THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

# COURSE SCHEME

# FOR

# M. Sc. BIOTECHNOLOGY

# 2022

*Approved in 107th meeting of the Senate held on June 16, 2022*

**DEPARTMENT OF BIOTECHNOLOGY**
**M. Sc. Biotechnology**

**Programme Educational Objectives (PEO)**

I. The programme focuses on basic understanding in the diverse fields of traditional and modern biotechnology with emphasis on industrial applications and product developments.

II. The programme is aimed towards the scientific research with focus on cell and molecular biology, biochemistry, microbiology, immunology and modern bioengineering subjects.

III. It also gives emphasis on skill development in various fields of biotechnology in addition to research training which make students to plan, design, execute, analyze, and solve industrial and research associated problems.

IV. The objective of this programme is to make students competitive enough to make successful career in industries and research institutes/universities.

**Programme Outcome**

After successful completion of this MSc programme in Biotechnology, students will:

I. comprehend and integrate theoretical and practical skills in basic and applied disciplines of biotechnology.

II. acquire knowledge to develop a research plan in which research question, hypothesis, experimental set-up and data analysis are described in relation to relevant literature.

III. be able to design new biotechnological products or processes by applying knowledge of different disciplines of biotechnology in an integrated manner.

IV. be trained enough to take employment in diverse areas of biotechnology as well as for further higher studies.

*Approved in 107$^{th}$ meeting of the Senate held on June 16, 2022*

**COURSE SCHEME & SYLLABUS FOR M. Sc. (BIOTECHNOLOGY)**

**SEMESTER – I**

| SR. NO. | COURSE NO. | TITLE | L | T | P | CR |
|---|---|---|---|---|---|---|
| 1 | PIM101 | BASIC MATHEMATICS (FOR MEDICAL GROUP) | 3 | 1 | 0 | 3.5 |
| | PBT107 | INTRODUCTION TO LIFE SCIENCES (FOR NON-MEDICAL GROUP) | | | | |
| 2 | PBT110 | MICROBIOLOGY | 3 | 0 | 2 | 4.0 |
| 3 | PBT113 | BIOCHEMISTRY | 3 | 0 | 2 | 4.0 |
| 4 | PBT114 | MOLECULAR BIOLOGY | 3 | 0 | 2 | 4.0 |
| 5 | PBT115 | BIO-TECHNIQUES | 3 | 0 | 2 | 4.0 |
| 6 | PHU002 | PROFESSIONAL COMMUNICATION | 2 | 1 | 0 | 2.5 |
| **TOTAL** | | | **17** | **2** | **8** | **22.0** |

**SEMESTER – II**

| SR. NO. | COURSE NO. | TITLE | L | T | P | CR |
|---|---|---|---|---|---|---|
| 1 | PBT202 | BIOPROCESS TECHNOLOGY | 3 | 1 | 2 | 4.5 |
| 2 | PBT204 | GENETIC AND METABOLIC ENGINEERING | 3 | 0 | 2 | 4.0 |
| 3 | PBT205 | IMMUNOLOGY | 3 | 0 | 2 | 4.0 |
| 4 | PBT206 | MICROBIAL TECHNOLOGY | 3 | 0 | 2 | 4.0 |
| 5 | PBT209 | FOOD PROCESSING | 3 | 0 | 2 | 4.0 |
| 6 | PBT211 | BIOSTATISTICS | 2 | 1 | 2 | 3.5 |
| **TOTAL** | | | **17** | **2** | **12** | **24.0** |

**SEMESTER – III**

| SR. NO. | COURSE NO. | TITLE | L | T | P | CR |
|---|---|---|---|---|---|---|
| 1 | PHU301 | ENTREPRENEURSHIP AND IPR | 3 | 1 | 0 | 3.5 |
| 2 | PBT301 | ANIMAL BIOTECHNOLOGY | 3 | 0 | 2 | 4.0 |
| 3 | PBT303 | BIOINFORMATICS | 3 | 0 | 2 | 4.0 |
| 4 | PBT304 | PHARMACEUTICAL TECHNOLOGY | 3 | 0 | 2 | 4.0 |
| 5 | PBT305 | PLANT BIOTECHNOLOGY | 3 | 0 | 2 | 4.0 |
| 6 | | **ELECTIVE-I** | 3 | 0 | 2 | 4.0 |
| **TOTAL** | | | **18** | **1** | **10** | **23.5** |

**ELECTIVE-I**

PBT312: MOLECULAR FARMING
PBT314: MEDICAL BIOTECHNOLOGY
PBT315: PROTEIN ENGINEERING

**SEMESTER – IV**

| SR. NO. | COURSE NO. | TITLE | L | T | P | CR |
|---|---|---|---|---|---|---|
| 1. | PBT491 | SEMINAR | - | - | - | 2.0 |
| 2. | PBT493 | MAJOR RESEARCH PROJECT | - | - | - | 10.0 |
| **TOTAL** | | | **-** | **-** | **-** | **12.0** |

**TOTAL NUMBER OF CREDITS: 81.5**

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**PIM101: BASIC MATHEMATICS**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 3.5 |

**Course Objective:** The objective is to develop basic computing skills and application of quantitative and statistical operations required for biological studies and rationalization of experimental designs.

**Algebra:** Linear and quadratic equations; Complex numbers, Argand plane and polar representation of a complex number, square root of a complex number; Permutations and Combinations; Binomial theorem for positive/negative index and its simple applications; Arithmetic and Geometric progression.

**Trigonometry:** Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations .and C-D formulas for trigonometric functions; Identities related to sin (2x), cos(2x) and tan (2x).

**Determinants and Matrices:** Matrices, Operations on Matrices, Determinants and its properties, singular and non-singular matrices, Adjoint and inverse of a matrix and its properties, Solution of system of linear equations using Cramer's rule and inverse of a matrix.

**Differentiation:** Review of sets, relations and functions, Limit, Continuity and Differentiability, Differentiation of standard functions (polynomials, trigonometric, inverse trigonometric exponentials and logarithmic); Product rule, Quotient rule, applications of derivatives in Graphing,

**Integration:** Integral as anti-derivative. Integration by substitution, by partial Fractions and by parts. Definite integral and its properties. Areas of bounded regions

**Coordinate Geometry:** Rectangular Coordinate system, Straight lines, Circles. (in standard form)

**Course Learning Outcomes (CLO)*:***

**S**tudents will be able to:

1. Acquire mathematical concepts in continuous learning and connecting ideas like numerical analyses, calculus, and coordinate geometry to other subjects.
2. Learn various applications of mathematics.

***Text Books:***

1. *Mathematics, A Text book (Parts I & II), NCERT, New Delhi (2011).*
2. *Thomas, G.B. and Finney, R.L. Calculus and Analytical Geometry, Pearson Education (2007).*

***Reference Books:***

1. *Shanti Narayan, Differential and Integral Calculus, S. Chand (2005).*
2. *Krishnamurthy V.K., Mainra V.P. and Arora J.L. An introduction to Linear Algebra. Associated East West Press (2007).*

**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 30 |
| 2 | EST | 45 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 25 |

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**PBT101: INTRODUCTION TO LIFE SCIENCES**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 3.5 |

**Course Objective:** The objective of this course is to enable the students to gain knowledge of diversity of life and to understand various aspects of living systems. The course will provide understanding of basic organization of plant and animal systems at cellular, tissue and organ levels and their specialized functions.

**Introduction:** Definition of biology and its various branches, Origin of life, Molecular basis and characteristics of life, Levels of Biological Organization.

**Diversity of Living World:** Lower and higher forms of life, Plant Kingdom and its classification, Major phyla of Animal Kingdom and their distinguishing features, General features of plant and animal life.

**Cell Reproduction:** Process of Mitosis and Meiosis and their significance, Karyotyping

**Genetics**: Mendelian Genetics, Patterns of inheritance – Incomplete dominance, Multiple alleles, Co-dominance, Lethal genes, Polygenic inheritance, Sex linked inheritance

**Cell Specialization and Structural Organization:** Organization of plant and animal tissues, Vegetative and reproductive parts of a flowering plant, modifications of its vegetative parts, Reproduction in Plants.

**Plant Physiology:** Absorption and transportation of water, Photosynthesis in higher plants, Plant growth hormones.

**Animal and Human Physiology:** Digestion and absorption of food, Breathing and exchange of gases

**Self-Learning:** Structure of human heart and circulation of blood, Excretion and Osmoregulation, Nervous system and sense organs of human body, Endocrine system.

**Course Learning Outcomes (CLO):**

**S**tudents will be able to:

1. comprehend diverse eukaryotic systems, and various biological processes.
2. apply the basic knowledge of animal and human physiology in biomedical sciences.
3. analyze basic concepts of genetics and their applications in molecular biology.
4. comprehend some important physiological processes in plants, and the role of hormones.

***Text Books:***


1. *Bhatia K.N. and Tyagi M.P., Elementary Biology, Trueman Book Company (2007).*
2. *Dhami P.S., Srivastava H.N. and Chopra G., A Textbook of Biology, Pradeep Publications (2007).*


***Reference Books:***


1. *Campbell, N.A. and Reece, J.B., Biology, Pearson-Education (2005).*
2. *Paulose,P.A., Certificate Biology, Oxford University Press*


**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 30 |
| 2 | EST | 45 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 25 |

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**PBT110: MICROBIOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The objective of this course is to make students understand the existence of microbial world and diversity along with their origin and scope in present day life.

**Introduction to Microbiology**: Scope of microbiology and emerging avenues, Development of microbiology.

**Microbial Diversity**: Microbial taxonomy and detailed classification of the microbial world as per Bergey's manual of classification (Bacteria, Archaea, Eukarya), Bacterial cell structure and morphological features (cell wall, outer membrane, flagella, endospores and gas vacuoles), microbes beyond cellular organization (Viruses, viroids, virusoids and prions).

**Microbial Nutrition and Growth:** Cultural characteristics of microorganisms, Techniques for enumeration of microorganisms in soil and water, Pure culture and enrichment culture techniques for the isolation of heterotrophs and autotrophs, Reproduction and growth, Growth measurement and growth yields, factors affecting growth, synchronous growth continuous culture.

**Microbial Physiology:** Metabolic diversity among microorganisms, Aerobic and anaerobic respiration, Fermentation, Bacterial photosynthesis.

**Preservation and Control of Microorganisms**: Culture collection and maintenance and preservation, Cryopreservation and lyophilization, Physical and chemical agents for the control of microbial growth, Antimicrobial agents, Antibiotics and their mode of action, Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP.

**Microbial Genetics**: Transfer of genetic material in bacteria - Transformation, conjugation and transduction, Plasmid biology, Transposons, Sources of variation, Mutation and induced mutagenesis, Strain improvement, Ames test.

**Self-Learning:** Microbial diseases, Major diseases in plants and animals, food and water borne diseases; emerging and resurgent infectious diseases.

**Laboratory Work**:
Cell morphology and cell identification, Cell counting, Measurement of cell dimension, Microscopic observations of stained cell preparations, Media preparation and enumeration of microorganisms in air soil and water, Identification of various sources of contamination in aseptic microbiological work, Isolation of pure cultures (aerobic and autotrophic bacteria) and culture techniques, Bacterial growth curve, Growth measurement, Plasmid isolation and transformation, Induced mutagenesis and replica plating technique.

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

1. recognize and compare the structure and function of microbes.
2. check microbial contamination in environmental samples.
3. demonstrate aseptic microbiological techniques in the laboratory.
4. control microbial contamination and take safety measures.
5. apply norms of biosafety practices in various set ups.

***Text Books:***


1. *Cappuccino, J.G. and Sherman, N., Microbiology- a Laboratory Manual, Pearson Education (2006).*
2. *Pelczar Jr. M.J., Chan E.C.S. and Krieg R., Microbiology, McGraw Hill (1998).*
3. *Stainer R.Y., Ingraham J.L., Wheelis M.L. and Pamler P.R., General Microbiology, MacMillan (2003).*


***Reference Books:***


1. *Tortora G.J., Funke B.R., and Case C.L., Microbiology, An Introduction, Pearson Education (2009).*
2. *Madigan, M., Martinko, J., Dunlap, P. and Clark, D., Biology of Microorganisms, Pearson Education (2008).*



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**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 30 |
| 2 | EST | 45 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 25 |

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**PBT113: BIOCHEMISTRY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** Objective of studying biochemistry is to know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving things.

**Chemical Foundations of Living Systems:** Molecular basis of life, Biological chemistry – Biomolecules, Metabolism – Basic concepts and Design, Bioenergetics- Entropy, Biochemical equilibria, Dissociation and association constants, pH and buffers.

**Interactions in Biological Systems:** Intra and intermolecular forces, Electrostatic and hydrogen bonds, Disulfide bridges, Hydrophobic and hydrophilic molecules and forces, Water and weak interactions, Debye-Huckel Theory.

**Biomolecular Organization:** Configuration and Conformation of carbohydrates, proteins and nucleic acids, Conformational analysis, Structural simulations of biomolecules (Monte Carlo methods, Molecular dynamics methods).

**Biocatalysis:** The basis of metabolism, Nomenclature of enzymes, Enzyme kinetics, Mechanism of enzymatic catalysis, Active site, Activators and inhibitors, Coenzymes, Isoenzymes, Michaelis-Menten equation, *K*m and *V*max value, Regulation of enzyme activity (single-substrate and multi-substrate reactions).

**Signal Transduction and Regulation:** Hormones and their classification, Hormone analogs, Agonists and antagonists, Endocrine, Receptors and hormones, Receptor classification and signaling pathways (metabotropic/ionotropic/steriod/peripheral and cellular receptors), Signal transduction and metabolism, Signaling in plants and their function.

**Metabolism of Carbohydrates**: Glycolysis, Gluconeogenesis, Pentose phosphate pathway, TCA cycle, Minor pathways of glucose metabolism, Electron transport system, Oxidative phosphorylation and bioenergetics, C3 and C4 photosynthesis.

**Lipid Metabolism:** Fatty acids, Phospholipids, Cholesterol and related steroids, Complex lipids, Oxidation of fatty acids, Biosynthesis of fatty acids and cholesterol.

**Protein and Nucleic Acid Metabolism:** Amino acids, Conformation and configuration of proteins and peptides, Catabolism of amino acids and amino-acid derived products, Nucleotides, Nucleic acid and protein metabolism.

**Self-Learning:** Integration of Metabolism, Inter-relationships between carbohydrate, protein, lipid and nucleic acid metabolism.

**Laboratory Work:**
Preparation of buffer solutions, Determination of pK values, Estimation of reducing sugars, total carbohydrates, amino acids and proteins, Quantitative analysis of lipids, Enzyme assays from microbes and eukaryotes, Basic strategies for enzyme purification, Enzyme kinetics, Estimation of total and available nitrogen, phosphorous and sulphur, Estimation of chlorophyll and other photosynthetic pigments.

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

1. explain the structure-function relationships of biomolecules.
2. characterize properties of enzymes and their kinetics, understand their role as biocatalysts involved in biochemical transformations.
3. correlate how different signals perceived by the organisms are converted into biochemical information which drives different functions of living systems.
4. comprehend various metabolic pathways through which the biomolecules transform form one form to another and generate energy for carrying out the life processes.

***Text Books:***


1. *Metzler, D.E., Biochemistry - The Chemical Reactions of Living Cells, Vol. I &II, Elsevier (2002).*
2. *Berg, J.M., Tymoczko, J.L., Stryer, L., Biochemistry, WH Freeman and Company (2006).*
3. *Nelson, D.L., Cox, M.M., Lehninger's Principles of Biochemistry, McMillan Publishers (2008).*


***Reference Books:***


1. *Daune, M, Molecular Biophysics, Oxford University Press (1999).*
2. *Glaser, R, Biophysics, Springer (2004).*


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**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 35 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 40 |

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PBT114: MOLECULAR BIOLOGY

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objectives**: To understand the storage repair and replication of genetic information in living organisms. The students will learn about gene expression by detailed study of transcription, RNA processing (in case of eukaryotes) and translation. Emphasis will be there on learning basic principles of transcriptional regulation also.

**Genome, repair and replication:** Introduction to genome and its gene content in different types of organisms, Chromosomal structure and organization, Structure and properties of nucleic acids, DNA replication in prokaryotes and eukaryotes, DNA damage and repair mechanisms, Recombination.

**Transcription** – Gene structure, mechanisms of transcription in prokaryotes and eukaryotes, RNA processing, Ribosomes, Structure and function of tRNA, Genetic code, Codon bias, Protein synthesis, Post-translational modifications.

**Regulation of gene expression**: Transcriptional regulation in phages/viruses, prokaryotes and eukaryotes, regulation of Lac and Trp operon, epigenetic regulation of gene expression.

**Self-Learning:** Transfer of genetic material in microorganisms - Molecular mechanisms, Proto-oncogenes, Oncogenes and tumour suppressor genes, Genetic and Metabolic disorders, Aging and senescence.

**Laboratory Work*:***
Isolation of genomic DNA and total RNA, Quantitation of nucleic acids, Agarose gel electrophoresis, Gene induction, Isolation of auxotrophic mutants, Search for CpG islands in genome.

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

1.Analyze architecture of the genomes, genes, and the flow of genetic information through replication, transcription, translation.
2. Utilize the mechanisms of gene expression in genetic engineering applications.
3. Decipher DNA repair mechanisms and apply the concepts in cancer biology.

***Text Books:***


1. *J. E. Krebs, E. S. Goldstein, S. T. Kilpatrick, Lewin's Genes XI, International Edition, Pearson Education (2014).*
2. *Becker, W.M., Kleinsmith, L.J. and Haldin, J., The world of the Cell, Seventh Edition, Pearson Education (2008).*


***Reference Books:***


1. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2008).*
2. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*


**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 40 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 35 |

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**PBT115: BIO-TECHNIQUES**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The course is aimed to acquaint the students with various analytical techniques used in biological sciences and emerging areas of biotechnology. The course also aims to make students learn about instruments used for various analyses.

**Chromatographic techniques:** Theory, types of chromatography, Column and planer, normal and reverse phase, ion-exchange, size exclusion, affinity and gas Chromatography. Instruments such as High performance liquid chromatography (HPLC) system, Gas chromatograph, etc. and various detectors used with these instruments, separation, peak purity and estimation of biomolecules.

**Electrophoretic techniques:** General principle and electro-endosmosis, Support media (agarose and polyacrylamide gels); agarose gel electrophoresis, Native PAGE, SDS-PAGE, isoelectric focusing and 2-D gel electrophoresis, western transfer, capillary electrophoresis, etc. and applications

**Centrifugation techniques:** Basic principle of sedimentation, Centrifuges and their uses, preparative, density gradient and analytical centrifugation, different rotors types and safety aspects of centrifuges.

**Spectroscopic techniques:** Nature of electromagnetic radiations and their interaction with the matter; theory and applications of X-ray fluorescence, UV-VIS, IR, Fluorescence, Atomic absorption spectroscopy and nuclear magnetic resonance (NMR) spectroscopy.

**Mass spectrometry:** Principle and instrumentation, technique and its applications in biological sciences.

**Radioisotope techniques:** Introduction to radioactivity and radioisotopes, detection and measurement of radioactivity and Cerenkov counting, applications in biological sciences- analytical, diagnostics and metabolic studies.

**Microscopy:** Principles of microscopy: Light, dark field, epi-fluorescent microscopy. Electron microscopy (transmission and scanning electron microscopy), Confocal microscopy, images documentation and analysis, micro-photography and micrometry.

**Self-Learning:** Applications in biological Sciences-Analytical, diagnostics and metabolic studies, Safety aspects of radioactive handling.

**Laboratory Work:**
Thin layer chromatography (preparative, analytical, reverse phase), Column chromatography, HPLC, UV-Vis spectroscopy, Atomic absorption spectroscopy, Microscopy, PAGE, SDS-PAGE, Agarose Gel electrophoresis.

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

1. comprehend the principles of various bioanalytical techniques
2. learn separation of molecules, chromatography, centrifugation and electrophoretic involved in isolation, purification of biomolecules.
3. learn spectrophotometric techniques and their application in quantitative analyses and characterization of biomolecules.
4. learn various microscopic i.e. imaging techniques to study structural and morphological features.

***Text Books:***


1. *Wilson K and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (2010).*
2. *Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. Bioseparations: Science and Engineering, Oxford University Press (2006).*


***Reference Books:***


1. *McHale, J.L., Molecular Spectroscopy, Prentice Hall (1998).*
2. *Marimuthu, R., Microscopy and Microtechniques. MJP Publishers (2008).*


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Evaluation Scheme:

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 40 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 35 |

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**PHU002: PROFESSIONAL COMMUNICATION**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 1 | 0 | 2.5 |

**Course Objective:** To provide the students with the essential skills required for effective communication and to provide a comprehensive view of business communication and its role in the corporate environment.

**Essentials of Communication:** Meaning, Definition, process, feedback, emergence of communication as a key concept in the corporate and global world, impact of technological advancements on communication.

**Channels of Communication:** Formal and Informal: Vertical, horizontal, diagonal, and grapevine.

**Methods and Modes of Communication**: Verbal and nonverbal, Verbal Communication: Characteristics of verbal communication, Non-verbal Communication: Characteristics of non-verbal communication, kinesics, proxemics and chronemics.

**Barriers to Communication:** Physical, semantic, language, socio-cultural, psychological barriers, Ways to overcome these barriers.

**Listening:** Importance of listening skills, cultivating good listening skills.

**Written Communication**: Business letters, memos, minutes of meeting, notices, e-mails, agendas and circulars.

**Technical Report Writing**: Types of Reports, contents of reports. Formatting, writing styles and documentation. **Presentations**: Principles of effective presentation, power-point presentation, video and satellite conferencing.

**Interviews and Group Activities**: Personal interviews, group discussion and panel discussion

**Creative writing:** Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.

**Self-Learning:** Paper writing: Styles of paper writing: Short Communication, Review papers and Research papers, referencing styles: MLA, Chicago Style and APA.

**Course Learning Outcome (CLO)**:
Students will be able to:

1. understand and demonstrate the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction.
2. write effective and concise letters and memos, prepare informal and formal reports, proofread and edit copies of business correspondence.
3. develop interpersonal skills that contribute to effective personal, social and professional relationships.

***Text Books:***


1. *Lehman C. M., DuFrene D.D., & Walker. B-BCOM-An Innovative Approach to Learning and Teaching Business Communication. Cengage Learning New Delhi*
2. *McMurrey A.M& Buckley J., Handbook for Technical Writing. Cengage Learning, New Delhi.*


***Reference Books:***


1. *Lesikar R.V & Flately M.E.,Basic Business Communication-Skills for Empowering the Internet Generation. Tata McGraw-Hill Publishing Company Limited. New Delhi.*


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**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 30 |
| 2 | EST | 45 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 25 |

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**PBT202: BIOPROCESS TECHNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** To acquire knowledge on reaction engineering systems with emphasis on bioreactor design and operation and analysis of kinetics in biochemical engineering reactions along with separation and purification of desired products.

**Introduction and Basic Concepts:** Introduction to upstream processing, Downstream processing, Bioprocess technology, Relation between Bioprocess engineering and Biotechnology, Bioprocess Development, Advantages over chemical process, Material and Energy balance.

**Sterilization Concepts:** Sterilization principles and practices, Media sterilization, Thermal-death kinetics, Batch and continuous sterilization systems, Sterilization of air filters.

**Bioreactor Studies:** Types of Bioreactors, Study of Batch, CSTR (Continuous stirred tank fermenter), Plug flow reactor (PFR), and Airlift bioreactors. Calculations for steady state substrate and product concentration.

**Aeration and Agitation:** Aeration and agitation systems for bioreactors, Functions of mixing, Mixing Equipment, Vessel Geometry, Flow patterns in stirred tanks, Mass transfer in microbial system, Gas liquid mass transfer.

**Downstream Processing:** Product isolation and recovery, Disruption of microbial cells, Filtrations, Reverse osmosis

**Self-Learning:** Spray drying methods, Quality control and bioprocess Economics-Scale-up considerations of bioprocesses, Freeze drying.

**Laboratory Work:**
To study different types of bioreactors, Fermenter sterilization, Medium preparation, sterilization and checking sterility by thermal death kinetics, Surface culture fermentation to study the production of lactic acid using sucrose and lactose as the raw material, Production of citric acid, Growth kinetics for some industrially useful organism, Immobilization of cell, Estimate the mass transfer coefficient in a fermenter, Study solid state fermentation.

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

1. apply the concepts of basic chemical engineering principles in a bioprocess
2. produce bio-products on an industrial scale using fermenters
3. operate and optimize process parameters in a for producing industrial products.

***Text Books:***


1. *Shuler M.L. and Kargi F., Bioprocess Engineering: Basic Concepts, Prentice-Hall (2014).*
2. *Stanbury, P.F., Principles of Fermentation Technology, Book News, Inc. (2013).*
3. *Vogel H. C.and Haber C. C., Fermentation and Biochemical Engineering Handbook, Noyes Publications (2010).*


***Reference Books:***


1. *Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill (2012).*
2. *Wang D.C. and Humphrey, L, Fermentation and Enzyme Technology, John Wiley (1989).*
3. *Doran P M, Bioprocess Engineering Principles, Academic Press (2018).*


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**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 35 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 40 |

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**PBT204 GENETIC AND METABOLIC ENGINEERING**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The objective of this course is to make students learn about basic techniques of recombinant DNA technology such as molecular cloning, gene manipulation and producing GMOs. This will also make students learn about fundamentals and applications of metabolic engineering.

**DNA Modifying Enzymes:** DNA modifying enzymes: Restriction enzymes, Modifying methylases, Nucleases, RNA Polymerases, DNA Polymerases, Polynucleotide Kinase, Alkaline Phosphatases, DNA Ligases, Uses of linkers and adapters in DNA manipulations

**Molecular Cloning and Expression**: Essential features of cloning vectors: plasmids, phages, phagemids, YACs, BAC, PAC; Restriction mapping of DNA fragments, Prokaryotic (T7 expression system in *E. coli*) and eukaryotic expression systems (yeasts, Baculovirus, mammalian and plant-based vectors); isolation and purification of recombinant proteins

**Genomic and cDNA Libraries**: Strategies of construction genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; screening of the libraries, subtractive hybridization for tissue specific cDNA libraries, Isolation and characterization of specific nucleic acid sequences; PCR and Real time PCR and their applications.

**Molecular Techniques of Genetic Engineering**: Gene expression studies by reporter gene assays, DNA sequencing, Site-directed mutagenesis, hybridization based detection (Southern blot, Northern blot analysis), DNA-protein interaction studies (EMSA, DNase I footprinting, South-Western blot assay), introduction to genome editing techniques; protein-protein interaction studies (phage display, yeast two hybrid analyses), RNA interference, DNA Microarrays

**Metabolic Engineering:** Principle of engineering metabolic pathways, Directed production of small molecules in microorganisms, Production of novel compounds and diverse chemical structures, Case studies on re-routing of metabolic pathways in microbes, plants and animals.

**Self-Learning: Applications of Gene Technology:** Therapeutic proteins, Recombinant vaccines, Monoclonal antibodies, Gene therapy and tools of molecular diagnostics

**Laboratory Work:**
Competent cells preparation, Bacterial transformation, Isolation of plasmid/bacteriophage DNA, Restriction analysis of DNA, Cloning in plasmid vectors, PCR amplification, applications of PCR, Gene expression in bacterial system, Reporter gene assay.

**Course Learning Outcomes (CLO):**
Student will be able to:

1. comprehend the importance of various modifying enzymes and tools in rDNA technology.
2. select the suitable hosts for the individual vectors for different purposes.
3. know the uses of restriction and other enzymes in molecular cloning, PCR and genetic manipulations.
4. construct and screen the genomic and cDNA libraries.
5. design experiments for expression of the cloned gene (s) for useful products.
6. apply the principles of metabolic engineering for novel products.

***Text Books:***


1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
2. *Lewin, B., Genes VIII, International Edition, Pearson Education (2003).*
3. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2007).*


***Reference Books:***


1. *Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Concepts in Biotechnology, Universities Press (2007).*
2. *Satyanarayana, U., Biotechnology, Books and Allied (P) Ltd. (2005).*
3. *Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1989).*


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Evaluation Scheme:

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 40 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 35 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT205 IMMUNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of infectious diseases, cancer, autoimmune disease, AIDS.

**Basic Concept and Cells of the Immune System**: Hematopoietic Stem Cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in Innate and Adaptive Immunity, Antigen and Antibody, Antigen Presentation and processing, MHC

**Cell Activation and Cell Mediated Immune Response**: T and B cell maturation, activation and differentiation, T and B cell tolerance, Cytokines and its role in immune response, Cell mediated Cytotoxic Response: Cytotoxic T cell, NK cell and Antibody dependent cell mediated cytotoxicity, inflammatory response

**Immunological Techniques:** Cross reactivity, Precipitation and Agglutination reaction, Coomb's test, Immuno-electrophoresis, RIA, ELISA, ELISPOT assay, Western blotting, Immunofluorescence and Flow cytometry, Immunomagnetic and Immunodensity method of Cell isolation, Lymphocytes cell proliferation assay, Immunological database and immunoinformatics tool

**Autoimmunity, Hypersensitivity and Immunodeficiency**: Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, AIDS

**Immune Response to Infectious Disease, Cancer and Transplantation:** Immune Response to viral, bacterial and other infections, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

**Vaccine**: Live and Killed Vaccines, Sub unit vaccines, Recombinant Vaccines, DNA vaccines, Peptide vaccines, Plant-based vaccines, Reverse vaccinology, Vaccines against infectious diseases,

**Self-Learning:** Immunotherapy, Immunosuppressive therapy, Immunostimulation, Cytokines therapy, Immunotherapy for infectious diseases, allergies, autoimmune diseases and cancer

**Laboratory Work**:
Blood film preparation and identification of cells, Immuno-diffusion, Hemagglutination, Agglutinaton inhibition, Rocket immunoelectrophoresis, Western blotting, ELISA, Epitope prediction using Immunoinformatics tool, Isolation of Peripheral blood mononuclear cells

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

1. explain the role of immune cells and their mechanism in body defense mechanism.
2. apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. adopt immunological techniques for industrial uses.
4. demonstrate the association of immune system with cancer, autoimmunity, transplantation and infectious disease.
5. find out new vaccine target and develop strategy to design new vaccine.

***Text Books:***


1. *Janeway C. A. Travers P., Walport M., Immuno biology: the immune system in health and disease, Garland Science Publishing New York (2012).*
2. *Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- Immunology W.H. Freeman & Company (2013).*


***Reference Books:***


1. *Roitt I., Brostoff J., Male D., Immunology, Mosby Elsevier (2004).*
2. *Khan F.H. The Elements of Immunology, Pearson Education (2009)*


**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 35 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 40 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT206 MICROBIAL TECHNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective** The course will impart a comprehensive knowledge and understanding of technological processes involved in biotechnological industries exemplifying a wide range of manufacturing and production of commercially important Bio products.

**Microbial Systems:** Introduction to microbial activities in nature (soil, water, industry, food and environment), Importance and industrial applications.

**Beneficial Soil Microbes**: The soil-plant-microorganism system, Rhizosphere and phyllosphere microorganisms, Rhizosphere engineering, Microbial interactions; Symbiotic and non-symbiotic nitrogen fixation; Microbes involved in improving soil fertility (biofertilizers) and pest control (biopesticides).

**Biogeochemical Cycling:** Microbial transformations, Nitrogen (ammonification, nitrification, denitrification), Phosphorus, Sulphur and Iron cycling, Organic matter Degradation, Microbes as activator's in rapid decomposition, Humus formation and its benefits.

**Biotransformation**: Industrially important primary and secondary metabolites and their production (alcohol, organic acids, amino acids, antibiotics), Microbiology of production of wine, beer, vinegar and distilled beverages, Non-ribosomal peptides and polyketides, Utilization of microbial biomass as food/feed, Fuel, Chemicals.

**Microbial Food Products**: Microbes in fermented dairy products, Mushroom cultivation, biopreservatives: Nisin, cheese, biopolymers: xanthan gum, PHB, SCP

**Microbes and Alternative Sources of Energy:** Biofuels, Biogas production and its advantages, Production of bioethanol.

**Self-Learning: Innovative Microbial Approaches in Remediation:** Bioleaching concepts and application, Soils, sediments and aquatic systems contaminated with metals, pesticides and PAHs.

**Laboratory Work:**
Isolation and enumeration of free living and symbiotic nitrogen fixers, Phosphate solubilizers and plant growth promoting bacteria, Organic matter decomposition, Estimation of soil pH, EC, organic carbon, N, P, K, Whc and soil texture, Preservation of cultures, Microbiological assays of vitamins and hormones, Ethanol production from sugars and molasses, Fermentative production of enzymes, amino-acids and organic acids.

**Course Learning Outcomes (CLO):**

Students will be able to:

1. comprehend various microorganisms in the biosphere, their behavior and beneficial effects particularly their relevance with regard to industrial applications.
2. correlate the role of microorganisms in biogeochemical cycling and various bio-transformations.
3. apply use of various microorganisms in food and fermentation industries.
4. recognize the growing importance of the microbes in alternative renewable energy sources.

***Text Books:***


1. *Microbial Biotechnology, Alexander N.Glazer, Hiroshai Nikaido.*
2. *Stanbury P.F., Whitaker A. and Hall S.J, Principles of Fermentation Technology, Aditya Books Pub., Ltd., New Delhi (1997).*
3. *Casida L.E, Industrial Microbiology, Wiley Eastern, New Delhi (1991).*


***Reference Books:***


1. *Crueger W and Crueger A, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, New Delhi (2000).*
2. *Patel A.H., Industrial Microbiology, Macmillan India Ltd., New Delhi (2004).*
3. *Peppler H.J and Perlman D, Microbial Technology, Vol I and II, Academic Press, New York (2006).*


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Evaluation Scheme:

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 40 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 35 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT209 FOOD PROCESSING**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course objective:** The objective of this course is to provide knowledge on various preservation and processing technologies of food and food products. In addition, the students will also know about the food safety aspects and laws applicable to foods.

**Detail contents:**

**Introduction:** Introduction to food technology, constituents of foods their properties and nutritive aspects, and general characteristics of raw food material.

**Food processing:** Basic principles of food preservation and processing; Preservation of food by high and low temperatures, dehydration, the addition of chemicals and fermentation

**Novel processing methods:** Advantages/disadvantages of conventional processing technologies, nutritional and consumer considerations. Advanced food processing operations, operational criteria and applications.

**Food packaging and quality control:** Food packaging technology, packaging materials and their properties. Different packaging systems: vacuum packaging, shrink packaging, active and smart packaging. Labelling guidelines. Quality: appearance, texture, flavour, quality standards,

**Food safety and laws:** Food-related hazards: physical, chemical and biological, HACCP, good manufacturing practices and sanitation procedures. Mandatory and voluntary food laws.

**Self Learning:** Characteristics of food/agro-industry wastes, Current treatment options– Overview, Feasibility of reuse and conversion processes for value-added products.

**Laboratory Work*:*** Microbial and other quality tests of foods; Dehydration of fruits and vegetables, Thermal processing of foods, Cold preservation of foods, Packaging and labelling of foods, HACCP plan of food industries, Value addition of food byproducts, Qualitative analysis of processed food samples. Sensory analysis of

**Course Learning Outcome (CLO):**
Students will be able to:

1. *acquire knowledge of food and its components,*
2. *distinguish different food preservation and processing techniques.*
3. *acquire knowledge about novel methods of food processing*
4. *comprehend the need for packaging foods and know about the food labelling*
5. *differentiate between mandatory and voluntary food laws*
6. *conduct the quality analysis of food products.*

***Text Books:***


1. *Manay, S. & Shadaksharaswami, M., Foods: Facts and Principles, New Age Publishers, 2013*
2. *Fellows, P.J., Food Processing Technology: Principles and Practice, Woodhead Publishers Ltd. (2016) 4th ed.*
3. *Fennema. O R, Food chemistry, 5th Ed. Marcel Dekker, Inc, New York. 2017*


***Reference Books:***


1. *Sun DW. Emerging Technologies for Food Processing: Academic press. 2nd Ed. 2014.*
2. *Theodoros Varzakas and Constantina Tzia, Handbook of Food Processing: Food Safety, Quality, and Manufacturing Processes, 2016, CRC press, Taylor and Francis group.*


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**Evaluation Scheme:**

| S.No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 40 |
| 3 | Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 35 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT211: BIOSTATISTICS**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 1 | 2 | 3.5 |

**Course Objective:** Students will learn about descriptive and inferential statistics and its application in biological data analysis.

**Descriptive Statistics:** Biology and statistics, Variables and data, Sampling and sampling errors in biological data, Sampling techniques, measures of central tendency, measures of dispersion and variability, Permutations and combinations, Probability, addition and multiplication of probabilities, normal, binomial and Poisson distributions, Binomial and Poisson probabilities, prior probabilities, posterior probabilities and Bayes' theorem.

**Hypothesis Testing:** Test of hypotheses, one and two sample analysis, Paired sample analysis, Nonparametric statistics and limitations. Confidence limits and tests of confidence, Single, Two and Multifactorial analysis, Non-parametric Analysis of Variance (Kruskal-Wallis test), Multiple comparison tests – Tukey, Newman Keul, Dunnett's test, Scheffe's tests, Contingency tables, Chi-square goodness of fit test.

**Regression and Correlation Analysis:** Concept of least squares, Simple linear regression, residual sum of squares, regression coefficients, covariance, Pearson coefficient of correlation, coefficient of determination, hypothesis about correlation coefficient, Rank correlation.

**Design of Experiments and Data Presentation:** Blocking factors, Latin square design, Factorial experiments, Response Surface Methods, Survivorship curves, Graph plotting and significance of Curves, Data representation.

**Laboratory Work:**
MS Excel / SPSS software, Data entry and graphical representation, Equation formulation and analysis for sample testing, correlation and regression, ANOVA, Multiple comparisons, Chi-square test, Survivorship curve plotting.

**Course Learning Outcome (CLO):**
Students will be able to:

1. Classify various types of data and apply basic statistical concepts such as measure of central tendencies, measure of dispersion and sampling.
2. Use concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis.
3. Perform statistical hypothesis testing using tools such as t-test, ANOVA, Chi-square test.
4. design experiments and solve problems based on relationships among multiple variables.

**Text Books:**


1. Zar, J. H., Biostatistical Analysis. Pearson Education (2014) Fifth Edition.
2. Banerjee, B., Mahajan's Methods in biostatistics for medical students and research workers. Jaypee Brothers Medical Publishers (2018) Ninth Edition
3. Montgomery, D. C., Design and Analysis of Experiments. John Wiley & Sons, Inc. (2009) Seventh Edition


**Reference Books :**


1. Rao, K. V., Biostatistics – A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers (2009) Second Edition.


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**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 35 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 40 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PHU301 ENTREPRENEURSHIP AND IPR**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 3.5 |

**Course Objectives:** Students will be able to demonstrate and develop awareness of personal as well as external resources with a view to successfully launching and subsequently managing their enterprises. They will be able to develop skills in operations, finance, marketing and human resource management and be aware of rights resulting from intellectual property rights, infringement of intellectual property rights (with particular emphasis on patent infringement and plagiarism) and free use of intellectual property rights

**Entrepreneurship:** Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneur.

**Project Management**: Formulation, Identification and selection based on size, Technological assessment, Project cost and market potential and marketing concepts.

**Project Appraisals**: Technical reports and feasibility reports with commercial viability, Break-even analysis, Depreciation, Sources of funding.

**Financing:** Sources of finance, Initial capital, Capital structure, Venture capital and Institutional finance.

**Economics**: Demand-supply-pricing, Business ethics, Industrial laws, Women entrepreneurs – Role, problems and development.

**Industrial Sickness**: Symptoms, control and rehabilitation of sick units.

**Introduction to Intellectual Property**: Intellectual property and IPR, patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs, Patent law, Legislations covering IPR's in India, product planning and development, filing patent, provisional and complete specification, patentable and non-patentable items, Valuation & business concerns.

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

1. assess their personal characteristics and interests to that of the "successful" entrepreneur, identification and assess sources of support for small businesses and entrepreneurs.
2. evaluate methods of entering an entrepreneurship venture – including but not limited to starting a new venture, buying an existing business, or becoming a franchisee.

***Text Books:***


1. *Desai, V., Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).*
2. *Singh, I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).*


***Reference Books:***


1. *Sateesh, M.K., Bioethics and Biosafety, IK International (2008).*


**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 30 |
| 2 | EST | 45 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 25 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT301 ANIMAL BIOTECHNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The objective of this course is to introduce students to develop basic aseptic skills for vertebrate cell culture and the maintenance of cell lines and *in vitro* application of cell and molecular techniques.

**Introduction to Animal Tissue Culture:** Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation.

**Layout and Equipment's:** Layout, Essential equipment's, Aseptic technique, Objectives, Elements, Sterile handling, Safety, Risk assessment, General safety, Fire, Radiation, Biohazards.

**Media:** Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages and their applications.

**Primary Culture and Culture of Specific Cell Types:** Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity

**Characterization, Contamination and Cryopreservation of Cell Line:** Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time, Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cell banks, Transporting cells.

**Transgenic Animals and Animal Cloning:** Methodology, Embryonic stem cell method, Microinjection method, Retroviral method, Applications of transgenic animals, Fertilization and Cloning, Conventional methods for animal improvement, Embryo biotechniques, Transfection techniques, Micro manipulation and cloning, Somatic cell cloning, Embryo sexing Artificial insemination, Creation of Dolly, Polly, Hand guided cloning

**Nucleic Acid Based Therapeutic Agents & Gene Therapy:** siRNA, Aptamers, antisense oligodeoxynucleotides (AS-ODN), Ribozymes, Peptide Nucleic Acids, Gene therapy: *Ex-vivo* gene therapy, *In-vivo* gene therapy, Use of Retro and adenovirus as vectors for gene therapy, Gene therapy used for treatment of Cystic Fibrosis, SCID.

**Stem Cell Biology**: Introduction to stem cells, Basic concepts, properties and molecular basis of totipotency, Pluripotency, Multipotency, Adult stem cells, Fetal Stem Cells, Niches of stem cells, Blastocyst and inner cell mass cells; Organogenesis; Embryonic stem cells, Hematopoietic stem cells, Clinical use of HSC, stem cell transplantation, Embryonic origin of MSC's, Harvesting, Isolation and Characterization, Differentiation studies of MSC's

**Self-Learning:** Stem Cells and Cloning: Therapeutic and reproductive cloning, Nuclear Transfer method, Application of NT ES cells, Safety of NT ES cells. Applications of stem cells in medicine and different disease models, Biosafety and Stem cell research, Regulatory considerations and FDA requirements for stem cell therapy.

**Laboratory Work:**
Laboratory Design & Instrumentation in ATC, Quality Assurance in Animal tissue culture facility, Preparation of animal cell culture media, Isolation and Culturing Peripheral Blood Lymphocytes, Viability assay, Cryopreservation technique, Sub-culturing and maintenance of Cell line, In vitro anticancer assay (MTT Assay), Genomic DNA Isolation from Blood and Tissue.

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

1. explain the fundamental scientific principles that underlie cell culture.
2. acquire knowledge for isolation and growth of cells.
3. develop proficiency in establishing and maintaining of cell lines
4. apply the concept of stem cell technology in biomedical research

***Text Books:***


1. *R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique (2000).*
2. *Ranga, M.M., Animal Biotechnology, Agrobios (2007).*


***Reference Books:***


1. *Masters, J. R.W., Animal Cell Culture, Oxford (2000).*
2. *Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).*


*Approved in 107$^{th}$ meeting of the Senate held on June 16, 2022*

**Evaluation Scheme:**

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 35 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 40 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT303: BIOINFORMATICS**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The objective of this course is to provide students with basic understanding and applications of bioinformatics. The course will provide the basic concepts behind the sequence and structural alignment, database searching, protein and RNA structure prediction.

**Introduction to bioinformatics**: Introduction, goals, application and limitations of Bioinformatics, Biological sequence and molecule file formats.

**Biological databases**: Introduction to Biological Databases, Types of Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases.

**Sequence alignment**: Pairwise Sequence Alignment, Database Similarity Searching, Multiple Sequence Alignment, Basics of phylogenetic, Phylogenetic Tree Construction Methods and Programs, Protein Motifs and Domain Prediction

**Gene and promoter prediction**: Gene Prediction, Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes, Gene Prediction in Eukaryotes, Promoter and Regulatory Element Prediction in Prokaryotes, Promoter and Regulatory Elements in Eukaryotes, Prediction Algorithms.

**Structural bioinformatics:** Protein Structure Basics, Protein Structure Visualization, Comparison, and Classification, Protein Secondary Structure Prediction, Protein Tertiary Structure Prediction, RNA Structure Prediction

**Self-learning:** Machine Learning and Bio-programming, Development of Algorithms, Hidden Markov Models, Artificial Neural Networks.

**Laboratory Work:** DNA and protein sequence and PDB file formats, Sequence Alignment, Sequence search, Gene Prediction, Phylogenetic tree construction, Secondary structure prediction, Visualization and editing of three dimensional structure, Homology modelling, Active site prediction.

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

1. comprehend the key concepts of different bioinformatics databases and tools
2. analyse and compare the sequence of bio-macromolecule data
3. understand the structure and function of bio-macromolecules
4. apply the knowledge of bioinformatics in the biotechnology research and industry

**Text Books:**

1. Xiong J, Essential Bioinformatics, Cambridge University Press (2010).
2. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001).
3. Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2013).

**Reference:**

1. Dwyer, R.A., Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press (2004).
2. Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).

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**Evaluation Scheme:**

| Sr.No. | Evaluation Elements | Weight age (%) |
|---|---|---|
| 1. | MST | 25 |
| 2. | EST | 40 |
| 3. | Sessionals (May include assignments/quizzes) | 35 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT304: PHARMACEUTICAL TECHNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objectives:** To acquire knowledge about the new drug discovery, development and approval process and drug manufacturing and its quality control in pharmaceutical industry.

**Discovery and Development of Drugs:** Introduction to drug discovery, finding a lead compound, combinatorial chemistry, rational drug design, target selection, computer aided drug design, new drug development and approval process, preclinical and clinical trials.

**Drug Pharmacokinetics:** Routes of drug administration, membrane transport, absorption, distribution, metabolism and excretion of drugs.

**Drug Pharmacodynamics:** Pharmacological classification of drugs, mechanism of drug action on human beings, receptor pharmacology, factors modifying drug action, pharmacogenomics, adverse effects of drugs and drug toxicology.

**Natural Products:** Natural products from animal, plant and microbial origin having pharmaceutical importance. Principles of pharmacognosy, composition, physical and chemical properties, occurrence and uses of carbohydrates and glycosides, proteins, peptides and amino acids, sterols, saponins, alkaloids, phenols, volatile oils.

**Pharmaceutical Manufacturing:** Drug formulations and their classification- oral solid dosage forms, ~~coating of pharmaceutical dosage forms~~, parenteral preparations, novel drug delivery systems-carrier systems and liposomes for drug targeting, good laboratory and good manufacturing practices-issues, packing techniques.

**Pharmaceutical Testing, Analysis and Control**: Analysis of pharmaceuticals using physical, chemical and biological methods, quality assurance and control, stability of pharmaceutical products, Quality control and testing as per Indian/US Pharmacopoeia.

**Self-Learning: Biotechnology and Drugs** – Recombinant drugs, biotechnology derived therapeutics- approved and in developmental stage.

**Laboratory Work:**
Quality assurance of antibiotic/non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic and biological methods as per Indian/US Pharmacopoeia, sterility testing of pharmaceutical products (intra-venous injections, antibiotics and vitamins), assays for screening antimicrobial/antifungal agents from plants and other natural sources.

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

1. explain the regulatory aspects and various steps of new drug discovery process.
2. explain the pharmacodynamics and pharmacokinetics of drugs.
3. apply the knowledge of manufacturing and quality control in the production of biopharmaceuticals.
4. apply the knowledge of natural products in the development of drugs.

***Text Books:***

*1. Allen, L.V., Popovich, N.G. and Ansel, H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins (2005).*

*2. Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2004).*

***Reference Books:***

*1. Klefenz, H., Industrial Pharmaceutical Biotechnology, Wiley –VCH Verlag GmbH., (2002).*

*2. Walsh, G., Biopharmaceuticals-Biochemistry and Biotechnology, John-Wiley (2003).*

**Evaluation Scheme**:

| Sr. No. | Evaluation Elements | Weightage (%) |
|---|---|---|
| 1 | MST | 25 |
| 2 | EST | 40 |
| 3 | Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations) | 35 |

*Approved in 107th meeting of the Senate held on June 16, 2022*

**PBT305: PLANT BIOTECHNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

**Introduction, Aim and Scope of Plant Biotechnology:** Major challenges and prospects of traditional and modern plant biotechnology, Important milestones of plant biotechnology

**Plant Tissue Culture**—its history, development and applications, Plant tissue culture media, Types of cultures, Callus cultures, Cell and suspension cultures, Single cell clones, Protoplast culture and somatic hybridization.

**Micropropagation:** Techniques and various steps involved in micropropagation, Production of disease free plants, Commercial aspects and limitations of micropropagation.

**Production of Haploid Plants**: Androgenesis and Gynogenesis, Significance and uses of haploids. Embryo culture and embryo rescue and its applications in plant improvement.

**Strategies for Producing Novel Plants:** Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, direct and indirect gene transfer methods, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, various strategies for the improvement of crop yield and quality, Applications of plant transformations/transgenics, Commercial transgenic crops. Molecular farming of commercially/pharmaceutically important products.

**Secondary Metabolite Extraction:** Primary vs secondary metabolites, Role of plant tissue culture in secondary metabolite production, Hairy root culture, Immobilized cell system, Elicitation and Biotransformation.

**Somaclonal Variations:** Isolation of somaclonal variants, Applications and limitations of somaclonal variations, Gametoclonal variations. Germplasm conservation and Cryopreservation

**Self-Learning:** Transgenics-Issues and Concerns, Biosafety, Societal and ethical concerns on genetically modified foods and crops.

**Laboratory Work:**

Plant tissue culture media, Explant preparation, Callus induction and differentiation, microscopic study of callus, Meristem culture for virus free plants, Rooting of plantlets and accilimatization, Protoplast isolation, Preparation of artificial seeds, Isolation and purification of plant DNA and RNA, Quantification of DNA, restriction analyses, *Agrobacterium*-mediated transformation of plants, Electroporation techniques.

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

1. familiarize with organization of PTC Lab., aseptic manipulations and learn techniques of culturing tissues, single cells, protoplast and anther culture, hairy root culture and germplasm conservation
2. undertake large scale *in vitro* propagation of plants and plan commercial production through micropropagation
3. generate plants with desirable/novel traits through genetic manipulations using different methods of gene transfer and marker associated selections.
4. recognize the importance of plant secondary metabolites, their production, and commercial application.

***Text Books:***


1. *Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008).*
2. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing (2006).*
3. *Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Concepts in Biotechnology, Universities Press (1999).*


***Reference Books:***


1. *Satyanarayana, U., Yeast Biotechnology: Diversity and Applications, Springer (2009).*
2. *Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003).*


*Approved in 107$^{th}$ meeting of the Senate held on June 16, 2022*

**Evaluation Scheme:**

| Sr.No. | Evaluation Elements | Weight age (%) |
|---|---|---|
| 1. | MST | 25 |
| 2. | EST | 35 |
| 3. | Sessionals (May include assignments/quizzes) | 40 |

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**ELECTIVE- I**

**PBT312: MOLECULAR FARMING**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective:** The students will learn about molecular farming an emerging branch of plant biotechnology and wide range of products for molecular farming such as carbohydrates, fats, proteins, secondary products and commercially important molecules using plant systems as 'bioreactors'.

**Introduction:** Definition and common perception of molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.

**Strategic Details of Various Molecular Farming:** Major targets for carbohydrate and lipid molecular farming; Introduction to the crucial metabolic pathways and the involved gene functions in plants & other suitable organisms; Various molecular approaches & strategies relevant to molecular farming; Production of carbohydrates: increased starch amount, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acids having pharmaceutical and nutraceutical values, Critical evaluation on various case studies of molecular farming & their future prospects; Economic and regulatory considerations for molecular farming.

**Production of Biodegradable Plastics in Plants**: Various gene functions involved in the production of polyhydroxy butyrate (PHBs) & polyhydroxyalkanoate co-polymers; Strategies for production of biodegradable plastics in plants.

**Self-Learning:** Genetically engineered plants as protein factories, Enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subunit vaccines, protein antibiotics; The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes.

**Laboratory Work:**

Isolation & characterization of genomic & cDNA clones relevant to molecular farming, making genetic constructs, Transient expression studies in plants, Genetic transformation of plants, Gene expression studies, studying molecular techniques/protocols related to various case studies: production of carbohydrates, lipids, proteins, antibodies, edible vaccines.

**Course Learning Outcomes (CLO):**

Students will be able to:

1. recognize the overall importance of plant molecular farming.
2. develop strategies for modification of various plant-made products such as carbohydrates, lipids, proteins and other novel molecules
3. generate transgenic plants that can produce commercially important proteins and enzymes
4. design strategy for production of biodegradable plastics in plants.
5. apply steps involved in downstream processing of plant-made products.

***Text Books:***


1. *Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University Press (2008).*
2. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*


***Reference Books:***


1. *Satyanarayana, U., Biotechnology, Books and Allied (P) Ltd. (2005).*
2. *Barnum, S.R., Biotechnology-an Introduction, Thompson Brooks/Cole (2007).*
3. *Primrose, S.B., Molecular Biotechnology, Second Edition, Panima Publishing Corporation (2001).*


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**Evaluation Scheme:**

| Sr.No. | Evaluation Elements | Weight age (%) |
|---|---|---|
| 1. | MST | 25 |
| 2. | EST | 35 |
| 3. | Sessionals (May include assignments/quizzes) | 40 |

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**PBT315: PROTEIN ENGINEERING**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objective**: Aiming to provide basic knowledge of engineering and design of the protein for its application, this course will make students learn structural and functional relationships in proteins and enabling students to improvise protein structure and function.

**Elements of protein structure**: Introduction to protein engineering; Primary structure: amino acids and their –R groups; Secondary structure: α helix, β strand, β sheet, loops, Ramachandran plot; Super secondary and tertiary structure: motifs, domain, and fold; Quaternary structure: oligomer assembly; Relationship between structure and function: protein active site, catalytic site, crypto sites and druggability, cooperativity and allosteric effect.

**Experimental and computational tools used in protein structural Biology:** Protein structure determination by X ray diffraction (XRD) and NMR, Prediction of protein structure and conformation from sequence data (Homology Modeling, Threading and *de novo* prediction.); Computational tools for prediction of protein active sites; Spectroscopy methods (CD and fluorescence) of determination of protein structural conformation; Protein activity and stability measurement ($k_{cat}/K_m$; $T_m$) using spectroscopy

**Protein Engineering:** Mutagenesis methods: site directed mutagenesis–insertion, deletion, substitution, modular protein domain, random mutagenesis- directed evolution, gene shuffling; Kunkle mutagenesis; Phage display technology; Overview of CRISPR/Cas method (*in vivo*); Insertion of unnatural amino acids in protein using orthogonal system; Chemical modifications of proteins

**Protein expression and purification systems:** Expression of proteins in bacteria, yeast, insect and mammalian cells; Protein purification overview; Different chromatography methods (Affinity, ion exchange, gel exclusion, hydrophobic)

**Applications of Protein Engineering:** Case study-protein engineering in lysozyme; Applications in drug delivery, biosensors, immunotherapy; antibody engineering

**Laboratory work:** Computational prediction of protein function and structure from protein arbitrary sequence; Retrieving protein structure from database (PDB); Visualization and analysis of protein structure; Protein precipitation using ammonium sulfate; SDS-PAGE analysis of the protein; Quantification of protein using spectroscopy (Bradford or Lowry); Protein denaturation study using UREA; Protein denaturation study using heat; Chromatography method of protein purification.

**Course Learning Outcomes (CLO):**

Students will be able to

1. Understand the protein structure and function relationship.
2. Know the methods for determination of protein structure and studying protein structure, function and stability.
3. Apply the methods involved in protein engineering.
4. Design strategy of protein expression and purification
5. Comprehend the scope of protein engineering application

**Text Books:**

1. Primrose SB and Twyman RM: *Principles of Gene Manipulation and Genomics* Blackwell Publishing (2006).
2. Cleland JL and Craik CS: *Protein Engineering: Principles and Practice*, Wiley-Liss. (1996).
3. Lutz S and Bornscheuer U T: *Protein Engineering Handbook*, Wiley-VCH (2009)
4. Zhao H(Editor), Lee SY (Series Editor), Nielsen J(Series Editor), Stephanopoulos G (Series Editor): *Protein Engineering: Tools and Applications*, Wiley-VCH (2021)
5. Park SJ(Editor), Cochran JR(Editor), *Protein Engineering and Design*, CRC Press (2009).

**Reference Books**:

1. Branden CI, Tooze J: *Introduction to Protein Structure*, Garland Science (1998)
2. Williamson M: *How Proteins Work*, Garland Science (2012)

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**Evaluation Scheme:**

| Sr.No. | Evaluation Elements | Weight age (%) |
|---|---|---|
| 1. | MST | 25 |
| 2. | EST | 35 |
| 3. | Sessionals (May include assignments/quizzes) | 40 |

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**PBT314: MEDICAL BIOTECHNOLOGY**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 2 | 4.0 |

**Course Objectives:** 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.

**Detail contents:**

**Introduction:** History and scope of medical biotechnology, current status and future prospects

**Classification of genetic diseases**: Chromosomal disorders – Numerical disorders (trisomies & monosomies), Structural disorders (deletions, duplications, translocations & inversions), Chromosomal instability syndromes. Gene controlled diseases (Autosomal and X-linked)

**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.

**Gene therapy**: *Ex-vivo*, *In vivo*, *In situ* gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy Biological vectors (retrovirus, adenoviruses, baculovirus), Synthetic vectors (liposomes, receptor mediated gene transfer), Gene therapy trials (ADA, AIDS, Cystic Fibrosis, cancers)

**Nucleic acid-based Therapy:** Gene silencing technology, siRNA, Aptamers, antisense oligodeoxynucleotides, Ribozymes, Peptide Nucleic Acids.

**Recombinant & Immunotherapy**; Clinical applications of recombinant technology (insulin, growth factor, blood clotting factor), Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosuppressors in organ transplants; Cytokine therapy, CAR-T immunotherapy.

**Metabolic disease and clinical management and Metabolic syndrome:** Obesity, insulin resistance, NAFLD, PKU, ADA, Congenital hypothyroidism.

**Laboratory work:** G & C banding of mammalian metaphase chromosome, Blood urea analysis, Analysis of alkaline phosphatase in serum samples, Estimation of serum cholesterol and friedewald equation, Assay of AST and ALT in serum, Blood sugar analysis & calculation of insulin sensitivity and insulin resistance, Estimation of Creatinine from urine samples.

**Course Learning Outcomes (CLO):**

Students will be able to

1. Explain insights about genetic diseases and also about the molecular aspects related to human disease
2. Gain new insights into molecular mechanisms of nucleic acid and gene therapy
3. Gain knowledge about therapeutic recombinant proteins and immunotherapy for the treatment of different diseases

**Text books**

*1. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000)*

*2. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl Amazon*

**Reference Books**

1 *Human Molecular Genetics by T. Strachan, Andrew. Garland Science.* ISBN 978- 0-815-34149-9

2. Medical Biotechnology. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten. ASM press. ISBN 978-1-55581-705-3

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**Evaluation Scheme:**

| Sr.No. | Evaluation Elements | Weight age (%) |
|---|---|---|
| 1. | MST | 25 |
| 2. | EST | 35 |
| 3. | Sessionals (May include assignments/quizzes) | 40 |

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**PBT491: SEMINAR**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 0 | 2.0 |

**Course objective**: The students will choose a topic of their interest and do a literature survey and compile information with latest update and also find gaps or lacunae to plan for next series of experiments to be conducted to fill the gaps as a major research project. The students will acquire skill to write, compile and analyze data and present the detailed technical or scientific report.

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

1. carry out literature survey and compile existing data and information.
2. formulate a research problem in research laboratory.
3. design experiments to solve research problem.
4. make a presentation of compiled data and its interpretation to a meaningful conclusion.
5. acquire presentation and oral communication skills of scientific information and data.

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**PBT493: MAJOR RESEARCH PROJECT**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 0 | 10.0 |

**Course objective**: The semester project is aimed to impart an in-depth and thorough training on some specific research problems. Such exposures would enable the students to address the various real-time challenges prevalent in different areas of biotechnology. The students will gain knowledge of different experimental skills associated with biochemistry, microbiology, molecular genetics, genetic engineering, immunology and bioinformatics. The students acquire experience and knowledge to work in professional setup.

**Scope of Training**: The students will get an opportunity to become a part of ongoing research activities in the institutes. The student will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The students will develop understanding of biosafety, bioethic, regulatory affairs and compliances. The students will acquire skill to write, compile and analyze 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. identify a problem in biotechnology based industry.
3. formulate a research problem in research laboratory
4. design experiments to solve the industrial/research problem.
5. compile and/or interpret the industrial data.
6. analyze and interpret the experimental data.

**MSc (Biotechnology) Dissertation Evaluation**

Name of the candidate:.....
Name of Father.....Name of Mother.....
Roll No.....Year.....
Date of *Viva Voce*.....

| **I** | **Dissertation (50%)** | MM | Marks Obtained |
|---|---|---|---|
| 1 | Subject Matter | 10 | |
| 2 | Literature Review | 10 | |
| 3 | Presentation of matter (structuring) | 10 | |
| 4 | Discussion of results and inferences drawn | 20 | |
| **II** | **Presentation and *viva-voce* (40%)** | | |
| 1 | Subject matter of presentation | 10 | |
| 2 | Presentation structuring | 10 | |
| 3 | Response to questions | 10 | |
| 4 | Usefulness/contribution of the work to the profession | 10 | |
| **III** | **Overall perception which includes communication of paper to a journal (10%)** | 10 | |
| | Total | 100 | |

Brief outcome of work:.....
.....

Name and Signature of Examiner
Affiliation

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