PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR

SALEM – 636 011

DEGREE OF MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM

SYLLABUS FOR M.Sc. BIOTECHNOLOGY
(Affiliated Colleges)

FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2021 – 2022 ONWARDS

REGULATIONS

1. Eligibility

A candidate who has passed a Bachelor degree in Science with Biotechnology / Botany / Zoology / Biology / Microbiology / Microbial Gene technology / Bioinstrumentation / Bioinformatics / Biochemistry / Chemistry / Agriculture / Marine Biology / Home Science / Farm Science / Nutrition and Dietetics / Integrated Biology / Plant Science / Animal Science / Fisheries Science / Aquaculture / Mathematics with Physics, Chemistry as Ancillary / Medical Lab Technology / MBBS / BDS / B. Pharm / BSMS of this University or any of the above degree of any other University accepted by syndicates as equivalent thereto, subject to such conditions as may prescribed therefore shall be permitted to appear and qualify for the M. Sc., Biotechnology Degree Examination of this University after a course of study of two academic years.

2. Duration of the Course

The course for the degree of Master of Biotechnology shall consist of two academic years divided into four semesters. Each semester consist of 90 working days.

3. **Maximum Duration for the completion of the PG Programme**

The maximum duration for completion of the PG Programme shall not exceed 8 semesters.

4. **Transitory Provision**

Candidates who are admitted to the PG course of study before 2021-2022 shall be permitted to appear for the examinations under those regulations for a period of three years i.e., up to and inclusive of the examination of April/May 2024. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

PROGRAMME EDUCATIONAL OBJECTIVES:

- To understand the prime importance of higher education and research in the domain of Biotechnology.
- To create an awareness of biotechnology products and its process.
- To develop an interest in the realm of biotechnology and its allied areas.

M.Sc. BIOTECHNOLOGY-COURSE STRUCTURE UNDER CBCS

(Applicable to the candidates admitted from the academic year 2021-2022)

Semester	Course	Paper code	Course Title	Inst Hours/ Week	Credit	Marks		Total
						Int	Ext	
I	Core –I	21PBT01	Cell Biology	5	5	25	75	100
	Core-II	21PBT02	Biological Chemistry	5	5	25	75	100
	Core -III	21PBT03	Microbiology	5	5	25	75	100
	Elective-I	21PBTE01 21PBTE02	**Select Any one** Environmental and Nano Biotechnology Food Science and Technology	5	4	25	75	100
	Core -IV	21PBTP01	Practical I -Lab in Cell Biology and Biological Chemistry	5	3	40	60	100
	Core -V	21PBTP02	Practical II -Lab in Microbiology	5	3	40	60	100
			Total	**30**	**25**			**600**
II	Core-VI	21PBT04	Genetics & Molecular Biology	4	5	25	75	100
	Core –VII	21PBT05	Immunology and Immunotechnology	4	5	25	75	100
	Core – VIII	21PBT06	Genetic Engineering	4	5	25	75	100
	Elective – II	21PBTE03 21PBTE04	**Select Any one** Genomics, Proteomics and Bioinformatics Pharmaceutical and Medical Biotechnology	4	4	25	75	100
	EDC-I		Course selected from other department	3	3	25	75	100
		21PBTHR1	Human Rights	1		25	75	100
	Core -IX	21PBTP03	Practical III- Lab in Immunology and Immunotechnology	5	3	40	60	100
	Core -X	21PBTP04	Practical IV- Lab in Genetic Engineering and Molecular Biology	5	3	40	60	100
			Summer Internship(vacation)					
			SWAYAM Online Course					
			Total	**30**	**28**			**800**

III	Core -XI	21PBT07	Plant Biotechnology	4	5	25	75	100
	Core –XII	21PBT08	Animal Biotechnology	4	5	25	75	100
	Core –XIII	21PBT09	Bioprocess Technology	4	5	25	75	100
	Core –XIV	21PBT10	Research methodology & Bioinstrumentation	4	5	25	75	100
	Elective-III	21PBTE05 21PBTE06	**Select Any one** Bio-Entrepreneurship Human Physiology	4	4	25	75	100
	Core -XV	21PBTP05	Practical V- Lab in Plant & Animal Biotechnology	5	3	40	60	100
	Core –XVI	21PBTP06	Practical VI- Lab in Bioprocess Technology	5	3	40	60	100
			Total	**30**	**30**			**700**
IV	Core -XVII	21PBTPR1	Project/Dissertation/ Viva Voce	30	8	40	60	100
			Total	**30**	**8**			**100**
			Grand Total	**120**	**91**			**2200**

List of Elective Course: select any one from each semester

Semester	Course	Paper code	Elective course Title
I	**I**	**21PBTE01**	Environmental and Nano Biotechnology
	II	**21PBTE02**	Food science and Technology
II	**I**	**21PBTE03**	Genomics, Proteomics and Bioinformatics
	II	**21PBTE04**	Pharmaceutical and Medical Biotechnology
III	**I**	**21PBTE05**	Bio-Entrepreneurship
	II	**21PBTE06**	Human Physiology

List of Extra Disciplinary Courses (To be selected by other department students)

S.NO	Paper code	**Extra Disciplinary Course Title**
1	21PBTED01	Analytical Techniques in Biotechnology
2	21PBTED02	Concepts of Biotechnology
3	21PBTED03	Microbial Technology

MARKS DISTRIBUTION PATTERN

a) Theory examination

Internal

ATTENDANCE	ASSIGNMENT	SEMINAR	UNIT TEST	TOTAL
5 MARKS	5 MARKS	5 MARKS	10 MARKS	25 MARKS

External

Maximum Marks: 75

b) Practical examination

INTERNAL	EXTERNAL	TOTAL
40 MARKS	60 MARKS	100 MARKS

c) Project

Maximum Marks: 100

Internal - 40 Marks

Dissertation - 40 Marks

Report Valuation-10 Marks

Viva Voce - 10 Marks

Passing Minimum

S.NO	EXAMINATION	INTERNAL MARKS	EXTERNAL MARKS	AGGREGATE OF INTERNAL AND EXTERNAL MARKS
1	THEORY	12	38	50
2	PRACTICAL	20	30	50
3	PROJECT	20	30	50

Question paper pattern (Theory)

Maximum (75 Marks)	**Question Paper Pattern**	**Duration of Examination: 3 Hrs**
Section A (15*1=15 Marks)	Answer all the question multiple choice questions	Each unit three questions
Section B (2×5=10 Marks)	Answer any two question	One question from each unit
Section C (5×10=50 Marks)	Answer all the questions	Two question from each unit with internal choice

Note to questions paper setters

All units in the syllabus should be given equal weightage; key and scheme of valuation should be provided.

Question paper pattern (Practical)

Maximum: 60 marks

1.Major Experiment - 20 Marks
2.Minor Experiment -10 Marks
3.Spotters -20 Marks (5 x 4 Marks)
4.Record -5 Marks
5. Viva Voce -5 Marks

CORE I	21PBT01	CELL BIOLOGY	5 Hrs/Week	5 Credit

Course Objectives: Student will be able to understand the structures and purposes of fundamental components of prokaryotic and eukaryotic cells especially macromolecules, membranes and organelles. Students will also understand the cellular components under laying mitotic cell division.

UNIT I

Origin of Cells: The First Cell-The Evolution of Metabolism-Cell as a basic unit of living organisms- Diversity of cell size and shapes- Present day Prokaryotes and Eukaryotes- Single cell to multicellular organism: Cell - Cell interactions; Cell adhesions, and cell junctions.

UNIT II

Cell Membrane structure and function: Model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

UNIT III

Structural organization of intracellular organelles: Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic Reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, Cytoskeleton and its role in motility.

UNIT IV

Cell- to -Cell Signaling: Hormones and Receptors, Intracellular signaling in Development and Disease , cell surface receptors, signaling through G-protein coupled receptors, signal transduction pathways, second messengers-Regulation of signaling pathways -Regulation of Cell Death; Apoptosis Circadian Rhythms

UNIT V

Cellular basis of Differentiation: Cell division and cell cycle -Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle- Cancer and the cell cycle.

References

1. Molecular Biology of the Cell- Bruce Alberts et al.
2. The Cell A Molecular Approach-Cooper-Hausman.
3. Molecular Cell Biology, Harvey L, Arnold B, Chris AK, Monty K, Matthew PS, Anthony B & Paul M, 8th Edition, WH Freeman & Co Ltd., 2016.
4. Molecular Biotechnology by B.R. Glick and J.J.Pasternak Third Edition, CBS Publishers

Web Sources:

http://www.cellbiol.com

http://molbiolcell.com

http://cell.com

Course learning outcome: By the end of the course, the student should able to

CO 1: Understanding the prokaryotic and Eukaryotic cell.

CO 2: Discussing in detail the cell membrane and function.

CO 3: Understanding the structural and functional organization of cell organelles.

CO 4: Gaining knowledge for cell to cell signaling.

CO 5: Examining the cellular basis of differentiation.

CORE II	21PBT02	BIOLOGICAL CHEMISTRY	5 Hrs/Week	5 Credit

Course Objectives: Biochemistry is the study of biological phenomena at the molecular level. Its primary aim is to understand the fundamental chemical principles that govern complex biological systems. The major focuses, however, on disciplines within biology and chemistry, ranging from cell biology and molecular biology to analytical chemistry and physical chemistry. Understanding the molecular logic of life and being able to participate in the acquisition of this knowledge is integral to the liberal education. The main objectives are, to give students a solid foundation in biology and chemistry. To comprehend the structure-function relationships of various biomolecules and concepts of metabolism, and to develop analytical and critical – thinking skills, introduce modern methods of biochemical experimentation within the disciplines of biology and chemistry.

UNIT I

Chemical foundations of Biology: Definition - pH, pK, acids, bases and buffers, Henderson- Hassel Balch Equation, biological buffer solutions. Concept of free energy: Principles of thermodynamics; Kinetics, dissociation and association constants; energy rich bonds and weak interactions; Coupled reactions; group transfer; biological energy transducers.

UNIT II

Carbohydrates Classification and Metabolism: Chemical nature, properties and biological importance. Carbohydrate metabolism: Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, interconversion of hexoses and pentoses.

UNIT III

Amino acid- Classification and Structure: Chemical nature, properties. Biosynthesis of amino acids. Catabolism of amino acids. Peptides. Primary, secondary, tertiary and quaternary structures of proteins; Ramchandranplot plot in protein structure validation and purification, X-ray crystallography.

UNIT IV

Lipids and Nucleic acid chemistry: Lipids- classification, chemical nature, properties. Biosynthesis of fatty acids- Triglycerides, phospholipid, sterols. Oxidation of fatty acids. Nucleic acid chemistry, Purines and pyrimidines biosynthesis.

UNIT V

Hormones and Enzymology: Hormones-Definition, classification, mechanism of action, Endocrine glands Pituitary-Follicle stimulating hormone(FSH), luteinizing hormone (LH).Pineal gland –Melatonin .Thyroid and para thyroid; Pancrease – insulin and glucagon. Enzyme Nomenclature; Enzyme kinetics; Michaelis-Menten equation, Ordered and ping pong mechanism, Enzyme catalysis, Active sites, coenzymes: Coenzymes interactions, activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes.

References

1. Donald Voet, Judith G Voet. (2010). Biochemistry, 4th Edition, John Wiley & Sons, Inc.
2. Robert K Murray, Darryl K Granner, Peter A Mayes, Victor W Rodwell. (2012). Harper's Illustrated Biochemistry, 29th Edition, McGraw-Hill Professional.
3. Geoffrey L Zubay. (1993). Principles of Biochemistry, 3rd Edition, Wm.C. Brown Publishers.
4. David Lee Nelson, Michael M Cox. (2008). Lehninger Principles of Biochemistry, 5th Edition, MacMillan Works Publisher.
5. Jeremy Mark Berg, John L Tymoczko, Lubert Stryer (2006). Biochemistry, 6th Edition, W. H. Freeman.
6. Trevor Palmer. (2001). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 5th Edition, Horwood Publishing Limited.

7. Sathanarayana U and Chakrapani. U. (1995). Essentials of Biochemistry, 2nd Edition.

8. Shlomo Melmed,Kenneth Polonsky (2019).Williams Textbooks of Endocrinology-14th Edition.Print book and E-Book

9. Golder Wilson(2010). Concise Textbook of Biochemistry, 5th edition.

Web sources

https://linkwww.biochemistry .org

https://link.springer.com

https://www.harpercollins.com

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

CO1: To make students have a strong foundation in chemical biology.

CO2: To introduce them to metabolic pathways of the major biomolecules and re**l**evance to clinical conditions

CO3: To correlate Biochemical process with biotechnology applications.

CO4: To discuss the significance of various metabolic processes occurring in biological system.

CO5: To evaluate of both Hormones and Enzymology and also its medical importance in the human life.

CORE III	21PBT03	MICROBIOLOGY	5 Hrs/Week	5 Credit

Course Objectives: To provide a detailed knowledge about taxonomy and diversity of microbes, growth, disease/infectious microbe and the role of microbes in Agricultural and Environmental sector.

UNIT-I

Scope and History of Microbiology: Landmark discoveries relevant to the field of microbiology; Pure culture techniques: Theory and practice of sterilization and methods of sterilization. Staining - Principles and types of staining (simple and differential) Microscopy - Instrumentation, principles and applications of light microscopes (bright field, dark field, phase contrast, fluorescent microscopes) and electron microscopes (transmission and scanning electron microscopes)

UNIT-II

Microbial Taxonomy and Diversity: Bacteria, viruses, archea, fungi, algae and protozoa. Eukaryotic microbes: Yeasts, molds and protozoa; Biovars, Serovars and Prions. Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth. Microbial metabolism-an overview. Methanogenesis, acetogenesis and auxotrophs.

UNIT-III

Microbial Diseases and Host Pathogen Interaction: Normal microbiota; Classification of infectious diseases; Reservoirs of infection; Nosocomial infection; Emerging infectious diseases; Mechanism of microbial pathogenicity; Nonspecific defense of host; Antigens and antibodies; Humoral and cell mediated immunity; Vaccines; Immune deficiency; Human diseases caused by viruses, bacteria, and pathogenic fungi.

UNIT-IV

Pandemic and Epidemic diseases: COVID-19, SARS, Plague, Yellow Fever, Flu, Polio, AIDS, H1N1 Swine Flu, Ebola, Zika Virus, Cholera, Small Pox, Measles, Tuberculosis, Leprosy, Malaria, Nipha virus, Dengue, and Chickungunya.

UNIT-V

Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremphiles-Thermophiles Acidophiles, Halophiles and alkalophiles; Biotechnological application of extremophiles.

References

1. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall. 2016. Principles of Fermentation Technology. 3rd Edn. Elsevier Science Ltd. Netherlands.
2. Joanne Willey, Linda Sherwood, Christopher J. Woolverton.2016. Prescott's Microbiology. 10th Edn. McGraw-Hill Education. United States
3. Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
4. Pelczar MJ, Chan ECS, and Krieg NR. (2006). Microbiology, 5th Edition, Tata McGraw Hill Publishing Company.
5. Prescott LM, Harley JP and Klein DA. (2005). Microbiology, 6th Edition, McGraw Hill. 3. Talero KP and Talero A. (2002). Foundations in Microbiology, 4th Edition, McGraw Hill.
6. Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, McGraw Hill. 5
7. Qiu, W. & Rutherford, Shannon & Mao, A. & Chu, Cordia. (2017). The Pandemic and its Impacts. Health, Culture and Society. 9. 1-11. 10.5195/HCS.2017.221.
8. Managing epidemics- Key facts about major deadly diseases, World Health Organization (WHO) 2018.
9. O'Flaherty, Vincent & Collins, Gavin & Mahony, Thérèse. (2010). Environmental Microbiology, Second Edition. 10.1002/9780470495117.ch11.
10. Agriculture Microbiology, 2016. E-Course Developed By TNAU (ICAR)

Web Sources:

https://aem.asm.org/content/77/5/1907

http://www.biologydiscussion.com/biotechnology/downstream-processing/stages-indownstream-processing-5-stages/10160

https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf.

https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf ISBN 978-92-4-156553-0.

Course learning outcome:

CO1: To understand the landmarks of microbiology, sterilization and principle and working of microscopes.

CO2: To get in depth knowledge of microbial diversity and growth curve of microbes.

CO3: To know microbial diseases and host pathogens interaction by microbes.

CO4: To examine on epidemic and pandemic diseases.

CO5: To learn agricultural and environmental microbiology.

ELECTIVE I	**21PBTE01/ 21PBTE02**	**ANY ONE OF FROM THE ELECTIVE LIST**	**5 Hrs/Week**	**4 Credit**

CORE IV	**21PBTP01**	**PRACTICAL I- LAB IN CELL BIOLOGY AND BIOLOGICAL CHEMISTRY**	**5 Hrs/Week**	**3 Credit**

Course objectives: Students get to know the technical knowledge and gain hands on practical skills in various aspects of cell biology and Biological chemistry.

Cell Biology

1. Principles of Microscopy and optics
2. Measurement of Cell size by Micrometry
3. Mitosis and Meiosis
4. Giant Chromosomes (Polytene-Chirnomous larvae)
5. Sex Chromatin (Barr Body)
6. Blood cells identification

BIOLOGICAL CHEMISTRY

1. Preparation of Buffer
2. Estimation of glucose (DNS method)
3. Estimation of DNA (Diphenylamine)
4. Estimation of RNA (Orcinol)
5. Estimation of Protein (Lowry's Method)
6. Extraction and Estimation of starch from potato
7. Thin Layer Chromatography-separation of aminoacids
8. Qualitative analysis of carbohydrate
9. Qualitative analysis of aminoacids.
10. Separation of protein (SDS-PAGE)

Course learning outcome: By the end of the course, the students will be able to

1. Find out the various stages of Cell division.
2. Sex chromatin determination by performing a Barr body experiment.
3. Differentiate the bacterial cells.
4. Obtain knowledge for the preparation of stains, buffers, standard solutions for various biochemical assays.
5. To train the students for estimation of nucleic acid, protein and starch.
6. Use chromatography techniques, students will be able to separate pigments and amino acids from a mixture of samples

CORE V	**21PBTP02**	**PRACTICAL II- LAB IN MICROBIOLOGY**	**5 Hrs/Week**	**3 Credit**

Course objectives:

The main objective for this laboratory course is to provide the students with a basic fundamental knowledge of how microorganisms grow, react with specific types of growth media and their biochemical reactions with media used in identification. Laboratory procedures are used to show students the effects of antimicrobial chemotherapeutic drugs on specific bacteria.

1. Cleaning of Glassware and laboratory rules.
2. Isolation pure culture and Maintenance of microorganisms from soil and water - Serial dilution method, Plating and Streaking.
3. Staining methods – Simple staining, differential staining-Acid fast, Endospore ; LCB mount.
4. Motility of bacteria by hanging drop method.
5. Growth curve, Measurement of bacterial population by turbidometry and serial dilution methods
6. Biochemical characterization of Bacteria – IMVIC, Catalse test, oxidase test, sugar fermentation, urease test, TSI test, starch hydrolysis.
7. Differential and Selective Media Unknown organism.
8. Kirby Bauer (AST) antibiotic sensitivity test
9. Effect of various factors on growth of bacteria ϖ Temperature and pH.

Course learning outcome:

1. To understand the practical skills in microscopy and their handling techniques and staining procedures
2. To understanding various Culture media and their applications and also understand various physical and chemical means of sterilization
3. To realize General bacteriology and microbial techniques for isolation of pure cultures of bacteria and fungi
4. To master aseptic techniques and be able to perform routine culture handling tasks safely and effectively
5. Comprehend the various methods for identification of unknown microorganisms
6. To know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.

CORE VI	21PBT04	GENETICS AND MOLECULAR BIOLOGY	4 Hrs/Week	5 Credit

Course Objectives: To understand the fundamentals of genetic concepts, advanced aspects of chromosome biology, genome organization and their role in information transfer and also provide the knowledge about genetic test molecular marker and oncogenes.

UNIT-I

Concepts of Genetics: Model systems in genetic analysis (*E. coli*, *Neurospora crassa*, yeast, *Arabidopsis*, *Drosophila* and *C. elegans*), Laws of inheritance-Mendel's Laws, Chromosome theory of inheritance, Cytoplasmic inheritance, Allelic and non-allelic interactions, Concept of alleles, lethal alleles, multiple alleles, Interaction of genes-types of dominance and Epistasis. Linkage, Sex-linked inheritance and Quantitative inheritance.

UNIT-II

Physical basis of heredity and cytogenetic: Chromosome - Structural organization, Giant chromosomes and chromosomal variation**,** Gene- concept, structure and function. Cell cycle, cell division and Cell signaling, Apoptosis and Genome- Organization of nuclear and organellar genomes from Bacteria, Plant and Animal, repetitive elements-LINES, SINES and Mutation and mutagenesis.

UNIT-III

Microbial and Population genetics: Recombination in prokaryotes, Transformation, conjugation, transduction and sexduction. Transposons, retrotransposons and mechanism of transposition. Viral genetics. Biology of plasmids. Extra chromosomal inheritance. Hardy-Weinberg equilibrium. eugenics and euphenics. Genetic testing in individuals and populations-Direct testing-Gene tracking, Population screening-DNA profiling and genetic councelling.

UNIT-IV

Informational molecules and its function: DNA as genetic material, DNA structure, replication and repair mechanism. RNA as genetic material, types of RNA, role of RNA in information transfer, concept of central dogma, Genetic code, codon usage, Transcription and Translation in prokaryotes and eukaryotes, post-translational modifications. Leader sequences & protein targeting. Regulation of gene expression-lac and trp operons and gene silencing.

UNIT-V

Genome mapping with molecular markers and oncogenes: Genetic and physical mapping and map based cloning, Southern and fluorescence in situ hybridization in genome analysis, RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis and genetic counseling. Oncogenes - Viral and cellular oncogenes, tumor suppressor genes- structure and function pRB and p53.

References

1. The Cell-A molecular approach. Cooper, G.M and Hausman, R.E. 2007 4th Edition, Sinauer Associates Inc. USA.
2. Cell and Molecular Biology. Gerald Karp. 2009. 6th Edition, John Wiley & Sons, Inc.
3. Molecular Biology of the Gene. Watson, J.D, Baker, T.A, Bell, S.P, Gann, A, Levine, M and Losick R. 2008. 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.
4. Molecular genetics, Phundan Singh. 2010. Ibdc Publishers
5. A Textbooks of Genetics and Molecular Biology. Sabyasachi Roychoudhuri. 2011. New Central Books Agency; 1 edition.
6. Molecular Biotechnology. Primrose, S.B. 1994. 2nd Edition, Blackwell Scientific Publishers, Oxford.
7. Molecular and cellular methods in Biology and Medicine Kaufman, P.B. Wu, W. Kim, D.and Cseke, L.J. 1995. CRC Press, Florida.
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA., Bernard, R. Glick, Jack, J. Pasternak, and Cheryl L. Patten. 2010 Asm Press. Washington, DC, USA
9. Human Molecular Genetics. Tom Strachan and Andrew P.Read. 1996. Bios Scientific Publishers.
10. Principles of Genetics. Gardner, Simmons, M. J and Snustad, D. P. 2006. 8th Ed.John Wiley & Sons,
11. Genetics: Analysis of Genes and Genomes. Daniel, L. Hartl and Maryellen Ruvolo. 2011. 8th Edition.
12. Genetics. Gupta, P.K. 2010 Rastogi Publications, New Delhi, India
13. Genetics: Analysis and Principles. Robert Brooker. 2012 6th Edition, Kindle Edition.

14. Molecular Biology. David Clark, Nanette Pazdernik and Michelle McGehee. 2018. 3rd Edition, Academic Cell, Elsevier.
15. Molecular Cell Biology. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon and Kelsey C. Martin. 2016. 8th Edition, W. H. Freeman.

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1. https://www.kumc.edu/gec/
2. https://www.genetics.org/
3. https://otago.libguides.com/c.php?g=171475&p=1130955
4. https://www.genome.gov/about-genomics/teaching-tools/Genomics-Education-Websites
5. http://cellbiol.com/
6. http://www.cellbio.com/education.html
7. https://www.easybiologyclass.com/biology-life-sciences-online-resources-lecture-notes-and-study-materials-for-students-and-teachers/
8. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-161-molecular-biology-and-genetics-in-modern-medicine-fall-2007/lecture-notes/
9. https://www.gmb.org.br/
10. https://libguides.lib.umt.edu/cellular_molecular_biology
11. https://onlinelibrary.wiley.com
12. www.scielo.br/gmb.
13. https://www.khanacademy.org/science/biology

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

CO1: Learn the basic concept of genetics with Mendelian and non Mendelian inheritance with suitable model organisms.

CO2: Understand the structural organization of chromosome, gene and genome

CO3: Apply the principles and mechanisms of microbial and population genetics

CO4: Analyze the structure and functions of informational molecules like DNA, RNA, and proteins

CO5: Evaluate the mechanism of genome mapping with molecular markers and oncogenes

CORE VII	21PBT05	IMMUNOLOGY AND IMMUNOTECHNOLOGY	4 Hrs/Week	5 Credit

Course Objectives: The students will be able to understand the fundamental concepts of Immunology and learn the applications of immunological techniques. The students will learn about immunity and its origin, properties of antigen and antibodies, mechanism involved in immune response, role of cytokines and complements, theories and techniques in hypersensitivity reactions and transplantation immunology, causes, symptoms and treatment of autoimmunity, Cancer causes & immunotherapy and Vaccine development strategies

UNIT- I

Historical perspectives of Immunology and early theories. Types of immunity - Innate and adaptive; Haematopoiesis; Cells of immune system; Organs of immune system. Antigens: Factors that influences immunogenicity, Adjuvants, Epitopes, Haptens & Mitogens. Basic structure of antibodies; Immunoglobulin fine structure; Antibody classes, properties and its biological activities; Immunoglobulin super family

UNIT II

Hybridoma technology and Monoclonal antibodies production in mice and humans and its applications, Abzymes. Organization and expression of immunoglobulin genes; Antibody engineering. Antigen - Antibody interactions: Principles and applications of Preciptation and Agglutination reactions, RIA, ELISA, Western blotting, Immunofluorescence, Flow cytometry and Immunoelectron microscopy.

UNIT III

General organization of Major Histocompatibility Complex, MHC molecules and genes; Antigen Processing & Presentation. T cell receptors: Structure and role, Organization and rearrangement of TCR genes, TCR complex; T Cell Maturation, Activation and Differentiation, Apoptosis in T cells; Cell Mediated Effector responses & properties of Effector T cells. B Cell receptors; B Cell Maturation, Activation and Proliferation, Clonal selection and immunological memory; Induction of humoral response. Germinal centres and Antigen induced B Cell differentiation.

UNIT IV

Cytokines: Properties, types and functions; Cytokine receptors, Cytokine related diseases, Therapeutic uses; Complement functions and components, Complement activation pathways and its biological consequences. Hypersensitivity reactions. Concept of Immunization and strategies in vaccine development: Traditional and novel vaccines.

UNIT V

Immune response to infectious diseases; Primary and Secondary Immunodeficiency diseases, Autoimmune diseases; Transplantation Immunology, Immunosuppressive therapy, Clinical transplantations, HLA typing; Origin of cancer, Oncogenes and cancer induction, Tumor antigens and immune response, Cancer immunotherapy.

References

1. Goldsby R. A., Kindt T. J., Osborne B. A. , Kuby J. (2003). Immunology, 6th Edition, WH Freeman & Co. New York.
2. Kuby J. (2000). Immunology, 4 th Edition, WH Freeman & Co. New York.
3. Benjamini E., Coico R. and Sunshine G. (2000). Immunology, 4th Edition, A John Wiley & Sons, Inc. Publications.
4. Tizard I. R. (1995). Immunology, 4th Edition. Saunders College Publishing Harcourt. Brace College Publishers.
5. Ivan Riot and Peter I Delvis (2004). Essentials of Immunology, 10th Edition: Blackwell Scientific Publications, Oxford
6. Abul K Abbas, Andrew H. Litchman (2004). Basic Immunology: Functions and disorders of the immune system, 2nd Edition, ELSEVIER Publications.
7. Gerd Rudiger Burmester and Antonio Pezzuto (2003). Color Atlas of Immunology, Thieme Stuttgart, New York
8. Gabriel Virella (1998). Introduction to Medical Immunology, 4th Edition. Marcel Dekker. Inc. New York
9. William E. and Md. Paul (2003). Fundamentals of Immunology, 5th Edition. Lippincott William and Wilkins Publishers.
10. Rajasekara Pandian M and Senthilkumar B. (2007). Immunology and Immunotechnology. Panima Publishing Corporation, New Delhi.
11. Myron M. Levine, James B Kaper, Rino Rappuoli, Margret A. Liu, Michael F. Good (2004). New Generation Vaccines, 3rd Edition Marcel Dekker,Inc. New York

Web sources

https://www.immunology.org/public-information/immunology-related-activities-and-resources/immunology-resources-links

Course learning Outcome

CO 1: To present an overview on types of immunity & immunological responses and to illustrate about different cells and organs involved in immune system, properties and role of antigens and antibodies in immune system.

CO 2: To demonstrate the principle of antigen and antibody interactions and its diagnostic applications

CO 3 : To display the role of MHC in antigen processing and presentation and the elaborate the process of T cell and B cell activation during the course of Cell mediated and Humoral immune responses respectively

CO 4: To elucidate on the properties and functions of cytokines and complement components in immune response, hypersensitivity reactions and different types of vaccines

CO 5: To interpret the mechanism of immune response against the Infectious diseases, Immunodeficiency and Autoimmune diseases, Transplantations and Cancers.

CORE VIII	21PBT06	GENETIC ENGINEERING	4 Hrs/Week	5 Credit

Course Objectives: The specific objective of course is-to impart adequate knowledge about principles and methods in genetic engineering; to expedite the students to understand the techniques involved in gene cloning and cDNA synthesis; to expand their understanding towards latest technologies in DNA sequencing; to impart sufficient information about expression strategies for heterologous genes; to enrich the students' knowledge with respect to genome mapping and gene therapy.

UNIT I

Enzymes in Genetic Engineering: Restriction endonucleases (REs) – classification, mechanism of action, use of REs for molecular cloning, DNA Ligases, topoisomerases, gyrases, methylases, phosphatase(Acid, Alkaline, BAP, CIP & SAP) Polynucleotide kinase, terminal transferase, koren bergs enzyme, klenow fragment, TAQ DNA Polymerase and RNase.

UNIT II

Vectors and their application in genetic engineering: Plasmids – Types of Plasmid and plasmid vectors (P^{BR322}, pUC and pBlueScript); Expression vectors; pMal, GST-based, pET vectors. Bacteriophages- M13, lambda insertion vectors – λgt10, λgt11, λ ZAP and replacement vectors – EMBL; cosmids - Artificial chromosome vectors (YACs; BACs); Other viral vectors: SV-40, baculovirus & retroviral vectors.

UNIT III

Introduction of recombinant DNA into hosts: Introduction of recombinant DNA into suitable hosts transformation, Agrobacterium-mediated transformation; physical method of gene transfer. **Characterization of cloned genes -** Sequencing of DNA- Sanger's enzymatic method and Gilbert's chemical sequencing method; automated DNA sequencing; pyrosequencing. Site directed mutagenesis and genome mapping.

UNIT IV

Construction and screening of genomic libraries: Construction of genomic and cDNA libraries, Screening: DNA probe-based screening - molecular hybridization techniques: Preparation of nucleic acid probes by nick translation, random primer labeling and end labeling, hybridization techniques for identification of clones with gene of interest, Screening by antibody-based methods: induction of protein expression, immunodetection using specific antibodies, radioactive and chemiluminescent methods of detection.

UNIT V

Transgenic animals (mice, cattle and fish). Transgenic plant (herbicide tolerance, delayed fruit ripening), Antisense RNA Technology, Human gene therapy. DNA foot printing, chromosome jumping. Micro array, SAGE and PCR.

References

1. Primrose, S.B and R.M Twyman, (2006) Principles of Gene Manipulation. Seventh edn. Blackwell Scientific Publishers, Oxford.
2. Davis J.A. and W.S.Roznikolf (1992) Milestones in Biotechnology. Classic papers on genetic Engineering, Butterworth-Helnemann, Boston.
3. Kingsman S.M. and A.J.Kingsman, (1998) Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes. Blackwell Scientific Publications, Oxford.
4. James D. Watson. Recombinant DNA (2001). Scientific American Books. USA
5. Benjamin Lewin. Genes-VIII. Oxford university press.
6. Glover, D.M and B.D Hames. DNA Cloning 1-4. (2006). Oxford University Press.
7. From Genes to Clones Introduction to Gene Technology - Winnacker, E.L. 1987., Panima Educational Book Agency, New Delhi.
8. T.A.Brown. 2016, An Introduction to Gene cloning & DNA analysis, 7th edition, Wiley balckwell, US.
9. Bernard R.Glick and Cheryl L.Patten, 2017, Principles and Applications of Recombinant DNA - Molecular Biotechnology.,5th ed, ASM Press, United states.

Web Resources

www.icgeb.org

www.genengnews.com

www.genome.gov

www.bio.org

Course learning outcome: By the end of the course, the students should be able to

CO 1: To learn the theoretical knowledge in the genetic engineering enzymes and application.

CO 2: Understanding the basic concept of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.

CO 3: Students expanded their knowledge about gene transfer methods and identifying suitable hosts for cloning and sequencing.

CO 4: To learn the genomic library construction, hybridization and labeling techniques.

CO 5: Describe the Transgenic methods, chromosome jumping and PCR and methods for gene therapy.

ELECTIVE II	**21PBTE03/ 21PBTE04**	**ANY ONE OF FROM THE ELECTIVE LIST**	**4 Hrs/Week**	**4 Credit**

EDC I		**COURSE SELECTED FROM OTHER DEPARTMENT**	**3 Hrs/Week**	**3 Credit**

CORE IX	21PBTP03	PRACTICAL III-LAB IN IMMUNOLOGY AND IMMUNOTECHNOLOGY	5 Hrs/Week	3 Credit

Course Objectives:

- To access knowledge about immune cells and to understand their applications.
- To know the applications immune cells in diagnosis.

1. Study on Blood Cells
   - Identification of blood cells
   - Differential count of white blood cells
   - Separation of mononuclear cells from Human peripheral blood
2. Preparation of specimen for Immunology
   - a) Preparation of serum
   - b) Preparation of plasma
   - c) Preparation of blood antigens
3. Agglutination test
   - a) ABO Blood grouping
   - b) Widal test for typhoid fever (qualitative and quantitative test)
   - c) Haemagglutination test
4. Passive agglutination test
   - a) Anti - Streptolysin O (ASO) test
   - b) C-reactive protein (CRP) test
   - c) Rheumatoid arthritis (RA) test
5. Agglutination inhibition test - Pregnancy test for detection of HCG
6. Flocculation test - Rapid Plasma Reagin Test (RPR)

7. Precipitation test

a) Ouchterlony's Double Immunodiffusion Technique (ODD)

b) Counter Current Immunoelectrophoresis (CIE)

c) Immuno Electrophoresis (IE)

d) Radial Immuno Diffusion (RID)

e) Rocket Immuno Electrophoresis (RIE)

8. Demonstration of laboratory animal handling, Route of inoculation, bleeding

9. IgG separation by affinity chromatography

10. ELISA

11. Western blotting –Demonstration

Course learning outcome: At the end of the course, learners will be able to:

1. Identify various immune cells and enumerate them.
2. Competently perform serological diagnostic tests such as ASO, CRP.
3. Identify blood groups and types.
4. Students will learn the ELISA and western Blotting Techniques.

CORE X	**21PBTP04**	**PRACTICAL IV-LAB IN GENETIC ENGINEERING AND MOLECULAR BIOLOGY**	**5 Hrs/Week**	**3 Credit**

Course Objectives: To study the molecular techniques and its applications.The objectives of this practical course are to provide students with laboratory experimental knowledge of genetic engineering aspects. Also, this course is aimed to teach students with different approaches to perform genetic engineering and their practical applications in biotechnological research as well as in pharmaceutical industries.

1. Isolation of genomic DNA from bacteria & Detection in AGE
2. Isolation of plasmid DNA & Detection in AGE
3. Determination of molecular weight of Nucleic acids by Gel Doc.
4. Quantification of DNA by UV spectrophotometer.
5. Restriction digestion
6. Ligation Technique
7. Bacterial Transformation.
8. Bacterial Conjugation
9. Amplification of DNA - PCR.

Course learning outcome:

1. Outline the fundamental steps in a genetic engineering procedure.
2. Describe the mechanism of action and the use of restriction enzymes in biotechnology.
3. Explain the steps of a bacterial transformation and various selection processes for identifying transformants.
4. Students will become familiar with the tools and techniques of genetic engineering DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools.
5. Students will be able to perform basic genetic engineering experiments at the end of course.

SUMMER TRAINING

Objective:

The main purpose of this training is to particularly provide exposure to the working environment of various industries and research institution. During this period, the Students will get hands on training in the diverse areas of biotechnology.

Scope of training:

The Students will get an opportunity to know the ongoing R&D activities in different industries, institutes and universities. The Students will explore and gain experience in different branches of biotechnology viz agriculture, food, medicine and pharmaceutical. The Students will develop a thorough understanding of biosafety, bioethic, regulatory and compliances. Therefore, the summer training programme will help Students to figure out the areas of their interest. Moreover, the students will obviously know how to write, analyze and compile data, and present the technical/scientific report.

Course Learning Outcomes (CLO): The Students will be able to:

1. Adapt to the varying working environment in industry and research institute

2. Design experiments pertaining to different areas of biotechnology

3. Analyze and interpret the experimental data

SWAYAM Online Course

Swayam (meaning 'self') that stands for "Study Webs of Active-Learning for Young Aspiring Minds" is an Indian Massive Open online course (MOOC) platform. The platform offers free access to everyone. Online education courses offered through the portal of SWAYAM (Swayam.gov.in) can be accessed by anyone anywhere, anytime.

CORE XI	21PBT07	PLANT BIOTECHNOLOGY	4 Hrs/Week	5 Credit

Course Objectives:

- The course curriculum helps in understanding of the plant tissue culture and applications in the culture techniques.
- The course ensures the students to understand about the industrial production of secondary metabolites and transgenic products and therapeutics.

UNIT I

History of plant tissue culture. Concept of totipotency. Application of plant tissue culture- Agriculture, horticulture, forestry, cryopreservation, germ plasm conservation. Design of Plant tissue culture laboratory. Nutritional requirements of plant tissue culture. Composition of MS media, Gamborgs media, Nitchs media, Whites media and their preparation. Plant growth regulators. Sterilization techniques.

UNIT II

Plant micro propagation- micro grafting, advantages of hairy root culture and culturing of meristem and shoot tip. Establishment and maintenance of callus and suspension culture. Somatic embryogenesis-Synthetic seeds.

UNIT III

Haploid plant production - Anther and microspore culture, triploid production, embryo culture and embryo rescue. In vitro pollination and fertilization. Protoplast isolation – fusion and culture regeneration. Somatic hybrids and cybrids. Somaclonal and gametoclonal variation.

UNIT IV

Plant genome organization. Role of RFLP in plant breeding. DNA barcoding in plants. Transposable elements in plant. Plant transformation technology: Ti and Ri plasmids, binary & co-integrated vector systems; viral vectors and their applications; 35S and other promoters; genetic markers; reporter genes; virulence genes; Cloning Strategies; Gene transfer methods in plants – Direct DNA transfer methods, Agrobacterium mediated gene transfer.

UNIT V

Application of gene transformation in plant: Insect resistance, fungus resistance, virus resistance, drought, cold resistance, saline resistance, Transgenic plant with vitamin A, Gene silencing in crop plants, Terminator seed technology, Production of therapeutic antibodies, edible vaccine. Extraction of secondary metabolites using plant tissue culture.

References

1. Hammond J, McGarvey P and Yusibov V. (2000). Plant Biotechnology, Springer verlag.

2. Satyanarayana U. (2005). Biotechnology, Books and Allied (p) Ltd.

3. Bhojwani SS and Razdan MK. (2004). Tissue Culture Theory and Practice.

4. Guptha PK. (1996). Elements of Biotechnology, Rastogi and Co. Meerut. 6. Chawla. HS. (1998). Biotechnology in crop improvement, International Book.

5. Adrian Slater, Nigel Scott, and Mark Fowler, 2008, Plant Biotechnology, 2ndedition, Oxford university press, USA.

6. Paul Christou,Harry Klee,2010,Handbook of Plant Biotechnology, Vol-I &Vol-II,Wiley publishers,USA.

7. Roberta H. Smith,2013. Plant Tissue culture, Techniques and Experiments 2rd edition, Academic Press,USA.

8. Kalyan Kumar De, 2013. Plant Tissue Culture 2nd Edn. New Central Book Agency, Calcutta. Purohit S.S .2010. Plant Tissue Culture , Axis books, Jodhpur.

Web sources

https://plant-biotech.net/
https://onlinelibrary.wiley.com
www.nipgr.res.in

Course Learning Outcomes (CLO): Students will be able to:

CO 1: Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.

CO 2: Learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology

CO 3: Learn the large scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under in vitro conditions

CO 4: A good understanding of r-DNA technology, methods of gene transfer, molecular markers and marker assisted selection

C0 5: Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement

CORE XII	21PBT08	ANIMAL BIOTECHNOLOGY	4 Hrs/Week	5 Credit

Course Objectives: The course aims at preparing the students with the basic knowledge and the scientific understanding on the emerging field of Animal Biotechnology. It provides knowledge about the essential laboratory technique for the study of biochemical and physiological processes in animal cells. The subject provides relevant information about the cell culture requirements, types and methods of cell culture propagation, growth, maintenance, monitoring & analysis and safety issues. The students will gain theoretical skills in the maintenance and manipulation of animal cell and tissue culture. Students will be able to apply the aspects of the molecular biology and recombinant DNA technology in Animal Science.

UNIT I

Structure, organization and physiology of animal cells; History, Scope and applications of animal cell culture- Advantages and limitations; Types of animal cell culture; Biology of cultured cells, evolution of cell lines and senescence

UNIT II

Animal cell culture: Laboratory design and layout, Equipment and materials, culture vessels and substrate; Media and supplements: Physiochemical properties, balanced salt solution, complete media and its biochemical ingredients, selection of medium and serum; Serum free media. Contamination, aseptic conditions, preparation and sterilization

UNIT III

Basic techniques of animal cell culture *invitro*, disaggregation of tissue and primary culture, subculture and establishment of cell line, Cloning and selection, Cell separation, Characterization, Differentiation, Transformation and immortalization, Quantification of cell culture. Scale-up and cell synchronization.

UNIT IV

Cytotoxicity: Viability, toxicity and survival assay; Cryopreservation and cell banks; Risk assessment, General safety regulations, Biohazards, Bioethics and validation; Specialized techniques in animal cell culture: Autoradiography, Time- lapse recording, Confocal microscopy, *Insitu* Molecular hybridization

UNIT V

Culture of specific cell types: Epithelial cells, mesenchymal cells, neuroectodermal cells, Gonads, haematopoietic cells; Culture of tumor cells; Organotypic culture and histotypic culture, tissue engineering and its application; Stem cell technology and its applications. *Invitro* fertilization (IVF), Embryo transfer and test tube babies. Genetic engineering and gene therapy using Embryonic stem cells.

References

1. Freshney, R. I. (2005). Culture of animal cells: A manual of basic techniques. 5th edition, John Wiley and Sons.
2. John R. W. Masters (2000). Animal cell culture. 3rd Edition, *Oxford University Press*.
3. Migel. J. (2005). Animal cell Biotechnology- Methods and Protocols, Humana press.
4. Florence, P.R. (2006). Animal Biotechnology. Dominant Publishers and Distributors.
5. Sandy Primrose, Richard Twyman and Bob Old. (2001). Principles of Gene Manipulation, Sixth edition. *Blackwell Science Ltd*. p: 174-319
6. John R. W. Masters. (2000). Animal cell culture, 3rd edition. *Oxford University Press*.
7. Ranga, M.M. (2006). Animal Biotechnology
8. Purohit, S.S (2006). Biotechnology. 3rd Edition, Fundamentals and Applications.
9. Martin. C. Animal Cell culture techniques, Springer

Web sources

1. http://ecoursesonline.iasri.res.in/course/view.php?id=733
2. https://swayam.gov.in/nd1_noc20_me04/preview
3. https://nptel.ac.in/courses/102/104/102104059/
4. https://www.edx.org/learn/biotechnology
5. https://www.nature.com/subjects/animal-biotechnology

6. https://www.ncbi.nlm.nih.gov/books/NBK207572/
7. https://nifa.usda.gov/animal-biotechnology
8. https://www.sciencedirect.com/book/9780124160026/animal-biotechnology#book-description
9. https://www.omicsonline.org/scholarly/animal-biotechnology-journals-articles-ppts-list.php

Course learning outcome: The overall goad of this course is to make the students gain a fundamental knowledge on concepts and techniques involved in animal biotechnology that may be required for their professional development. Upon completion of the course, the student accomplishes the following:

CO 1: To know and be familiar with the organization of animal cells, scope & limitations of animal cell culture, types and characteristics of cell culture.

CO 2:To gain knowledge on the infrastructure requirements for animal cell culture like laboratory layout & design, equipments, substrates and media requirements for animal cell culture, properties of animal cell culture medium and maintenance of aseptic condition.

CO 3: To become aware of the basic techniques involved in animal cell culture for establishment of cell line, cloning & selection, cell line characterization, quantification and scale up techniques.

CO 4: To understand about the applications of animal cell culture in drug testing like viability and cytotoxicity assay, cryopreservation of cell lines and establishment of cell banks, bio-safety regulations and Bioethics in animal cell culture and specialized techniques preferred in animal cell culture.

CO 5: To interpret about culture of specific cell types like hematopoietic cells and tumor cells, tissue engineering and stem cell technology and its applications, role of animal cell culture in IVF & test tube babies and gene therapy using embryonic stem cells.

CORE XIII	**21PBT09**	**BIOPROCESS TECHNOLOGY**	**4 Hrs/Week**	**5 Credit**

Course Objectives: To acquaint students with technical and biological aspect of microbial utilization for production of metabolites. The skills are developed in the area of bioprocess technology and downstream processing. Students are able to understand different facets of fermentors .The implementation of knowledge in separation , isolation steps and purification involved in downstream process .

UNIT I

Introduction to Fermentation technology: Principles of Fermentation technology, Isolation and Screening of industrial important microbes-Primary and secondary. Detection and assay of fermentation products. Strain improvement. Culture preservation and stability, Fermentation- Submerged, solid state and immobilization of Enzymes & Cells.

UNIT II

Media formulation ,Sterilization and types of Biofermentor: Media formulation. Sterilization. Thermal death kinetics. Batch and continuous sterilization systems. Sterilization of air. Fibrous filter. Bioreactor design, parts and their functions, Alternative vessel designs - CSTR, Tower, Airlift, Loop jet, Bubble Column, Packedbed.

UNIT III

Mass transport phenomena in Bioprocess: Mass transfer, Mass transfer coefficient for gases and liquids. Dimensionless groups. Mass transfer resistance. Rate of oxygen transfer. Determination of oxygen transfer coefficients. Biological properties of medium. Biological heat transfer. Heat transfer coefficients.

UNIT IV

Bioprocess control and monitoring process: Monitoring process variables such as temperature, agitation, pressure, pH. On line measurement. On/Off control. PID control. Control systems, Computer control. Fermentation process- Data analysis.

UNIT V

Downstream Processing : Disruption of Microbial Cells, Centrifugation, Filtration of Fermentation Broths, Ultrafiltration, Liquid-Liquid Extraction, Chromatography - Ion Exchange, Molecular Sieve, Affinity, HPLC. Distillation, Fluid Extraction & Electro dialysis.Recombinant products with representative examples-Organic acids, vitamins,antibiotics and biopreservatives

References

1. Michael L Shuler Fikret Karg. (2001). Bioprocess Engineering Basic concepts, 2nd Edition, Prentice Hall International services.
2. EMT El-Mansi and CF A Bryce. (2002). Fermentation Microbiology and Biotechnology, Taylor &Francis.
3. Wulf Crueger and Anneliese Crueger. (2000). Biotechnology-A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation New Delhi.
4. Peter F Stanbury, Allan Whitaker, Stephen J Hall. (2007). Principles of Fermentation Technology, 2nd Edition, Elsevier Science Ltd.
5. Pauline M. Doran. (2006). Bioprocess Engineering Principles, Elsevier.
6. Juan AA senjo. (2007). Separation Process in Biotechnology, Taylor & Francis group.
7. Patel AH. (2005). Industrial Microbiology, Mac Millan India Ltd, New Delhi.
8. Presscott,S.Cand CecilG.Dunn,''Industrial microbiology,Agrobios (India),2005"
9. Kalaichelvan and Arulpandi,Bioprocess technology.MJP. Publishers2008.
10. R.O.Jenkins.-Product recovery in bioprocess technology,Butterworth-Heinemann(1992).

Web Sources:

https://link .springer.com

https://www.nap.edu.

https://www.fh-campuswien.ac.at.

Course learning outcome: After completion of this course , the students will be able to

CO 1: Designing of bioreactors and control necessary for maximizing production.

CO 2: Select and optimize media for maximum production of microbial metabolites.

CO 3: Designing of protocols for strain improvement and separation of molecules after separation process

CO 4: Describe and analyze the control of *invitro* cellular growth process within the industrial –scale bioreactor environment

CO 5: To understand the various techniques for isolation, recovery and purification of a protein and evaluate the outcome.

CORE XIV	**21PBT10**	**RESEARCH METHODOLOGY AND BIOINSTRUMENTATION**	**4 Hrs/Week**	**5 Credit**

Course Objectives: To provide knowledge about tools and techniques related with scientific communication and research methodology and the core principles of various techniques used in biological experiments and also enable them to understand the concept of statistics in biology.

UNIT-I

Introduction to research; Definitions, characteristics and types of research, Main components of research work. Planning and selection of research problems, Criteria for good research. Defining and formulating a research problem. Definition and Basic principles of research design, Informal and formal experimental designs; Sampling design: Steps and types of sample design. Methods of data collection - Execution of project -Processing and analysis of data- Hypothesis testing.

UNIT-II

Technical writing skills: - Interpretation and report writing- Steps, layout and types of research report, basic criteria for writing dissertation and thesis. Bibliography, Manuscript preparation for publication. Problems while writing a scientific document; plagiarism, software for plagiarism; elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

UNIT-III

Measurement techniques: Colorimeter-Beer Lambert's law, UV-Visible spectroscopy, Atomic absorption spectroscopy, Flame photometer, Mass Spectrophotometry. Centrifuge-principle and types, Chromatography: Paper chromatography, thin layer chromatography, Column chromatography, GC and HPLC, Partition chromatography, Ion exchange chromatography, Permeation chromatography. Measurement of radioactivity- GM Counter, Liquid scintillation, flourimetry.

UNIT-IV

Separation and Imaging techniques: Electrophoresis (Gel Electrophoresis - AGE and PAGE and Paper Electrophoresis). Physical and Biomedical Imaging techniques X-ray, CAT-SCAN, ECG, EEG, NMR) Autoradiography, X ray crystallography, ultrasound, MRI, Angiography.

UNIT-V

Statistical analysis of biological data: Diagrammatic and graphical representation of data- Measure of central tendency (Mean, median and mode) - Measure of dispersion: Variance & Standard deviation and Standard Error. Correlation and regression: Types- Methods- Significance and uses. Chi square test- Characteristics & applications. Student't' test (one tailed & two tailed tests) - Analysis of Variance (One way and two way ANOVA), Analysis of covariance, Multivariate analysis. Statistical software: SPSS, Epi info, Biplot analysis.

References

1. Research Methodology: Methods and techniques, Kothari CR. 2010. 2nd Edition, New age International Publishers.
2. Research Methodology for Biological Science, Gurumani N. 2006. MJP Publishers, Chennai.
3. Introductory Biostatistics, Lee T. 2007. Wiley – Interscience Publishers.
4. Statistical methods, Stephen, W. Looney. 2002. Humana publications.
5. Biostatistics: A Methodology for the Health Sciences, Gerald Van belle. 1993. 2nd Edition. Wiley – Interscience publication.
6. Fundamentals of Biostatistics, Khan and Khanum. 2004. Ukaaz Publications.
7. Biostatistics- A foundation for health Sciences, Daniel WW. 1983. John Wiley Publications.
8. Biostatistical analysis, Jerrold H Jar. 2009. 5th Edition, Pearson Publications.
9. Biostatistics: A foundation for Analysis in the Health Sciences, Wayne W.Daniel. 1996. Wiley Series in Probability and Statistics.
10. Instrumental methods, A Laboratory Manual, Charles Norwood Reilley and Donald Turner Sawyer. 1961. McGraw-Hill, New York.

11. Laboratory Instrumentation M. Prakash, C.K.Arora. 2005. Anmol Publications Pvt Ltd.,
12. Introductory Statistics, Prem, S. Mann. 2004. John Wiley and Sons (ASIA) Pvt. Ltd. Fifth Edition.
13. Bioinstrumentation, John Webster, 2004. John Wiely & Sons.
14. Bioinstrumentation, Veerakumari. 2006. MJP Publishers.

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2. https://bbamantra.com/research-methodology/
3. https://groups.google.com/forum/#!topic/klubs_mba/e24oSszYJPI
4. https://www.scribd.com/doc/185378498/Research-Methodology-Full-Notes
5. https://lecturenotes.in/subject/27/biomedical-instrumentation-bi
6. http://www.robots.ox.ac.uk/~gari/teaching/b18/lecture_slides/B18_LectureA.pdf
7. https://www.smartzworld.com/notes/biomedical-instrumentation-pdf-notes-bi/
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9. http://www.ktunotes.in/ktu-biomedical-instrumentation-notes/
10. https://faculty.franklin.uga.edu/dhall/sites/faculty.franklin.uga.edu.dhall/files/lec1.pdf
11. https://www.easybiologyclass.com/biostatistics-free-lecture-notes-online-tutorials-ppts-and-mcqs/
12. https://www.easybiologyclass.com/biostatistics-introduction-significance-applications-and-limitations-of-statistics/

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

CO1: learn about Introduction, types and methods of research

CO2: acquiring the skills of scientific reading, writing and presentations of research

CO3: apply the working principles and methodology of various types of measurement techniques like spectroscopy, centrifuge, chromatography and flourimetry

CO4: Analyze the mechanism of separation and imaging techniques

CO5: learn the statistical analysis of biological data

ELECTIVE III	**21PBTE05/ 21PBTE06**	**ANY ONE OF FROM THE ELECTIVE LIST**	**4 Hrs/Week**	**4 Credit**

CORE XV	**21PBTP05**	**PRACTICAL V- LAB IN PLANT AND ANIMAL BIOTECHNOLOGY**	**5 Hrs/Week**	**3 Credit**

Course Objectives

- To examine the culture techniques of the plant tissue in-vitro and its applications
- To point out the genomic isolation technique
- To probe into the animal cell culture techniques.
- To learn about the animal cell count

Plant Biotechnology

1. Preparation of media.
2. Sterilization Techniques.
3. Organ cultures.
4. Callus induction, organogenesis, transfer of plants, hardening process.
5. Protoplast isolation.
6. Anther and pollen cultures - production of haploids.
7. Synthetic Seed Culture
8. Isolation of plant DNA

Animal cell science and technology

1. Preparation of tissue culture media and membrane filtration.

2. Preparation of single cell suspension from spleen and thymus.

3. Cell counting and cell viability.

4. Preparation chicken embryo fibroblast culture (monolayer).

5. Trypsinization of monolayer and sub-culturing.

6. Embryonated egg inoculation.

Course learning outcome:

1. On completion of course, students should be able to gain basic skills in plant biotechnology.
2. Gain the knowledge on animal cell cultures.
3. Learn about the culture media used in animal cell culture.
4. Gain the knowledge on Preparation of media for animal cell culture. Primary culture of chick embryo fibroblasts. Primary culture of chick organ - spleen and kidney cells.

CORE XVI	**21PBTP06**	**PRACTICAL VI- LAB IN BIOPROCESS TECHNOLOGY**	**5 Hrs/Week**	**3 Credit**

Course Objectives: To make the students perform the isolation of industrially important microorganisms for amylase, protease, carotenoids and antibiotic. The culture optimization and the knowledge of citric acid production skills are fully developed. Students are able to understand assay of different enzymes, antibiotics and alcohol. The technical skills are understood on immobilization and purification techniques of enzymes.

1. Isolation of Amylase and protease producing organisms from soil.
2. Isolation of antibiotic producing microbes from soil.
3. Isolation of nitrogen fixing bacteria and carotenoid producing bacteria
4. Culture optimization (pH, Temperature, Carbon & Nitrogen sources).
5. Production and assay of amylase and protease by solid-state fermentation.
6. Bioassay of Antibiotics.
7. Microbial production of citric acid using Aspergillus niger.
8. Immobilization of cells for enzyme production.
9. Alcohol production by yeast fermentation and its estimation.
10. Purification of enzymes by salting and dialysis and column chromatography technique.

Course learning outcome: On successful completion of this practical, the student will be able to

1.To isolate the industrially important microorganisms from soil .

2.Carry out the basic technique for the isolation of antibiotic and carotenoid producing bacteria.

3. Assay technique for protease, amylase and antibiotic .

4.Immobilization technique and production techniques for citric acid and alcohol .

5.Learn the purification of enzymes .

CORE XVII	**21PBTPR1**	**PROJECT**	**30 Hrs/Week**	**8 Credit**

Course Objectives:

The semester project is aimed to impart an in-depth and thorough training on some specific industrial problems. Such exposures would enable the students to address the various real-time challenges prevalent in biotech based industries. The students acquire experience and knowledge to work in professional set up. The Students aware of the challenges faced by industries and research laboratories and the possible solutions. During this period, the students will get training in the diverse areas of biotechnology.

Scope of Training:

The students will get a chance to be a part of ongoing QA, QC, Production, and R&D activities in different industries, commercial enterprises and organization. The students can also join laboratories in research institutes and reputed universities. The students will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The students will acquire skill to write, analyze and compile data, and present the detailed technical/scientific report. At the end of successful project, semester training, potentially the Students become employable in the industries/organizations.

Course Learning Outcomes (CLO): The Students will be able to:

1. Work in a team
2. Adapt to the varying working environment in industry and research institute
3. Identify a problem in biotechnology based industry.
4. Formulate a research problem in research laboratory
5. Design experiments to solve the industrial/research problem.
6. Compile and/or interpret the industrial data.

LIST OF ELECTIVE COURSE: SELECT ANY ONE FROM EACH SEMESTER

SEMESTER I	**21PBTE01**	**ENVIRONMENTAL AND NANO BIOTECHNOLOGY**	**5 Hrs/Week**	**4 Credit**

Course Objectives: To learn the environmental monitering techniques and to give the basic idea on environmental sample analysis.The basic principles involved in the waste water management and usage of bioremidation are informed,and also it provide an introduction to Nanotechnology ,to make the students understand about the synthesis, application of nanomaterials and its characterization technique.

UNIT I

Introduction to Environmental Biotechnology: Basic concepts and global issues- Global warming & Acid rain. Pollution measurements- air and water. Biosensor in environmental monitoring. Bioremediation of environmental pollutants in soil and water- oils, heavy metals and detergents. Biodegradation of xenobiotics- Ecological considerations, decay behavior and degradative plasmids, hydrocarbon, hydrocarbon substitutes, pesticides and surfactants. Phytoremediation.

UNIT II

Pollution Control and Treatment Methods: Air pollution and its control through biotechnology. Waste water treatment: Physical, chemical and biological treatment processes. Various industrial effluent treatment methods- Sugar, distillery, dairy, tannery and pharmaceutical industries. Solid wastes: Types and characteristics. Solid waste disposal- land filling, incineration. Biogas from solid waste. Composting and vermicomposting. Monitoring parameters for composting.

UNIT III

Environmental Sample Analysis: Physicochemical and bacteriological analysis of soil and water,problems associated with soil alkali soils,amd sodic soils. Use of genetically modified (insect, pest and pathogen resistant) plants. Ecotoxicology of soil pollutants ,municipal solidwaste treatment strategies.

UNIT-IV

Nanobiology and Application of Nanomaterials: Nanobiology- Concepts, definition & prospects. Classification of Nanostructures- Bionanoparticles& nanocomposites. Types of biomaterials & biodegradable polymers. Applications of nanomaterials – Catalysis in dye & heavy metal removal, cosmetics, batteries, biosensor, food, agriculture, energy, tissue engineering (wound healing). Nanobiotechnology in medicine, drug designing & cancer treatment.

UNIT-V

Synthesis of Nanomaterials and Characterization Techniques: Bottom-up approach- Sol-Gel synthesis, Physical vapor deposition, top-down approach -ball milling, microfabrication. Electron Microscopy -Scanning & Transmission, Scanning Probe Microscopy, Atomic Force Microscopy, Differential Thermal Analysis– Differential Scanning Calorimetry.

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Course learning outcome:

CO1: An understanding of global issues and source of environmental pollution.

CO2: The ability to formulate technique for bioremediation process.

CO3: The capability to advanced knowledge on environmental sample analysis.

CO4: The detail understanding of the importance of nanoparticles and its application in Nano biotechnology.

CO5: Understand the various types of nanoparticle characterization techniques.

SEMESTER I	21PBTE02	FOOD SCIENCE AND TECHNOLOGY	5 Hrs/Week	4 Credit

Course Objectives: To equip students with importance and significance of microorganism in food science, their spoilage and diseases, food processing techniques and preservation technology, food toxicology, use of enzymes in food science and food safety, laws and regulations.

UNIT I

Food Microbiology: Importance and significance of microorganisms in food science. Micro-organisms importance in food - Factors involving the growth of microorganisms in food - Intrinsic and Extrinsic parameters. Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and diseases. Indian Food regulations – History of Indian Food Regulations: BIS, ISI, FPO, PFA and FDA. Food Safety and Standards Act 2006.

UNIT II

Food processing and Preservation Technology: Principles of fresh food storage: Nature of harvested crop, plant, animal, product storage, effect of cold storage and quality – storage of grains. Processing and preservation by heat, low temperature, drying, concentration, non-thermal methods and evaporation. Food additives; types of additives and functions, permissible limits and safety aspects.

UNIT III

Food Toxicology: Principles of Toxicology: Natural Toxins in Food: Natural toxins of importance in food- Toxins of plant and animal origin; Microbial toxins -Algal toxins, bacterial toxins and fungal toxins. Food poisoning; significance of Mycotoxicoses. Determination of toxicants in foods and their management. Environmental Contaminants and drug residues in food and food additives and toxicants added or formed during.

UNIT IV

Enzymes in Food science: Enzymes classification, properties, characterization, kinetics and immobilization; fermentative production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing. Enzymes for starch modification, role of enzymes in brewing, production of flavour, dairy processing, meat processing and fish processing.

UNIT V

Food Safety, Quality Control, Food laws and Regulations: Good Manufacturing Practices (GMPs), Pest Control Program, Facility Maintenance, Personal Hygiene, Supplier Control, Sanitary Design of Equipment and Infrastructure, Procedures for Raw Material Reception, Storage and Finished Product Loading, Sanitation Program. (Sanitation Standard Operating Procedures (SSOPs). ISO certifications.

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Web Source

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https://libguides.reading.ac.uk/food/citing-references

https://guides.library.uq.edu.au/food-science

Course learning outcome:

CO1: Describe the significance and importance of microbes in food.

CO2: Details of food processing and preservation techniques.

CO3: Explain about principles of toxicology and its process.

CO4: Elaborate study on epidemic and pandemic diseases.

CO5: Describe agricultural and environmental microbiology.

SEMESTER II	21PBTE03	GENOMICS, PROTEOMICS AND BIOINFORMATICS	4 Hrs/Week	4 Credit

Course Objectives: The course is aimed to prepare the students with the basic understanding on Genome databases and strategies involved in genome annotations and metagenomic analysis. The student gains knowledge on gene expression profiling and advanced sequencing methods. The chapter provides an insight into functional genome analysis including gene prediction methods & tools, proteomic profiling, the role of mass spectrometry in proteomic analysis and bioinformatics tools for analyzing proteomics. The subject also focuses on knowledge in the realm of bioinformatics databases, sequence alignment methods and tools, homology modeling and drug targeting.

UNIT I

Genomics: Genome databases of plant, animal and microbial pathogens; Large scale genome sequencing strategies, genome assembly and annotations; Metagenomic analysis: Basic concepts, gene networks and computational models; Identification of disease gene by OMIM databases; Markers for genetic mapping: RFLP, SSLP- VNTRs, STRs; Gene expression profiling; SNP databases & SNP array.

UNIT II

DNA sequencing methods: Chemical degradation & Sanger's methods, Shot gun sequencing, Clone contig method, Next Generation sequencing. Comparative genomics: Whole genome alignment, BLAST2, megablast algorithm, Comparative genomic database (COG & VOG). Functional genomics: Sequence based & structure based approaches to assign gene function. Gene/ Protein function prediction using neural network. DNA microarray: Databases and tools; SAGE databases; Gene expression omnibus (GEO).

UNIT III

Proteomics: Protein profiling; 2D gel electrophoresis, Multidimensional chromatography, Quantitative Mass spectrometry: Peptide mapping, N & C terminal sequencing and analytical protein chips – Computational pattern, recognition of proteomes: protein network and pathways. Principle of protein microarrays, Mass spectrometry analysis for proteomic analysis, Bioinformatics based tools for analysis of proteomic data. Application of proteomics in disease diagnosis: Biomarker, drug development and their target identification.

UNIT IV

Biological databases: Nucleic acid sequence databases – Genbank, NCBI, EMBL, DDBJ; Protein sequence databases; Swiss Prot, PIR; Structure data bases: PDB, CATH, SCOP and specialized databases. Tools for Bioinformatics: Pairwise alignment, Dot plots, Scoring matrices: BLOSUM matrices, PAM matrices, Gap penalty.

UNIT V

Alignment algorithms: Needleman – Wunsch Global Alignment algorithm; Smith- Waterman Local Alignment algorithm. Use of HMM algorithm for Multisequence alignment, CLUSTALW. Genome alginers: BLAST, MUMmer, WABA, Glass, Dialign, Avid, LAGAN and Multi LAGAN; protein gene prediction method: ORF finder, restriction analysis, secondary structure prediction; homology modelling and drug designing.

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5. https://swayam.gov.in/nd1_noc19_bt26/preview
6. https://www.denbi.de/online-training-media-library/proteomics
7. https://www.coursera.org/specializations/bioinformatics
8. https://nptel.ac.in/courses/102/103/102103017/

Course learning outcome: The overall goad of this course is to make the students to gain a fundamental knowledge on concepts, tools and techniques in genomics, proteomics and bioinformatics that may be required for their professional development.

Upon completion of the course, the student accomplishes the following:

CO 1: To familiarize the students with genome databases and metagenome database and analysis, markers for genetic analysis and gene expression profiling

CO 2: To gain insight into different sequencing methods, comparative and functional genomic analysis which enables the students to understand about sequence and structure based approaches for gene prediction and function determination.

CO 3: To have better understanding about proteomics and learn about protein profiling and analysis of data generated through mass spectrometry and to be aware of the bioinformatics tools available for analysis of proteomic data.

CO 4: To have an enhanced theoretical knowledge on biological databases and sequence analsysis

CO 5: To understand well about sequence alignment tools, gene prediction methods and homology modelling & drug targeting.

SEMESTER II	21PBTE04	PHARMACEUTICAL AND MEDICAL BIOTECHNOLOGY	4 Hrs/Week	4 Credit

Course Objectives

- To learn the development and monitoring of the drugs.
- To understand the preparation of medicines according to the norms.
- To enlighten the knowledge of the Students on different areas of Medical Biotechnology.
- To train the students in a hospital based setup and familiarize them with the clinical diagnostics of diseases.

UNIT 1

Development of Drug and Pharmaceutical Industry -Therapeutic agents, their uses and economics; Routes of drug administration. Selection criteria for route of administration. Pharmacodynamics, pharmacokinetics and drug metabolism.

UNIT II

PHARMACEUTICAL PRODUCTS: Therapeutic categories such as laxatives - analgesics - non steroidal contraceptives - external antiseptics - antacids and other, antibiotics - biological - hormones - vitamins with respect to system. Pharmaceutical Development: Introduction to drug regulations, pre-clinical and clinical trials.

UNIT III

Protein mode of action and pharmacodynamics- Overview of the mode of action of a biopharmaceutical Pre-clinical studies- -Toxicity (Reproductive toxicity and Teratogenicity, Mutagenicity, Carcinogenicity and Other tests); Clinical trials - Clinical trial design, Trial size design and study population.

UNIT IV

Detail contents: Introduction: History and scope of medical biotechnology, current status and future prospects. Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.

UNIT V

Molecular basis of human diseases: - Pathogenic mutations Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases

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https://guides.lib.berkeley.edu/pharma_medical_devices

https://www.ebsco.com/corporations/industries/pharmaceutical-biotechnology

Course Learning Outcomes (CLO):

CO 1: To gain the knowledge about the genetic and chromosomal disorder

CO 2: Getting the knowledge for the diagnostics and treatment of genetic and chromosomal disorders.

CO 3: Getting the knowledge for the Protein mode of action and pharmacodynamics

CO 4: Students will learn the medical biotechnology and its application.

CO 5: Explain insights about genetic diseases and also about the molecular aspects related to human disease

SEMESTER III	21PBTE05	BIO-ENTREPRENEURSHIP	4 Hrs/Week	4 Credit

Course Objectives: The course is aimed to prepare the student with the basic knowledge on entrepreneurship, beginning with principle of management, how to start a business venture, gather financial sources, utilize banking and financial institutional support, perform accounting practices, analyzing profit & loss and income tax payment. The topic on Human Resource Development helps the students to understand about recruitment process, managerial and marketing skill development and customer satisfaction. The subject enables the students to realize the concept of entrepreneurship and role of entrepreneurs in economic development of India. Further, information on small scale industry makes the student to realize the scope & objectives of SSI and government policy and support for SSI.

UNIT I

Principles of Management: Introduction, Definition: Principles and decisions on starting a venture, Sources of financial assistance: Making a business proposal, approaching loan from bank and other financial institutions, budget planning and cash flow management, Basics in accounting practices: Balance sheet, P & L account, double entry book keeping, estimation of income, expenditure, profit, income tax.

UNIT II

Human Resource Development (HRD): Recruitment and selection process, Leadership skills, Managerial skills, Organization structure, Training, Team building, Team work; Marketing: Assessment of market demand for potential products of interest; Market conditions, segments, prediction of market changes, Identifying needs of customers including gaps in the market.

UNIT III

Entrepreneur: Meaning of entrepreneur, Evaluation of the concept, function of an entrepreneur types of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development in India; Entrepreneurship- its barriers.

UNIT IV

Small scale industry: Definition, characteristics, need and rationale, objectives, scope, role of SSI in economic development, advantages of SSI, steps to start an SSI- Government policy towards SSI, different policies of SSI, Government support for SSI during 5 year plans. Impact of liberalization, privatization, globalization on SSI, effect of WTO/ GATT, supporting agencies of Government for SSI, meaning & nature of support, objectives and functions, types of help, Definitions: ancillary industry and tiny industry.

UNIT V

Institutional support: Different schemes, TECKSOK, KIADB, KSSIDC, KSIM, DIC single window agency SISI, SIDBI, KSFC. Preparation of project: Meaning of project; Project identification project selection. Project report, need and significance of report, contents, formulation, guidelines by Planning Commission for Project report; Network analysis; Errors of project report, Project appraisal, Identification of Business Opportunities, Market feasibility study, Technical feasibility study, Financial Feasibility study & Social feasibility study.

References

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2. Vasant Desai. Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House
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2. https://elearningindustry.com/entrepreneurship-and-elearning-top-5-elearning-options-newbie-entrepreneurs

3. https://www.startupindia.gov.in/content/sih/en/reources/l-d-listing.html
4. https://swayam.gov.in/nd2_cec19_mg39/preview
5. https://nptel.ac.in/courses/110/106/110106141/
6. https://www.coursera.org/browse/business/entrepreneurship

Course learning outcome: The overall goad of this course is to make the students gain a fundamental knowledge on concepts of entrepreneurship that may be required for their professional development.

Upon completion of the course, the student accomplishes the following:

CO 1: To have a fundamental idea about the principles of management, learn to make a business proposal, arrange for financial resources and maintenance of business establishment by accounting practices and other essential concepts required for executing a business plan.

CO 2: To establish basic knowledge on the role of human resource development and learn about recruitment process, developing managerial and marketing skill, team work and achieve customer satisfaction.

CO 3: To understand the features of entrepreneurships and enabling the students to develop their capacity as an entrepreneur thereby emphasising their role in building the economy of the nation

CO 4: To gain insight into the characteristics and objectives of small scale industry (SSI), thereby making the students to be aware of the government support to small scale industry.

CO 5: To be familiar with the different schemes offered by Government institutions to support entrepreneurs and also provides the basic knowledge on project proposal preparation, feasibility analysis, execution and management.

SEMESTER III	21PBTE06	HUMAN PHYSIOLOGY	4 Hrs/Week	4 Credit

Course Objectives: To provide fundamental knowledge about principles, structure and functions of different anatomical features relating to human physiology.

UNIT-I

Medical terminology and Cardio physiology - Human body structure-Useful terms to describe body parts and activities Directional terms- Planes of the body-Body cavities- Cells, Tissues, and Membranes. Cardio physiology - functional anatomy of heart- genesis and spread of cardiac impulses- cardiac cycle- heart sound- cardiac output- cardiovascular regulatory mechanisms. Blood composition, Erythrocytes, leukocytes and functions. Platelets and its function. Buffer systems, Blood coagulation – mechanism and regulation, blood bleeding and clotting, anticoagulants, blood volume, blood pressure and their regulations. Plasma lipoproteins and their functions.

UNIT-II

Respiratory and Renal physiology - Lungs, structure and functions- mechanism of respiration-lung volumes and capacities- gas exchange in the lungs- regulation of respiration. Structure of nephron- glomerular filtration- tubular reabsorption and secretion- formations of urine-regulation of water and mineral excretioncounter current multiplier and exchanger- renal role in acid base balance.

UNIT-III

Nerve and Muscle physiology: Structure of neuron and synapse- excitability- action potential conduction of never impulse-synaptic transmission- neurotransmitter systems. Skeletal and smooth muscle- electrical properties and ionic properties- types of muscle contraction-Neuromuscular transmission.

UNIT-IV

Structure and functions of the digestive system-Organs of the digestive system-Digestion-digestive processes at various regions of digestive system, regulation of - gastric secretion and motility- intestinal secretion and motility-role of gastrointestinal hormones. Structure and functions of human skin.

UNIT-V

Sensory physiology- Structure and functions of sensory organs. Endocrinology-Endocrine glands, hormones and their functions. Physiology of reproduction: male and female reproductive system, hormonal control of testicular and ovarian functions. Estrous and menstrual cycle, implantation, gestation and parturition.

References

1. Textbook of Medical Physiology, Pal, G.K., 2007. Ahuja Publishing House, Delhi.
2. Textbook of Medical Physiology, Hall. J.E. Guyton and Hall, 2011. 12th ed. Saunders, Elsevier Inc.
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4. https://www.docsity.com/en/study-notes/subjects/human-physiology/
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1763271/
6. https://learn.careers360.com/biology/human-physiology-chapter/
7. https://www.freebookcentre.net/medical_text_books_journals/respiratory_diseases_ebooks_online_texts_download.html
8. https://biolympiads.com/human-physiology-notes/

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

CO1: Learn about medical terminology and cardio physiology

CO2: Understand the structure and functions of respiratory and excretory system

CO3: Apply the working principles of nerve and muscle physiology

CO4: Analyze the mechanism and regulation of digestion and structure and functions of skin system

CO5: Synthesis and functions of various hormones and also learn the Structure and functions of sensory organs and reproductive system

LIST OF EXTRA DISCIPLINARY COURSES (TO BE SELECTED BY OTHER DEPARTMENT STUDENTS)

EDC I	**21PBTED01**	**ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY**	**Hrs/Week**	**Credit**

Course Objectives:

- To get an insight into the working principles of optical methods, radioisotopes, spectroscopy and separation methods.
- This will enable the students to carry out the research work innovatively

UNIT I

BASIC INSTRUMENTATION: Cell disruption techniques, Basics of Microscope and its types - Bright field Microscope, Dark field Microscope, Phase contrast Microscope, Fluorescent Microscope, Electron Microscope (TEM, SEM, Tunnelling EM) & Confocal Microscope, Microtechnique, pH meter.

UNIT II

BASIC SPECTROSCOPY: Principles and Working of colorimetry, Spectroscopy : Basic principles, nature of electromagnetic radiation, Beer-Lambert laws- UV- Visible Spectrophotometry, Fluorescence Spectrophotometry, Atomic Absorption Spectrophotometry, FTIR, Raman Spectroscopy, Mass Spectrometry, Nuclear Magnetic Resonance (NMR) -Electron Spin Resonance(ESR).

UNIT III

SEPARATION AND PURIFICATION TECHNIQUES: Centrifugation - Principles & types - Differential, Rate zonal and Isopycnic centrifugation. Electrophoresis of nucleic acids - Agarose , PAGE and Pulse field Electrophoresis. Electrophoresis of proteins - SDS-PAGE, IEF and 2D PAGE. Protein purification methods, Chromatography - Principles, methodology and applications of chromatography: paper, Thin layer, column (gel filtration, ion exchange, affinity), GC and HPLC. Basics of flow cytometry.

UNIT IV

RADIO ISOTOPE TECHNIQUES: Radioactive isotopes - storage, safety, handling and radioactive waste management. Liquid Scintillation counter - α-counter and β-counter. X- ray Diffraction, Crystallography, Autoradiography. Magnetic Resonance Imaging (MRI) and CT scan.

UNIT V

MOLECULAR TECHNIQUES: Quantification of proteins, DNA and RNA. Blotting techniques - Southern, Northern and Western blotting. Gene transfer and transfection methods. PCR and its types. Biosensors and types Biosensors

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4. Biophysical chemistry : Principles and Techniques - Upadhayay and Nath - Himalaya publishing house , 2nd Review Edition, 2009.

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Web Resources

www.egr.msu.edu

www.wiley.com

www.irisensors.com

Course learning outcome:

CO 1: The students will be able to handle the equipment available and identify the suitable and appropriate experiments for their research.

CO 2: To plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project.

CO 3: To Understand the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.

CO 4: The students will be able to understand the radioisotope technique.

CO 5: The students will be able to understand the molecular techniques.

EDC II	21PBTED02	CONCEPT OF BIOTECHNOLOGY	Hrs/Week	Credit

Course Objectives: To equip students with scope and applications of biotechnology, genetic engineering strategies, vectors and recombinants, history and concepts of plant biotechnology, resistant plants, production of edible vaccine, Animal biotechnology and modern concepts and principles of Bioinformatics.

UNIT I

Biotechnology: Scope and applications of biotechnology, Historical development of biotechnology, Conventional & modern biotechnology, Impact of biotechnology on different aspects in human life.

UNIT II

Genetic Engineering: Cloning strategies- Genome Organization. Tools of gene cloning Enzymes- Restriction endonucleases, Ligases; Vectors – Bacterial- PBR322 ,PUC vectors, Artificial chromosomes: BAC and YAC, Agro bacterium vectors, yeast vectors and phage vectors. Gene library constructions: Genomic and cDNA libraries. Screening and analysis of recombinants.

UNIT III

Plant Biotechnology: History and Concept of Plant Tissue Culture, Types of media, nutritional and plant growth regulators. Methods of sterilization in plant tissue culture. Callus and suspension culture, Somatic embryogenesis, Anther and pollen culture, Protoplast isolation and culture. Gene transformation in Plants: Insect resistance, drought, cold and stress tolerance resistance plants. Gene silencing in crop plants, Terminator seed technology, Production of therapeutic antibodies and edible vaccine.

UNIT IV

Animal Biotechnology: Scope and History of animal cell culture: Type of media and sterilization, disaggregation of tissue (Enzymatic and Mechanical methods), Cell viability and cytotoxicity. Concepts in mammalian cell culture: maintenance, contamination and Application of cell culture. Common cell lines: lung cancer, breast cancer, brain cancer, cervical cancer, oral cavity and throat cancer.

UNIT V

Principles of Bioinformatics and Nanobiotechnology - Databases, Phylogenetic tree, Protein engineering – Genome projects – HGP. Structural genomics, Nanobiotechnology – Bionano particles – Nano biosensors, IPR and bioethics.

References

1. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation, 7th Edition, Blackwell Scientific Publishers, Oxford.
2. James D Watson. (2001). Recombinant DNA, Scientific American Books. USA
3. Glick B Pasternak JJ. (2007). Molecular Biotechnology, ASM Press, Washington
4. Dubay RC. (2008). A Text book of Biotechnology, S.Chand & Company, New Delhi.
5. Sathyanarayana U. (2005). Biotechnology, 1st Edition, Books and Allied (P) Ltd,Kolkata.
6. Freshney RI. (2005). Culture of animal cells: A manual of basic techniques, 5th Edition, John Wiley and Sons.
7. Migel J. (2005). Animal cell Biotechnology- Methods and Protocols, Humana press.
8. Ranga MM. (2006). Animal Biotechnology.
9. Christof M.Niemayer, Chad A Mirkin. (2004). Nano biotechnology: Concepts, Applications and Perspectives, Wiley VCH publishers.
10. Irfan Ali Khan. (2004). Fundamentals of Biotechnology, Forensic Science and Genetic Engineering, Ukaaz Publications. Hydrabad.
11. Pradeep T. (2012). A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd.,ISBN: 9781259007323.

Web Source

https://www.chromatographyonline.com/view/analytical-tools-characterization-biotechnology-products-and-processes

https://cosmolearning.org/courses/analytical-technologies-biotechnology/

https://www.springer.com/gp/book/9781441997845

https://www.fda.gov/files/drugs/published/Analytical-Procedures-and-Methods-Validation-for-Drugs-and-Biologics.pdf

Course learning outcome:

CO1: Describe the scope and applications of biotechnology.

CO2: Details of genetic strategies and vector system.

CO3: Explains about plant biotechnology and its important in modern agriculture

CO4: Elaborate study on history and scope of animal biotechnology and its applications.

CO5: Describe about principles of bioinformatics and nanobiotechnology.

EDC III	21PBTED03	MICROBIAL TECHNOLOGY	Hrs/Week	Credit

Course Objectives: To introduce students to basic and advanced knowledge in the field of microbial technology, fermentation and downstream processing for the benefit of mankind.

UNIT I

Introduction: Scope and importance of microbial technology. Production of Proteins: SCP production. Bacterial, fungal and yeast strains. Bacteria- Chymosin, Yeast- Hepatitis B surface Ag, Production of Recombinant and synthetic Vaccines, Peptide Vaccines.

UNIT II

Fermentative production of industrial alcohol, beer and Wine, uses, raw materials, microorganisms, inoculums preparation, preparation of wort, fermentation and recovery. Production of citric acid, glutamic acid and vitamin B12, uses, microorganism, inoculum preparation, medium preparation, fermentation, recovery and mechanism of citric acid production. Cheese production and Mold modified Foods- Soy Sauce, Miso, Hamanatto, Sufu, Tempeh.

UNIT III

Biocontrol agents: *Trichoderma, Pseudomonas, Bacillus*. Microbial Insecticides-*B.thuringiensis, B.sphaericus, B.popillae* and Baculovirus. Microbial Biofertilizer-*Rhizobium* sp., *Azospirillum*. Phosphobacteria, *Azolla*, BGA.

UNIT IV

Microbial Production of Polysaccharides- Xanthane Gum and Polyesters. Aminoacids- Histidine. Production of Microbial Enzymes-Amylase, Protease. Microbial degradation of Lignin, Cellulose. microbial products from genetically modified organisms eg. Insulin.

UNIT V

Microbial treatment of sewage- Primary & Secondary treatment. Degradation of Xenobiotics, Bioremediation. Genetic aspects of Biodegradation, Microorganisms in mineral recovery and removal of heavy metals.

References

1. Microbial Biotechnology: Progress and Trends, Harzevili, F.D and Chen, H. 2017. 1st ed., CRC Press.
2. Microbial Biotechnology. Cooper, E. 2016. Syrawood Publishing House.
3. Microbial Biotechnology: Principles and Applications. Hackensack. 2013. 2nd ed. Lee, YK, World Scientific.
4. Comprehensive Biotechnology. Moo-Young, M. 2011 3rd ed., Elsevier.
5. Microbial Biotechnology. Alexender N Glazer & Hiroshi Nikaido WH. 1995. Freeman and Company.
6. Microbial Technology.Volume I & II. Peppler, H.J and Perlman, D. 2004. 2nd Edition, Academic press.
7. Biotechnology. Wulf Crueger and Anneliese Crueger. 2000. 2nd Edition, Panima Publications.
8. A text book of Biotechnology. Dubay, R.C. 2008. S. Chand & Company, New Delhi.
9. Microbial Ecology. Ronald, M. Atlas and Richard Bartha. 2005. 4th Edition. Benjamin/Cummings Science Publishing.
10. Biofertilizers in Agriculture and forestry. Subbarao, N.S. 1995., 3rd Edition, Oxford and IBH Pub.Co.Pvt.Ltd, New Delhi.
11. Biotechnology. Sathyanarayana, U. 2005. 1st Edition, Books and allied (P) Ltd, Kolkata.
12. Industrial Microbiology. Patel, A.H. 2005. Mac Millan India Ltd, New Delhi.

Web sources

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2. https://byjus.com/biology/single-cell-protein/
3. https://biokamikazi.files.wordpress.com/2013/09/principles_of_fermentation_technology-stanburry_whittaker.pdf
4. https://www.wakenbtech.co.jp/wp/wp-content/uploads/2015/11/nbs_fermentation_basics.pdf
5. https://www.kaznau.kz/page/GPIIR/UMCDzarubej/Guerrini%20Lorenzo.pdf
6. https://byjus.com/biology/microbes-biocontrol-agents/
7. https://www.examfear.com/notes/Class-12/Biology/Microbes-In-Human-Welfare/2299/Microbes-as-biocontrol-agents.htm

8. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
9. https://link.springer.com/chapter/10.1007/978-981-10-6241-4_2
10. https://www.sciencedirect.com/science/article/pii/S1878818119318390
11. https://www.biotechnologynotes.com/industrial-biotechnology/microbial-polysaccharides/list-of-microbial-polysaccharides-carbohydrates-industrial-biotechnology/13954
12. https://www.biotechnologynotes.com/enzymes/industrial-production-of-enzymes-with-applications-biotechnology/13928
13. http://www.biologydiscussion.com/vitamins/microbial-production-of-vitamins-an-overview/10372
14. https://www.cliffsnotes.com/study-guides/biology/microbiology/aquatic-microbiology/sewage-and-wastewater-treatment#:~:text=During%20the%20secondary%20treatment%20of,for%20metabolism%20by%20other%20organisms.
15. https://www.elsevier.com/books/microbial-technology/perlman/978-0-12-551501-6
16. https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf

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

CO1: learn about Introduction, scope and methods for production of proteins

CO2: acquiring the skills for fermentative production of alcohol, beer, Wine, citric acid, glutamic acid, vitamin B12 and Mold modified Foods.

CO3: apply the working principles and production methodology of biocontrol agents, microbial insecticides and microbial biofertilizer.

CO4: Analyze the production strategies for microbial production of polysaccharides, enzymes and insulin

CO5: learn the mechanism of microbial treatment of sewage and degradation of Xenobiotics and heavy metals