial interactions and infections	K4, K5
CO4	To examine the microorganisms in different environment	K4, K5
CO5	To apply the knowledge of microbes in food processing and production	K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	M
CO2	S	M	S	S	M
CO3	S	M	S	S	M
CO4	S	S	S	S	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT13D	MICROBIOLOGY	SEMESTER - I
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Total Credits: 4
Hours / Week: 5

CONTENTS

UNIT - I

Microbial Diversity & Systematics

Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods - Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

UNIT - II

Microbial Growth & Physiology

Ultrastructure of Archaea (Methanococcus); Eubacteria (*E.coli*); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adaptation and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group).

UNIT - III

Microbial Interactions and Infection

Host-Pathogen interactions; Microbes infecting humans – Urinary tract infection, Sexually transmissible infection, Oral cavity and respiratory infection, Nosocomial infection. Microbes infecting plants; Pathogenicity islands and their role in bacterial virulence. Diseases caused by Viruses: Chicken pox, Rabies virus, hepatitis, Dengue. Emerging Diseases: Swine flu, Chikun gunya, Ebola.

UNIT - IV

Microbes and Environment

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.

UNIT - V

Applications of Microbes in food process operations and production

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

TEXT BOOKS:

1. *Pelczar MJ Jr., Chan ECS and Kreig NR.*, 1993. **Microbiology**, 5th Edition, Tata McGraw Hill, New Delhi.
2. *Maloy SR, Cronan JE Jr., and Freifelder D*, 2006. **Microbial Genetics**, Jones Bartlett Publishers, Sudbury, Massachusetts.
3. *Crueger and A Crueger*, 1990. (English Ed., TDW Brock); **Biotechnology: A textbook of Industrial Microbiology**, Sinaeur Associates.
4. *G Reed, Prescott and Dunn's*, 1987.**Industrial Microbiology**, 4th Edition, CBS Publishers.
5. *Patel A H*. 2008. **Industrial Microbiology**. PB Books.

REFERENCE BOOKS:

1. *Casida, L.E*. 1997. **Industrial Microbiology**. New Age International Publishers.
2. *Julian E Davies and Arnold L Demain*. 2009. **Manual of Industrial Microbiology and Biotechnology**. ASM Publisher.
3. *Vidhyasekaran , P*. 2008. **Fungal pathogenesis in plants and crops: molecular biology and host defence mechanisms**, Volume 58 of Books in soils, plants, and the environment, 2nd ed., illustrated, CRC Press.
4. *Presscott, L. M. Harley, J. P. and Klein, D. A*. 1999. **Microbiology**, International edn. 4th edn. WCB Mc Graw-Hill.

17PBT13P	CORE PRACTICAL- I: BASIC BIOTECHNOLOGY	SEMESTER – I
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**Total Credits: 3
6 Hours / Week**

CONTENTS

1. Isolation of enzyme producing Bacteria from soil.
2. Isolation of Fungi from spoiled food.
3. Isolation of Antibiotic producing microorganisms against given pathogen.
4. Observation of Bacterial growth rate.
5. Estimation of Protein from the given source by Lowry's & Bradford method.
6. Estimation of Sugar from the given source.
7. Estimation of Vitamin C from Citrus fruits.
8. Estimation of Amino acid by Ninhydrin method.
9. Estimation of DNA & RNA.
10. Analysis of Protein by TLC, Paper Chromatography.
11. Isolation of Auxotrophic mutants.
12. UV mutagenesis.

REFERENCE BOOKS :

1. *Cappuccino*. 2005. **Microbiology: A Laboratory Manual**, Pearson Education.
2. *Joseph Sambrook, Michael R. Green*. 2012. **Molecular Cloning: A Laboratory Manual**. 4th edition. Cold Spring Harbor.
3. *Thomas R. Mertens and Robert L. Hammersmith*. 1997. **Genetics Laboratory Investigations**. 11th edition. Benjamin Cummings.
4. *Sadasivam, S. and Manickam, A*. 1996. **Biochemical Methods**, New Age International.

17PBT1EA	ELECTIVE - I: BIODIVERSITY	SEMESTER - I
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Total Credits: 4
Hours Per Week: 4

PREAMBLE:

To study the diversity and conservation of flora and fauna and to know the importance of biodiversity.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the nature, concept and definition of Biodiversity, conservation strategies.	K3,K4,K5
CO2	Focus on Plant Diversity and its conservation	K3,K4,K5
CO3	Highlight importance of Animal Diversity and its conservation	K3,K4,K5
CO4	To comprehend the importance of Microbial Diversity	K3,K4,K5
CO5	Familiarize with the Ethics of Biodiversity and its conservation	K3,K4,K5

1. Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	S
CO2	S	M	S	M	S
CO3	S	M	S	M	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

2. S-Strong; M-Medium; L-Low

17PBT1EA	ELECTIVE - I: BIODIVERSITY	SEMESTER - I
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Total Credits: 4
Hours Per Week: 4

UNIT - I

Biodiversity -Concept, Threats and Conservation

Basic concept of Biodiversity - What is Biodiversity, Why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity. Global patterns of Biodiversity - measuring biodiversity, Cataloging and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, and Migratory Species), GAP Analysis. Threats to biodiversity.

UNIT - II

Plant Biodiversity and Conservation

Status of Plant Diversity in India. Botanical Survey of India - Objectives, Roles and Responsibilities. Indian Herbaria. Indian Mangroves. Coastal Plant Diversity in India. Rare and endangered Plant species in India. Rare and endangered medicinal plants and their uses. Angiosperms of India. Plant diversity conservation - *In situ* and *ex situ* conservation. Botanical Garden. Museums.

UNIT - III

Animal Biodiversity and Conservation

Wild life Biodiversity of India. Rare and endangered Animal species in India. IUCN Red List India 2016. Animal diversity conservation - Project Elephant (PE), Project Tiger, Indian Crocodile Conservation Project,

Convention on International Trade in Endangered Species (CITES). National Parks, Wildlife Sanctuaries, Parks and Zoo. Animal Welfare Board of India. The Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA).

UNIT - IV

Microbial Biodiversity

Algal diversity in India, Fungal diversity in India, Lichen diversity in India, Bacterial diversity of various ecosystems - deep biosphere, icy biosphere, Fragile Ecosystem - deserts, semi-arid lands, mountains, wetlands, small islands and certain coastal areas.

UNIT - V

Ethics of Conservation

Values of Biodiversity, Biopiracy, Hybridized plants, GM crops (benefits & criticism), Economic Value of Biodiversity & Legal, Ethical and Conservation issues related to uses of biodiversity, Global Conservation Issues.

TEXT BOOKS:

1. *Krishnamurthy K V.*2003. **Textbook of Biodiversity.** 1st edition. Science Publisher.
2. *Narendran, T. C.* 2006. **An Introduction to Taxonomy.** Zoological Survey of India, Kolkata.
3. *Singh, G.*2008. **Plant Systematics: Theory and Practice.** Oxford & IBH Publishing Co. Pvt. Ltd.
4. *Joanne M. Willey, Linda M. Sherwood.* 2011. **Prescott's Microbiology.** 8th edition. McGraw Hill Education.

REFERENCE BOOKS:

1. *Negi, S.S.* 1993. **Biodiversity and its Conservation in India.** 1st edition. Indus Publishing Co.
2. *Mike J Jeffries.* 2006. **Biodiversity and Conservation.** 1st edition. Routledge.
3. *Michael I. Jeffery, Jeremy Firestone, Karen Bubna-Litic.* 2008. **Biodiversity Conservation, Law and Livelihoods.** 1st edition. Cambridge University Press.

17PBT1EB	ELECTIVE I: PROTEIN ENGINEERING	SEMESTER - I
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Total Credits: 4
Hours / Week: 4

PREAMBLE:

To understand the structure, functions, characteristics and designing of protein.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Learning and analyzing different characteristics and properties of proteins	K3, K4
CO2	Analyze in-depth structural knowledge of proteins	K3, K4
CO3	Enable to analyze interactions and characterization of proteins	K3, K4
CO4	Interpret the structural and functional relationship of proteins.	K4, K5
CO5	Applications, production/synthesis of de novo proteins and other proteins	K3, K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	S	S	M
CO3	S	M	S	S	M
CO4	S	M	S	S	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT1EB	ELECTIVE I: PROTEIN ENGINEERING	SEMESTER - I
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Total Credits: 4
Hours / Week: 4

CONTENTS

UNIT - I

Bonds and Energies in Protein Makeup

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Amino acids, their characteristics, molecular properties (size, solubility, charge, pKa). Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT - II

Protein Architecture

Primary structure, peptide mapping, peptide sequencing - Edman method. Secondary structures, super secondary structure, nucleotide binding folds, prediction of substrate binding sites. Tertiary structure, Domains, folding, denaturation and renaturation. Overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Ramachandran Plot.

UNIT - III

Elucidation and characterization of Proteins

Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Characterization of protein using NMR spectroscopy, x ray crystallography, spectroscopic and calorimetric methods.

UNIT - IV

Structure-function relationship of Proteins

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, *trp* repressor, Eukaryotic transcription factors, Zn fingers, helix-turn - helix motifs in homeodomain, Leucine zippers. Membrane proteins - characteristics, transmembrane segments. Bacteriorhodopsin and photosynthetic reaction center.

UNIT - V

Protein engineering and Designing

Overview, advantages, principles with specific examples: thermal stability, T4-lysozyme, recombinant insulin. Strategies for design of novel protein, production of *de novo* protein design. Computer methods in protein modeling. Understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis and other commercial applications.

TEXT BOOKS:

1. *Walsh, G.* 2014. **Proteins: Biochemistry and biotechnology.** 2nd edition. Wiley Blackwell. NJ, USA.
2. *Williamson, M.P.* 2012. **How Proteins Work.** Garland Science, NY, USA
3. *Carey, P.R.* 1996. **Protein Engineering and Design.** Academic Press, USA.
4. *Ponmurugan, P. and Ramya.M.* 2015. Protein Engineering. Narosa Publication, India.
5. *Craik, C.S., Cleland, J.L.* 1996. Protein Engineering: Principles and Practice. Wiley Blackwell, NJ, USA.

REFERENCE BOOKS:

1. *Voet D. and Voet G.* 2001. **Biochemistry**. 3rd Edition. John Wiley and Sons.
2. *Branden C. and Tooze J.* 1999. **Introduction to Protein Structure**. 2nd edition. Garland Publishing, NY, USA.
3. *Creighton T.E.* 1993. **Proteins**. 2nd Edition. Freeman WH.
4. *Moody P.C.E. and Wilkinson A.J.* 1990. **Protein Engineering**. IRL Press, Oxford, UK.

17PBT23A	IMMUNOTECHNOLOGY	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

PREAMBLE :

1. To study the mechanism of immune system.
2. To learn various detection methods of antigen-antibody and vaccine technology.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand about basic of immune response	K3
CO2	Know the antigen - antibody related test	K3
CO3	Learn about new generation of antibody production techniques	K3, K4, K5
CO4	Awareness on vaccine immunological types and its role in immune system	K3,K4,K5
CO5	Know about allergic reaction, tumour immunology and its affect on immune system	K3,K4,K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	M	S	S
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT23A	IMMUNOTECHNOLOGY	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

CONTENTS

UNIT - I

Cells and Organs of Immune system

History and scope of immunology. Types of Immunity: Passive, Active and Acquired immunity. Humoral, Cell Mediated immunity. Cells and organs of immune response and their functions. Antigens - Types, haptens, epitopes and Factors influencing antigenicity. Antibody - Structure, types, properties and functions. Immunoglobulin gene rearrangements.

UNIT - II

Antigen Antibody Reactions

Antigen - Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Agglutination reactions and Precipitation reactions. Immuno assays -Immuno Diffusion and Immunoelectrophoresis, RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance, Biosensor assays for assessing ligand -receptor interaction

UNIT - III

New Generation Antibodies

Antibody engineering; Hybridoma and monoclonal antibody (MCAb) techniques, Production of murine hybridoma, Production of MCAbs in cultures and animal (Ascites), Purification of MCAbs. Characterization of

MCAbs/ and Labelling of antibodies. Phage display libraries; Antibodies as *in vitro* and *in vivo* probes

UNIT - IV

Vaccine Technology

Rationale vaccine design based on clinical requirements: Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines.

UNIT - V

Hypersensitivity and Transplantation

Hypersensitivity - Mechanism and Types. Tumor immunology: tumor antigens, oncogenes, immune responses, detection of cancers and therapy-chemotherapy and radiation therapy. Transplantation Immunology.

TEXT BOOKS:

1. *Arvind Kumar*. 2013. **Textbook of Immunology**. TERI Publisher.
2. *Seemi Farhat Basir*. 2012. **Textbook of Immunology**. 2nd edition. Phi learning pvt. Ltd- New Delhi.
3. *Nandini Shetty*. 2005. **Immunology: Introductory Textbook**. 2nd edition. Newage Publishers.
4. *Ramesh*. 2016. **Immunology**. 1st edition. McGraw Hill Education India Private Limited.

REFERENCE BOOKS :

1. *F.C. Hay, O.M.R. Westwood.* 2002. **Practical Immunology**, 4th Edition, Blackwell Publisher.
2. *Ed Harlow, David Lane.*1988. **Antibodies Laboratory Manual**, Cold Spring Harbor, Laboratory Press.
3. *Janis Kuby.* 1997. **Immunology**. WH Freeman& Company, New York.
4. *Ivan Riot.* 1988. **Essentials of Immunology**. 6th edition. Blackwell Scientific Publications, Oxford.
5. *Harlow and David Lane.* 1988. **Antibodies A laboratory Manual**. Cold spring Harbor laboratory Press.

17PBT23B	GENETIC ENGINEERING	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

PREAMBLE:

1. To learn various types of vector host systems and steps in creating rDNA molecule.
2. To gain knowledge on various recombinant DNA techniques and their applications.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the steps in recombinant DNA preparation and labeling	K3,K4
CO2	Explain the features of various types cloning vectors for bacteria, yeast , animals and plants	K3, K4
CO3	Understand the methods of gene transfer and hybridization	K3,K4
CO4	Describe various molecular techniques and its applications	K4, K5
CO5	Knowing different types of sequencing and gene therapy	K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	S
CO4	S	S	S	S	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT23B	GENETIC ENGINEERING	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

CONTENTS

UNIT - I

Basics concepts

Genetic engineering - Overview and scope. Steps involved in recombinant DNA constructions, enzymes involved in genetic engineering, role of linkers, adaptors and Homopolymer tailing. Selectable and Screenable markers. Labeling of DNA - Nick translation, Random priming, Radioactive and non-radioactive probes.

UNIT - II

Cloning Vectors

Plasmids -pBR322 and pUC vectors, Bacteriophage vectors - M13 vectors, Lambda vectors (Insertion and Replacement vectors), Phagemids, Cosmids, Yeast vectors, Shuttle vectors, Animal Viral vectors - SV-40, baculo & retroviral vectors, Expression vectors - pMal, GST and pET-based vectors, Plant vectors -Ti and Ri. Artificial chromosome vectors (YACs; BACs).

UNIT - III

Cloning Methodologies

Introduction of cloned genes into cell - transformation, particle bombardment, liposome mediated transfer, electroporation, microinjection and calcium phosphate mediated transfer. Construction of cDNA and genomic libraries. Hybridization techniques - Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization, South western and Far-western cloning.

UNIT - IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes, DNA polymerases, PCR and Types - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, PCR in gene recombination, Site specific mutagenesis, PCR in molecular diagnostics, PCR based mutagenesis, Mutation detection - SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

UNIT - V

Gene silencing and Therapy

DNA sequencing- Chain termination method and NGS. Gene silencing techniques - Introduction to siRNA, siRNA technology, Micro RNA, Construction of siRNA vectors, Principle and application of gene silencing. Gene knockouts and Gene Therapy - Creation of knockout mice, Disease model, Somatic and germ-line therapy (*in vivo* and *ex-vivo*), Suicide gene therapy, Gene replacement, Gene targeting.

TEXT BOOKS :

1. *Brown, T. A.* 1998. **Introduction to Gene Cloning.** 3rd edition. Stanley Thornes Publishing Ltd.
2. *Primrose, S. B.* 2003. **Principles of Gene Manipulation.** 6th edition. Blackwell Science Ltd.
3. *Ernst, L. Winnacker.* 2003. **From Genes to Clones.** 2nd edition. Panima Publishing Corporation.
4. *James, D. Watson.* 2001. **Recombinant DNA technology.** 2nd edition. WH Freeman and company.

REFERENCE BOOKS :

1. *Bernard R. Glick, Jack J. Pasternak.* 2010. **Molecular Biotechnology: Principles and Applications of Recombinant DNA**, ASM press, U.S.A
2. *Singh, B.D.* 2008. **Text book of Biotechnology**, Fourth Edition, Kalyani Publishers, New Delhi.
3. *J. Sambrook and D.W. Russel.* 2001. **Molecular Cloning: A Laboratory Manual**, Vols 1-3, CSHL.
4. *Snustad D. P. And Simmons M. J.* 2015. **Principles of Genetics**, 7th edition. John Wiley & Sons.

17PBT23C	MICROBIAL BIOTECHNOLOGY	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

PREAMBLE:

1. To recognize the fundamentals of Microbial Biotechnology and to analyze the bioprocess paradigm
2. Development of Microbial products and their regulations.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the concepts, History and scope of Microbial biotechnology	K3,K4
CO2	Acquire information about types of Fermentation and their mechanism	K3, K4
CO3	Recent development in microbial product production like organic acids, probiotics, vitamins and health care products.	K4, K5
CO4	Learning about microbes in agriculture field and bioprospecting	K4, K5
CO5	Concept and regulatory mechanism of finished products and quality management, GMP regulations.	K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	S	M	M
CO3	S	S	S	M	M
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT23C	MICROBIAL BIOTECHNOLOGY	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

CONTENTS

UNIT - I

History and scope of Microbial biotechnology

Basic principles of microbial biotechnology. Strategies for Microbial product development - Microbial biomass, enzymes, metabolites, recombinant products, transformation process. Upstream and Downstream processing. Isolation, screening and maintenance of industrially important microbes; Strain improvement for increased yield and other desirable characteristics.

UNIT - II

Fermentation - Types of fermentations

Aerobic and anaerobic fermentation, Submerged and solid state fermentation. Basic structure and types of fermentor. Submerged fermentation types - Batch, continuous and fed batch - CSTR, Tower fermenter, Jet loop, Air lift, Bubble column, Packed bed. Solid state fermentation types - Tray fermenter, Column fermenter, and Drum fermenter. Factors affecting submerged and solid state fermentation. Fermentation kinetics- Rheological properties of the medium, Theory of mixing. Mass transfer coefficient(K_LA).

UNIT - III

Microbial Products

Organic acids (Citric acid, Lactic acid and Acetic acid), aminoacids (Glutamic acid, lysine and Tryptophan), probiotics, healthcare products

(β Lactam Antibiotics, Peptide antibiotics, Vitamin B₁₂ and Riboflavin) and edible biomass.

UNIT - IV

Microbes in Agribiotechnology

Biofertilizer, Bio-inoculants manufacture. Biopreservation of food and feed by postharvest biocontrol with microorganisms. Microbial control of plant diseases. Safety and regulation of microbial control of weeds. Plant growth promotion with microorganisms. OECD guidelines and harmonization for microbial control agents. Understanding public risk perception for the use of beneficial microorganisms

UNIT - V

Finished Product Guidelines

Testing - Writing product specifications - Conditions and options for finished product testing, distributors - product storage - packaging, distribution. Definition of GMP, Principles and Importance of GMP, Quality management, Personnel, Risk management, Quality control, Documentation, Inspections. GMP regulations - USFDA, Europe, Japan, ICH, PICS/S, WHO.

TEXT BOOKS :

1. *Stanbury, A. H., Whittaker, A and Hall, S. J.* 1995. **Principles of fermentation Technology**. 2nd edition. S.J. Pergamon Press.
2. *El-Mansi, E.M.T, Bryce, C. F., A, Arnold L. Demain, and Allman, A.R.* 2011. **Fermentation Microbiology and Biotechnology**. 3rd edition. CRC Press.

3. GMP manual: Good manufacturing practices and implementation, http://www.gmppublishing.com/media/ebooks/flyer/files/gmp_manual_eu_4c_online.pdf.
4. *Prescott, L. M. Harley, J. P. and Klein, D. A.* 1999. **Microbiology**, International edn. 4th edn. WCB Mc Graw-Hill.

REFERENCE BOOKS:

1. *Pelczar MJ Jr., Chan ECS and Kreig NR.,* 1993. **Microbiology**, 5th Edition, Tata McGraw Hill, New Delhi.
2. *Crueger and A Crueger,* 1990. (English Ed., TDW Brock); **Biotechnology: A textbook of Industrial Microbiology**, Sinaeur Associates.
3. *G Reed, Prescott and Dunn's,* 1987. **Industrial Microbiology**, 4th Edition, CBS Publishers.
4. *Patel A H.* 2008. **Industrial Microbiology**. PB Books.
5. <http://www.cabi.org/bookshop/book/9781845938109>

17PBT23D	GENOMICS AND PROTEOMICS	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

PREAMBLE:

1. To know the scope of Bioinformatics
2. Focus on Protein and Genome analysis using Bioinformatics tools

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand about Bioinformatics and Databases	K3, K4
CO2	Data interpretation using Alignment Algorithms	K3, K4
CO3	Highlight Genome Analysis and Principles of Docking	K3, K4, K5
CO4	Learning Proteome analysis, tools and databases available	K3, K4, K5
CO5	Concept of pharmacogenomics and other omics along with their applications	K3, K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	S	M	M
CO3	S	S	S	S	M
CO4	S	S	S	S	M
CO5	S	S	S	S	M

S-Strong; M-Medium; L-Low

17PBT23D	GENOMICS AND PROTEOMICS	SEMESTER - II
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Total Credits: 4
Hours / Week: 5

CONTENTS

UNIT - I

Bioinformatics and Databases

Bioinformatics - Introduction and History. Biological Databases. Primary and secondary databases with examples. Data generation - large scale molecular biology data - Genome sequencing, BIOSEQ. Protein sequencing, Nucleic acid sequence databases: Gene bank, Protein sequence databases - Swiss-Prot, PDB, PIR. Rasmol - Molecular modeling. Steps to retrieve sequence and structure of a protein. Applications of Bioinformatics.

UNIT - II

Genomics

Introduction and classification of genomics. Sequencing of genomes and sequencing methods (next-generation sequencing). General/main databases of genomes. Structure, organization and composition of prokaryotic genomes. Microbial genomics and genome epidemiology. Metagenomics and methods of Metagenomics.

UNIT - III

Genome Analysis and Docking

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, Fragment Assembly- ESTs and genomic fragments, Mapping, Annotation, Gene predictions. Codon optimization tools and its advantages.

Bioinformatics of Microarray and its applications. Gene Expression Profiling. GENSCAN. Molecular docking principles, molecular dynamic simulation.

UNIT - IV

Tools in Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); Proteomics classification. 1D-SDS-PAGE and 2D-SDS PAGE. Detection and quantitation of proteins in gels. Pros and cons of various staining methods. Basics of mass spectrometry. MALDI - TOF and ESI and their application in proteomics. Tandem MS/MS spectrometry - Peptide sequencing by tandem mass spectrometry - Affinity purification of protein - TAP tag.

UNIT - V

Pharmacogenomics and other omics

High throughput screening in genome for drug discovery-identification of gene targets Pharmacogenetics; Pharmacogenomics - classical and non-classical. Pharmacogenomics of genetic diseases e.g. hypertension and Cancer - case study. Metabolomics - techniques involved. Nutrigenomics and its applications. Other omics - lipidomics, transcriptomics, metagenomics, toxicogenomics, venomics and its applications. Basics of CADD, its importance.

TEXT BOOKS:

1. *Rao, S. D.* 2010. **Bioinformactis.** Biotech Pharma Publications, India.
2. *Pevsner, J.* 2015. **Bioinformatics and Functional Genomics.** 3rd edition. Wiley Blackwell Publications.
3. *Hubbard, S.J. and Jones, A.R.* 2010. **Proteome Bioinformatics.** Springer Protocols.
4. *Lesk, A.M.* 2014. **Introduction to Bioinformatics.** Oxford Publications.
5. *Baxevanis, A.D. and Ouellette, B.F.F.* 2004. **Practical Guide to Analysis of Genes and Proteins.** 3rd edition. Wiley Jone and Sons.

REFERENCE BOOKS:

1. *Campbell, A.M. and L. J. Heyer.* 2007. **Discovering Genomics, Proteomics and Bioinformatics.** 2nd edition. Pearson Education.
2. *Tramontano A.* 2005. **The Ten Most Wanted Solutions in Protein Bioinformatics.** 1st edition. CRC Press.
3. *Womble D D, Krawetz S A.* 2003. **Introduction to Bioinformatics.** Humana Press.
4. *Heyer L J and Campbell A M.* 2002. **Discovering Genomics, Proteomics and Bioinformatics.** Benjamin/Cummings Publisher

17PBT23P	CORE PRACTICAL- II: APPLIED BIOTECHNOLOGY - I	SEMESTER - II
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Total Credits: 3
Hours / Week: 6

CONTENTS

1. Total RBC and WBC count
2. Immunodiffusion - Single and Double
3. Rocket Immuno electrophoresis
4. Western Blotting
5. Isolation of genomic DNA from plant
6. Isolation of genomic DNA from bacteria
7. Isolation of genomic DNA from animal tissue
8. Isolation of Plasmid DNA
9. Elution of DNA from Agarose gel
10. Bacterial Transformation
11. PCR
12. Restriction digestion
13. Ligation
14. Wine making
15. Production, purification and assay of extra cellular enzyme.

REFERENCE BOOKS :

1. *Olivier Cochet, Jean-Luc Teillaud, Catherine Sautes Wiley. 1998. Immunological Techniques Made Easy. 1st edition. John Wiley & Son Ltd.*
2. *S. Ignacimuthu. 2001. Methods in Biotechnology. 1st edition. Phoenix publishing house.*

17PBT2EA	ELECTIVE- II: BIOPROSPECTING	SEMESTER - II
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Total Credits: 4
Hours / Week: 4

PREAMBLE :

1. To Learn various methods of Bioprospecting.
2. To study about potentials of Bioprospecting

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Focus on Major areas of Bio-prospecting	K3, K4
CO2	Comprehend knowledge on Natural products from plants	K3, K4
CO3	Elucidate Screening for bioactive Compounds	K3, K4, K5
CO4	Highlight Drug discovery and product development	K4, K5
CO5	To understand Regulatory legislation and convention in Bioprospecting	K3, K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	S	M	M	M
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT2EA	ELECTIVE- II: BIOPROSPECTING	SEMESTER - II
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Total Credits: 4
Hours / Week: 4

CONTENTS

UNIT - I

Major areas of Bio-prospecting

Chemical prospecting, Bionic prospecting and Gene prospecting. Bioresources mapping, inventorisation and monitoring of biological diversity. Biodiversity - conservation biology, endangered species. The convention on biological diversity and benefic sharing, historical context of present bioprospecting, biodiversity prospecting - the INBio experiences, contracts for bioprospecting, natural products research partnerships with multiple objectives in global diversity hotspots.

UNIT - II

Natural products from plants

Volatile, pigments and biosynthesis of terpenes, Phenols, nitrogenous compounds and their role. Drugs derived from plants, Antitumor agent - Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotonic- Convallatoxin, Acetyldigoxin, Adoniside, Antiinflammatory-Aescin, Bromelain, Choleric - Curcumin. QuinineCinchona-Antimalarial Morphine-Opium plant- analgesic.

UNIT - III

Screening for bioactive Compounds

Antimicrobials, pharmacologically active agents of microbial origin, bioprospecting for industrial enzymes, plant growth promoting agents, biotreatment, bioprospecting novel antifoulants and anti-biofilm agents

from microbes. Extinction and the loss of evolutionary history. Biofuels. Bioprospecting of marine organisms.

UNIT - IV

Drug discovery and product development

Discovery from traditional medicine. Modern tools in drug discovery
Role of chromatography in drug analysis including HPLC, GC - LC and GC Mass spectrometry, FTIR, NMR their principles and merits. Product development procedures and policies.

UNIT - V

Regulatory legislation and convention in Bioprospecting

Rules and regulations in patenting of products. Process development and various conventions pertaining to Bioprospecting of products from microorganism, plant and animal products. Bioprospecting policies. Approval and IPR , protection policies of Bioprospecting.

TEXT BOOKS :

1. *Alan T. Bull.*2004. **Microbial Diversity and Bioprospecting.** ASM Press.
2. *Judith A. Scheppler, Patricia E. Cassin and Rosa M. Gambier.* 2000. **Biotechnology explorations: Applying the fundamentals.** American Society for Microbiology.
3. *Purkayastha Jubilee.* 2016. **Bioprospecting of Indigenous Bioresources of North East India.** 1st Edition. Springer Singapore.

REFERENCE BOOKS:

1. *Londa Schiebinger*. 2007. **Plants and Empire - Colonial Bioprospecting in the Atlantic World**. 1st Edition. Harvard University Press.
2. *Vanessa Sunkel*. 2010. **Marine Bioprospecting and Natural Product Research**. LAP Lambert Academic Publishing.
3. *Russell Paterson, Nelson Lima*. 2017. **Bioprospecting - Success, Potential and Constraints**. Springer International Publishing

17PBT2EB	ELECTIVE- II : PRINCIPLES CLINICAL TRAILS	SEMESTER - II
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Total Credits: 4
Hours / Week: 4

PREAMBLE:

To learn about the guidelines in Clinical trials and its regulations.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the Pre and Post Clinical Studies	K3, K4
CO2	To understand about the regulations and guidelines in clinical research	K4,K5
CO3	Understand the concepts about clinical research on Humans	K3,K4
CO4	Know the protocols and Standardization methods	K4,K5
CO5	Comprehend information's regarding clinical trials	K4,K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	M	M	S
CO3	S	M	S	S	S
CO4	S	M	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT2EB	ELECTIVE- II : CLINICAL TRAILS	SEMESTER - II
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Total Credits: 4
Hours / Week: 4

CONTENTS

UNIT - I

Pre and Post Clinical Studies

Introduction to Pharmaceutical Industry, Preclinical studies - Preclinical technology, Chemistry manufacturing and controls/Pharmaceutics Pharmacology/Toxicology. Phase I, Phase II A and B, Phase III A and B, Phase IV and Types of Post marketing surveillances.

UNIT - II

Regulations and Guidelines

History of GCP, FDA Regulations for Clinical Trials, ICH Guidelines for Good Clinical Practice, FDA Guidelines and Information Sheets, FDA Compliance Program Guidance Manuals, NIH Regulated Research, FDA Bioresearch Monitoring Program (BIMO), Good Clinical Practice (GCP).

UNIT - III

Clinical Research on Humans

Ethical Guidelines for Biomedical Research in Human Subjects, Central Ethics committee on Human Research (CECHR), ICMR-2000, Clinical research regulation DCGI.

UNIT - IV

Organizational chart

GCP Guidelines, Central Drugs Standardization and Control Organization, Government of India, Schedule Y.

UNIT - V

Clinical Trials

Sponsor's responsibilities, Essential documentation and Investigator's Brochure, Protocol design, CRF design, Informed Consent Documents - Subject Information Sheet and Informed Consent Form, Ethics Committee Approvals.

TEXT BOOKS:

1. *Allan Hackshaw*. 2009. **A Concise Guide to Clinical Trials**. 1st edition. Wiley Publishers.
2. *Richard Chin* and *Bruce Y. Lee*. 2008. **Principles and Practice of Clinical Trial Medicine**. 1st edition. Academic Press.

REFERENCE BOOKS:

1. *Sandy Weinberg*. 2009. **Guide Book for Drug Regulatory Submissions**. 1st edition. *John Wiley & sons* .
2. *Haynes, R.B., Sackett, D.L., Guyatt, G.H.,and Tugwell, P.* 2005. **Clinical Epidemiology: How to Do Clinical Practice Research**. 3rd edition. Lippincott- Williams and Wilkins.

17PBT33A	PLANT BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

PREAMBLE:

- To understand the various *in vitro* culture techniques
- Gains knowledge on Preservation of plant cells
- Familiarity to Gene transferring mechanisms

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Review the culture media types and the role of different media constituents	K3
CO2	Understand the plant genome organisation	K3, K4
CO3	Imparts knowledge on Agrobacterium biology and transgenesis technology	K3, K4, K5
CO4	Focuses on various types of resistance and green house technology	K4, K5
CO5	In depth understanding of Secondary metabolites and its applications	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	M	M
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	S	S	S	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT33A	PLANT BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

CONTENTS

UNIT - I

Plant Tissue culture

Media, Micropropagation: Callus and suspension culture, somoclonal variation, somatic embryogenesis: Embryo culture, protoplast isolation and somatic hybridization; Haploid plants, Artificial seeds and hardening.

UNIT - II

Genome organization

Nuclear genome, chloroplast genome, mitochondrial genome, CMS, Protein targeting to chloroplast and mitochondria, Heat shock proteins, seed storage proteins.

UNIT - III

Plasmids, Vectors and Nuclear Transformation

Features of Ti and Ri plasmids, uses of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, viral vectors, use of reporter genes, Transgenic biology - methods of nuclear transformation - physical, chemical and biological gene transfer methods in plants.

UNIT - IV

Plant Resistance

Engineering of plants for herbicide resistance, insect resistance, virus resistance, disease resistance, antifungal proteins, nematode resistance, abiotic stress, long shelf life of fruits and flowers. Green house and green - home technology.

UNIT - V

Metabolic Pathways

Secondary metabolic pathways in plants. Extraction & purification of phyto-chemicals. Industrial phytochemical products from plants- Alkaloids, Biodegradable Plastics, Therapeutic proteins, antibodies, plant vaccines, herbal drugs, bioethanol and biodiesel.

TEXTBOOKS:

1. *Singh, B.D.* 2006. **Plant Biotechnology** . 1st edition. Kalyani Publishers.
2. *Chawla, H. S.* 2013. **Introduction to Plant Biotechnology**. 3rd edition. Oxford & IBH publishing company.

REFERENCE BOOKS:

1. *Grierson, D. and Covey, S.V.* 1988. **Plant Molecular Biology**. 2nd edition. Blackie Publishers.
2. *Bhojwan, S. S.* 1996. **Plant tissue culture - Theory and Practice**. 1st edition. Elsevier Publishers.

17PBT33B	ANIMAL BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

PREAMBLE:

The students will be able to understand the

- Various *in vitro* culture techniques
- Preservation of animal cells
- Gene transferring mechanisms

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Review the culture media types and the role of different media constituents	K3
CO2	Learn the technique of tissue and organ culture and the applications of the culture products	K3
CO3	Imparts knowledge on cell line maintenance and cryopreservation	K3, K4, K5
CO4	Focuses on scale up of animal cell culture	K4, K5
CO5	In depth understanding of Tissue engineering and its applications	K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	M	M
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	S	S	S	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT33B	ANIMAL BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

CONTENTS

UNIT - I

Animal cell culture media and its constituents

Structure and organization of Animal cells - Culture media; Balanced salt solutions and simple growth medium, Physical, chemical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum, growth factors, glutamine in cell culture; Serum and protein free defined media and their applications.

UNIT - II

Tissue and organ culture

Advantages and limitations of Tissue and organ culture - medical/pharmaceutical products of animal cell culture-genetic engineering of animal cells and their applications. Risks in a tissue culture laboratory and safety - biohazards. Facilities for animal cell culture-infrastructure, equipment, culture vessels.

UNIT - III

Cell culture techniques and cryopreservation

Primary cell culture techniques - mechanical disaggregation, enzymatic disaggregation, separation of viable and non-viable cells. Mass culture of cells - manipulation of cell line selection - types of cell lines - maintenance of cell lines - immobilization of cells and its application - synchronization of cell cultures and cell division. cryopreservation - germplasm conservation.

UNIT - IV

Animal cell culture scale up

Scale up in suspension - stirrer culture, continuous flow culture, air-lift fermentor culture; Scale up in monolayer - Roller bottle culture, multisurface culture, multiarray disks, spirals and tubes - monitoring of cell growth. Organ culture - whole embryo culture - specialized culture techniques - measurement of cell death.

UNIT - V

Tissue engineering

Design and engineering of tissues - tissue modeling. Embryonic stem cell engineering - ES cell culture to produce differential cells - Human embryonic stem cell research. Transgenic animals-transgenic animals in xenotransplantation

TEXT BOOKS:

1. *M.M. Ranga, 2000. Animal Biotechnology.* Agrobios, India.
2. *Satyanarayana, U., 2006. Biotechnology.* Books and Allied (P) Ltd.
3. *D.C.Darling and S.J.Morgan, 1994. Animal Cells Culture and Media.* BIOS , Scientific Publishers Limited.

REFERENCE BOOKS:

1. *Jennie P.Mathur and David Barnes, 1998. Methods in Cell Biology.* Volume 57, Animal Cell Culture Methods Academic Press.
2. *Ann Harris, 1996. Epithelial Cell Culture.* Cambridge University Press

17PBT33C	ENVIRONMENTAL BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

PREAMBLE:

This subject will provide the information about the

- Basic vocabulary of environmental biology
- Hazards of industrial pollutants on environment
- Effect of pollution on biodiversity

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Review on the organization of ecosystem and its functions	K3
CO2	Understand the global environment problems and the hazards of pollution	K3, K4
CO3	In depth understanding of waste water treatment and Vermicomposting	K3, K4, K5
CO4	Imparts knowledge on Xenobiotics and bioremediation methods	K4, K5
CO5	Create awareness on environmental monitoring and environmental laws	K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	S	S	S	S
CO3	S	S	S	S	M
CO4	S	M	S	M	S
CO5	M	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT33C	ENVIRONMENTAL BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 5

Hours / Week: 5

CONTENTS

UNIT - I

Ecosystem structure and functions

Abiotic and biotic components, Energy flow, food chain, food web and trophic levels, Ecological pyramids, N,P,C and S cycles in nature. Threats to environment (Pollutions, waste materials and Xenobiotics). Effect of environment on human genome. Effect of human activities on environment (Bioaccumulation and Biomagnification)

UNIT - II

Hazards of Pollution

Types of pollution (Water, Land, Air, Noise and Nuclear), Methods for the measurement of pollution, Global environmental problems: ozone depletion, UV-B, green house effect and acid rain.

UNIT - III

Waste water Treatment

Physical, Chemical, Biological treatment system. Solid waste pollution and its management: Current practice of solid waste management, composting systems, vermicomposting. Biomedical waste management: Current status of biomedical waste management.

UNIT - IV

Xenobiotics and Bioremediation

Xenobiotics in Environment - Biodegradation of Hydrocarbons, Substituted hydrocarbons, Pesticides, Lignin, Synthetic dyes. Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation. Bioabsorption and Bioleaching of heavy metals (Mercury and Lead), advantages and disadvantages of bioleaching.

UNIT - V

Environmental Monitoring and Impact Assessment

Biological monitoring program, bioindicators and environmental monitoring, environmental management. Environmental Laws: Problems in making and implementing environmental laws, Indian environmental laws, national environmental policy.

TEXT BOOKS:

1. *Prohit. S.S.* 2003. **Ecology and environment and pollution.** 1st edition. Agrobios publications.
2. *Varma. P.S.* 1998. **Concept of ecology.** 1st edition. Chand & Co Ltd.

REFERENCE BOOKS:

1. *Dash. M.C.* 1998. **Fundamentals of Ecology.** 2nd edition. Tata McGraw Hill.
2. *Alan Scragg.* 2007. **Environmental biotechnology.** 2nd edition. Oxford university press.

17PBT33D	MOLECULAR THERAPEUTICS	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

PREAMBLE:

- To study about the types of PCR and its applications in diagnosis
- To learn about the human genome project

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Review on the process of drug targeting and gene therapy	K3
CO2	Understand the current techniques of gene delivery and other therapeutic products	K3, K4
CO3	Imparts knowledge on recombinant gene therapy	K3, K4, K5
CO4	Focus on pathogenic diseases and metabolic disorders	K4, K5
CO5	In depth understanding of immunotherapy and its applications	K3, K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	M	M	M	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT33D	MOLECULAR THERAPEUTICS	SEMESTER - III
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Total Credits: 5
Hours / Week: 5

CONTENTS

UNIT - I

Concepts of Gene Therapy and Drug Delivery

Gene Therapy, Drug targeting and drug delivery system. Intracellular barriers to gene delivery, overview of inherited and acquired diseases for gene therapy, virus mediated gene transfer.

UNIT - II

Gene delivery and Tissue engineering

Liposome and Nanoparticles mediated gene delivery, cellular therapy, Concept of tissue engineering, role of scaffolds. HIV diagnostics and treatment.

UNIT - III

Recombinant Gene therapy

Recombinant therapy, Clinical application of recombinant technology, Erythropoietin, insulin analogs and its role in diabetes, Recombinant human growth hormone, streptokinase and urokinase in thrombosis.

UNIT - IV

Microbial Pathogenicity and Metabolic Disorders

Factors predisposing to microbial pathogenicity, types of infectious diseases. General concept of infectious disease, metabolic disorders and their diagnosis.

UNIT - V

Immunotherapy

Phage and their application, Immunotherapy, Monoclonal antibodies and their role in cancer, role of recombinant interferons, Immunosuppressors in organ transplants, role of cytokine therapy in cancer.

TEXT BOOKS:

1. *Bernhard Palsson and Sangeeta N Bhatia, 2004. Tissue Engineering. 2nd Edition, Prentice Hall,*
2. *Pamela Greenwell, Michelle McCulley, 2008. Molecular Therapeutics: 21st century medicine. 1st Edition, Springer,*
3. *Lele Buckingham and Maribeth L. Flaws, 2007. Molecular Diagnostics: Fundamentals, Methods & Clinical applications. First Edition, F.A. Davis Company.*

REFERENCE BOOKS:

1. *W.B. Coleman, 2006. Molecular Diagnostics for the Clinical Laboratorian. 2^{Ed}. Humana Press.*
2. *D. G. B. Leonard, 2007. Molecular Pathology in Clinical Practice. Second Edition. Springer International Publishing.*

17PBT33P	CORE PRACTICAL - III: APPLIED BIOTECHNOLOGY - II	SEMESTER - III
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**Total Credits: 3
Hours/Week: 6**

1. *In vitro* Seed Germination
2. Micropropagation
3. Meristem culture
4. Callus induction
5. Artificial Seed production
6. Suspension cultures
7. Embryo culture
8. Protoplast Isolation
9. Preparation of primary cell culture
10. Trypsinizing and subculturing cells
11. Determining cell number and viability with a haemocytometer and try pan blue staining
12. Water Quality analysis-Colour, pH, Acidity
13. MPN Test
14. Total hardness by EDTA titrimetric method
15. Estimation of Total alkalinity, carbonate and bicarbonate
16. Determination of Chemical oxygen demand
17. Screening for dye decolourisation by bacteria/ fungi

REFERENCE BOOKS:

1. Sant Saran Bhojwani, Razdan, M. K. 1996. **Plant tissue culture: theory and practice**. 1st edition. Elsevier science.
2. Freshney, R. I. 2010. **Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications**. 6th edition. Wiley Blackwell.
3. Choudhary, S. S, Choudhary, P. and Choudhary, S.K. 2005. **Laboratory guide in biosciences**. 2nd edition. Kalyani publishers.

17PBT3EA	ELECTIVE - III: TISSUE ENGINEERING AND BIOIMPLANT TECHNOLOGY	SEMESTER - III
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Total Credits: 4
Hours / Week: 4

PREAMBLE:

- To study the Bioimplant Technology
- To learn about the applications of Tissue Engineering

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Review the process of cell architecture and cell division	K3
CO2	Understand the membrane architecture and signaling molecules	K3, K4
CO3	Imparts knowledge on the mode of DNA replication and repair mechanisms	K3, K4, K5
CO4	In depth understanding of transcriptional events and its role in gene regulation	K4, K5
CO5	Focus on translational events and its role in gene expression	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	M
CO2	M	M	S	S	S
CO3	S	M	S	S	S
CO4	M	S	S	S	S
CO5	M	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT3EA	ELECTIVE - III: TISSUE ENGINEERING AND BIOIMPLANT TECHNOLOGY	SEMESTER - III
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**Total Credits: 4
Hours / Week: 4**

CONTENTS

UNIT - I

Structural and Organization of Tissues

Introduction, Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and *in-vitro* testing. Cell culture- Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors.

UNIT - II

Molecular biology of the Cell

Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

UNIT - III

Biomaterials and Scaffolds

Introduction, Criteria of modifying biomaterials as tissue engineering scaffolds, Properties and types of scaffolds, Different methods employed in the synthesis of scaffolds, animal cell biology, stem cells, organization of cells into tissues, tissue microenvironment, tissue injury and wound healing 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver.

UNIT - IV

Tissue Engineering

Basic immunology, response of body to foreign materials. Animal cell culture on scaffolds, consequences, optimization strategies and important considerations for Skin, Liver, Bone, Cartilage, Nerve and Vascular tissue engineering;

UNIT - V

Ethical and Regulatory Issues

Case study and regulatory issues-cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering, Dental and Otologic Implants. Ethical, FDA and regulatory issues.

TEXTBOOKS:

1. *Bernhard Palsson, Sangeeta Bhatia* , 2003. **Tissue Engineering**. Pearson Prentice Hall.
2. *Robert. P.Lanza, Robert Langer & William L. Chick*, 1997. **Principles of tissue engineering**. Academic press.
3. *Gordana Vunjak-Novakovic, R. Ian Freshney*, 2006 .**Culture of Cells for Tissue Engineering**. WIS.

REFERENCE BOOKS:

1. *B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino*. **Tissue Engineering**. CRC Taylor & Francis.
2. *Joseph D., Bronzino*, 2006. **The Biomedical Engineering –Handbook**. CRC; 3rd edition.

17PBT3EB	ELECTIVE - III: STEM CELL TECHNOLOGY	SEMESTER - III
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**Total Credits: 4
4 Hours / Week**

PREAMBLE:

- To study the types of Stem cells
- To learn about the applications of Tissue Engineering

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Know the process of stem cell and storage	K3
CO2	Understand the stem cell importance in plants	K3, K4
CO3	Imparts knowledge on the stem cells in animals	K3, K4, K5
CO4	In depth understanding of haemopoietic stem cell	K4, K5
CO5	Focus on stem cell therapies and its application	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	S
CO4	S	S	M	M	M
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT3EB	ELECTIVE-III: STEM CELL TECHNOLOGY	SEMESTER - III
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**Total Credits: 4
Hours / Week: 4**

CONTENTS

UNIT - I

Stem Cells and Cellular Pedigrees

Scope of stem cells - definition of stem cells - concepts of stem cells - differentiation , maturation , proliferation , pluripotency, self - maintenance and self - renewal - problems in measuring stem cells - preservation protocols.

UNIT - II

Stem Cell Concept in Plants

Stem cell and founder zones in plants - particularly their roots - stem cells of shoot meristems of higher plants.

UNIT - III

Stem Cell Concept in Animals

Skeletal muscle stem cell - Mammary stem cells - intestinal stem cells - keratinocyte stem cells of cornea - skin and hair follicles - Tumour stem cells, Embryonic stem cell biology - factors influencing proliferation and differentiation of stem cells - hormone role in differentiation.

UNIT - IV

Haemopoietic Stem Cell

Biology - growth factors and the regulation of haemopoietic stem cells.
Hematopoietic stem cell niche, Embryonic stem cell-derived Hematopoietic stem cells. Cord blood hematopoietic stem cells- Cord

blood transplantation Characteristics of cord blood stem cells Genomics and proteomics of cord blood stem cells

UNIT - V

Potential Uses of Stem Cells

Cellular therapies - vaccines - gene therapy - immunotherapy - tissue engineering - blood and bone marrow - Fc cells. Stem cells for the treatment of muscular dystrophy- Cellular environment of a dystrophic muscle, Myogenic stem cells from embryonic stem cells and inducible pluripotent stem cells.

TEXT BOOKS:

1. *CS Potten* , 1997. **Stem cells**. Elsevier.
2. *Robert Paul Lanza* , 2006. **Essentials of stem cell biology**. 2nd edition. Academic Press;

REFERENCE BOOKS:

1. *Song Li, Nicolas L'Heureux, Jennifer Elisseeff*. 2011. **Stem Cell and Tissue Engineering**. 1st edition. World Scientific Publishers.
2. *Robert Lanza, John Gearhart, Brigid Hogan*. 2006. **Essentials of Stem Cell Biology**. 2nd edition. Macmillan Publishing Solutions.

17PBT43A	RESEARCH METHODOLOGY	SEMESTER - IV
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Total Credits: 5
Hours / Week: 5

PREAMBLE:

The student will understand the

- Basic concepts of research and its methodologies
- Identify appropriate research topics
- Basic theory, philosophy and application of statistics

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Know the process of thesis writing	K2, K3
CO2	Understand the result interpretation and report presentation process	K3, K4
CO3	Imparts knowledge on the publication process in the basic and reputed journals	K3, K4, K5
CO4	In depth understanding of basic sampling methods and error calculation	K4, K5
CO5	Focus on basic Statistical analysis related to thesis work	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	M	M	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT43A	RESEARCH METHODOLOGY	SEMESTER - IV
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Total Credits: 5
5 Hours / Week

CONTENTS

UNIT - I

Introduction to Research

Research/Experimental design, Literature collection, Literature citation, Research report: components, Format of thesis and dissertation, Manuscript/research article, Review monographs, Bibliography and Reference, Significance of research.

UNIT - II

Reports

Reporting the results of research in conference - Oral presentation - Poster presentation - Written reports - Planning and preparing a thesis - Proof correction.

UNIT - III

Journals

Standard of research journals impact factor - citation index. Information retrieval - access to archives and databases, search engines - Google, Pubmed - national informatics center network services. Online database library.

UNIT - IV

Sampling methods

random sampling - types of variables: qualitative and quantitative variables - continuous and discontinuous variables - scaling method - mean - standard deviation - standard error - coefficient of variation: elucidation with model sums.

UNIT - V

Data Interpretation

Chi square test, students t test, ANOVA with interpretation of data - introduction to ANOVA - statistical tables and their uses - significance tests and fixing levels of significance. Uses of statistical software like SPSS.

TEXT BOOKS:

1. *Kothari, C. K.* 2004. **Research Methodology- Methods and Techniques.** 2nd edition. New Age International.
2. *Motulsky, H.* 1995. **Intuitive Biostatistics.** 1st edition. Oxford University press.

REFERENCE BOOKS:

1. *Lee, E. S. and Forthofer, R. N.,* 2006. **Introduction to Biostatistics: A guide to design, analysis and discovery.** 2nd edition. Academic press.
2. *Krishnaswamy, K. N., Sivakumar, Appa Iyer and Mathiranjani, M.* 2006. **Management Research Methodology, Integration of Principles, Methods and Techniques.** 1st edition. Pearson Education.

17PBT4EA	ELECTIVE IV- BIOENTREPRENEURSHIP, IPR AND BIOSAFETY	SEMESTER - IV
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**Total Credits: 4
5 Hours / Week**

PREAMBLE:

- To study the good laboratory procedure and practices, standard operating procedures for biotechnology research
- To learn about the legal and institutional framework for Biosafety
- To learn about the entrepreneurial opportunities in Biotechnology.

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the factors and legal issues in entrepreneurship	K3
CO2	Review the role of different funding agencies that support the entrepreneurs	K3, K4
CO3	Imparts knowledge on the Biosafety issues in biotechnology	K3, K4, K5
CO4	Distinguish the Biosafety measures on GMOs and ethical guidelines	K4, K5
CO5	Focus on IPR and patenting	K4, K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	M	S	S	M
CO3	S	M	M	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT4EA	ELECTIVE IV- BIOENTREPRENEURSHIP, IPR AND BIOSAFETY	SEMESTER - IV
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Total Credits: 4
Hours/Week: 5

CONTENTS

UNIT - I

Bioentrepreneurship

Entrepreneurship definition, factors necessary for entrepreneurship, desirables in a startup, mistakes to be avoided, pillars of bio-entrepreneurship, promoting bio-entrepreneurship, biotech company roadmap, legal, regulatory and other business factors.

UNIT - II

Funding sources of Biotech Business

Funding of biotech business (Financing alternatives, VC funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio-entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives), Role of knowledge centers and R&D (knowledge centers like universities and research institutions, role of technology and upgradation)

UNIT - III

Biosafety measures

Introduction to biosafety - biosafety issues in biotechnology - risk assessment and risk Management - safety protocols: risk groups -

biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containment.

UNIT - IV

Public Concerns on GMOs and cloning

Public debate and concern on Genetically modified microorganisms, plants and animals, Biosafety regulation and guidelines on developing and using the Genetically modified organisms, radiation safety. Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

UNIT - V

IPR and Patenting

Introduction to intellectual property and intellectual property rights – types: patents, copy rights, Trade marks, design rights, geographical indications – importance of IPR – world intellectual Property rights organization (WIPO). Patenting – Legal protection of biotechnological Inventions – Patenting in India: Indian patent act.

TEXTBOOKS:

1. *Deepa Goel*. 2013. **IPR Bio safety and Bioethics**. 1st edition. Pearson Education.
2. *Sateesh, M.K.* 2008. **Bioethics and Biosafety**. 1st Edition. I K International Publishing House.

REFERENCE BOOKS:

1. *Srinivasan, K. and Awasthi, H.K.* 1997. **Law of Patents.** 1st edition. Jain Book Agency.
2. *Thomas H. Murray and Maxwell J. Mehlman.* 2005. **Encyclopedia of Ethical, Legal and Policy issues in Biotechnology.** 1st edition. Wiley-Interscience.

17PBT4EB	ELECTIVE- IV: ORGANIC FARMING	SEMESTER - IV
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Total Credits: 4
Hours / Week: 5

PREAMBLE:**COURSE OUTCOMES**

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Know about the basic of organic farming national and international level	K2, K3
CO2	Understand the farming systems and its management	K3, K4
CO3	Imparts knowledge on the plant protection and weed management	K3, K4, K5
CO4	In depth understanding of Organic crop production practices	K4, K5
CO5	Focus on Organic Certification and terrace farming technology	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	S	S
CO2	M	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PBT4EB	ELECTIVE- IV: ORGANIC FARMING	SEMESTER - IV
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Total Credits: 4

Hours / Week: 5

UNIT - I

Concept of organic farming

Introduction: Farming, organic farming, concept and development of organic farming. Principles of organic farming, types of organic farming, biodynamic farming. Benefits of organic farming, need for organic farming, conventional farming v/s organic farming Scope of organic farming; Tamil nadu, National and International status. Agencies and institutions related to organic agriculture. Requirements for organic farming, farm components for an organic farm.

UNIT - II

Organic plant nutrient management

Organic farming systems, soil tillage, land preparation and mulching. Choice of varieties. Propagation-seed, planting materials and seed treatments, water management Green manuring, composting- principles, stages, types and factors, composting methods, Vermi composting Bulky organic manures, concentrated organic manures, organic preparations, organic amendments and sludges. Bio-fertilizers- types, methods of application, advantages and disadvantages, standards for organic inputs-fertilizers

UNIT - III

Organic plant protection

Plant protection- cultural, mechanical, botanical pesticides, control agents. Weed management, Standards for organic inputs- plant protection.

UNIT - IV

Organic crop production practices

Organic crop production methods- rice, coconut. Organic crop production methods- vegetables- okra, amaranthus, cucurbits. Livestock component in organic farming. Sustainable Agriculture-Apiculture, Mushroom cultivation.

UNIT - V

Organic Certification

Farm economy: Basic concept of economics- demand & supply, economic viability of a farm. Basic production principles, reducing expenses, ways to increase returns, cost of production system. Benefit/ cost ratio, marketing, imports and exports. Policies and incentives of organic production. Farm inspection and certification. Terrace farming.

TEXT BOOKS:

1. *Palaniappan SP & Anandurai K. 1999. Organic Farming-Theory and Practice.* Scientific Publishers, Jodhpur.
2. *Joshi, M. 2014. New Vistas of Organic Farming 2nd Ed.* Scientific Publishers, Jodhpur.

3. *S.A.Solaimalai, 2003. Farming system : Theory and Practice. Manohar Publishers & Distributirs, New Delhi.*

REFERENCE BOOKS:

1. *S.P.Palaniappan and K.A. Annadurai. **Organic Farming: Theory and Practice.** First edition, Scientific Publishers Journals Dept.*
2. *A.K. Sharma. 2002. **A hand book of Organic Farming.** Agro-Bios.*

17PBTSS1	SELF STUDY PAPER-I: FOOD BIOTECHNOLOGY	SEMESTER III
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Total Credits: 1

OBJECTIVES :

1. To study about various alternate foods.
2. To study the various preservation methods.

CONTENTS

UNIT - I

Food Biotechnology – Introduction and Scope; Production of Single cell protein and Baker’s yeast; Mushroom cultivation. Food and dairy products: Cheese, bread and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages.

UNIT - II

Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs enzyme biotransformations. Role of Plant tissue culture for improvement of food additives; color and flavor. Genetic modifications of microorganisms; detection and rapid diagnosis. Genetically modified foods and crop

UNIT - III

Food borne infections and intoxications; with examples of infective and toxic types – *Clostridium*, *Salmonella*, *Staphylococcus*. Mycotoxins in food with reference to *Aspergillus* species. Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation. Chemical and naturally occurring antimicrobials; Biosensors in food industry

UNIT - IV

Types of beverages and their importance: Synthetic beverages-carbonated, low-calorie and dry beverages; isotonic and sports drinks; soft drinks. Production of pectin, vitamins from apple pomace; Production of citrus oil from peels of citrus fruits. Processing of tea waste - as a feed for livestock and poultry; Fermented foods: alcoholic beverages - beer, wine and distilled spirits non alcoholic beverages - yoghurt and vinegar.

UNIT - V

Quality assurance: Microbiological quality standards of food, Intellectual property rights and animal welfare. Government regulatory practices and policies. FDA, EPA, HACCP, ISI. Risk analysis; consumer and industry perceptions.

REFERENCE BOOKS :

1. *Lee Byong, H.V.* 1996. **Fundamentals of Food Biotechnology**. 1st edition. C H Publishers.
2. *Roger, A.* 1989. **Food Biotechnology**, 1st edition. Elsevier Applied Sci. Pub.
3. *Goldberg Israel.* 1994. **Functional Foods**. 1st edition. Chapman & Hall Publishers.
4. *Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin.* 2005. **Food Biotechnology**. 2nd edition. CRC Publication.

17PBTSS2	SELF STUDY PAPER-II: DEVELOPMENTAL BIOLOGY	SEMESTER III
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Total Credits: 1

OBJECTIVES :

1. To study about basics of Developmental Biology.
2. To study the various tools used in Developmental Biology.

CONTENTS

UNIT - I

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

UNIT - II

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

UNIT - III

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis - vulva formation in *Caenorhabditis elegans*; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic

development - larval formation, metamorphosis; environmental regulation of normal development; sex determination. Programmed cell death and aging.

UNIT - IV

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems, floral development and senescence in *Arabidopsis* and *Antirrhinum*.


UNIT - V

Techniques for the study of development: Microscopy - Study of gene expression by biochemical methods - Study of gene expression by *in situ* methods - Microinjection - Cell-labeling methods - Cell sorting.

REFERENCE BOOKS:

1. Jonathan Michael Wyndham slack, 2006. **Essential developmental biology**. Wiley-Blackwell.
2. GERAL P. Schatten. 2006. **Current topics in developmental biology**. Academic press.
3. Wallace Arthur. 2000. **The origin of animal body plans: a study in evolutionary developmental biology**, Cambridge university press.
4. Werner A. Müller. 1997. **Developmental biology**. Springer.

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