

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.

OBJECTIVES OF THE COURSE :

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

SCHEME OF EXAMINATIONS

Subject Code	Subject	Hrs of Instruction	Exam Duration (Hrs)	Max Marks			Credit Points
				CA	CE	Total	
First Semester							
16PBT13A	Cell and Molecular Biology	5	3	25	75	100	4
16PBT13B	Biochemistry	5	3	25	75	100	4
16PBT13C	Genetics	5	3	25	75	100	4
16PBT13D	Microbiology	5	3	25	75	100	4
16PBT13P	Core Practical- I	5	6	40	60	100	4
	Elective -I:	5	3	25	75	100	4
		30				600	24
Second Semester							
16PBT23A	Immunotechnology	5	3	25	75	100	4
16PBT23B	Genetic Engineering	5	3	25	75	100	4
16PBT23C	Microbial Biotechnology	5	3	25	75	100	4
16PBT23D	Omics Technology	5	3	25	75	100	4
16PBT23P	Core Practical- II	5	6	40	60	100	4
	Elective- II:	5	3	25	75	100	4
		30				600	24
Third Semester							
16PBT33A	Plant Biotechnology	5	3	25	75	100	4
16PBT33B	Animal Biotechnology	5	3	25	75	100	4
16PBT33C	Environmental Biotechnology	5	3	25	75	100	4
16PBT33D	Molecular Therapeutics	5	3	25	75	100	4
16PBT33P	Core Practical -III	5	6	40	60	100	4


 BoS Chairman/HoD
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 Dr. N. G. P Arts and Science College
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16PBT33T	Internship *	--	--	--	--	50	2
	Elective- III:	5	3	25	75	100	4
		30				650	26
Fourth Semester							
16PBT43A	Research Methodology	5	3	25	75	100	4
16PBT43V	Project and Viva Voce	20	-	80	120	200	8
	Elective -IV:	5	3	25	75	100	4
		30				400	16
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 subject as Elective-I in first semester)

S.No	Subject Code	Name of the Subject
1.	16PBT1EA	Biopharmaceutical Technology
2.	16PBT1EB	Biodiversity

ELECTIVE - II

(Student shall select any one of the following subject as Elective-II in second semester)

S.No	Subject Code	Name of the Subject
1.	16PBT2EA	Protein Engineering
2.	16PBT2EB	Bioprospecting

ELECTIVE - III

(Student shall select any one of the following subject as Elective-III in third semester)

S.No	Subject Code	Name of the Subject
1.	16PBT3EA	Stem Cell Biology and Tissue Engineering
2.	16PBT3EB	Bioentrepreneurship, IPR and Biosafety

ELECTIVE - IV

(Student shall select any one of the following subject as Elective-IV in fourth semester)

S.No	Subject Code	Name of the Subject
1.	16PBT4EA	Principles of Clinical Trails
2.	16PBT4EB	Organic farming

TOTAL CREDIT DISTRIBUTION

Subjects	Credits	Total Marks		Credits	Cumulative Total credits
Core	4	13 X 100 =	1300	52	74
Core Lab	4	3 X 100 =	300	12	
Internship	2	1 X 50 =	50	02	
Project and Viva Voce	8	1 X 200 =	200	08	
Elective	4	4 X 100 =	400	16	16
Total			2250	90	90

FOR COURSE 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**)

3. Award winners in Paper Presentation in Sponsored International Seminar/conference/Participation in short term workshop (minimum 5 days) will be given one credit extra.
4. 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.	I Sem.	16PBTSS1	Food Biotechnology
2.	to III Sem.	16PBTSS2	Developmental Biology

5. 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.

16PBT13A	CELL AND MOLECULAR BIOLOGY	SEMESTER - I
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**Total Credits: 4
5 Hours / Week**

OBJECTIVES :

1. To study the Basic concepts of Cells.
2. To learn Basis of regulatory mechanisms

CONTENTS

UNIT-I

Discovery of the cells, development of cell theory, Prokaryotic cell structure (Bacteria) and Eukaryotic cell structure (Plant and Animal). Structure and Function of Ribosome, Mitochondria, Chloroplast, Golgi apparatus, Micro bodies, Endoplasmic reticulum. Transport across membrane -Passive (Diffusion & Osmosis), Active (Sodium - Potassium pump).

UNIT-II

Structural elucidation of DNA, Forms of DNA (A,B&Z), Evidence for DNA as genetic material (Griffith, Avery & Hershey experiments). Replication - Experiment to prove semi conservative mode of replication (Meselson and Stahl experiment), Mechanism of DNA Replication, Enzymes involved in Replication (Helicase, Primase, DNA Polymerases (Type I, II & III), Topoisomerase, Ligase), Difference between prokaryotic and eukaryotic replication, DNA repair systems (Photoreactivation, excision, recombination and SOS).

UNIT-III

Structure and Types of RNA, Transcription - Structure of RNA polymerase, Initiation, Elongation, Termination, Difference between prokaryotic and eukaryotic transcription, Inhibitors of Transcription. Post transcriptional processing of mRNA, rRNA and tRNA.

UNIT-IV

Elucidation of Genetic code, Wobble hypothesis, Translation - Initiation, elongation and Termination, Difference between prokaryotic and eukaryotic translation, post translational modification (Deformylation,

Glycosylation, Acetylation, Amidation, lipid attachment and Disulfide bond formation).

UNIT-V

Regulation of gene expression in prokaryotes - Negative control (*lac* operon), Positive control (*trp* Operon). Regulation of gene expression in eukaryotes at transcriptional level - Environmental & Biological control (Temperature, light & Hormone), Molecular control (Zinc finger, helix- turn- helix, Leucine zipper and helix- loop-helix).

REFERENCE BOOKS :

1. *Lewin, B.* 2004. **Genes V.** Oxford University press.
2. *Freifelder, D. and Malacinski, G. M.* 1996. **Essential of Molecular Biology**, 2nd edition. Panima Publishing Co., New Delhi.
3. *Lewin, B.* 2004. **Genes VIII.** Oxford University press.
4. *Lodish, H., Berk, A., Zipursky, L., Matsudaira, P., Baltimore, D. and Darnell, J.,* 2000. **Molecular Cell Biology.** 4th edition. WH Freeman & Co, New York.

16PBT13B	BIOCHEMISTRY	SEMESTER - I
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Total Credits: 4

5 Hours / Week

OBJECTIVES :

1. To study the Structure, function and interrelationship of various biomolecules & consequences of deviation from normal.
2. To understand the integration of the various aspects of metabolism and their regulatory pathways.

CONTENTS

UNIT-I

Carbohydrates - classification and reactions: occurrence, properties and biological reactions. Structural features of carbohydrates, Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Gluconeogenesis; interconversion of hexoses and pentoses.

UNIT-II

Classification, Structure, functions and reactions of Lipids, Biosynthesis of saturated fatty acids, Triglycerides, phospholipids and Sterols, Catabolism of Fatty acids: - Oxidation(α , β and ω), Catabolism of triglycerides and phospholipids, Structure and functions of Glycolipids and Lipoproteins.

UNIT-III

Amino Acid Classification and Biosynthesis. Peptides, Classification of Protein, Primary structure of proteins, structural comparison at secondary and tertiary levels (Ramachandran Plot), quaternary and domain structure. Metabolisms and biosynthesis regulations of Protein and Amino acid.

UNIT-IV

Enzymes and coenzymes: IUBMB classification and nomenclature of enzymes, active site, Lock and key Model and induced fit hypothesis. Mechanism of enzyme catalysis: Lysozyme, Enzyme kinetics- Michaelis - Menten (MM) equations and Kinetics, Transformations of MM equation and their significance, Enzyme inhibition: Reversible - Competitive, Noncompetitive, Uncompetitive, Irreversible inhibition, Kinetics of

Enzyme inhibition. Isoenzymes, allosteric enzymes, ribozymes, abzymes and artificial enzymes.

UNIT-V

Classification, structure, functions and reactions of nucleic acids, Biosynthesis of Purines and Pyrimidines, Salvage pathway, Regulation and Metabolism of Purine and Pyrimidine biosynthesis.

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

16PBT13C	GENETICS	SEMESTER - I
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To learn basic vocabulary of genetics.
2. To understand the Mendelian and Non Mendelian modes of inheritance that governs passage of genetic traits across generation.

CONTENTS

UNIT-I

Principles of Mendelian inheritance; Mendel's experiments- monohybrid, dihybrid, trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; Pleiotrophy, genome imprinting, inheritance and lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies. Multiple alleles; Sex determination; Non-mendelian inheritance and their effects - maternal effect, epigenetic and extra nuclear inheritance.

UNIT-II

Genome Organization in prokaryotes: genome of bacteria. The fine structure of a prokaryote gene; Genetics of bacteria: transformation, conjugation, transduction; Genetics of viruses: Life cycle of virulent bacteriophages, temperate phages and prophage; genetic recombination in phages; mapping genes in phage lambda; The RNA phages, tumor viruses and cancer; viroids.

UNIT-III

Genome Organization in Eukaryotes, variation in chromosome number: haploidy, polyploidy, aneuploidy. Variation in chromosome structure: deficiency of deletion, duplication, translocation, inversion and B chromosome. The fine structure of Eukaryote gene; complementation test, pseudo alleles, split genes, overlapping genes; transposons. Linkage and crossing over.

UNIT-IV

Human Genetics: Introduction to Human Genetics. Normal human karyotype: Paris Nomenclature; Chromosomal changes resulting in abnormal phenotype: Numerical (Aneuploidy) changes resulting in genetic syndromes eg: Turner, Down & Klinefelter Syndromes. Structural changes resulting in genetic diseases: eg: Cri-du-chat syndrome, Retinoblastoma, Chronic granulocytic leukemia.

UNIT-V

Pedigree studies: Symbols used in pedigree analysis. Pedigree analysis of important genetic diseases like Haemophilia, Color blindness, Duchenne Muscular Dystrophy (DMD). Prevention of disease: Prenatal diagnosis; Genetic counseling.

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.

16PBT13D	MICROBIOLOGY	SEMESTER - I
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To study the science of microbiology and describe some of the general methods used to investigate microorganisms.
2. To learn various activities of microorganisms.

CONTENTS

UNIT-I

History of Microbiology & Microscopy: Biogenesis vs Abiogenesis, Contributions of Louis Pasteur, Robert Koch, Edward Jenner, Alexander Fleming. Light microscopy-Bright, Dark Field, Phase contrast, Fluorescence. Electron Microscopy - Scanning Electron Microscope(SEM), Transmission Electron Microscope(TEM). Staining of microorganisms and its types.

UNIT-II

Sterilization: Definition - Methods of sterilization: Physical methods - Dry Heat (Hot Air Oven), Moist Heat (Autoclave), Cold sterilization and Chemical methods of sterilization. Culture Media: Definition - Different types of media. Isolation of microorganisms from various sources(Soil, Water, Food and Air).

UNIT-III

Microbial Growth - Growth curve, Determination of Generation Time, Measurement of Growth - Viable count, Turbidometry and Direct Cell count. Nutritional classification of microbes. Molecular taxonomy of microorganisms - 16S rDNA sequencing.

UNIT-IV

Bacterial Structure, Reproduction of Bacteria. Diseases caused by *Mycobacterium tuberculosis*(Tuberculosis), *Salmonella typhi*(Typhoid), *Vibrio cholera* (Cholera), *Clostridium tetani* (Tetanus) and *Staphylococcus aureus* (Skin Infections). Industrial importance of Bacteria.

UNIT-V

Virus structure, Classification (Baltimore), Reproduction – Generalized and Specialized, Diseases caused: HIV (AIDS), Hepatitis B Virus (Jaundice), *Varicella zoster* (Chicken Pox), H₁N₁ Virus (Swine Flu) and *Polio myelitis* (Polio).

REFERENCE BOOKS :

1. *Atlas M, Ronald. 1995. Principles of Microbiology.* McGraw - hill Inc.
2. *Michael Pelzar Jr.,. 2001. Microbiology.* 5th edition. McGraw Hill Education (India) Pvt Ltd.
3. *Prescott, L. M., John P. Harley, Donald A. Klein. 2004. Microbiology.* 6th edition. McGraw-Hill Science Publication.
4. *Gerard J. Tortora. 2012. Microbiology: An Introduction,* 11th edition. Benjamin Cummings Publishers.

16PBT13P	CORE PRACTICAL- I	SEMESTER - I
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Total Credits: 4
5 Hours / Week

CONTENTS

1. Estimation of protein by Lowry's method and Bradford method
2. Estimation of sugars by Anthrone method.
3. Estimation of DNA by Diphenyl amine method.
4. Estimation of RNA by Orcinol method.
5. Quantification of Vitamin C
6. Estimation of amino acids by Ninhydrine method
7. Identification of Amino acids by Paper chromatography and TLC.
8. Isolation of Auxotrophic Mutants.
9. Sex chromatin observation from Buccal smear.
10. UV- Mutagenesis.
11. Enumeration of Bacteria, Fungi and Actinomycetes from soil.
12. Bacterial staining – Simple, Gram and Spore.
13. Fungal staining (Lactophenol Cotton Blue).
14. Bacterial growth curve.
15. Antibiotic sensitivity test.
16. Carbohydrate fermentation test.
17. IMViC Test
18. TSI test

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.

16PBT1EA	ELECTIVE-I: BIOPHARMACEUTICAL TECHNOLOGY	SEMESTER - I
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**Total Credits: 4
5 Hours / Week**

OBJECTIVES :

1. To study about different pharmaceutical parameters of current biotechnology products.
2. To learn parameters related to stability and formulation of biotechnology products

CONTENTS

UNIT-I

History of Pharmaceutical Industry, Drug discovery, development phases and Drug manufacturing process. Drugs and cosmetics ACT and regulatory aspects. Generics and its advantages. Biogenerics and biosimilars. Protein based biopharmaceuticals.

UNIT-II

Pharmacodynamics of protein therapeutics; Chemical modification of proteins therapeutics; Immuno suppressive antibody therapy; Pharmacogenomics, Molecular modification of lead compounds; Assay system models (e.g., Knock-out Mice). Antisense technology as cell based therapeutics.

UNIT-III

Drugs derived from plants: antitumor agent - Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotoxic - Convallatoxin, Acetyldigoxin, Adoniside. Anti - Inflammatory - Aescin, Bromelain. Choleric - Curcumin, Biopharmaceuticals Expressed in plant alternative expression systems.

UNIT-IV

DNA Vaccine Construction and Immunology. Delivery of DNA Vaccines. Peptide vaccine, Gene Pharming, Cytokines as biopharmaceuticals, Rituximab, therapeutic enzymes.

UNIT-V

Erythropoietin (EPO), Colony stimulating Factors (CSFs), Human Growth Hormone (hGH), Insulin, Hepatitis B Vaccine, Factor VIII (FVIII), Interferon (IFN).

REFERENCE BOOKS :

1. *Oliver Kayser and Rainer H. Müller.* 2005. **Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications.** 1st edition. Wiley Publishers.
2. *Jay P. Rho. and Stan G. Louie.* 2003. **Hand book of Pharmaceutical Biotechnology.** 1st edition. CRC Press.
3. *Goodman and Gilman.* 2006. **The Pharmacological Basis of Therapeutics.** 11th edition. Mc Graw Hill Medical Publishing Division.
4. *Heinrich Klefenz.* 2002. **Industrial Pharmaceutical Biotechnology.** 1st edition. WILEY-VCH Publication.

16PBT1EB	ELECTIVE- I: BIODIVERSITY	SEMESTER - I
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To study about the types and conservations of Biodiversity
2. To learn the ethical issues in Biodiversity

CONTENTS

UNIT-I

Biodiversity - Definition and types. Biodiversity as a natural resource. Indian Biodiversity- vegetational zones and zones of faunal distribution. Major protected areas and their importance. Major biodiversity areas of the world and biodiversity hot spots. Values of Biodiversity.

UNIT-II

Important criteria used for classification in each taxon. Outline of classification - plants, animals and microorganisms. Evolutionary relationships among taxon. Microbial diversity Magnitude, occurrence and distribution. Molecular taxonomy - Scope and its Significance.

UNIT-III

Threats to biodiversity (Terrestrial and Marine area). Factors affecting biodiversity - Climate change, Deforestation and Habitat loss, over exploitation, Impact of exotic species and Pollution. Diversity - stability relationship.

UNIT-IV

Biodiversity Conservation - Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves. Single species/single habitat based conservation programmes. *Ex-situ* & *In-situ* conservation. Conservation Breeding, Organisms of conservation concern: Rare, endangered species. Conservation strategies.

UNIT-V

International conventions and treaties on conservation, India's role & contribution. Institutions and their role in conservation; Zoos, Natural history museums & collections. Biosphere reserves. Zoological survey of India, Botanical survey of India, Forest research Institute, Central Marine Fisheries research Institute.

REFERENCE BOOKS :

1. *Negi, S.S.* 1993. **Biodiversity and its Conservation in India.** 1st edition. Indus Publishing Co.
2. *Krishnamurthy K V.* 2003. **Textbook of Biodiversity.** 1st edition. Science Publisher.
3. *Mike J Jeffries.* 2006. **Biodiversity and Conservation.** 1st edition. Routledge.
4. *Navjot S. Sodhi and Paul R. Ehrlich.* 2010. **Conservation Biology for All.** 1st edition. Oxford University Press.

16PBT23A	IMMUNOTECHNOLOGY	SEMESTER - II
		Total Credits: 4 5 Hours / Week

OBJECTIVES :

1. To study the Cells of immune system
2. To learn regulation of immune systems

CONTENTS

UNIT-I

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. Antibodies Structure types, properties and functions of immunoglobulins.

UNIT-II

T-Cells, B-Cells, antigen presenting cells, cell mediated subset of T- Cells - helper and suppressor cells, natural killer cells. Lymphoid organs (primary and secondary) MHC molecules, Antigen presentation, B cell and T cell activation, cytokines. Complement system - Structure, components, properties and functions.

UNIT-III

Antigen antibody reactions. Immuno-electrophoresis, Hemagglutination, RIA, ELISA and Immuno-fluorescent techniques. Blood cell components, ABO blood grouping, Rh typing. Hybridoma technology- production of monoclonal antibodies and their applications. Human monoclonal catalytic antibodies and plantibodies.

UNIT-IV

Hypersensitivity reactions, autoimmune disorders, deficiencies (Primary and secondary) and immuno tolerance. Vaccines and immunization: passive and Active immunization.

UNIT-V

Tumor immunology: tumor antigens, immune responses and therapy, Transplantation Immunology. Types of Carcinogens- Chemical and Physical, Mechanism of Carcinogenesis. Different forms of therapy - chemotherapy, radiation therapy and detection of cancers.

REFERENCE BOOKS :

1. *Janis Kuby*. 1997. **Immunology**. WH Freeman & Company, New York.
2. *Rober, A. Weinberg*. 2013. **The Biology of Cancer**. Garland Science.
3. *Ivan Riot*. 1988. **Essentials of Immunology**. 6th edition. Blackwell Scientific Publications, Oxford.
4. *Harlow and David Lane*. 1988. **Antibodies A laboratory Manual**. Cold spring Harbor laboratory Press.

16PBT23B	GENETIC ENGINEERING	SEMESTER - II
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To learn the guidelines for Recombinant DNA Technology research which involves all the Molecular Biology techniques
2. To study about different Cloning techniques

CONTENTS

UNIT-I

History and scope of rDNA technology, Strategies of cloning, Cutting and Joining of DNA- Linkers and Adapters, other enzymes involved in cloning, Features of host cell. Selectable and Screenable markers used in recombinant DNA technology. Enzymes used in genetic engineering.

UNIT-II

Plasmids - properties of plasmid, types of plasmids, plasmid compatibility and incompatibility, copy number and its control. Features of Bacterial Vectors, *E.coli* vectors- pBR322 and pUC vectors, Bacterial Artificial Chromosome (BAC). Cloning in *Bacillus*.

UNIT-III

Viral Vectors Lambda Phage vectors, cosmid, phagemid, M13. Yeast vectors - YIP, YEP, YRP and YAC. Animal vectors- SV40 Vectors, Retroviral and Baculo viral vectors. Plant Vectors- Ti plasmid as a gene vector, expression vectors and shuttle vectors.

UNIT-IV

Construction of cDNA and genomic DNA libraries. PCR and its types. DNA Sequencing, Probes - probe construction and labeling. Introduction of cloned genes into cell - transformation, particle bombardment, liposome mediation and electroporation. Blotting techniques Southern, Western and Northern blotting. Micro array, Site - directed mutagenesis and its applications.

UNIT-V

Recombinant DNA based products - Humulin, Somatotropin, Erythropoietin, Tissue Plasminogen activator, Factor-VIII and Interferon. Ethical issues in GM products, Institutional Animal Ethics Committee, Recombinant DNA Advisory Committee and Institutional Bio safety Committee.

REFERENCE 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.

16PBT23C	MICROBIAL BIOTECHNOLOGY	SEMESTER - II
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To recognize the fundamentals of Microbial Biotechnology
2. To analyze the bioprocess paradigm: Scale-down, bioprocess simulation and economics, sterilization in biological manufacturing.

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. Screening of industrially important microbes - Isolation, preservation and improvement of strains for increased yield - primary metabolite and secondary metabolite. Advantages of bioprocess over chemical process.

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. Oxygen transfer rate, Oxygen transfer coefficient and correlation. Mass transfer, Biological heat transfer and heat transfer coefficient.

UNIT-III

Recent developments in the production of valuable 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 (Livestock and transgenic plants); Bio-insecticides, biofertilizer, Bio-inoculants manufacture. Microbes in production of alternative energy; Bioprospecting of microbial endophytes.

UNIT-V

Finished Product 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.

REFERENCE 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/gmpmanual_eu_4c_online.pdf.
4. Compendium of Good Practices in Biotechnology, BIOTOL series

16PBT23D	OMICS TECHNOLOGY	SEMESTER - II
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To study the Genome
2. To learn sequencing of genome and Protein functions.

CONTENTS

UNIT-I

Bioinformatics - Introduction and History. Biological Databases. Data generation; Generation of large scale molecular biology data - Genome sequencing, Protein sequencing, Nucleic acid sequence databases: Gene bank, Protein sequence databases - Swiss-Prot, PDB. Applications of Bioinformatics.

UNIT-II

The Genome Analysis Perspective of Bioinformatics : Fragment Assembly- ESTs and genomic fragments, Mapping, Annotation, Gene predictions, ORFs, UTRs, introns, exons and promoters. The Bioinformatics of Microarray Gene Expression Profiling. Codon optimization tools.

UNIT-III

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-IV

Pharmacogenomics: Overview; present status and Basic Principles of Pharmacogenetics, Pharmacogenomics of genetic diseases e.g. hypertension and Cancer, Approaches to Pharmacogenomics studies; Classical and non- Classical Pharmacogenomics. Metabolomics. Technologies in metabolomics. Nutrigenomics. Other omics.

UNIT-V

Overview of Alignment Algorithms - BLAST: types, steps involved in use, interpretation of results, Multiple sequence alignment - ClustalW, Phylogenetic Analysis, Gene finder and Primer designing tools. Basics of CADD and its importance.

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.

16PBT23P	CORE PRACTICAL- II	SEMESTER - II
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Total Credits: 4
5 Hours / Week

CONTENTS

1. Blood smear preparation for the identification of Blood cells
2. Total RBC and WBC count
3. Radial Immunodiffusion
4. Ouchterlony double diffusion
5. Precipitin ring test
6. Immunelectrophoresis
7. Rocket immuno electrophoresis
8. SDS-PAGE and Immuno blotting
9. Extraction of genomic DNA from plant
10. Extraction of genomic DNA from bacteria
11. Extraction of genomic DNA from animal tissue
12. Plasmid DNA extraction
13. Bacterial Transformation
14. PCR
15. Restriction digestion
16. Ligation
17. Wine making
18. Production and assay of extra cellular enzyme - Protease
19. Purification of Enzyme by Ammonium Sulphate precipitation, Dialysis and Column chromatography.

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.*

16PBT2EA	ELECTIVE - II: PROTEIN ENGINEERING	SEMESTER - II
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**Total Credits: 4
5 Hours / Week**

OBJECTIVES :

1. To study the Structure and Functions of Protein
2. To learn about the characteristics of Protein

CONTENTS

UNIT-I

Bonds and Energies in Protein Makeup: Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure.

UNIT-II

Amino acids and their characteristics: Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups) and peptide synthesis

UNIT-III

Protein Architecture: Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass-spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures 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.

UNIT-IV

Structure-function relationship: DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, *trp* repressor, Eucaryotic transcription factors, Zn fingers, helix-turn - helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center. Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes - Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis and other commercial applications

UNIT-V

Protein engineering: Advantages and purpose, overview of methods, underlying principles with specific examples: thermal stability, T4-lysozyme, recombinant insulin to reduce aggregation and inactivation, *de novo* protein design.

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.

16PBT2EB	ELECTIVE- II: BIOPROSPECTING	SEMESTER - II
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

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

CONTENTS

UNIT-I

Major area 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 bioactivity, 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.

REFERENCE 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.
4. *Londa Schiebinger.* 2007. **Plants and Empire - Colonial Bioprospecting in the Atlantic World.** 1st Edition. Harvard University Press.

16PBT33A	PLANT BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To understand various *in vitro* culture techniques of Plants
2. To learn gene transferring mechanisms in Plants

CONTENTS

UNIT-I

Plant Tissue Culture technique - History and Scope. Totipotency of plant cells- redifferentiation and dedifferentiation. Criteria for Plant Selection. Plant Tissue Culture lab - Architecture and Instruments. Plant tissue culture media and its types. Growth conditions and contamination management.

UNIT-II

Culture of plant materials- explants selection and technique of culturing the same. Micropropagation, Callus culture, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture and fusion, Somaclonal variation.

UNIT-III

Ti and Ri plasmids, binary & co-integrated vector systems; viral vectors and their applications; 35S and other promoters; genetic markers-reporter genes. Cloning Strategies- Gene transfer methods in plants- Direct DNA transfer methods, *Agrobacterium* mediated nuclear transformation.

UNIT-IV

Transgenic Plants -herbicide resistance, insect resistance, virus resistance, drought resistance and transgenic plants as bioreactors. Application of antisense RNA technology, genetically modified foods and Golden Rice. Green house and green - home technology.

UNIT-V

Extraction & purification of phyto-chemicals. Industrial phytochemical products from plants - Alkaloids, antibodies, plant vaccines. Safety Assessment of GM crops, Biosafety regulations in India (Guidelines for research in transgenic plants, 1998). Issues related to transgenic plants - Transgene escape, Transgene loss, Terminator Seeds. Intellectual Property Rights and Regulatory Issues related to biotechnology of tropical species in India. DBT and Ministry of Agriculture Guidelines for Plant Tissue Culture.

REFERENCE BOOKS :

1. *Chawla, H. S.* 2013. **Introduction to Plant Biotechnology.** 3rd edition. Oxford & IBH publishing company.
2. *Razdan, M. K.* 2002. **Introduction to Plant tissue culture.** 2nd edition. Oxford & IBH publishing company.
3. *Grierson, D. and Covey, S.V.* 1988. **Plant Molecular Biology.** 2nd edition. Blackie Publishers.
4. *Bhojwan, S. S.* 1996. **Plant tissue culture - Theory and Practice.** 1st edition. Elsevier Publishers.

16PBT33B	ANIMAL BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To study about various *in vitro* culture techniques
2. To learn about preservation of animal cells

CONTENTS

UNIT-I

Animal cell culture - History and scope, ATC Lab organization, Basic requirement for animal tissue culture lab, Sterilization and contamination management. Safety aspects of cell culture, Preparation of culture media- Types of animal cell culture media. Role of pH, Carbon dioxide, Oxygen, Temperature, serum and growth factors in cell culture.

UNIT-II

Process of initiation of cell culture, Growth of cells in culture- methods of culture, Types of animal cell culture: primary cell culture, Continuous culture. Maintenance and storage of culture, Cell line banking, Cell quantitation methods and Cytotoxicity assays.

UNIT-III

Applications of animal cell culture - Hybridoma technology and its applications. Production of native and recombinant proteins in animal cell. Scaling up of cultures - Suspension and Monolayer cultures.

UNIT-IV

Conventional methods of improvement of animal live stock: artificial insemination, *in vitro* fertilization, embryo culture, embryo sexing, splitting and cloning. Somatic cell nuclear transfer. Production of transgenic animals and its applications. Gene targeting, silencing and knock-out.

UNIT-V

Trends in Aquaculture Biotechnology, Silk worm Biotechnology. Stem cells - Properties, types, potential uses of human stem cells and stem cell controversy. Ethical issues in animal transgenics.

REFERENCE BOOKS :

1. *Wilson Aruni. , A. and Ramadass. , P.* 2011. **Animal Tissue culture.** 1st Edition. MJP Publishers, India.
2. *John R. Masters.* 2000. **Animal cell culture.** 3rd edition. Oxford University Press.
3. *Freshney, R.I.* 1996. **Animal cell culture: A practical approach.** 2nd edition. Oxford University Press
4. *Rastogi, V.* 2001. **Developmental Biology.** 1st edition. Kedarnath Ramnath Publishers.

16PBT33C	ENVIRONMENTAL BIOTECHNOLOGY	SEMESTER - III
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To understand the basic vocabulary of environmental biology
2. To study about hazards of industrial pollutants on environment

CONTENTS

UNIT-I

Biodegradation - Definition, Acclimation, detoxification, activation, bio-availability, effect of chemical structure on biodegradation, recalcitrance, predicting products of biodegradation, co-metabolism and biotransformation. Factors affecting biodegradation.

UNIT-II

Biodegradation of Hydrocarbons- Microbial degradation of hydrocarbons: Methane, ethane, propane, butane and other long chain alkanes, alkenes, alkynes. Aerobic and anaerobic biodegradation of aromatic compounds. Microbial degradation of halogenated and sulfonated compounds. Biodegradation of pesticides. Microbial degradation of biopolymers- Cellulose, starch, pectin and lignin. Polyhydroxy alkanooates (Bioplastics).

UNIT-III

Bioremediation- Definition, Constraints, advantages and applications, Types of bioremediation - Natural and engineered, *ex-situ* and *in-situ*, Bioaugmentation and biostimulation, solid phase and slurry phase bioremediation, Oxygen delivery for Bioremediation, Criteria to be met for considering bioremediation- factors affecting bioremediation, treatability studies for bioremediation- purpose, experimental design and example protocol.

UNIT-IV

Specific bioremediation technologies - Application, advantages and disadvantages. Phytoremediation, Hazardous wastes, biotechnology for hazardous waste management, cyanide detoxification, detoxification of oxalate and urea.

UNIT-V

Bio-magnification and Bio-amplification. Bio-leaching and Bio-mining. Restoration of degraded lands - Reforestation through micropropagation of *Casurina* for tropical reforestation on adverse sites, development of stress tolerant plants; use of *mycorrhizae* in reforestation, reforestation of soils contaminated with heavy metals.

REFERENCE BOOKS :

1. *Katherine H. Baker*. 1994. **Bioremediation**. 1st edition. Mc Graw-Hill.
2. *Levin M.A.* 1993. **Biotreatment of industrial and hazardous waste**. 1st edition. McGraw-Hill, Inc.
3. *Martin Alexander*. 1999. **Biodegradation and Bioremediation**. 2nd edition. Academic Press.
4. *Alan Scragg*. 2007. **Environmental Biotechnology**. 2nd edition. Oxford university press.

16PBT33D	MOLECULAR THERAPEUTICS	SEMESTER - III
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

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

CONTENTS

UNIT-I

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

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

UNIT-III

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

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

UNIT-V

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.

REFERENCE 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**. 2nd edition. F.A.Davis Company.
4. *Pamela Greenwell, Michelle McCulley*. 2008. **Molecular Therapeutics: 21st Century Medicine**. John Wiley & Sons.

16PBT33P	CORE PRACTICAL - III	SEMESTER - III
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Total Credits: 4
5 Hours / Week

CONTENTS

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 trypan 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.

16PBT3EA	ELECTIVE - III: STEM CELL BIOLOGY AND TISSUE ENGINEERING	SEMESTER - III
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To study the types of Stem cells
2. To learn about the applications of Tissue Engineering

CONTENTS

UNIT-I

Introduction to Stem Cells – Definition, Classification, Characteristics
Differentiation and dedifferentiation, Stem cell niche, stem cell vs cells;
Basic culture procedures – isolation, culture methods, identification, stem
cell markers, feeder layer; Instrumentations in stem cell biology.

UNIT-II

Different kinds of stem cells – Adult stem cells, Embryonic stem cells,
Haematopoietic stem cells, Neural stem cells, muscle and cardiac stem
cells, Umbilical cord blood stem cells, cancer stem cells, Mesenchymal
stem cells, Induced pluripotent stem cells.

UNIT-III

Therapeutic applications – stem cells and neurodegenerative disorders,
stem cells and diabetes, stem cells and cardiac disorders, regeneration of
epidermis, Stem cell banking, Stem cell research - World federal funding
for stem cell research; Public view and ethical approaches on stem cells.

UNIT-IV

Principles of Tissue Engineering – History and scope, Basics of Tissue
Engineering, Tissue Engineering triangle, Cell-ECM interaction, wound
healing mechanism, Tissue Engineering Bioreactors, Models of Tissue
Engineering and Biomaterials in Tissue Engineering.

UNIT-V

Bioartificial organs – source of cells, choosing the right scaffold material,
mode of transplantation. Epidermal Tissue engineering, Bladder
reconstruction, Skin equivalents, Liver reconstruction, Bone regeneration
through tissue engineering, Tissue Engineering and future perspectives.

REFERENCE BOOKS :

1. *Robert Lanza*. 2013. **Principles of Tissue Engineering**. 4th edition. Academic Press.
2. *Christopher Thomas Scott*. 2005. **Stem cell now**. 1st edition. Pearson Education.
3. *Song Li, Nicolas L'Heureux, Jennifer Elisseeff*. 2011. **Stem Cell and Tissue Engineering**. 1st edition. World Scientific Publishers.
4. *Robert Lanza, John Gearhart, Brigid Hogan*. 2006. **Essentials of Stem Cell Biology**. 2nd edition. Macmillan Publishing Solutions.

16PBT3EB	ELECTIVE III- BIOENTREPRENEURSHIP, IPR AND BIOSAFETY	SEMESTER - III
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**Total Credits: 4
5 Hours / Week**

OBJECTIVES :

1. To study the good laboratory procedure and practices, standard operating procedures for biotechnology research
2. To learn about the legal and institutional framework for biosafety

CONTENTS

UNIT-I

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 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

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 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

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.

REFERENCE BOOKS :

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

16PBT43A	RESEARCH METHODOLOGY	SEMESTER - IV
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Total Credits: 4
5 Hours / Week

OBJECTIVES :

1. To learn basic concepts of research and its methodologies
2. To study the basic theory, philosophy and application of statistics

CONTENTS

UNIT-I

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

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

UNIT-III

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

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.

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

16PBT4EA	ELECTIVE- IV: PRINCIPLES OF CLINICAL TRAILS	SEMESTER - IV
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**Total Credits: 4
5 Hours / Week**

OBJECTIVES :

1. To learn about the regulations in Clinical trials.
2. To study about the various guidelines

CONTENTS

UNIT-I

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

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

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

UNIT-IV

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

UNIT-V

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.

REFERENCE 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.
3. *Sandy Weinberg*. 2009. **Guide Book for Drug Regulatory Submissions**. 1st edition. *John Wiley & sons* .
4. *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.

16PBT4EB	ELECTIVE- IV: ORGANIC FARMING	SEMESTER - IV
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**Total Credits: 4
5 Hours / Week**

OBJECTIVES :

1. To learn about the importance of organic farming.
2. To study about the various guidelines of organic farming.

CONTENTS

UNIT-I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT-II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and bio-fertilizers.

UNIT-III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT-IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, bio-pesticides.

UNIT-V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

REFERENCE BOOKS :

1. *Peter V. Fossil*. 2007. **Organic Farming: Everything You Need to Know**. Voyageur Press.
2. *Richard Wiswall*. 2009. **The Organic Farmer's Business Handbook: A Complete Guide to Managing Finances, Crops and Staff and Making a Profit**. Chelsea Green Publishing Co.
3. <http://casfs.ucsc.edu/about/publications/Teaching-Organic-Farming/PDF-downloads/TOFG-all.pdf>
4. http://www.navdanya.org/attachments/Organic_Farming3.pdf

16PBTSS1	SELF STUDY PAPER-I: FOOD BIOTECHNOLOGY	I To III SEMESTER
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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.

16PBTSS2	SELF STUDY PAPER-II: DEVELOPMENTAL BIOLOGY	I To III SEMESTER
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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. Muller. 1997. **Developmental biology**. Springer.

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