

MOTHER TERESA WOMEN'S UNIVERSITY,
KODAIKANAL - 624 102
Tamil Nadu.



Curriculum Framework and Syllabi for
M.Sc Biotechnology

(For the candidates to be admitted from the academic year 2018-2019
onwards)

(UNDER CHOICE BASED CREDIT SYSTEM- CBCS)

PREAMBLE

Mother Teresa Women's University, whose foundation stone was laid by St. Mother Teresa herself, stands as an epitome of Women empowerment. The University stands as the first and the only Women's University in the State, and the third University in the Nation. With emphasis on research, supported by strong postgraduate programs in various disciplines, the University fosters high quality research activities in various disciplines at M.Phil. And Ph.D. levels.

Department of Biotechnology was started in 2002 with a vision to make an impact through research and technology based training. An herbal garden is maintained within the campus by the Department of Biotechnology which spreads on 0.25 acres of land where about 50 species of important traditional, medicinal and aromatic herbs are flowering. A state of art nanoscience lab is setup in the Department of Biotechnology funded by Consolidation of University Research for Innovation and Excellence in Women Universities (CURIE Programme), DST.

VISION

- ❖ To emerge into a top-notch International Women's University by creating empowered and socially responsible woman achievers through excellence in teaching, research and extension and enabling them to attain gender equity.

MISSION

- ✚ Striving for excellence in the tripartite goal of teaching, research and extension
- ✚ Promoting the educational standard of women at all levels
- ✚ Identifying and addressing the emerging trends and needs
- ✚ Providing community based learning experience
- ✚ Promoting community issues based research activities with global standards
- ✚ Developing intellectual professionals with ethics for the benefit of mankind and environment.
- ✚ Extending collaborative and innovative research work for National Development.
- ✚ Equipping the learners with employability skills and groom them as Capacity Builders.
- ✚ Promoting global entrepreneurs addressing the market challenges.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The graduates of M.Sc. Biotechnology program will be able to

PEO1:	Think critically and creatively about the use of biotechnology to address local and global problems.
PEO2:	Implement the scientific skills for development of industrial applications and entrepreneurship.
PEO3:	Function on interdisciplinary framework of biotechnology and related fields.
PEO4:	Adopt ethical attitude and exhibit effective skills in teamwork and leadership qualities
PEO5:	Apply research strategies to solve biotechnology problems.
PEO6:	Discover in depth knowledge of animal and plant biotechnology, and also broad area of biochemistry, Immunology and molecular biology

PROGRAMME OUTCOME (PO)

At the end of the program the students will be able to:

PO1:	Scientific Knowledge: Understand the scientific knowledge about the living organisms both prokaryotic and eukaryotic cells, morphology, cellular, molecular and its functions.
PO2:	Problem Solving: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of biological data and thereby solve the biotechnological problems
PO3:	Design and Development of Solution: Design applications for any specific needs from societal and environmental aspects.
PO4:	Conduct investigations of complex problems: Recognize the need for continuous learning and will prepare oneself to create, select, learn and apply appropriate techniques, resources, and modern instrumentation to solve complex biotechnological activities with an understanding of the limitations

PO5:	Modern tool usage: Bioinformatics methods are widely used for Gene Mapping, DNA analysis and Protein Samples. Biotechnology and Bioinformatics do a great favour to evolutionary biology and offer new vistas for Drug design and discovery
PO6:	Communication: Apply their knowledge in other advanced subject area like Nano biotechnology, immunotechnology, and animal and plant biotechnology for the betterment and advancement of their professional career.
PO7:	Individual and team work: Students gain sound professional Ethics, Leadership and consensus building skills relevant to Biotechnology aspects of business enterprise.
PO8:	Link with society & Ethics: Apply reasoning informed by the background knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional.

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO1:	Students will learn the basic knowledge about cell structure and functions, major bio-molecules, will be taught. Understanding of metabolic pathways (catabolism as well as anabolism)
PSO2:	Students will understand the importance of microbes in environmental aspects, medical, industrial, agriculture, microbe interaction with plant and animal, food aspects which is an integrated part of Biotechnology. Students will become familiar with the tools and techniques of genetic engineering- DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools
PSO3:	This course includes molecular aspects of cellular function of eukaryotic cell, immune cells, human pathogens, current therapy and environmental issues. By studying developmental biology along with physiology students will gain an understanding of the causes, diagnosis and treatment of disease, and how they affect different parts of the body.
PSO4:	Students will imbibe the importance of plant biotechnology regarding basic as well as advance knowledge about the in vitro culture, maintenance and preservation of plant cells, tissues and organs. Animal biotechnology basic as well as gain knowledge about cell culture techniques, large scale production of bioproducts. Students attain knowledge on types of pollution and waste water management and solid waste management and biopesticides, biofertilizer and composting.
PSO5:	Apply the knowledge of basic sciences and technology as well as nanotechnology in cancer biology and its applications to demonstrate research skills and develop technology for commercialization and employability skill and become entrepreneur. Students will imbibe the importance of Ethical issues, Biosafety, IPR.

MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL

M.SC. BIOTECHNOLOGY

STRUCTURE 2018-2019 ONWARDS

P. No .	Paper Code	Course Title	Hours	Credits	Internal	External	Total
Semester I							
1	PBTT11	Core I (Theory)- Biochemistry	5	5	25	75	100
2	PBTT12	Core II (Theory)- Microbiology	5	5	25	75	100
3	PBTT13	Core III (Theory)- Molecular Biology	5	5	25	75	100
4	PBTP11	Practical-I- Lab in Analytical Biochemistry, Microbiology and Molecular Biology	5	5	25	75	100
5	PBTE11	Elective I Choice 1: Cell Biology and Genetics Choice 2: Developmental Biology	5	4	25	75	100
		Total	25	25			500
Semester II							
6	PBTT21	Core IV (Theory)- Immunology	5	5	25	75	100
7	PBTT22	Core V (Theory)- Recombinant DNA Technology	5	5	25	75	100
8	PBTT23	Core VI (Theory)- Environmental Biotechnology	5	5	25	75	100
9	PBTP22	Practical-III- Lab in Immunology and Recombinant DNA Technology, Lab in Environmental Biotechnology	5	5	25	75	100
10	PBTE22	Elective II- Other Department Elective Choice 1: Bioinformatic and computer Application Choice 2: Nanotechnology and cancer biology	5	4	25	75	100

		<i>Total</i>	25	25			500
Semester III							
11	PBTT31	Core VII (Theory)-Plant Biotechnology	5	5	25	75	100
12	PBTT32	Core VIII (Theory)- Animal Biotechnology	5	5	25	75	100
13	PBTT33	Core IX (Theory)- Bioinstrumentation and Biostatistics	5	5	25	75	100
14	PBTP33	Practical-V- Lab in Plant Biotechnology & Animal Biotechnology	5	5	25	75	100
15	PBTE33	Elective III Choice 1: Women Studies Choice 2: Employability Skill	5	4	25	75	100
		<i>Total</i>	25	25			500
Semester IV							
16	PBTT41	Core X (Theory)Bioethics, Biosafety and IPR	5	5	25	75	100
17	PBTT42	Core XI (Theory) Bioprocess Technology	5	5	25	75	100
18	PBTP44	Major Project	5	5	25	75	100
		<i>Total</i>	15	15			300
Grand Total				90			1800

Regulations:

1. Course Objectives

To enable the students

- To understand the emerging trends in biotechnology.
- Students will get knowledge about the structure and functions of biomolecules, enzyme kinetics, bio polymers and metabolic reactions in a living system.
- To learn knowledge in genome organization of organisms.
- To develop practical and theoretical knowledge in Applied biotechnology

2. Qualification for Admission:

- i. Candidate should have passed a UG degree (B.Sc Microbiology/ Biochemistry/ Zoology/ Botany/ Immunology/ Biotechnology/ Applied Microbiology / Integrated Biology / Medical Microbiology) or equivalent life science degree.
- ii. Candidate should have secured at least 50%.
- iii. A relaxation of 5-10% in the total percentage will be given to SC, ST candidates.
- iv. Candidates sponsored by industries/hospitals/Clinical laboratories may be considered for admission.

3. Duration of the course:

The students will undergo the prescribed course of study for a period of not less than two academic years (Four semesters).

4. Medium of Instruction: English

5. Subject of Study: As given in Appendix A

6. Scheme of Examination: As given in Course Structure and Scheme of Examination Appendix B

7. Eligibility of the degree:

- i. Candidates will be eligible if they complete the course with the required credits and pass in the prescribed examinations.
8. The candidate requires 75% of attendance to attend the semester exam.
9. The internal marks would be divided as 5 for assignment 5 for seminar and 15 for written tests. One or two seminars/assignments can be given and a consolidate of them can be considered.

11. The passing minimum is 50 percent (both in internal and external separately) in each paper.

12. The candidate has to undergo a project individually.

13. To complete the course the students should gain the prescribed credits i.e. 90 credits.

Core –The candidate has to study 14 cores including practical and gain the respective credits. (14 * 5 credits each = 70 credits).

Elective- Each candidate has to study three electives and gain the respective credits. (3 * 5 credits each = 15 credits).

Project – The candidate has to undergo one project in the fourth semester and gain 5 credits.

MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL

M.SC. BIOTECHNOLOGY

Semester I

Course Title & Code	CORE I (Theory) – BIOCHEMISTRY – PMTT11		
Semester	Semester-I	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • Students will get knowledge about the structure and functions of biomolecules, enzyme kinetics, bio polymers and metabolic reactions in a living system. • To learn about structure of biomolecules. • To determining how they are metabolized in organisms, and elucidating their role in the operation of the organism. • On the successful completion of the course the students will get an overall understanding of Biomolecules, their structure and classifications, enzyme kinetics and metabolic reactions in a living system. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: CO2: CO3: CO4: CO5:	Know the molecules, metabolisms of biochemical pathways K1 Understand the lipid molecules, vitamins and hormones K2 Know the structure, classification and properties of amino acids and proteins K1 Know about nucleotide structure, biosynthesis, its regulation & degradation K1 To learn the basic concept of Enzymes – Nomenclature and Classification, factors influencing enzyme activity K4	
UNIT I	Atom, Molecules & chemical bonds properties of H ₂ O, acid and buffer. Carbohydrates – Occurrence, chemical properties, stereo and optical isomerism, structure and classification. Metabolism and its regulation – Glycolysis, TCA cycle, Oxidative phosphorylation, pentose phosphate pathway and gluconeogenesis, ATP synthesis, Photosynthesis, Glycolysis.		

UNIT II	Lipids – occurrence, chemical properties and classification-biosynthesis of fatty acids triglycerides, phospholipids and cholesterol – Oxidation of fatty acids, Vitamins – classifications, derivatives, hormones – Types functions & disorders
UNIT III	Amino acids and Proteins – Amino acids: structure, classification and chemical properties, structure of peptide bond – protein: classification, amino acid composition. Protein structure – Primary structure, secondary structure – alpha helix and beta pleated structure, tertiary and quaternary structure. Protein metabolism and degradation: A.A oxidation & Urea cycle. Ramachandran plot.
UNIT IV	Nuclie acids – DNA & RNA – structure of purine and pyrimidine bases, nucleotides and nucleotide biosynthesis, its regulation & degradation of purine and pyrimidine nucleotides – Biosynthesis of deoxyribonucleotides
UNIT V	Enzymes – Nomenclature and Classification – protein enzymes, coenzymes, prosthetic groups, cofactors, isoenzymes, ribozymes, abzymes: chemical properties of enzymes: types of specificity – absolute, group, stereochemical and geometrical; factors influencing enzyme activity – temperature, pH, concentration of enzyme, substrate and effect of ions; enzyme kinetics, types of enzyme inhibition – reversible, competitive, non-competitive, uncompetitive, irreversible inhibition; allosteric enzymes
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Nelson D.L and Cox M.M. 2006. Lehninger Principles of Biochemistry, 4th edition, Macmillan worth Publishers. 2. Murray R.K, Granner D.K and Rodwell V.M. 2006. Harper's Illustrated Biochemistry, 27th Edition, The McGraw-Hill companies, Inc. 3. Berg J.M, Tymoczke J.L and Stryer W.H. 2007. Biochemistry, Freeman and Company, USA 4. Principles of Biochemistry Third Edition International Student Version Chapter 13 Biochemical Signaling Copyright © 2008 by John Wiley & Sons, Inc. Donald Voet • Judith G. Voet • Charlotte W. Pratt

	5. U. Satyanarayana, Biochemistry, Books and Allied (P) Ltd., Calcutta, Latest Edition.
E-book links	1) https://doi.org/10.1002/cbf.1216 2) https://www.pdfdrive.com/biochemistry-biochemistry-e19576202.html 3) https://www.pdfdrive.com/textbook-of-biochemistry-e14983388.html 4) https://www.pdfdrive.com/biochemistry-genetics-molecular-biology-e18198970.html 5) https://www.pdfdrive.com/lehninger-principles-of-biochemistry-5th-edition-e164892141.html

Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE	
	1	2	3	4	5	6	7	8	1	2	3	4	5		
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
														Mean score	3.0

The Mean Score is 3.0, which is strongly correlated

- Strongly Correlating(S) - 3 marks
- Moderately Correlating (M) - 2 marks
- Weakly Correlating (W) - 1 mark
- No Correlation (N) - 0 mark

Course Title & Code	CORE II (Theory) –MICROBIOLOGY – PBTT12		
Semester	Semester-I	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To learn about the basic applications of microorganisms. • To understand the identification of microorganisms using advanced microbiological methods • The knowledge about different types of microorganisms and their identification techniques in modern biology. • To identify the microorganisms based on the modern polyphasic approach. • The students will be able to identify any microorganisms, predict the intermediate metabolism of any microbe used in industrial production processes, economical uses of microorganism and pathogenesis of various microbes in the environment. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	<p>CO1: Know the history, criteria, Classification and diversity of Bacteria K1</p> <p>CO2: Understand the culture technique for isolation and molecular identification of any microbes K2</p> <p>CO3: Well-known with the extremophiles organisms, Archaea, structure and characteristics of fungi and algae K2</p> <p>CO4: Know about Classification, Cultivation of virus as well as host and microbial interaction K4</p> <p>CO5: To learn the essential conception of bacteria, fungi and virus pathogenicity, transmission, diagnosis and treatment with examples K3</p>		
UNIT I	Historical perspectives of microbiology, Domain and Kingdom concepts in classification of microorganisms, Criteria for classification. Classification of Bacteria according to Bergey's manual. Diversity of prokaryotic microorganisms		
UNIT II	Microbial growth: Isolation of microorganisms – Bacteria's and fungi, pure culture technique and enrichment culture techniques, methods of sterilization. Growth curve, Measurement of growth and Growth yields, diauxy growth, Synchronous culture, continuous		

	culture, influence of environmental factors on growth. Current methods of microbial identification
UNIT III	Bacteria – Purple and Green Bacteria, Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci; Mycobacteria and Mycoplasmas, Archaea: Halophiles; Methanogens; Hyperthermophilic archaee – Eukarya: Fungi – Introduction, structure and characteristics of fungal divisions Algae – Introduction, Characteristics of Algal divisions.
UNIT IV	Viruses: General properties of viruses. DNA and RNA viruses, Classification of viruses – Baltimore, Virioids and Prions. Cultivation and Host parasite relationship, Host defense against microbial invasion, Microbial mechanism for escaping host defenses. Bacteriophage – lytic and lysogenic cycle and types
UNIT V	Bacterial pathogenicity: <i>Mycobacterium tuberculosis</i> - Progress of tuberculosis –classical and recent advances in diagnosis and treatment. <i>Treponema pallidum</i> - process of infection, transmission diagnosis and treatment. Viral pathogenicity: HIV, Rabies, Ebola and Dengue - replication cycle, transmission, diagnosis and treatment; fungal pathogenicity: Ringworm infection and treatment. Protozoan diseases: malaria – life cycle of plasmodium, classical and recent advances in diagnosis and treatment.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Atlas R. M and Bartha R. 2000. Microbial Ecology- Fundamentals and Applications 2. Prescott L.M, Harley J.P. and Klein D.A. 2005. Microbiology, Sixth edition 3. McGraw Hill, Boston. 4. Maier R.M., Pepper I.L. and Gerba C.P. 2006.

	<p>Environmental Microbiology, Elseiver Publication, New Delhi, India.</p> <ol style="list-style-type: none"> 5. Salyers A.A. and Whitt B.D. 2001. Microbiology – Diversity, Disease and the Environment, Fitzgerald Scientific Press, Maryland. 6. Persing D.H. 2004. Molecular Microbiology – Diagnostic Principles and Practice, ASM Press, Washington, USA. 7. Zhou J., Thomson D.K, Xu Y and Tiedje J.M. 2004. Microbial Functional Genomics, J.Wiley and Sons Publishers. 8. Greenwood D, Slack R and Peutherer J. 1997. Medical Microbiology. ELST, Churchill Livingstone, Hong Kong. 9. Microbiology: An Introduction (2014), Twelfth edition. Gerard J. Tortora, Berdell R. Funke, Christine L. Case. 10. Alcamo’s Fundamentals of Microbiology (2011), Fifteenth edition. Jeffery C. Pommerville and I. Edward Alcoma. Chicago, Sudburg, Mass: Jones and Bartlette Publishers. 11. Molecular Microbiology – Diagnostic Principles and Practice (2004), D.H. Persing, ASM Press, Washington, USA. 12. Microbial Functional Genomics (2004) by J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje, J.Wiley & Sons Publishers 13. Microbial Ecology. Fundamentals and Applications (2000) by R. M. Atlas and R. Bartha 14. Microbiology (1993) by M.J. Pelzer Jr., E.C.S. Chan and N.R. Kreig, McGraw Hill Inc., New York.
E-book links	<ol style="list-style-type: none"> 1 https://www.pdfdrive.com/medical-microbiology-e18737002.html 2 https://www.pdfdrive.com/microbiology-and-immunology-textbook-of-2nd-edition-e33405391.html 3 https://www.pdfdrive.com/prescotts-microbiology-

	e166597880.html https://www.pdfdrive.com/food-microbiology-fundamentals-and-frontiers-e175273799.html
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Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE	
	1	2	3	4	5	6	7	8	1	2	3	4	5		
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
														MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	CORE III- MOLECULAR BIOLOGY – PBTT13		
Semester	Semester-I	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To learn basic knowledge about nucleotides structure and its function. • To Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function. • To learn knowledge in genome organization of organisms. • Understanding the structural and functional aspects of the genes provides the student with a strong foundation in the molecular mechanisms. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: know the Structure, types, replication process and function of nucleic acids both prokaryotic & Eukaryotic K1 CO2: understand the RNA synthesis and processing and Protein synthesis and processing inside the cell K2 CO3: well-known with the Control of gene expression and molecular Recombination event inside the cell K4 CO4: know about the different methods of DNA repair mechanisms in the cell, Gene mapping techniques and cellular signal transduction pathways K3 CO5: to study the basic concept of Quorum sensing, Oncogenes and anti-oncogenes. K2		
UNIT I	DNA as genetic material. Structure, types and function of DNA & RNA, mi RNA, RNA i– Si RNA, PNA, extra chromosomal genetic material. DNA replication models: prokaryotic & Eukaryotic replication. DNA binding proteins, Histones, Mutations, Mutagens – Physical & chemical. Transposon– types.		

<p>UNIT II</p>	<p>RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, Splicing and polyadenylation, RNA transport.</p> <p>Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA – identity. Aminoacyl tRNA synthetase and translational proof-reading, translational inhibitors, post-translational modification of proteins.</p>
<p>UNIT III</p>	<p>Control of gene expression at transcription and translation level (Regulating the expression of phages, viruses, prokaryotic and eukaryotic gene, role of chromatin in gene expression and gene silencing). Recombination -Homologous, Non homologues and site specific recombination.</p>
<p>UNIT IV</p>	<p>DNA repair mechanisms: photo activation, excision repair recombination repair; SOS and adaptive responses and their regulation. Gene mapping methods- linkage maps, tetrads analysis, mapping with molecular markers, mapping by somatic cell hybrids, development of cell signaling; hormones & their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, and regulations of signaling pathways.</p>
<p>UNIT V</p>	<p>Bacterial and plant two component systems, light signaling in plants, bacterial chemo taxis and Quorum sensing. Molecular Chaperons-Heat Shock proteins. Oncogenes and anti-oncogenes.</p>

REFERENCES

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6. Cooper G. 2000. The Cell: A molecular approach. 2nd Eds, Sinauer Associates Inc.
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10. Molecular Biology of the Cell (2014), 6th Edition, B. Alberts Johnson, J. Lewis, M. Raff, K. Roberts and P Walter, Garland Publishing (Taylor & Francis Group), New York & London (ISBN: 9780815344322).
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12. Primrose S.B, Twyman R.M., Old R.W. 2002. Principles of Gene Manipulation and genomics. 7th Edition. Blackwell Science.

E-book links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/cell-division-genetics-and-molecular-biology-cell-division-genetics-and-molecular-biology-e22406140.html 2. https://www.pdfdrive.com/cell-biology-genetics-molecular-biology-evolution-and-ecology-e132225829.html 3. https://www.pdfdrive.com/molecular-cell-biology-molecular-cell-biology-e7302545.html 4. https://www.pdfdrive.com/biochemistry-genetics-molecular-biology-e18198970.html 5. https://www.pdfdrive.com/molecular-cell-biology-lodish-5th-ed-e15674865.html <p>https://www.pdfdrive.com/karps-cell-and-molecular-biology-e176035175.html</p>
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	M	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	PRACTICAL I: LAB IN ANALYTICAL BIOCHEMISTRY & LAB IN MICROBIOLOGY AND MOLECULARBIOLOGY – PBTP11		
Semester	Semester-I	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To learn the technique about identification of microorganism from biological samples. • To know the isolation and purification of actinomycetes and fungi and biochemical characterization of selected bacteria. • To know the technique about spontaneous mutation by gradient plate technique induced mutagenesis (UV, NTG) and replica plate technique. • To learn technique about molecular mechanisms underlying cellular function, isolation of plasmid DNA and genomic DNA and DNA repair mechanism. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: able to gain practical knowledge about biomolecules K1 CO2: develop skill and do different chromatography techniques K4 CO3: to gain hands on isolation and identification of microbes in the laboratory K1 CO4: gain knowledge about analysis of mutation studies K2 CO5: to train on isolation of nucleic acids K1		
LAB IN ANALYTICAL BIOCHEMISTRY	Preparation of solutions – Molar, Normal, Percentage, Stock, Working etc. 2. Preparation of buffers – PBS, Tris and Acetate buffer. 3. Qualitative analysis of carbohydrate, protein, and lipid 4. Estimation of mono saccharide 5. Extraction and Estimation of starch from potato/ tapioca		

	<ol style="list-style-type: none"> 6. Estimation of protein 7. Estimation of nucleic acids by absorbance at 260 nm 8. Enzyme assay: Estimation of salivary amylase from saliva & phosphatase from potato 9. Estimation of DNA by diphenylamine 10. Estimation of RNA by orcinol method. 11. Estimation of lipids 12. Estimation of vitamins – ascorbic acid, α-tocopherol & β – carotenoids. 13. Separation of amino acids by Paper chromatography 14. Separation of amino acids by and Thin layer chromatography 15. Separation of pigments by column chromatography 16. Estimation of glucose (DNS method)
<p>LAB IN MICROBIOLOGY AND MOLECULARBIOLOGY</p>	<ol style="list-style-type: none"> 1. Isolation of microorganism from samples. 2. Methods of Counting colonies in petridish cultures 3. Preparation of media. 4. Pure culture techniques – serial dilution – pour plate, spread plate, streak plate and stab culture 5. Bacterial staining methods – single, Grams and negative 6. Fungal staining methods – Lacto phenol cotton blue 7. Motility of bacteria 8. Enumeration of bacteria/Yeast cell, viable count(Plate count), Total count (Haemocytometer) 9. Isolation and purification of actinomycetes, fungi 10. Biochemical characterization of selected bacteria. 11. Spontaneous mutation by gradient plate technique. 12. Induced mutagenesis (UV, NTG) 13. Detection of mutants by replica plate technique.

	14. Study of mutation by Ames test. 15. Antibiotic sensitivity 16. Bacteriophage titration – plaque forming cells. 17. Isolation of Plasmid DNA 18. Isolation of Genomic DNA 19. DNA repair mechanism.
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3,0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3,0

. The Mean Score is 3.0, which is strongly correlated

Course Title & Code	<u>ELECTIVE I</u>		
	Option I: CELL BIOLOGY AND GENETICS – PBTE11		
Semester	Semester-I	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> • Knowledge about structure and function of cells, cellular energetics, protein trafficking, bio molecules and cellular development. • Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function • To pursue careers in cellular and sub cellular biological research, biomedical research. • This paper provides a thorough knowledge about cell structure and function, cellular transport, signaling, protein trafficking, cellular development, gene expression and genetic diseases. 		
UNIT I	Structure of prokaryotic and Eukaryotic cell. Structure and function of nucleus, endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast & lysosomes. Cytoskeleton (Microfilaments, intermediate filaments, microtubules and associated proteins), motile cells, Nerve cells, Nerve impulse, muscle cell, muscle contraction		
UNIT II	Ultra structure of plasma membrane – components & membrane asymmetry; Transport process – active transport, monophores & ion channels. Exo & endocytosis, Phago and pino cytosis, Ribosomes, vacuoles, peroxisomes.		
UNIT III	Chromosomes – morphology, Ultra structure, specialized chromosomes. Molecular events of cell cycle and its regulation. Cell division – Amitosis & meiosis. Cell differentiation and cell death.		
UNIT IV	Mendelian principles- segregation and independent assortment. Incomplete dominance. Trihybrid ratio. Epistasis. Pedegree analysis. Chromosome abnormalities, quantitative inheritance, Hardy-Weinberg equilibrium, genetic drift and speciation.		

UNIT V	Sex determination and Linkage: (Drosophila, Hymenoptera, Mammals). Environmental factor and Sex determination, Sex differentiation. Sex linkage in diploids crossing over. Genetic disorders.
COURSE OUTCOMES	<p>Upon completion of this course the students will be able to</p> <p>CO1: know the Structure of prokaryotic and Eukaryotic cell. Structure and function of different organelles K1</p> <p>CO2: understand the Ultra structure of plasma membrane, Transport process in the cell K2</p> <p>CO3: Understand the Molecular events of cell cycle and its regulation and Cell division K2</p> <p>CO4: know about the basic Mendelian principles, Pedigree analysis and Chromosome abnormalities K1</p> <p>CO5: to educated the vital perception of Sex determination and Linkage (Drosophila, Hymenoptera, Mammals). K3</p>
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Molecular Biology of the Cell, Fourth Edition.(Bruce Alberts) , Alexander Johnson , Julian Lewis, Martin Raff , Keith Roberts, Peter Walter. Academic Press. New York. (1994) 2. Molecular Cell Biology. 6th Eds. Lodish , Berk , Baltimore et al . W.H. Freeman & Co.(2000) 3. Cell and Molecular Biology: Concepts and Experiments, 5th Eds. Gerald Karp. Wiley (2008) 4. The Cell: A molecular approach. 2nd Eds. Geoffrey Cooper. Sinauer Associates Inc. (2000) 5. Kleinsmith, L. J. & Kish, V.M. 1995. Principles of Cell and Molecular Biology. 2nd edn.,McLaughlin, S.,Trost, K., Mac Elree, E. (eds.), Harper Collins Publishers, New York. 6. De Robertis and De Robertis. 8th Eds. Cell and Molecular Biology. Lippincott Williams & Wilkins (2005) 7. Molecular Biotechnology. 2nd Edition. Sandy B Primrose. Blackwell Scientific Publishers (1991) 8. Genomes. 2nd Edition. T.A.Brown. Wiley-Liss (New York). 2002 9. Molecular Genetics of Bacteria. 2nd Edition. Larry Snyder,

	<p>Wendy Champness. Amer Society for Microbiology. 2002.</p> <p>10. Benjamin Lewin. Genes VIII.2003. Benjamin-Cummings Pub Co.</p>
E-book links	<p>1) https://www.pdfdrive.com/cell-division-genetics-and-molecular-biology-cell-division-genetics-and-molecular-biology-e22406140.html</p> <p>2) https://www.pdfdrive.com/cell-biology-genetics-molecular-biology-evolution-and-ecology-e157248372.html</p> <p>3) https://www.pdfdrive.com/the-handy-biology-answer-book-the-handy-answer-book-series-e175569465.html</p> <p>https://www.pdfdrive.com/cellmolecular-biology-and-biotechnology-e33452455.html</p> <p>1) https://www.pdfdrive.com/molecular-cell-biology-e187264624.html</p>

Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	<u>ELECTIVE I</u>		
	Option II: DEVELOPMENTAL BIOLOGY – PBTE11		
Semester	Semester-I	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • Information on the development and physiology of various animal and plant systems. • To enable the students to know the actual pathway of physiological metabolism of mammals including humans. • The gained information about the various living system which will help in the future to develop the drugs. • Students can understand the basic concepts of developmental biology in both plants and animals. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: know the Fertilization process in the animal kingdom. K1 CO2: understand the –development of organs in chick and Hormonal control process in ovulation and pregnancy, menstrual cycle, gestation period, abortion. K2 CO3: Understand the Embryogenesis, seed formation and germination in plants. K2 CO4: know about the basic Sex determination as well as understand the Genetic errors of Human development K3 CO5: to study the critical model of Organization of shoot & root, floral meristems and floral development in Arabidopsis. K4		
UNIT I	Sperm & egg, spermatogenesis, Oogenesis, Sperm and Oocyte maturation. Cell surface molecules in sperm – egg recognition. Egg activation and signaling mechanism, Fertilization, polyspermy. Parthenogenesis		
UNIT II	Cleavage, blastula formation, gastrulation and formation of germ layers. Organogenesis –development of heart, eye and brain in chick. Hormonal control of ovulation and pregnancy, menstrual cycle, gestation period, abortion, ectopic pregnancy.		
UNIT III	Embryosac development and double fertilization in plants. Embryogenesis, establishment of symmetry in plants; seed formation and germination		

UNIT IV	Post embryonic development- larval formation, metamorphosis, Regeneration, Sex determination. Genetic errors of Human development, teratogenesis
UNIT V	Organization of shoot & root apical meristem; shoot & root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Developmental Biology, Gilbert, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA. 2. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA. 3. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi, INDIA. 4. Principles of Development, Second Edition. Lewis Wolpert, Rosa Beddington, Thomas Jessell, 5. Peter Lawrence, Elliot Meyerowitz, Jim Smith. Oxford University Press. 2002. 6. From embryology to Evo-Devo: a history of developmental evolution. Edited by Manfred D. Laubichler and Jane Maienschein. Cambridge, Mass: MIT Press, c2007.
E-book links	<ol style="list-style-type: none"> 1) https://www.pdfdrive.com/developmental-biology-9th-edition-e156874068.html 2) https://www.pdfdrive.com/developmental-biology-eighth-edition-e161981415.html 3) https://www.pdfdrive.com/developmental-biology-e188565455.html

Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	M	S	S	2.92
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S	2.92
CO4	S	S	S	S	S	S	S	S	S	S	S	S	M	2.92
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	2.95

The Mean Score is 2.95, which is moderately correlated

Course Title & Code	CORE IV- IMMUNOLOGY– PBTT21		
Semester	Semester-II	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To expose the students with various immune systems of human body. • Understanding the immune system, antigen antibody reactions, applications of immunological techniques, humoral and cell mediated immunity. • To learn about hypersensitivity reactions and hybridoma technology. • This course will provide the student insights into the various aspects of Immunology such as classical immunology, clinical immunology, Immunotherapy and diagnostic immunology. • Student can understand the basic concepts of immune system and will get trained in various techniques involved in Immunology for drug discovery and solve immune problems. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: to study and know the basic of immune system about the cells, Immunoglobins K1 CO2: Understand the difference of Antigens and Antibody and its mechanisms inside the host and future drug development aspects K2 CO3: to learn communication of immune cells by using cytokines, signaling molecules mediate and regulate immunity. K2 CO4: Current issues and problems of types of Hypersensitivity, Immunotolerance, Transplantation, graft rejection & immunosuppressive therapy. K3 CO5: to study the tools and techniques in immunotechnology, vaccine development. K4		

UNIT I	Overview of the immune system, Milestones of Immunology. Innate and adaptive immunity. Lymphoid glands – Primary and secondary structure and function. Cells of the immune system & their functions. Immunoglobulins – structure and function, immunoglobulins (organization and expression) Activation, maturation and Differentiation of B cells and t cells.
UNIT II	Immunogenicity – Immunogens, adjuvants, Epitopes, haptens and carriers. Antigens Antibody interactions. Cell mediated and humoral immune response. Cellular interactions – Cell surface receptors, CAMS, Major Histocompatibility complex (MHC); Structure and interactions. Antigen processing and Presentation.
UNIT III	Lymphokines and cytokine receptors, therapeutic uses. Complement systems: activation pathways – classical, alternative and lectin.
UNIT IV	Hypersensitivity I,II,III,IV, Immunotolerance, Transplantation, graft rejection & immunosuppressive therapy, HLA therapy, Auto immune disorders – types, mechanisms and treatment, congenited and acquired immunodeficiencies
UNIT V	Vaccines (traditional and novel) Hybridoma technology, ELISA, FACs, Immunofluorescent microscopy, Immunodiffusion , Immuno electrophoresis, Western blottin.

<p><u>REFERENCES</u></p>	<ol style="list-style-type: none"> 1. Weir D. M and Steward J. 1993. Immunology. VII edition, ELBS. London. 2. Riot I. M. 1994. Essential Immunology. Blackwell scientific. Publications. Oxford. 3. Jacqueline S, Williams and Wilkins A. 1998. Basic Immunology. Waterly Company. 4. Janeway Travers. 1997. Immunobiology. The immune system in health & disease. 3rd edition. Current biology Ltd., London, New York. 5. Lydyard P, Whelam A & Fanzer MW 2000. Instant notes in immunology, Edited by Hames BD, Viva books Pvt. Ltd. 6. Paul 1998. Fundamental Immunology. 3rd Edition. 7. Peter J. Delves, Ivan M. Roit (eds). 1998. Academic press encyclopedia of Immunology – 2nd edition. 8. Richard M. Hyde. 1995. Immunology III edition. National medical series. Williams & Wilkins, Harvard Publishing Company. 9. Clark WR 1991. The experimental foundations of modern Immunology, John Wiley & sons Inc, New York. 10. Kuby Immunology (2007) by Thomas J. Kindt, Richard A. Goldsby and Barbara A. Osborne. W.H.Freeman and Company 11. Immunology (2006) by David Male, Jonathan Brostoff, David B Roth and Ivan Roit. Elsevier Publishers. Chapel H and Halbey M. 1986. Essentials of Clinical Immunology. ELBS.
<p>E-book links</p>	<ol style="list-style-type: none"> 1) https://www.pdfdrive.com/microbiology-and-immunology-textbook-of-2nd-edition-e33405391.html 2) https://www.pdfdrive.com/cellular-molecular-immunology-7th-edition-e157242744.html 3) https://www.pdfdrive.com/basic-immunology-e21670961.html

	4) https://www.pdfdrive.com/medical-microbiology-virology-immunology-e43491517.html
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Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	CORE V- RECOMBINANT DNA TECHNOLOGY – PBT22		
Semester	Semester-II	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To expose students to application of rDNA technology to various fields of biotechnology (medicine and research areas). • The student a thorough knowledge in principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms and gene therapy. • To learn about techniques employed are carved as self-study. • To get information on the latest advances in recombinant DNA technology, principles, techniques for genetic engineering new organism to solve the social problems. Which is a powerful tool needed for modern biotechnology research. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: to study and know the tools and advanced current techniques of genetic engineering K1 CO2: Understand the difference between hosts and its suitable vectors for gene cloning K2 CO3: to learn procedure for gene transformation techniques into the cell. K4 CO4: to well versed in PCR techniques and primer design using bioinformatics tools and its importance to find solution and improvement in the field of plant and animal and man kind welfare K3 CO5: Apply advanced techniques for identification of any organisms using DNA barcoding, DNA based nanostructure and applications K4		
UNIT I	Restriction enzymes, DNA ligase, Klenow fragment, DNA polymerase I, T4/T7 DNA polymerase, Taq polymerase linkers, adaptors, Homopolymeric tailing, alkaline phosphatase, Reverse transcriptase, Radioactive and non radioactive probes, hybridization, Microarray.		
UNIT II	Host cells – Prokaryotic & Eukaryotic, Vectors – plasmids, Lamda phage, M13, PUC 18, Cosmids, artificial chromosomal vectors (YAC, BAC), Animal virus derived-SV40, Vaccinia, retroviral, Expression vectors-pET based yeast vectors and Shuttle vectors, Ti and R vectors.		

UNIT III	Transformation, Electroporation, Lipofection, Microinjection, Construction of Genomic DNA and cDNA libraries, cDNA and genomic cloning, Expression cloning, protein-protein interactive cloning.
UNIT IV	Primer design, PCR- Multiplex, nested, reverse transcriptase, realtime, Touchdown, Hot start and colony. PCR in molecular diagnostics, Viral & Bacterial detections, mutation & polymorphism detection – RFLP, SSCP, Oligo ligation assay, Allele specific amplification, DNA fingerprinting, site directed mutagenesis.
UNIT V	DNA sequencing –chemical, enzymatic, Automated & Pyro Human genome project, DNA barcoding, DNA based nanostructure and applications.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Gene Cloning and DNA Analysis. An introduction (2006) by T.A Brown, Blackwell Scientific Publications. 2. Principle of Gene Manipulation and Genomics (2006) by S.B Primrose and R.M Twyman, Blackwell Scientific Publications. 3. Molecular Biology of the Gene, 6th edition (2008) by James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine and Richard Losick, Benjamin Cummings. 4. From Genes to Clones: Introduction to gene technology (1987) by Winnacker, E.L. 5. Next generation sequencing (2008) by Michael Janitz, Wiley Blackwell Publications.
E-book links	<ol style="list-style-type: none"> 1) https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-4th-edition-e162050162.html 2) https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-e156918014.html 3) https://www.pdfdrive.com/recombinant-dna-technology-molecular-biology-and-paradigms-e11385991.html 4) https://www.pdfdrive.com/recombinant-dna-principles-and-methodologies-e185941491.html

Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	CORE VI- ENVIRONMENTAL BIOTECHNOLOGY – PBTT23		
Semester	Semester-II	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To expose students to application of rDNA technology to various fields of biotechnology (medicine and research areas). • The student a thorough knowledge in principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms and gene therapy. • To learn about techniques employed are carved as self-study. • To get information on the latest advances in recombinant DNA technology, principles, techniques for genetic engineering new organism to solve the social problems. Which is a powerful tool needed for modern biotechnology research. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	<p>CO1: to identify and conserve the diversity both plants and animals resources. Use the resource in the natural way to avoid pollution K1</p> <p>CO2: Understand and identify the environmental issues due to types of pollution in current situation today country facing and problem solve mechanisms K2</p> <p>CO3: to learn procedure and do research in water treatment, water borne diseases, treatment of effluent from industry K3</p> <p>CO4: gain knowledge about types of solid wastes generated in house and industry and solve the problems using natural process and earn income by recycling the waste K6</p> <p>CO5: to identify the environmental problems, find solution for chemical usage of pesticides and fertilizer and go far natural way of production technology and become good Entrepreneur K4</p>		
UNIT I	Natural resource and fuels: Environment components, Role of Biotechnology in Environmental protection, Classification of natural resources – Inexhaustible, Exhaustible- resources. Conservation of natural resources – water, forest, energy and soil resources. Insitu – Exsitu conservation. Production of biogas and biofuel (alcohol), environmental act.		

UNIT II	Pollution: Types of environmental pollution. Bioindicators and biosensors for detection of pollution. Biochemical methods for control of pollution. Green house effect and global warming. Ozone depletion and acid rain, Bhopal disaster, London smog.
UNIT III	Water chemistry – physical-chemical and biological parameters – sources and efficiency of water pollution, oil pollution, super bug, water treatment, water borne diseases, Treatment of effluent from distillery and sugar industry. Minamata disease, GAP, YAP, need for water management. Eutrophication, Oil disaster.
UNIT IV	Types of solid wastes, sources and its impact on environment, solid waste disposal-land filling, composting, incineration, 3R concepts, Vermicomposting, Radioactive wastes sources, Disposal - Deino coccus, Sources effects and control measures. Love canal disaster.
UNIT V	Biopesticides and Biofertilizers, Single cell protein, Biomineralisation, Mechanism of Biomineralization. Biomining. Xenobiotics – Pesticides degradation, Degradative plasmids, hydrocarbons, Biotechnology for Hazardous waste management, Persistent organic pollutants, Biological detoxification of PAH, Eco – mark, Biodegradable plastics.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Jordening HJ and Winter J. 2005. Environmental Biotechnology: Concepts and Applications. Wiley. 2. Dwivedi S.K, Kalita M.C, and Dwivedi P. 2007. Biodiversity and Environmental Biotechnology. 1st edition. Scientific Publishers, India, New Delhi. 3. Sharma P.D. 1994. Environmental Biology. Rastogi Publishers, New Delhi. 4. Chatterjee A.K. 2002. Introduction to Environmental Biotechnology. Printice Hall, India.
E-book links	<ol style="list-style-type: none"> 1) https://www.pdfdrive.com/environmental-biology-the-conditions-of-life-environmental-selection-extinction-creation-e116415545.html https://www.pdfdrive.com/environmental-biotechnology-biodegradation-bioremediation-and-bioconversion-of-xenobiotics-for-sustainable-development-e158141796.html

Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is moderately correlated

Course Title & Code	PRACTICAL III: LAB IN IMMUNOLOGY & RECOMBINANT DNA TECHNOLOGY & LAB IN ENVIRONMENTAL BIOTECHNOLOGY – PBTP22		
Semester	Semester-II	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To introduce students to different techniques that are commercially used in molecular diagnosis of diseases and give an account of different diseases that are routinely diagnosed using molecular testing. • To give a broad overview of molecular theory and exposure to molecular and immunology techniques, a forum to understand clinical applications of various molecular tests. • To introduce students to different techniques that are commercially used in molecular and immunology diagnosis of diseases and give an account of different diseases that are routinely diagnosed using molecular and immunology testing. • To get information on the latest advances in recombinant DNA technology, which is a powerful tool needed for modern biotechnology research. • To practice remediation of contaminated environments (land, air, water), and for environment-friendly processes such as green manufacturing technologies and sustainable development. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: able to gain practical knowledge about immunological techniques K1 CO2: Understand and identify the health issues and report very easily K2 CO3: to learn procedure and do research in protein, genes and gene transformation and opportunity to do research labs and company K3 CO4: gain knowledge about analysis of water quality and solve the problem to the society K6 CO5: to identify the environmental problems, find solution using biotechniques especially microbial techniques K6		

<p>LAB IN IMMUNOLOGY & RECOMBINANT DNA TECHNOLOGY</p>	<ol style="list-style-type: none"> 1. Preparation of Serum and Plasma 2. Differential count of WBC 3. Blood grouping 4. Widal slide test 5. Pregnancy test 6. Ouchterlony's double immunodiffusion technique 7. Rocket immune electrophoresis 8. Routes of inoculation of laboratory animals 9. ELISA 10. Western blotting 11. Restriction digestion, ligation 12. Preparation of competent <i>E.coli</i> cells & transformation of <i>E.Coli</i> using recombinant DNA 13. Primer designing and PCR
<p>LAB IN ENVIRONMENTAL BIOTECHNOLOGY</p>	<ol style="list-style-type: none"> 1. Sampling techniques of water 2. Determination of colour, pH and temperature 3. Estimation of total alkalinity 5. Estimation of chloride 6. Estimation of total hardness 7. Estimation of Calcium 8. Estimation of DO, BOD and COD 9. Estimation of phosphate 10. Estimation of chromium and ferrous ion 11. Quick field soil test 12. Isolation of micro-organism from chrome tanning effluent 13. MPN- Water portability Test 14. Microbial treatment of industrial (sugar or dye) effluent and determination of COD

Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	<u>ELECTIVE II: OTHER DEPARTMENT ELECTIVE – PBTE22</u> Option 1: BIOINFORMATICS – PBTE22		
Semester	Semester-II	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K5: Evaluate K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To Understand and learn the technical details of several current experiments or technologies used in the field of biology. • Understand some of the larger questions and issues with systems biology and large-scale data collection and analysis. • To give the students comprehensive training in the emerging exciting upcoming area of Systems Biology, which will help students to get a career in both industry/R&D. • To learn information in different areas of biology - on genome sequences of many organisms, genetic and biochemical interaction networks, cell interactions during development, and organism response to environmental stimuli, along with molecular understanding of diseases. • Students can acquire knowledge on tools to predict bio macromolecules structure and interaction, analyze the genomics and proteomics data and drug designing process. They also will get basic knowledge on computer application. 		
COURSE OUTCOMES	<p>Upon completion of this course the students will be able to</p> <p>CO1: able to gain practical knowledge about computer and its usage for academic purpose, research as well and gain job opportunity K1</p> <p>CO2: learn MS office, MS power point and software tool SPSS useful in research purpose K2</p> <p>CO3: to learn procedure and do research in protein, genes in Biological database, protein database opportunity to do research labs and company K3</p> <p>CO4: gain knowledge about analysis of Phylogenetic trees. K5</p> <p>CO5: to learn and gain knowledge in Submitting DNA sequence and protein sequence to database K6</p>		
UNIT I	Introduction to computer – Characteristics – Components of computers. Hardware, Software – basics of Windows: Operating system – Accessories of windows; paint, calculation, recycle bin, Windows explorer, Internet explorer, Internet services – Mail services. Google and yahoo search engines		

UNIT II	MS office; introduction – components; MS word – screen layout-formatting features, editing features, mail merge, insertion of objects: clip art, mathematical equation, charts, printing & page layout. MS excel. Introduction, spread sheet layout, Cell manipulation, formula automatic recalculation. Statistical function cell manipulation, creation of charts, sheet manipulation. Printing of worksheet.. MS power point – introduction – views: slide, sorter view, slide show – design template, animal setting, insertion of objects – land outs Software: origin, SPSS
UNIT III	Introduction to Bioinformatics – definition, History and application. Biological database; nucleic acid sequence databases: Nucleic acid sequence databases: Gen bank, NCBI, EMBL, DDBJ, Protein sequence Database: SWISSPORT, PIR; structural database; PDB, cath, SCOP.
UNIT IV	Sequence alignment – global Vs local alignment, pairwise alignment, principles of sequence similarity search algorithms. Multiple sequence alignment, formatting & editing multiple sequence alignments. Phylogenetic trees.
UNIT V	Submitting DNA sequence and protein sequence to database. Database similarity searching, collecting and shorting sequences. Types of BLAST and FASTA. Various file formats for biomolecular sequences: Genbank, FASTA, GCG, MSF, NBRF-PIR etc
<u>REFERENCES</u>	<p>Introduction to Bioinformatics: A theoretical and Practical Approach. 1st Edition. : Stephen A. Krawetz, David D. Womble. Humana Press. 2003</p> <ol style="list-style-type: none"> 1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 3rd Edition. Andreas D. Baxevanis , B. F. Francis Ouellette . Wiley, John & Sons.2004.

Mapping of COs with POs & PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S	2.92
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S	2.92
													MEAN SCORE	2.96

The Mean Score is 2.96, which is moderately correlated

Course Title & Code	<u>ELECTIVE II: OTHER DEPARTMENT ELECTIVE – PBTE22</u> Choice 2: NANOTECHNOLOGY AND CANCER BIOLOGY		
Semester	Semester-II	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To provide the students with knowledge and the basic understanding of nanotechnology and cancer. • The properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials. • To give an idea about Synthesis of nanomaterials, charecterisation and their application • To give students an historical perspective on the most commonly studied topics in cancer biology. • To link specific cancer biology subjects with clinical aspects of the disease. • Students can understand the nanomaterials, its synthesis and application for almost all the field to the benefit of humankind. Students will also acquire knowledge on cancer biology. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: to know basic about nanomaterials and Nanoparticles K1 CO2: learn the Application of nanotechnology in different field and problem solving solution K3 CO3: to learn update research in Nanotechnology for cancer research & therapy K4 CO4: gain knowledge about Epidemiology of cancer, cancer types, characteristics of cancer cells in molecular aspects K2 CO5: to find out and acquire knowledge about chemotherapy and chemoprevention in Tumor immunology K6		
UNIT I	Nanotechnology – definition – Quantum dots, Nanowires & properties, 2D films. Nano scale materials. Nanopores . Characterization of Nanoparticles and Nanomaterials.		
UNIT II	Application of nanotechnology; Nano sensors-types & its applications, Nano carriers for drug delivery-polymeric NP, Micelles, Micro emulsions, Lipoproteins as pharmaceutical carriers. Solid lipid NP as drug carriers.		

	Nanocapsules-Preparation, Characterization & therapeutic applications. Nano medicine-Biopharmaceuticals. Implantable materials, Devices, Surgical aids, diagnostic tools, Genetic testing, Imaging.
UNIT III	Nanotechnology for cancer research & therapy. Environmental nano remediation technology. Thermal, physico-chemical and Biological methods. Nano filtration for the treatment wastes, removal of organics, Inorganics and pathogens. Nanotechnology for water purification.
UNIT IV	Epidemiology of cancer, cancer types, characteristics of cancer cells, carcinogenesis: Cancer initiation, promotion and progression, termination. Factors responsible for Carcinogenesis; Physical, Chemical and Biological
UNIT V	Tumor immunology – tumor antigens, cytokines, vaccine development, immunotherapy and its limitations, Tumor cell evasions of immune defenses. Principles of chemotherapy and chemoprevention.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Maloy S.R., Cronan Jr. J. E., and Freifelder D. 2006. Microbial Genetics, Jones and Bartlett Publishers, Sudbury, Massachusetts. 2. Chichester and Dale JW, 1994. Molecular genetics of Bacteria. John Wiley & sons. New York. 3. Hartl D.A and Jones E.W. 2000. Genetics: Analysis of genes and genomes, Jones & Bartlett Publishers, Sudbury, Massachusetts. 4. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. 1994. Molecular Biology of the Cell, Fourth Edition, Academic Press. New York. 5. Lodish, Berk, Baltimore et al . 2000. Molecular Cell Biology, 6th Eds, W.H. Freeman & Co. 6. Cooper G. 2000. The Cell: A molecular approach. 2nd Eds, Sinauer Associates Inc. 7. Kleinsmith L. J. and Kish V.M. 1995. Principles of Cell and Molecular Biology. 2nd edn., McLaughlin, S., Trost, K., Mac Elree, E. (eds.), Harper Collins Publishers, New York. 8. De Robertis and De Robertis. 2005. 8th Eds. Cell and Molecular Biology. Lippincott Williams & Wilkins. 9. Brown T.A, 2002. Genomes. 2nd Edition. Wiley-Liss, New York. 10. Primrose S.B, Twyman R.M., Old R.W. 2002. Principles of Gene Manipulation and genomics. 7th Edition. Blackwell Science. 11. The Cell: A Molecular Approach (2016) 7th Edition, ASM Press, Washington D.C. & Sinauer Associates, Inc, Sunderland, Massachusetts. Geoffrey M.Cooper and Robert E.Hausman

	12. Cell and Molecular Biology – Concepts and Experiments (2016), (ed), John Wiley & Sons Inc, New York. Gerald Karp, Harris, D 13. Genes IX (2007), 9 th Edition, Jones and Barlett Publishers. ISBN: 0763740632. Benjamin Lewin
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE	
	1	2	3	4	5	6	7	8	1	2	3	4	5		
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S	2.92	
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S	2.92	
CO4	S	S	S	S	S	S	S	S	S	S	S	M	S	2.92	
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0	
													MEAN SCORE	2.95	

The Mean Score is 2.95, which is moderately correlated

Course Title & Code	<u>CORE VII-PLANT BIOTECHNOLOGY – PBTT31</u>		
Semester	Semester-III	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To equip students with theoretical knowledge regarding the techniques and applications of Plant Biotechnology and Genetic Engineering. • To give the students comprehensive training in the plant biotechnology and its application for increasing agricultural production, environment improvement, human, nutrition and health. • Students will learn about genome organization in plants, basic techniques in tissue culture and its applications. • To learn knowledge about Genetic transformation in plants, metabolic engineering, production of pharmaceuticals and industrial products known as plant molecular farming. • On successful completion of the course the students will be aware of various in vitro culture techniques, preservation of plant cells, gene transferring mechanism and transgenic plants. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: to know basic techniques and setup off plant tissue culture laboratory K1 CO2: understand the Application and techniques of germplasm conservation, hardening and green house technology. K2 CO3: to be trained and update research in plant transformation techniques K3 CO4: gain knowledge about Terminator seed technology and research advancement and its production of edible vaccines, plantibodies in transgenic plants and agriculture problems and medical problems adapt solution using transgenic plants. K6 CO5: to find out and acquire knowledge about Biosafety guidelines for research involving GMO's and IPR K2		
UNIT I	Laboratory setup- Plant cell and tissue culture-culture media; composition and preparation, plant hormones, sterilization, Callus culture, Micropropagation, suspension culture, root tip culture, anther culture pollen culture, ovary culture, embryo culture.		
UNIT II	Somoclonal variation, Somatic hybridization – protoplast isolation fusion and culture, synthetic seeds, germplasm conservation hardening and green house technology.		

UNIT III	Transgenesis in plants: Gene transfer – Agrobacterium mediated, Caulio virus, Baculo virus mediated, Promoters, reporter genes and marker genes, terminator. Gene silencing.
UNIT IV	Terminator seed technology – delayed fruit ripening, transgenic plants-plantibodies, golden rice, edible vaccine, insect resistant-Bt, herbicide resistance-glyphosate, Disease resistant-antifungal proteins, Virus resistance-coat protein & nucleocapsid, Nematode resistant, Abiotic stress tolerant.
UNIT V	Plant as bioreactor: Green & red fluorescent protein, starch and fructans. Nitrogen fixation and genes. Biosafety guidelines for research involving GMO's benefits and risks. IPR related to plants, IPP
REFERENCES:	<p>1. An introduction to genetic engineering in plants, Mantel, Mathews and Mickee, 1985. Blackwell Scientific Publishers. London.</p> <p>2. In Vitro culture of higher plants by Pierik, 1987. MartinusNijhoff Publisher, Dordrecht.</p> <p>3. Plant cell culture. A practical approach. Second edition. Edited by R.A. Dixon and R.A. Gonzales. 1994. Oxford University Press. Oxford.</p> <p>4. Plants, genes and agriculture by Chrispeels and Sadava, 2000. The American Scientific Publishers, USA.</p> <p>5. Plant Biotechnology by Hammond, Mc Garvey and Yusibov 2000, Springer Verlag, UK.</p> <p>6. Plant Biotechnology and Transgenic Plants, Edited by Kirsi-Marja Oksman-Caldentey and Wolfgang Barz. 2002, Marcel Dekker, Inc. New York.</p> <p>7. Plant Biotechnology: The genetic manipulation of plants by Slater, Scott and Fowler, 2008, Second edition, Oxford University press, UK.</p> <p>8. Molecular Plant Biology: A practical approach (Vol. I and II), Edited by Gilmartin and Bowler, 2002, Oxford University press, UK.</p>
E-book links	<p>1) https://www.pdfdrive.com/plant-biotechnology-and-genetics-principles-techniques-e15853574.html</p> <p>2) https://www.pdfdrive.com/plant-cell-and-tissue-culture-a-tool-in-biotechnology-e20389188.html</p>

	<p>3) https://www.pdfdrive.com/principles-of-plant-biotechnology-e33514134.html</p> <p>https://www.pdfdrive.com/plant-genomics-e28703875.html</p>
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	<u>CORE VIII - ANIMAL BIOTECHNOLOGY – PBTT32</u>		
Semester	Semester-III	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To understanding about the basics of Animal cell culture, transgenic animals, pest & animal management, Molecular markers and regulations about the use of Biotechnology. • To expose students to application of rDNA technology to various fields of biotechnology (medicine and research areas). • To learn about principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms and gene therapy. Techniques employed are carved as self-study. • To understand animal tissue culture techniques, advanced researches and stem cell technology. 		
COURSE OUTCOMES	<p>Upon completion of this course the students will be able to</p> <p>CO1: know the requirements for establish the cell culture laboratory K1 CO2: understand the procedure to do Primary cell culture techniques, mass production, storage methods, germplasm conservation and establishment of gene banks. K2 CO3: know the practical difficulties in sources of contamination in cell culture and importance of transgenic animals and Molecular pharming K3 CO4: know about advanced medical treatment methods using gene therapy for human diseases K4 CO5: to learn the basic concept of Collection, processing, preservation and banking of stem cells for future generation free from genetic disorders K6</p>		
UNIT- I	Structure and organization of animal cell. Constituents of culture medium; serum and supplements; Facilities for animal cell culture-infrastructure, equipment, culture vessels. Biology and characterization of cultured cells-cell adhesion, proliferation, differentiation, morphology of cells and identification.		

UNIT-II	Primary cell culture techniques - aggregation, Cell growth & viability determination. Measurement of cell death, Transformation and Cytotoxicity assays. Chromosome analysis and antigenic markers.. 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 - cryopreservation - germplasm conservation and establishment of gene banks.
UNIT -III	Sources of contamination, Monitoring and eradication – suspension, monolayer, organ culture. Knock out and Knock in, Suicide gene therapy Gene silencing. Transgenic animals and Molecular pharming: Animal Biotechnology for the production of regulatory proteins, blood products, cell culture based vaccines and hormones and other therapeutic proteins.
UNIT-IV	Gene therapy – IVF & Embryo transfer, Gene transfer techniques, Tissue engineering, Organ transplant. Synthetic viral vectors in gene transfer. Biotechnological applications for HIV. Diagnostics and therapy. DNA based diagnosis of genetic diseases. Oncogenes and anti oncogenes.
UNIT-V	Stem cells: types – Hematopoietic stem cells, Mesenchymal stem cells, embryonic stem cells, fetal stem cells, Adult stem cells- characterization, isolation, cultures. Stem cells as vector for cancer therapy. Collection, processing, preservation and banking of Umbilical cord blood stem cells.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Ralf Pörtner. 2007. Animal Cell Biotechnology: Methods and Protocols (Methods in Biotechnology). 2nd Edition. Humana Press. USA. 2. R.Spier and J.Griffiths. 1994. Animal Cell Biotechnology. Academic Press. London. 3. D.C. Darling and S.J. Morgan. 1994. Animal Cells Culture and media, BIOS Scientific Publishers Limited. Oxford. UK. 4. Jennie P. Mather and David Barnes. 1998. Methods in Cell Biology. Volume 57: Animal Cell Culture Methods. Academic Press. New York. 5. Ann Harris. 1996. Epithelial Cell Culture, Cambridge University Press. USA. 6. M .M. Ranga. 2000. Animal Biotechnology, Agrobios, India. 7. R Ian Freshney.2005. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): Wiley-Liss, New York.

	<p>8. John R W Masters. 2000. Animal Cell Culture – Practical Approach, Ed. Oxford Univ Press.</p> <p>9. JD Watson, M. Gilamn, J. Witkowski. 1992. Recombinant DNA technology. Scientific American books, New York.</p> <p>10. Bhernard R Glick and Jack J. Pasterna, 2009, Molecular Biotechnology II edition, 4th edition, ASM press. USA.</p>
E-book links	<p>1) https://www.pdfdrive.com/animal-cell-biotechnology-e22743665.html</p> <p>2) https://www.pdfdrive.com/animal-biotechnology-1-reproductive-biotechnologies-e187110512.html</p> <p>3) https://www.pdfdrive.com/animal-cell-biotechnology-e177857548.html</p> <p>4) https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-4th-edition-e162050162.html</p> <p>https://www.pdfdrive.com/biotechnology-plant-biotechnology-animal-cell-culture-immunobiotechnology-e186538297.html</p>

Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE	
	1	2	3	4	5	6	7	8	1	2	3	4	5		
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
														MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	<u>CORE XI-BIOINSTRUMENTATION AND BIOSTATISTICS – PBTT33</u>		
Semester	Semester-III	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To develop knowledge handle the instruments for biological research and interrupt the data. • To acquire knowledge on applications of statistics in research. • To gain knowledge in experimental design and data collection techniques. • To develop the technical art of writing research report and presentations. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: to know about types of microscopy and its principles, working procedure and sample preparation techniques K1 CO2: understand the importance of centrifuge and chromatography techniques in research aspects K2 CO3: know the the advanced methods to detect and study any biomolecules using XRD, NMR, MADI-TOF, thermocycler, microarray. Principles and handling procedure of Electrophoresis techniques K2 CO4: Skill development in the aspects of collection and presentation of biological data through biostatics K3 CO5: to learn the methods in statistics to solve the biological problems with accuracy K6		
UNIT -I	Microscopy-Principle and applications of light, phase contrast, fluorescence, inverted, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy, field emission scanning electron microscope, cytophotometry and flow cytometry. Micrometry, lyophilizer, Preparation of microbial, animal and plant samples for microscopy.		

UNIT - II	Centrifugation: Basic principle and applications: Differential, density and Ultracentrifugation, Principle methodology and applications of gel – filtration, ion –exchange and affinity chromatography; Thin layer and gas chromatography; High performance liquid chromatography, ultra sonicator, pH meter.
UNIT -III	Principle of biophysical method and used for analysis of biopolymer structure; X ray diffraction, fluorescence, UV, visible, IR. Atomic absorption and plasma emission spectroscopy, NMR, MS, ELISA reader, Electrophoresis: Principle and applications of Native, SDS,2D, Agarose gel, MADI-TOF, thermocycler, microarray.
UNIT-IV	Collection and presentation of experimental data. Brief description and tabulation of data and its graphical representation. Measures of central tendency: arithmetic mean, median, mode, geometric mean, Harmonic mean. Measures of dispersion: range, interquartile range, standard deviation.
UNIT-V	Hypothesis testing - Idea of two types of errors and level of significance. Tests of significance: Parametric (F & t test); Non parametric: Chi square tests. Simple linear regression and correlation. Analysis of variance.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. John G Webster. 2004. Bioinstrumentation .Student edition, John Wiley & sons, Ltd. New York. 2. Edward Batschelet. 1992. <i>Introduction to Mathematics for Life Scientists</i>, 3rd ed., Springer. New York. 3. M Becker, G A Caldwell and E A Zachgo. 1996. <i>Biotechnology: A laboratory course (Second Edition)</i> Academic Press, USA. 4. Sokal, R.R. and F.J. Rohlf. 1969. <i>Biometry: The Principles and Practice of Statistics in Biological Research</i>. W.H. Freeman and Company, USA. 5. Zar, J.H. 1996. <i>Biostatistical analysis</i>. Prentice Hall, USA.

E-book links	<p>1. https://www.pdfdrive.com/biostatistical-methods-biostatistical-methods-e15213717.html</p> <p>2. https://www.pdfdrive.com/biostatistics-e42988735.html</p> <p>3. https://www.pdfdrive.com/introductory-biostatistics-e15112721.html</p> <p>4. https://www.pdfdrive.com/introductory-biostatistics-e176105301.html</p> <p>5. https://www.pdfdrive.com/bioinstrumentation-instructional-resources-technology-austin-e15581883.html</p>
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	PRACTICAL V- LAB IN PLANT BIOTECHNOLOGY & LAB IN ANIMAL BIOTECHNOLOGY – PBTP33		
Semester	Semester-III	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To know the basic principles and techniques involved in plant cell culture and to understand the concepts of transformation and achievements of biotechnology in Plant systems. To know practical knowledge about the basics of animal cell culture, transgenic animals, pest & animal management, Molecular markers and regulations about the use of Biotechnology. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: able to gain practical knowledge about plant cell culture techniques requirements K1 CO2: know and skill in transformation techniques in plant cells K2 CO3: to learn culture media preparation and cell culture procedure K2 CO4: gain knowledge about Virus inoculation methods K3 CO5: to check Cell viability test – MTT and storage of cells K4		
LAB IN PLANT BIOTECHNOLOGY	<ol style="list-style-type: none"> Preparation of media, stock preparation and sterilization techniques. Plant genomic DNA extraction. Micropropagation using shoot tip. Callus culture. Synthetic seed preparation Protoplast isolation Transformation using <i>Agrobacterium tumefaciens</i>. Haploid culture Root induction. Root induction Embryo culture Nodal culture Single cell culture Suspension culture 		

LAB IN ANIMAL BIOTECHNOLOGY	<ol style="list-style-type: none"> 1. Balanced salt solutions 2. Animal cell culture media preparation 3. Filter sterilization of cultural media 4. Cell disaggregation 5. Handling of animals 6. Isolation of fibroblast from chick embryo 7. Virus inoculation methods 8. Isolation of genomic DNA from Animal cells 9. Cell growth analysis 10. Cell viability test – MTT 11. Resuscitation of frozen cell lines 12. Sub culture of Adherence cell line
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	<u>ELECTIVE III</u> Choice 1 : WOMEN STUDIES – PBTP44		
Semester	Semester-III	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> • To understand the role, rights and responsibility of women in society. • To know how to writing research paper and communication, Science indexed journals, impact factor, citation index, H- index. • Empowering youth in acquiring right soft skills required for their future. • To know the scope and opportunities for Biotechnology students • To learn about funding agencies, Proposal writing and Biodata, Resume and CV writing, References, Testimonials, cover letters 		
COURSE OUTCOMES	<p>Upon completion of this course the students will be able to</p> <p>CO1: able to gain knowledge about Government Organization for women and Child Development K1</p> <p>CO2: know Indian women –Family and Social System and Health status of women in India K2</p> <p>CO3: to learn Women in organized and unorganized sector-Training, skills and income generation. K3</p> <p>CO4: gain updates knowledge about Women Empowerment and Women Development K2</p> <p>CO5: aware of women -Labors Laws, Legal protection, Police and Judiciary and Human rights as women’s Rights K2</p>		
UNIT-I	Current women movements, National committees and Commissions for Women- Government Organization for women and Child Development		
UNIT-II	<p>Indian women-Family, Caste, Class, Culture, religion Social System, Division of Labor, Exploitation, Marriage, reproductive Technology and Motherhood, Freedom, Widows</p> <p>Health status of women in India-Morality and Morbidity factors, Issues of old age, Girl child in Society-child labors, Help lines</p>		
UNIT-III	Negative capability in education-values in education-Vocational education, Women in organized and unorganized sector-Training, skills and income generation. Importance of entrepreneurship Entrepreneurial traits-factors		

	contributing to women entrepreneurship
UNIT-IV	Women Empowerment and Women Development approaches in Indian five year Plans, State Policy and Programmes -Collectivity and group dynamics-Self help groups and leadership-Panchayati raj-Political role and participation-NGOs and women Development. National and International funding Agencies.
UNIT-V	Indian constitution and provision relating to women, personnel laws Labors Laws-violence against women-Legal protection Family courts-enforcement, machinery-Police and Judiciary Human rights as women's Rights

Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	M	S	S	2.92
CO2	S	S	S	S	S	S	S	S	S	S	M	S	S	2.92
CO3	S	S	S	S	S	S	S	S	S	S	M	S	S	2.92
CO4	S	S	S	S	S	S	S	S	S	S	M	S	S	2.92
CO5	S	S	S	S	S	S	S	S	S	S	M	S	S	2.92
													MEAN SCORE	2.92

The Mean Score is 2.92, which is moderately correlated

Course Title & Code	<u>ELECTIVE III</u> Choice 2 : EMPLOYABILITY SKILL – PBTP44		
Semester	Semester-III	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To Empower students to get ready for achieving their goals • To know how to writing research paper and communication, Science indexed journals, impact factor, citation index, H- index. • Empowering youth in acquiring right soft skills required for their future. • To know the scope and opportunities for Biotechnology students • To learn about funding agencies, Proposal writing and Biodata, Resume and CV writing, References, Testimonials, cover letters 		
COURSE OUTCOMES	<p>Upon completion of this course the students will be able to</p> <p>CO1: able to take Career Decision making K3 CO2: know how to take Career Plan K1 CO3: to gain knowledge and aware how to collect relevant materials K2 CO4: Think and take Steps taken to achieve the Goal K4 CO5: Prepare and qualifying themselves for that carrier with good resumes K3</p> <p>All the candidates of M.Sc (Biotechnology) are required to submit the following to enrich their employability skills.</p> <p>Career Decision</p> <p>Career Plan</p> <p>Relevant materials collected</p> <p>Steps taken to achieve the Goal</p> <p>Preparedness and qualifying themselves for that carrier</p> <p>Resume</p>		

Evaluation Guidelines.	<p>The project is evaluated on the basis of following heads:</p> <p>Presentation - 25% of total marks.</p> <p>Viva - 20% of total marks.</p> <p>Report - 30% of total marks.</p>
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	M	S	S	S	S	S	M	S	2.84
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S	2.92
CO3	S	S	S	S	S	M	S	S	S	S	S	M	S	2.84
CO4	S	S	S	S	S	S	S	S	S	S	S	M	S	2.92
CO5	S	S	S	S	S	M	S	S	S	S	S	M	S	2.84
													MEAN SCORE	2.87

The Mean Score is 2.87, which is moderately correlated

Course Title & Code	Core X: BIOETHICS, BIOSAFETY AND IPR – MBTC415		
Semester	Semester-IV	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> • To get an idea about the advantages and disadvantages of biotechnological applications, ethical implications, and intellectual property rights. • To study the diversity of plants and animal life in a particular habitat, ethical issues and potential of biotechnology for the benefit of mankind. • To learn about IPR – types; copy rights, patents, trademarks, trade secret design rights, geographical indication-patentable and non-patentable – PCT and importance of patent writing. • Student will acquire knowledge in bioethics, biohazard and bio-safety level and Intellectual property rights. 		
COURSE OUTCOMES	<p>Upon completion of this course the students will be able to</p> <p>CO1: to aware of bioethics in gene cloning and its application in agriculture K1 CO2: know about Ethical, legal and Socio economic aspects in medicines and Human rights K2 CO3: to gain knowledge and aware Biosafety levels in the laboratory K2 CO4: understand and have knowledge on the principles of IPR and types, procedure about patentable and non-patentable K2 CO5: Knowledge gain about Patenting procedure in India and Indian patent act K3</p>		
UNIT I	Introduction to bioethics, concepts, ethical terms, issues on genetic modification and recombinant DNA technologies, ethics in agriculture and Environment benefits and risks, GM crops, Release of GMO to the environment. Risk of genetic engineering, Ecocide-Eco terrorism.		
UNIT II	Animal rights, ethics of human cloning, Reproductive cloning, Ethical legal and Socio economic aspects of Gene therapy, Somatic, Embryonic and Adult stem cell research, ELSI of human genome project. Transgenic plants and animals.		
UNIT III	Primary containments for biohazards, Biosafety levels, recommended biosafety levels for specific microorganism, infectious agents and infected animals. Biosafety guidelines by Govt. of India, Role of Intuitional biosafety committee, GEAC, RCGM, Cartagena protocol. CPCSEA Guidelines		

UNIT IV	Introduction to IPR – types; copy rights, patents, trade marks, trade secret design rights, geographical indication-patentable and non-patentable – PCT, importance of IPR, Types of Patent applications, PCT cost, procedure and requirements for international patenting- patent infringement – scope, litigation, meaning, case studies & examples. Biopiracy.
UNIT V	Introduction to WTO, GATT,WIPO,TRIPS, Patenting in India, Indian patent act, WIPO treaty budapest treaty, publication of patents-Gazette of India, Patenting by research students, lectures and scientist University/Organizational rules in India and aboard.
<u>REFERENCES</u>	<p>Patents (2003), N.Subbaram, Pharma Book Syndicate, Hyderabad.</p> <p>2. Bioethics and Biosafety in Biotechnology (2007), V.Sree Krishna, New Age International (P) Limited Publishers. ISBN (13): 978-81-224-2248-1</p> <p>3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010), 4th Edition, Glick, B.R., and Pasternack, J.J., ASM Press, Washington, DC.</p> <p>4. Introduction to Plant Biotechnology (2001), 3rd Edition, H.S.Chawla, Oxford & IBH Publishing Co. Pvt. Ltd.</p> <p>5. Bioethics and Biosafety (2008) M. K. Sateesh, I. K. International Pvt. Ltd, New Delhi, India.</p> <p>6. Intellectual Property Rights (2008) Prabuddha Ganguly, Tata McGraw Hill Publishing Company, India. ISBN: 9780070077171 9. http://www.patentoffice.com/index.php</p> <p>7. Recombinant DNA Safety Guidelines, Department of Biotechnology, Ministry of Science and Technology. Government of India.</p> <p>8. Revised Guidelines for research in Transgenic Plants, Department of Biotechnology, Ministry of Science and Technology. Government of India.</p> <p>9. Ethics and Biotechnology by Anthony Oakley Dyson, John Harris. Routledge. 1994.</p>

E-book links	<p>1) https://www.pdfdrive.com/bioethics-and-biosafety-in-biotechnology-e52867075.html</p> <p>2) https://www.pdfdrive.com/bioethics-medicine-and-the-criminal-law-volume-1-the-criminal-law-and-bioethical-conflict-walking-the-tightrope-e176230762.html</p> <p>https://www.pdfdrive.com/patents-and-standards-a-modern-framework-for-ipr-based-standardisation-e45986739.html</p>
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Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	M	S	S	M	S	S	S	S	M	2.76
CO2	M	S	S	S	M	S	S	S	M	S	S	S	S	2.76
CO3	S	S	S	S	M	S	M	S	M	S	S	S	S	2.76
CO4	S	S	S	M	M	S	S	S	S	S	S	S	S	2.84
CO5	S	S	S	M	M	S	S	S	S	S	S	S	S	2.84
													MEAN SCORE	2.79

The Mean Score is 2.79, which is moderately correlated

Course Title & Code	Core XI: BIOPROCESS TECHNOLOGY – MBTC425		
Semester	Semester-IV	Credits:5	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> • To understanding the knowledge about food production, pest control, and the development of new drug and for other related biotechnological applications. • To exploiting knowledge about microbes and to study the downstream processes for product recovery in fermentation. • To learn about commercially valuable biochemical and genetic resources in plants, animals and microorganisms. • Student will understand basics of industrial Biotechnology and requirements for large scale productions. 		
COURSE OUTCOMES	Upon completion of this course the students will be able to		
	CO1: Able to identify the industrial important organisms K1 CO2: Know about principles and techniques in Designing and types of fermentor K2 CO3: Gain knowledge and aware bioreactor usage and fermentation process K2 CO4: Understand and have knowledge on the fermentation product purification and characterization K2 CO5: Know about Industrial production of bio products in market K3		
UNIT I	Milestones of fermentation technology. Identification of industrially important microorganism, primary and secondary screening, strain development, product assays.		
UNIT II	Designing and types of fermentor – liquid, solid state and immobilized, Media and ingredients for industrial fermentation, industrial sterilization of fermentor media and air. Types of heat exchangers, immobilization techniques, Bioreactor for cell cultures.		
UNIT III	Instrumentation for monitoring bioreactor and fermentation process – PH, temperature pressure dissolved O ₂ , air flow rate, shaft speed, foaming, viscosity and controlling.		
UNIT IV	Downstream processing – recovery and purification of fermentation products – filtration, centrifugation, cell disruption, liquid- liquid extraction, Solvent extraction, precipitation, chromatography, ultra filtration, drying, crystallization, lyophilization.		

UNIT V	Industrial production of Antibiotics – penicillin, enzymes – protease, organic acids-citric acid, vitamins – b12, amino acids-glucamic acid, Ethanol, Beer, wine, Dairy and food products.
<u>REFERENCES</u>	<ol style="list-style-type: none"> 1. Stanbury, RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997. 2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, Prentice Hall, Engelwood Cliffs, 2002. 3. Kalaichelvan and Arulpandi, Bioprocess Technology. MJP. Publishers 2008. 4. Doran. Bioprocess Engineering Principle. Elsevier. 2007. 5. Biotechnology: The Biological Principles (1990) Edited by M D Trevan, S Boffey, K H Goulding, and P Stanbury, Tata McGraw-Hill Publishing company Ltd, New Delhi, India.

Mapping of COs with POs &PSOs:

CO	PO								PSO					SCORE
	1	2	3	4	5	6	7	8	1	2	3	4	5	
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	3.0
													MEAN SCORE	3.0

The Mean Score is 3.0, which is strongly correlated

Course Title & Code	MAJOR PROJECT – MBTC435		
Semester	Semester-IV	Credits:5	Duration: 500 hours
Cognitive Level Learning outcome	<p>Empowering students to carryout individual research projects.</p> <p>All the candidates of M.Sc (Biotechnology) are required to undergo a Major project and submit the following:</p> <ol style="list-style-type: none"> 1. Dissertation/Thesis based on the work done by the student. 2. Soft copy of the project on CD/DVD <p>Project Evaluation Guidelines.</p> <p>The project is evaluated on the basis of following heads:</p> <p>Presentation - 25% of total marks.</p> <p>Viva - 20% of total marks.</p> <p>Thesis/ Dissertation - 30% of total marks.</p>		

Employability/Entrepreneurship/ Skill Development

Name of the Course	Course Code	Name of the Programme	Activities with direct bearing on Employability/ Entrepreneurship/ Skill development
Biochemistry	PBTT11	M.Sc. Biotechnology	Theory & Practical knowledge/skill can facilitate to become Biochemist/clinical lab analyst
Microbiology	PBTT12	M.Sc. Biotechnology	Theory & Practical skill/knowledge can provide to become microbiologist and lab analyst
Molecular Biology	PBTT13	M.Sc. Biotechnology	Student can enable to establish molecular biology lab for researchers
Recombinant DNA Technology	PBTT22	M.Sc. Biotechnology	Basic knowledge to become entrepreneur in biotechnology tissue culture lab
Lab in Analytical Bio Chemistry, Microbiology and Molicular Biology	PBTP11	M.Sc. Biotechnology	Employability/ Entrepreneurship
Cell Biology and Genetics/ Developmental Biology	PBTE11	M.Sc. Biotechnology	Employability
Bioinformatics and computer Applications/ Nano Technology and Cancer Biology	PBTE22	M.Sc. Biotechnology	Employability
Bio Instrumentation and Bio Statistics	PBTT33	M.Sc. Biotechnology	Employability
Lab in Plant Biotechnology and Animal Biotechnology	PBTT32	M.Sc. Biotechnology	Employability/ Entrepreneurship
Women's Studies/ Employability Skills	PBTE33	M.Sc. Biotechnology	Employability
Lab in Immunology and Recombinant	PBTP22	M.Sc. Biotechnology	Employability/ Entrepreneurship

DNA Technology and Environmental Bio Technology			
Bioethics, Bio-safety and IPR	PBTT71	M.Sc. Biotechnology	Employability
Immunology	PBTT21	M.Sc. Biotechnology	Employability/ Entrepreneurship
Environmental Biotechnology	PBTT23	M.Sc. Biotechnology	Student can able to set up lab for the analysis of environmental samples and can become environmental consultant
Plant Biotechnology	PBTT31	M.Sc. Biotechnology	Student can able to commercialize many important product like plant bodies, edible vaccine
Animal Biotechnology	PBTT32	M.Sc. Biotechnology	Skill and knowledge of Animal tissue culture can become entrepreneur in Animal product commercialization
Bioethics and Biosafety	PBTT41	M.Sc. Biotechnology	Skill Development and Employability
Bioprocess Technology	PBTT42	M.Sc. Biotechnology	Student can become entrepreneur by producing economically important industrial products