# CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

## PROGRAM: M.Sc., SUBJECT: Biotechnology

| Syllabus Developed by | | | |
|---|---|---|---|
| **Name of BoS Convenor/BoS Member** | **Designation** | **Department** | **College/University** |
| Prof S K Awasthi | Dean, Faculty of Life Sciences | Life Sciences & Biotechnology | CSJM University Kanpur |
| Prof. Nand Lal | Professor, Head & Convenor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Prof. Neelam Pathak | External Expert | Biochemistry | RMLAU, Ayodhaya |
| Prof. Ram Narain | External Expert | Biotechnology | VBS Purvanchal University, Jaunpur |
| Prof. B N Mishra | External Expert | Biotechnology | Instt. Of Engineering &Technology, Lucknow |
| Prof. Varsha Gupta | Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Prof. Rolee Sharma | Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Dr. Shilpa Deshpande Kaistha | Associate Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Dr Vishal Chand | Assistant Professor | Life Sciences & Biotechnology | CSJM University Kanpur |

| **I$^{ST}$ YEAR / I$^{ST}$ SEM** | | | | | | |
|---|---|---|---|---|---|---|
| **COURSE CODE** | **TYPE** | **COURSE TITLE** | **MIN CREDITS** | **CIA** | **ESE** | **MAX. MARKS** |
| L030701T | CORE | Cell and Developmental Biology | 4 | 25 | 75 | 100 |
| L030702T | CORE | General Biochemistry | 4 | 25 | 75 | 100 |
| L030703T | CORE | Bioanalytical Techniques | 4 | 25 | 75 | 100 |
| L030704T | CORE | General Microbiology | 4 | 25 | 75 | 100 |
| L030705P | PRACTICAL | PRACTICAL | 4 | 25 | 75 | 100 |
| | PROJECT | RESEARCH PROJECT | | | | - |
| | | TOTAL | 20 | | | 500 |
| **I$^{ST}$ YEAR / II$^{ND}$ SEM** | | | | | | |
| L030801T | CORE | Molecular Biology and Genetics | 4 | 25 | 75 | 100 |
| L030802T | CORE | Intermediary Metabolism | 4 | 25 | 75 | 100 |
| L030803T | CORE | Plant Biotechnology and Tissue Culture | 4 | 25 | 75 | 100 |
| L030804T | CORE | Enzymology | | | | |
| | MINOR ELECTIVE* | Medical Laboratory Management | 4 | 25 | 75 | 100 |
| | | Basic Of Exercise, Physiology and Nutrition | | | | |
| L030805P | PRACTICAL | PRACTICAL | 4 | 25 | 75 | 100 |
| L030806R | PROJECT | RESEARCH PROJECT | 8 | 25 | 75 | 200 |
| | | TOTAL | 28 | | | 700 |
| **II$^{ND}$ YEAR / III$^{RD}$ SEM** | | | | | | |
| L030901T | CORE | Cellular and Molecular Immunology | 4 | 25 | 75 | 100 |
| L030902T | CORE | Principle and Application of Genetic Engineering | 4 | 25 | 75 | 100 |
| L030903T | ELECTIVE -1 | Genomics and Proteomics | 4 | 25 | 75 | 100 |
| L030904T | | Fundamentals In Biostatistics and Biomaths | | | | |
| L030905T | ELECTIVE -2 | Animal Cell Culture & Medical Biotechnology | 4 | 25 | 75 | 100 |
| L030906T | | Computational Biology and Bioinformatics | | | | |
| L030907P | PRACTICAL-3 | PRACTICAL | 4 | 25 | 75 | 100 |
| | | MOOC/RESEARCH PROJECT | | | | - |

# CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

## PROGRAM: M.Sc., SUBJECT: Biotechnology

| | | | | | | |
|---|---|---|---|---|---|---|
| | TOTAL | | 20 | | | 500 |
| | **II$^{ND}$ YEAR / IV$^{TH}$ SEM** | | | | | |
| L031001T | ANY FOUR ELECTIVES TO BE CHOSEN | Bioprocess Technology | 5 | 25 | 75 | 100 |
| L031002T | | Oncotechnology | 5 | 25 | 75 | 100 |
| L031003T | | Nanotechnology | 5 | 25 | 75 | |
| L031004T | | Neurosciences and Technology | 5 | 25 | 75 | |
| L031005T | | IPR, Bioethics and Entrepreneurship | 5 | 25 | 75 | 100 |
| L031006T | | Environmental Biotechnology | 5 | 25 | 75 | |
| L031007T | | Microbial Biotechnology | 5 | 25 | 75 | 100 |
| L031008T | | Research Methodology | 5 | 25 | 75 | |
| L031009R | | DISSERTATION | 8 | 25 | 75 | 200 |
| | TOTAL | | 28 | | | 600 |
| | **GRAND TOTAL** | | 100 | | | **2300** |

**NOTE:**

1. * A Minor Elective from other faculty shall be chosen In 1$^{st}$ Year (Either Ist / IInd Semester) as per availability.
2. In both years of PG program, there will be a Research Project or equivalently a research-oriented Dissertation as per guidelines issued earlier and will be of 4 credit (4 hr/week), in each semester. The student shall submit a report/dissertation for evaluation at the end of the year, which will be therefore of 8 credits and 100 marks
3. Research project can be done in form of Internship/Survey/Field work/Research project/ Industrial training, and a report/dissertation shall be submitted that shall be evaluated via seminar/presentation and viva voce.
4. The student straight away will be awarded 25 marks if he publishes a research paper on the topic of Research Project or Dissertation.

# Semester wise Syllabus

## For

# M.Sc. – BIOTECHNOLOGY
# Academic Programme

(According to NEP 2022)

## Specialization/Discipline:

## Biotechnology

## Duration:
## 2 years (4 Semesters)

## With effect from academic year 2022-23

13/5/22

Prof. Neelam Pathak (Online)

Prof. Ram Narain (Online)

Prof. B. M. Mish (Online)

## M. Sc - BIOTECHNOLOGY PROGRAM OUTCOMES

**PO1:** This programme explores the knowledge for the changes occurring in living cells. Demonstrate the interdisciplinary skills in the fields of biochemistry, cell and molecular biology, bioprocess engineering, plant biotechnology, genetic engineering, microbiology and bioinformatics.

**PO2:** The program focuses on techniques used in industry for production of microbial/plant/Animal products thus it enables develop an understanding of an applied aspect of microbes/plants/animals in industry.

**PO3:** Developed in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies, & Academia.

**PO4:** To train the students in all the fundamentals of the subject of Biotechnology, progressively giving way to all essentials of the subject with good practical training and exposure to most modern concepts. Develop an ability to solve, analyse and interpret data generated from experiments done in project work or practical courses.

**PO5:** Demonstrate skills to use modern analytical tools/ software/ equipment's and analyse and solve problems in various courses of biotechnology.

**PO6:** The curriculum carries multiple options in terms of electives for incorporating innovative ideas generated in this field.

**PO7:** To provide ample opportunity for the students to gain sufficient practical knowledge in the subject with properly designed experiments. Adopt code of ethics in professional and social context and demonstrate exemplary professional, ethical and legal behaviours in decision making. Explore new areas of research in all the branches of biotechnology in addition to interdisciplinary fields

**PO8:** To help the students to mold themselves as competent enough in an international pursuit of knowledge by providing written and oral communication skills to communicate effectively in healthcare, industry, academia and research.

**PO9:** Apply responsibilities to promote societal health and safety, upholding the trust given to the profession by the society.

**PO10:** The interdisciplinary nature of the subject is to be incorporated to have option for employment and higher studies also develop skills, attitude and values required for self-directed, lifelong learning and professional development.

Govt. of India, which provides a strategic roadmap for India's emergence as a global biotechnology innovation and manufacturing hub, which also highlighted importance of human resource development and need for naturing tailor-made human capital for advanced strategic research and entrepreneurship.

## PROGRAMME SPECIFIC OUTCOMES (PSO's) OF MSC DEGREE IN BIOTECHNOLOGY

Students who passed with MSc. Biotechnology will,

**PSO1:** Have significant knowledge on various aspects of Biotechnology with special reference to microbes and their products.

**PSO2:** Expertise in laboratory techniques of basic microbiology, especially with regard to isolation, characterization of industrially important microbes.

**PSO3:** Understand the fundamental concepts in core (plant, animal, industrial biotechnology, molecular biology, genetic engineering and genetics) and allied (microbiology, immunology and physiology).

**PSO4:** Get exposure to various research fields and thrust area of the core and interdisciplinary subjects.

**PSO5:** Acquire technical skills especially in regard to industrially important metabolites and their production. PSO6: Have ability to plan and execute experiments as well as to analyse & interpret data for any research.

## COURSE OUTCOME OF MSC DEGREE IN BIOTECHNOLOGY

### I SEMESTER

Title of paper: CELL AND DEVELOPMENTAL BIOLOGY
Course code**: L030701T**
CO1: The student can understand how the cell is equipped with machineries to conduct activities as the basic structural and functional unit of life.
CO2: The structural features of cell organelles/machineries.
CO3: The functional mechanisms of cellular phenomena.
CO4: The fundamental principles of heredity and deviations from mendelian behaviour.

Title of paper: GENERAL BIOCHEMISTRY
Course code: **L030702T**
The student is exposed to:
CO1: The biochemical composition of the cell.
CO2: The structure and types of nutrient components.
CO3: The major metabolic pathways and their significance.
CO4: The coordination of metabolic pathways.

Title of paper: BIOANALYTICAL TECHNIQUES
Course code: **L030703T**
The student gets awareness in:
CO1: The techniques used in the visualization of cellular components and macromolecules.
CO2: Analytical techniques used in detection and quantification of biological compounds and the separation techniques used in biology.
CO3: The application of statistical principles in biological studies.
CO4: The research methodology and documentation.

Title of paper: GENERAL MICROBIOLOGY
Course code**: L030704T**
The students get an exposure in:
CO1: Microbial grouping and its taxonomical significance.
CO2: Cultivation and identification of microorganisms.
CO3: The Organization of Bacterial Cell CO4: Maintenance and preservation of bacterial cultures.
CO5: General characteristics of Archaebacteria and their phylogenetic overview
CO6: Overview of Bacterial Diversity: Morphology, Metabolism, Ecological Significance and Economic importance

### II SEMESTER

Title of paper: MOLECULAR BIOLOGY AND GENETICS
Course code: **L030801T**
The student gets a comprehensive knowledge of:
CO1: The structural and functional organization of genome.

CO2: The molecular phenomena of DNA copying and transmission of information.
CO3: The regulation of gene function and associated phenomena.
CO4: The fundamental principles of heredity and deviations from mendelian behaviour.
CO5: The effect of mutations and mutational analysis. Principles of behavioural and population genetics.

Title of paper: INTERMEDIARY METABOLISM
Course code: **L030802T**
CO1: The characteristics of enzymes as biological catalysts, enzyme kinetics, enzyme classification.
CO2: The role of nucleic acids in synthesis of macromolecules, particularly proteins and enzymes.
CO3: The structure and physico chemical properties of carbohydrates from monosaccharide to polysaccharides.
CO4: The difference between the water soluble and fat-soluble vitamins and their key role in the metabolism as coenzymes.
CO5: The rate of reactions and order of reactions, and inhibitions and their kinetics.
CO6: This course teaches the basic anatomy and physiology of human body.
CO7: The students are taught the functioning aspects of the human body at molecular level.
CO8: At the end of this course the students will be able to appreciate the anatomical and physiological aspects of the human body

Title of paper: PLANT BIOTECHNOLOGY AND TISSUE CULTURE
Course code: **L030803T**
Students get familiarized with the:
CO1: Fundamental requirements and design of lab to carry out plant Tissue culture experiments.
CO2: The different approaches and techniques involved in creating recombinant plant.
CO3: The applications and demerits of genetic modification in plants.
CO4: This course introduces the students to explore entrepreneurial avenues in this field.

Title of paper: ENZYMOLOGY
Course code: **L030804T**
CO1: It helps the students to learn the significant features of the biochemical catalysts.
CO2: It helps the students to learn the methodology involved in assessing the enzyme activity and mechanism of enzyme action.
CO3: It illustrates the enzyme catalysis, kinetics and regulatory aspects.

Title of paper: MEDICAL LABORATORY MANAGEMENT
Course code: **MMLT-201PT**
At the end of the course the student should be able to:
CO1: Supervise/Perform routine Hematological and Immuno-hematological laboratory testing.
CO2: Make specimen-oriented decision on predetermined criteria including working knowledge of critical values.
CO3: Communicate with other members of healthcare team, customers and patients in an effective manner.
CO4: Process information and ensure quality control as appropriate to routine laboratory.
CO5: Train students in routine/special laboratory procedure.

CO6: Upgrade knowledge and skills in a changing healthcare scenario.
CO7: Should know the logical interpretation of clinical lab investigations.

Title of paper: BASIC OF EXERSICE, PHYSIOTHERAPY & NUTRITION
Course code: **MPT-105**
On completion of this subject students should have the opportunity to:
CO1: Strengthen the basic fundamental basis of assessment and diagnosis and postulate this knowledge in clinical practice.
CO2: Analyses critical evaluate the patient conditions and formulation of accurate diagnosis.
CO3: Acquire a thorough understanding of basic exercise physiology which can be applied in clinical practice.

## III SEMESTER

Title of paper: CELLULAR AND MOLECULAR IMMUNOLOGY
Course code: **L030901T**
The students have knowledge of:
CO1: The cells and organs associated with immune system.
CO2: The details of immune system functioning.
CO3: Analytical techniques based on immunological reactions.
CO4: The after effects of defects in immune system.
CO5: This course provides you with knowledge and understanding of immunology and the way it is applied in diagnostic and therapeutic techniques and research.
CO6: It's a paper which accomplishes the learning of techniques involved in understanding the immunological aspects of physiology and biological samples.

Title of paper: PRINCIPLE AND APPLICATION OF GENETIC ENGEENERING
Course code: **L030902T**
This course will provide students with the recent knowledge of genetic engineering. At the end of the course, a successful student will be able to
CO1: Understand and explain the concept of genetic engineering including the techniques, applications and limitations.
CO2: Demonstrate the ability to design recombinant molecules and apply information extracted from a variety of sources including journal articles, technical bulletins, product manuals, and drug information sheet to solve problems.
CO3: Apply learned knowledge to their future research.

Title of paper: GENOMICS AND PROTEOMICS
Course code: **L030903T**
This course aims to provide the knowledge and practical skills of functional genomics and proteomics
CO1: The course also teaches the techniques used in functional genomics such as microarrays, NGST, mRNA expression and miRNA expression.
CO2: By the end of the course, students will have the necessary learning to radically advance our understanding of life and transform medicine.

Title of paper: FUNDAMENTAL OF BIOSTATISTICS AND BIOMATHS
Course code: **L030904T**
CO1: Mathematically model, solve, and analyse problems in biomathematics.
CO2: Implement computational approaches to solve and analyse problems in biomathematics.
CO3: Write lucidly about biomathematics.
CO4: Speak fluently and coherently about biomathematics.
CO5: Describe various application area of biostatistics, Summarize, organize and display quantitative data
CO6: Distinguish different types of data and sampling techniques, Compute and interpret the result of correlation and regression analysis
CO7: Calculate and interpret measures of central tendency and variability in statistical data, compare different population sample using ANOVA
CO8: Explain the characteristics and use of statistical software and packages of biostatistics
CO9: Identify appropriate tests to perform hypothesis testing and experimental design for biological experiment and interpret the output adequately.

Title of paper: ANIMAL CELL CULTURE AND MEDICAL BIOTECHNOLOGY
Course code: **L030905T**
Students get familiarized with the:
CO1: Comprehend basic concepts of establishing animal cell cultures
CO2: Understand the principles and applications of these technologies
CO3: Modern tools in diagnosis
CO4: Demonstrate antigen-antibody relationships and their detection methods.
CO5: The biotechnological approaches to therapy
CO6: Understand the principles of the new biotechnology-based assays
CO7: The therapeutic uses of plant products

Title of paper: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS
Course code: **L030906T**
Upon completion of the course the student will be able to:
CO1: Get to know effective use of Office package
CO2: Create a patient record database in MS Access and handle queries on the same.
CO3: Store and Retrieve drug related information using online tools
CO4: Design a questionnaire using word processing package
CO5: Comprehend the utility of tools & databases available in genomic & proteomics

## IV SEMESTER

Title of paper: BIOPROCESS TECHNOLOGY
Course code: **L031001T**
Upon completion of the course, the student will be:
CO1: Biological and kinetic concepts underlying bioprocesses engineering
CO2: Explain procedures for the design and control of bioreactors
CO3: Product isolation using various analytical methods
CO4: Understand the basic upstream processing principles

CO5: Apply the bioprocess engineering in different industries for the benefit of mankind

Title of paper: ONCOTECHNOLOGY
Course code: **L031002T**
CO1: Upon completion of this course, the students will be able to:
CO2: Understand the cellular and molecular basis of cancer.
CO3: Current strategies for cancer prevention and treatment.
CO4: Take up the research in the frontier area of cancer biology

Title of paper: NANOTECHNOLOGY
Course code: **L031003T**
Upon completion of this course, the students will be able to:
CO1: Comprehend the nanoscale phenomenon associated with cellular nanostructures
CO2: To reveal the nature of DNA bricks, aptamers and origami
CO3: Design and utilize the protein and enzyme-based nanostructures
CO4: Classify glycol nanostructures based on their binding ligands
CO5: Have knowledge about membrane transport and membrane-based nanostructures and their uses

Title of paper: NEUROSCIENCES AND TECHNOLOGY
Course code: **L031004T**
Upon completion of this course, the students will be able to:
CO1: Learn about anatomy and functioning of the central and peripheral nervous system.
CO2: Gain knowledge about various type of cells found in the nervous system.
CO3: Understand different types of learning and memory and senses.
CO4: Think about therapies for various neurological disorders.

Title of paper: IPR, BIOETHICS AND ENTREPRENEURSHIP
Course code: **L031005T**
Upon completion of this course, the students will be able to:
CO1: Teachings like good laboratory procedure and practices, standard operating procedures for biotechnology research, legal and institutional framework for biosafety, international agreements and protocols for biosafety.
CO2: learn about the Intellectual property rights and their usages to protect work created by human mind that has commercial value.
CO3: Makes students aware about different national and international IPR issues including patents, trademarks, copyrights etc. and various international agreements and treaties.

Title of paper: ENVIRONMENT BIOTECHNOLOGY
Course code: **L031006T**
Upon completion of this course, the students will be able to:
CO1: Apply the concepts of Biotechnology in Environmental Management.
CO2: Describe the concept of pollution management.
CO3: Bioremediation and biodegradation principles, processes and applications with advanced applications in wastewater, oil recovery, biohydrometallurgy, biofuel, carbon storage and capture, etc.

CO4: How modern biotechnology is developed to achieve better environmental protection and sustainability through the use of microbes and microbial communities in pollution abatement to mitigation of climate change, bioenergy, biomaterial to enzyme discovery.

Title of paper: MICROBIAL BIOTECHNOLOGY
Course code: **L031007T**
Upon completion of this course, the students will be able to:
CO1: Microbes and their metabolic pathways and products can be used in biotechnology.
CO2: Particular areas of concern will be environmental biotechnology, bioremediation and biomining, but will also allow students to develop their own interests in other aspects of biotechnology.
CO3: Apply the gene manipulation techniques Knowledge to Microbiota
CO4: Analyse the different applications of genetically modified organisms related issues

Title of paper: RESEARCH METHODOLOGY
Course code: **L031008T**
Upon completion of this course, the students will be able to:
CO1: Understand some basic concepts of research and its methodologies
CO2: Identify appropriate research topics
CO3: Select and define appropriate research problem and parameters
CO4: Prepare a project proposal (to undertake a project)
CO5: Organize and conduct research (advanced project) in a more appropriate manner
CO6: Write a research report and thesis
CO7: Write a research proposal (grants)

# FIRST SEMESTER

## CELL AND DEVELOPMENTAL BIOLOGY

**Paper- First**

**L030701T**

**Course Objective:** This course aims to give the student an overview of basic cell biology and its application. This course will focus on identifying key components that constitute living cells. The focus will be orientated on cell and its application in developmental biology, with emphasise on key techniques currently used in the study of cells.

**UNIT I: Cell Structure**

Cell as a unit of life, prokaryotic, and eukaryotic cell, differences between plant and animal cell, general idea about lipid bilayer membranes, membrane transport of small molecules, cell adhesion, cell junction and extra cellular matrix, chemical composition of cell wall, cross linkage, porosity, tensile strength, turgor modifications in special types of cells, plasmodesmata and fluid transport between cells.

**UNIT II: Cell Organelles**

Structure and functions of -Endoplasmic Reticulum: types – rough & smooth, intracellular transport & lipid biosynthesis, ribosomes, Golgi apparatus, role of mitochondria in cellular energies & biogenesis, chloroplast, lysosomes: general organization, polymorphism, enzyme systems and their functions, vacuoles and ergastic substances, peroxisomes: formation, enzyme content and role.

**UNIT III: Cytoskeleton and Cell Signalling**

Cytoskeleton: microtubules, microfilaments & associated proteins – actin, myosin and intermediate filaments, three-dimensional organization of cytoskeleton, chromatin and chromosomes, Roles of microfilaments and microtubules in cellular structure and function.

Cell Signalling: General principles of signalling switches. Receptor characteristics. Identification and characteristics of receptor proteins, G-proteins and receptor tyrosine kinase mediated signalling Ca2+ flux and its interpretation in cytoplasm, role of Ca2+ binding proteins.

**UNIT IV: Cell division and cell cycle**

Mitosis, meiosis and binary fission, cell cycle, cell cycle clock & check points, overview of cell cycle; molecular mechanisms for regulating mitotic events; check points in cell cycle regulation; meiosis; cell birth, lineage and death. Apoptosis: The role of programmed cell death in maintaining the social order of cells and in tissue sculpting. Pathways and hallmarks of apoptosis. Role of caspases and Bcl2 family proteins.

**UNIT V: Cellular Development**

Basics of Development: Potency, induction, commitment, specification, competence, determination and differentiation, morphogenetic gradient, cell fate and cell lineages, stem cell and their properties, transdiffrentiation, genomic equivalence, and cytoplasmic determinants, imprinting, mutants their analysis. Gametogenesis: Fertilization and early development, differentiation of germ layers, cellular polarity, maternal gene effects, zygotic gene effects, homeotic gene effect in Drosophila, Embryogenesis.

**Suggested Reading:**

1. Molecular Biology of the Cell-Alberts et al
2. Molecular Cell Biology-Lodish et al
3. Cells-Lewin
4. Becker's World of Cell-Hardin et al
5. The Cell: A molecular Approach-Cooper and Hausmann

## GENERAL BIOCHEMISTRY

### Paper-Second

### L030702T

**Course Objective:** The course aims is the understanding structure and function of major classes of biopolymers. Aims of the course are to understanding central metabolic process and role of enzymes in modulating pathways. The theoretical background of biochemical knowledge to interpret the results in biochemistry experiments.

**UNIT I: Properties of water and biological buffers**

Some Important Properties of Water: Dissociation of water and its ion product, pH, pka Bronsted Acids, ionization of weak acids and bases; Henderson-Hasselbalch equation, Titration curves and buffering action, physiological buffers; Principles of Thermodynamics

**UNIT II: Structure and Function of Carbohydrates**

Carbohydrates: Classification and properties of simple carbohydrates, monosaccharides, disaccharides and polysaccharides. Structural polysaccharides: cellulose and chitin; storage polysaccharides: starch and glycogen; glycosaminoglycans; glycoconjugates: proteoglycans, glycoproteins and glycolipids

**UNIT III: Structure and Function of Lipids**

Fatty Acids and Lipids: Structure, classification and properties of fatty acids, structure and functions of lipids: Triacyl glycerides, phosphoglycerates, sphingolipids, cholesterol, steroids, eicosanoids, Lipoproteins

**UNIT IV: Structure and Function of Nucleic Acid**

Sturcture and functions of DNA: Base pairing: Watson-crick, Hoogsteen and Wobble base pairs, The salient features of the Watson-Crick model of B-DNA, The structure and helical parameters of B-DNA, A-DNA, and Z-DNA. Melting temperature (Tm), Forces stabilizing the B-DNA.

Structure and functions of RNA: Physicochemical properties of RNA, classification, structure and functions of different types of RNAs (hnRNA, mRNA, rRNA, tRNA, snRNA, snoRNA, antisense RNA telomerase RNA, gRNA,etc.). The clover leaf and L-shaped structures of tRNA.

**UNIT V: Structure and Function of Amino Acid**

Amino acids and proteins: Classification, chemical structure and general properties of amino acids. Standard and nonstandard amino acids found in proteins. The peptide bond and its characteristics. Proteins: peptides, primary, secondary, tertiary and quaternary structure of proteins, Hydrolysis of proteins: Action of different proteases.

**Suggested Reading:**


1. Biochemistry by Voet B and Voet JG, Wiley Publishers, USA
2. Biochemistry 5th Revised edition by Lubert Stryer, Jeremy M. Berg, John L. Tymoczko, Macmillan Publishers, USA
3. D.L. Nelson and M.M. Cox Lehninger Principles of Biochemistry, Publisher: WH Freeman; 8th ed.NewYork


## BIOANALYTICAL TECHNIQUES

### Paper- Third

### L030703T

**Course Objective:** The purpose of this course is to provide an understanding of fundamental concepts and underlying principles in the instruments used in biotechnology. In addition, the course is expected to develop the analytical skill to enable them to interpret the data.

**UNIT I: Microscopy**

Important concepts in microscopy: Resolution, contrast, magnification; principle and application of light microscopy: compound, phase contrast; dark field, fluorescence and confocal microscopy, principle and application of electron microscopy- scanning and transmission electron microscopy.

**UNIT II: Centrifugation**

Sedimentation: Centripetal force, centrifugal force and sedimentation coefficient. Principle of centrifugation: RCF and RPM, types of rotors: fixed angle, swinging bucket and vertical rotors, types of centrifuges and their uses, ultracentrifuge and its applications: preparative and analytical.

**UNIT III: Chromatography techniques**

Principle and application of paper chromatography; thin layer chromatography; gel filtration chromatography; column chromatography- ion-exchange chromatography; affinity chromatography; gas-liquid chromatography; high performance liquid chromatography.

Electrophoresis and blotting techniques: Principle of electrophoresis; agarose gel electrophoresis; sodium dodecyl sulphate-polyacrylamide gel electrophoresis; first dimension and second dimension electrophoresis; isoelectric focusing; capillary electrophoresis; southern, northern and western blotting.

**UNIT IV: Spectroscopic techniques**

Electromagnetic radiation; principle of absorption of light; principle and application of UV-Visible spectroscopy and IR spectroscopy; Fourier transform infrared spectroscopy; Fluorescence spectroscopy; NMR; Atomic absorption spectroscopy; Mass spectroscopy; Raman spectroscopy.

**UNIT V: Radioactivity**

Radioactivity Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of

isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

**Suggested Reading:**

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2 nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5 th Edition, Cambridge University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected Readings from Methods in Enzymology, Academic Press.

## GENERAL MICROBIOLOGY

### Paper- Fourth

### L030704T

**Course Objective:** This 4-credit course is designed to give an in-depth view of prokaryotes with special concentration on the structure, metabolism and genetics of bacteria. The students will gain a breath of understanding of microbiology from the cellular to molecular levels of organization in conjunction with bacterial physiology and metabolism.

**UNIT I: History and Scope of Microbiology**

Major events leading to the establishment of science of microbiology; identification of microorganisms on the basis of morphological, physiological, biochemical, immunological, and molecular characteristics; bacterial classification according to Bergey's Manual of Systemic Bacteriology; relevance of microbiology to human life; microorganisms as model organisms

**UNIT II: Structure of Prokaryotic cell**

Overview of prokaryotic cell (size, shape and arrangement of the cell); structure of bacterial cell wall; structures external to cell wall (capsules, slime layer, pili and fimbriae, flagella, prosthecae); structures internal to cell wall (inclusion bodies, magnetosomes, nucleoid, mesosome); spores and cysts; differences between Gram +ve and Gram –ve bacteria,and archaebacteria and eubacteria

**UNIT III: Growth and Nutrition In Bacteria**

Nutritional types in microorganisms on the basis of sources of carbon, energy and electrons/hydrogen; Uptake of nutrients by bacterial cells: Passive diffusion, facilitated diffusion, group translocation; chemiosmotic theory and active transport; iron uptake; growth phases and mathematics of bacterial growth; physical and chemical agents to control bacterial growth

**UNIT IV: Microbial Metabolism**

Overview of microbial metabolism; types of photosynthesis in bacteria; photosynthetic machinery of bacteria (bacteriochlorophyll, carboxysomes, bacterial reaction centre, electron transport); photosynthetic fixation of $CO_2$ in bacteria; bacterial fermentation; assimilation of inorganic phosphorus, sulfur, and nitrogen

**UNIT V: Microbial Genetics**

Plasmids and episomes; transformation (Griffith's experiment, competent cells); conjugation (U-tube experiment; F+ X Fmating; Hfr conjugation, F' conjugation); transduction (generalized and specialized transduction); transposable elements in bacteria (IS elements)

**Suggested Reading:**


1. Ananthanarayan, R and Kapil, A. 2013. A & P Textbook of Microbiology. 9th ed. Orient BlackSwan
2. Pelczar, MJ, Chan, ECS and Krieg, NR. 2001. Microbiology. 5th ed. Tata McGraw Hill
3. Sharma, PD. 2010.Microbiology. Rastogi Publications.
4. Singh, RP. 2015.Microbiology. Kalyani Publishers
5. Black, JG. 2012. Microbiology. 8th ed. John Wiley & Sons
6. Tortora, GJ. 2008. Microbiology. 9th ed. Pearson Education
7. Willey, J, Sherwood, L and Woolverton, C. 2011. Prescott's Microbiology. 8th ed. McGraw Hill Education


## LAB IN BIOCHEMISTRY, CELL BIOLOGY, MICROBIOLOGY & ANALYTICAL TECHNIQUES (PRACTICAL-1)

**Paper- Fifth**

**L030705P**

**Cell Biology**

1. Theory and application of buffers and pH.
2. Study and maintenance of simple and compound microscope
3. Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
4. Study of stages in mitosis from onion root tips
5. Study of stages in meiosis in grasshopper testes/onion or Rhoeo flower buds.

**Colorimetry and Spectrophotometry**

6. Protein estimation by Lowry's method.
7. Estimation of protein by Bradford method.

**Analysis of Sugars, Amino acid and Fats/Oils**

8. Estimation of sugars and amino acid by Benedicts & Ninhydrin method.
9. Determination of acid value of a fat.
10. Determination of saponification value of a fat.

**Chromatographic Techniques**

11. Identification of sugars in milk by paper chromatography.
12. Separation of amino acids by thin layer chromatography.
13. Separation of Biomolecules by gel permeation chromatography.

**Electrophoresis Techniques**

14. Native-polyacrylamide Gel Electrophoresis.
15. SDS-polyacrylamide Gel Electrophoresis & staining using different methods (Coummassie blue, Silver staining and reverse staining)

**Microbiology Techniques**

16. To perform the Gram staining, Negative Staining, Fast staining, Capsule Staining, MIC test.
17. Isolation and purification of microorganisms (bacteria) from soil/water/air by streak plate method and serial dilution

# SECOND SEMESTER

## MOLECULAR BIOLOGY AND GENETICS

**Paper- First**

**L030801T**

**Course Objectives:** This course is to expose the students to the chromosome structure & gene expression in both prokaryotes and eukaryotes. It also familiarizes students with extra chromosomal elements, antisense technology.

**UNIT I: DNA Replication and Repair**

Central Dogma of molecular biology, DNA Replication- Prokaryotic DNA Polymerase I, II and III, Eukaryotic DNA Polymerases, Fidelity and Catalytic Efficiency of DNA Polymerases, Okazaki Fragments, Replication Origin, Primosomes, Concurrent Replication Mechanism Involving Leading and Lagging Strands of DNA. DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair

**UNIT II: RNA Transcription and Processing**

Transcription: Prokaryotic and Eukaryotic Transcription- RNA polymerase sub units, different sigma factors, initiation, elongation and termination - rho dependent and independent; RNA processing enzymes, modification in RNA: 5'-Cap formation; Transcription termination; 3'-end processing and polyadenylation; Splicing; RNA Editing, Nuclear export of mRNA; mRNA stability. Different modes of mRNA, tRNA, and rRNA splicing, role of various snRNPs.

**UNIT III: Translation and Posttranslational Modification**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis, inhibitors of protein synthesis, post-translational modifications and its importance.

**UNIT IV: Regulation of Gene Expression**

Regulation of gene expression in prokaryotes-The operon concept, lac & trp operons, Transcriptional control, Post translational control, Regulation in eukaryotes - Control by promoter, enhancer and silencers. Cis-trans elements, DNA methylation, Antisense technology, RNAi, siRNA, microRNA

**UNIT V: Cytogenetics**

Linkage and crossing over, Linkage mapping, Sex determination and sex-linked inheritance, Sex determination in plant and animal, Population and evolutionary genetics.

**Suggested Reading:**

1. Friefelder, David. "Molecular Biology." Narosa Publications, 1999.
2. Weaver, Robert F. "Molecular Biology" 2nd Edition, Tata McGraw-Hill, 2003.
3. Karp, Gerald "Cell and Molecular Biology: Concepts and Experiments" 4th Edition, John Wiley, 2005.

4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2nd Edition, Panima Publishing, 1993. 5. Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013)

## INTERMEDIARY METABOLISM

### Paper- Second

### L030802T

**Course objectives:** Students will be taught the metabolic pathways of carbohydrate, amino acid, lipid and coenzymes and their regulation. At the end of the they will be able to distinguish between different metabolic processes and their impact in metabolism of biomolecules.

**UNIT I Carbohydrate Metabolism and its Regulation**

Glycolysis, TCA cycle, Gluconeogenesis, HMP pathway, Glycogen metabolism, Oxidative phosphorylation, Regulation of carbohydrate metabolism.

**UNIT II Lipid Metabolism and its Regulation**

Beta-oxidation of fatty acids, Biosynthesis of triglycerides, glycerophospholipids, cerebrosides, ether lipids galactolipids and sulpho-lipids. Control of lipid metabolism.

**UNIT III Amino Acids Metabolism and its Regulation**

Biosynthesis of α-ketoglutarate, oxaloacetate, pyruvate family amino acids and the control of their synthesis. biosynthesis of ribose-5 phosphate, 3-phospoglycerate and phosphoenolpyruvate plus erythrose-4-phosphate family amino acids and the control of their synthesis.

**UNIT IV Nucleic Acid Metabolism and It's Regulation**

Biosynthesis of purines and pyrimidines, nucleosides and nucleotides; Degradation of purines and pyrimidines. Biosynthesis of coenzymes; Coenzyme A, NAD and NADP, FMN and FAD.

**UNIT V Inborn Error in Metabolism**

Disorders of carbohydrate metabolism, Inborn errors of amino acids Phenyl alanine & Tyrosine metabolism, Disorders of nucleic acid metabolism (Gout, Lesch Nyhan syndrome).

**Suggested Reading:**

1. Geoffrey L. Zubey, Biochemistry, Fourth Edition: Wm.C. Brown Publishers, 1998
2. Biochemistry by Robert Roskoski. W.B. Saunders, Philadelphia, ISBN 0-7216-5174-7
3. D.L. Nelson and M.M. Cox Lehninger Principles of Biochemistry, Publisher: WH Freeman; 8th ed.NewYork.
4. Biochemistry 5th Revised edition by LubertStryer, Jeremy M. Berg, John L. Tymoczko (ISBN: 8601300395166

## PLANT BIOTECHNOLOGY AND TISSUE CULTURE

### Paper- Third

### L030803T

**Course objectives:** The objectives of this course is to introduce students to the principles, practices and applications of plant biotechnology, plant tissue culture, genetic transformation and transgenics

to produce superior varieties. Students will learn the various applications of plant tissue culture and methods of gene transfer, and the production of hybrid varieties of plants in crop improvement.

**UNIT I Cloning in Plant Cells:**

Biology of Agrobacterium tumefaciens. Structure of Ti-plasmid, T-DNA and gene transfer mechanisms, selection marker genes and reporter genes. Methods of direct gene transfer, Chloroplast transformation. Effect of gene copies and position in transgenic production.

**UNIT II Transgenic Plants:**

Applications in phytoremediation, biopesticides, biodegradable plastics, pesticide and herbicide resistance plants, improving horticultural and nutritional value of plants.

**UNIT III Plant tissue culture:**

Historical perspective and general techniques for plant tissue culture. Tissue culture media, media preparation – nutrients and plant hormones; sterilization techniques.

**Unit IV**

Maintenance of callus, cell suspension culture, protoplast isolation and culture, somatic hybridization, haploid production.

**UNIT V Molecular Markers:**

RFLP maps, RAPD markers, STS, micro satellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism) AFLP, QTL, map-based cloning, molecular marker assisted selection.

**Suggested Reading:**

Plant tissue culture: Theory and Practice, a revised edition. Bhojwani SS, Razdan MK. An Imprint of Elseiver, First Indian reprint, 2004.

Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & molecular biology of plants.Chichester, West Sussex: John Wiley & Sons.

Glick, B. R., & Pasternak, J. J. (1994). Molecular biotechnology: Principles and applications of recombinant DNA. Washington, D.C.: ASM Press.

Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub.

Primrose, S. B., &Twyman, R. M. (2006). Principles of gene manipulation and genomics. Malden, MA: Blackwell Pub.

## ENZYMOLOGY

### Paper- Fourth

### L030804T

**Course Objectives:** The course aims to provide a basic understanding of the enzyme their properties and application in various industries.

**UNIT I: General Introduction of Enzyme**

Introduction and scope, Nomenclature, coenzyme and cofactors, Mechanisms of enzyme action, concept of active site and concept of ES complex, specificity of enzyme action, significance and evaluation of energy of activation, enzyme unit and turn over number.

**UNIT II: Enzyme Kinetics**

Order of reactions, kinetics of enzyme reaction–single and bi-substrate reaction, Michaelis-Menten equation, Different plots for the determination of Km & Vmax and their physiological significances, derivation of Michaelis-Menten equation, Allosteric enzyme, different type of enzyme inhibition,

**UNIT III: Enzyme Immobilization**

Physical and chemical techniques for enzyme immobilization, adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc, Examples advantages and disadvantages of different immobilization techniques

**UNIT IV: Multi Enzyme System**

Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes, Enzyme -enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase

**UNIT V: Application of Enzymes**

Commercial applications of enzymes in food, pharmaceutical and other industries, enzymes for analytical and diagnostic applications, purification and characterization of enzymes from natural sources, different methods of enzyme characterization

**Suggested Reading:**

1. Principles of Biochemistry BY A. Lehninger (1987)
2. Trevor Palmer and Philip Bonner; Enzymes: Biochemistry Biotechnology, Clinical chemistry.
3. Colin J. Suckling & Colin L. Gibson; Enzyme Chemistry: Impact & Application; Blackie Academic &Professional

## MEDICAL LABORATORY MANAGEMENT

### Paper- Fifth

### MMLT-201 PT

**Course Objectives:** To be made aware of basic ethics, good lab practices including awareness/safety in a clinical laboratory. To understand sample accountability, quality management system, biomedical waste management. To know calibration and validation of clinical laboratory instruments, laboratory information system (LIS), Hospital information system (HIS) and financial management.

**1. Preparation of operating budgets**

General aspects of financial management of laboratories

**2. Cost-analysis** (tests and instruments); justification of providing new services or rejecting existing ones; lease and purchase decision analysis; delegation of budget responsibilities, work load statistics.

**3. Laboratory design**

Designing laboratories for different types and sizes of institutions: selection of equipment and systems for the laboratory, concepts of workstation consolidation, workflow analysis, concepts in laboratory automation (sample transportation systems, modular systems, robotics).

**4. Laboratory safety**

Fire, chemical, radiation and infection control
(Body substance precautions), hazardous waste and transport of hazardous materials.

**5. Training of technical staff**

Familiarity is needed with the syllabi of various training programs; knowledge of the teaching requirements and level of knowledge technical staff; understanding of qualifications of technologists trained in other countries.

**6. Maintenance of records**

Procedure manuals, ward manuals, quality control programs, patient data retrieval.

**7. Personnel management**

Personnel policy manual; job descriptions; labor, supervision relations; conducting job interviews; motivation, recognizing job distress syndrome; delegation to a laboratory manager.

**8. Hospital organization**

Interactions between the laboratory service and the rest of the hospital.

**9. Professional ethics.**

**10. Quality assurance;**

Total quality management; development and monitoring of performance indicators.

**11. Public relations:**

hospital and community.

**12. Basic clinical epidemiology**

**13. Laboratory Data Processing**

**14.** General principles of methods for reduction of data into forms suitable for electronic data handling systems (computerized accessioning functions, sample identification and tracking (e.g. bar code systems), result reporting, storage and retrieval, electronic data transfer).

**15. Use of computers in quality control and management**

Use of computers for calculating analytical results (eg. non-linear functions).

**16. General aspects of system design**

Central vs. stand-alone systems, host computers and equipment interfaces.

**17. Laboratory information systems** (LIS), Hospital information systems (HIS).

**18. Personal computer use**

Word processing, spreadsheets, data-base, graphics, statistics, presentations, email, internet. Security of data storage and transmission.

**19. Data base structures and data mining.**

**20.** Appropriate access control to patient information.

## BASICS OF EXERCISE PHYSIOLOGY & NUTRITION

### Paper- Fifth

### MPT-105

**Course Objectives:** On completion of the subject, students will have the opportunity to develop the skills of intellect decision making. It also provides an extension of their communication skills to articulate the evidence based acquaintance and clinical knowledge for assessment and diagnosis of patients. It is a prospect to the students for the application of the research and professional information to novel situations.

**UNIT- I: Bioenergetics of exercise:**

High energy phosphates, Anaerobic and aerobic ATP synthesis, Bioenergetics Control, exercise intensity & substrate utilization, Protecting CHO stores, Muscle adaptation to endurance training, processes that potentially limit the rate of fat oxidation, Regulation of substrate utilization, training - induced increase in FFA oxidization: Basal metabolic and resting metabolic rates and factors affecting them, Classification of Physical Activities by energy expenditure, Concept of MET, measurement of energy cost of exercise

**UNIT- II: Nutrition**

Metabolism of Carbohydrate, fats and proteins, vitamin, mineral and water. Nutrition in exercise Optimum nutrition for exercise, Nutrition for physical performance, Pre-game meal, Carbohydrate loading, Food for various athletic events, Fluid and energy replacement in prolonged exercise.

**UNIT- III Respiratory responses to exercise**

Ventilation at Rest and during Exercise. Ventilation and the Anaerobic Threshold, static and dynamic lung volume. Gas diffusion, Oxygen and carbon dioxide transport, second wind Control of pulmonary ventilation during exercise, Adaptive changes in the respiratory systems due to regular physical activities.

**UNIT- IV Cardiovascular responses to exercise**

Cardiovascular system and exercise, acute vascular effects of exercise. Circulatory responses to various types of exerciseregulation of cardiovascular system during exercise. Pattern of redistribution of blood flow during exercise. Adaptive responses of cardiovascular system to aerobic and anaerobic training. Athlete heart

**UNIT- V Exercise and Acid Base Balance**

Acid and Bases, Buffers, Ph, Respiratory Regulation of pH, Alkali Reserve, The kidneys and Acid base balance, Alkalosis and Acidosis, Acid base balance following heavy exercise.

**UNIT- VI Hormonal responses to exercise with respect to**

Growth Hormone (GH), Thyroid and Parathyroid Hormones. Anti-diuretic Hormone (ADH) and Aldosterone, Insulin and Glucagon, The catecholamine; epinephrine and norepinephrine. The sex hormones. The glucocorticoids (Cortisol) and Adrenocorticotrophic Hormones (ACTH). Prostaglandins and Endorphins:

**Suggested Reading:**


1. Essentials of Exercise Physiology: McArdle, WD, Katch, FI, and Katch, VL. 2nd edn, Lippincott Williams and Wilkins (2000)·
2. Fundamentals of Exercise Physiology: For Fitness Performance and Health, Robergs RA, and Roberts, S.O. McGraw Hill (2000)
3. Exercise Physiology: Powers, SK and Howley ET. 4th edn; Mc Graw Hill (2001)
4. Physiology of Sport and Exercise: Wilmore, JH and Costil, DL. Human Kinetics (1994)
5. Exercise Physiology- Human Bioenergetics and its Application: Brooks, GA, Fahey, TD, White, TP. Mayfield Publishing Company (1996)
6. Komi, P. (Ed.) (1992) Strength and power in sport. Blackwell Scientific Publications.

## LAB IN PLANT TISSUE CULTURE, MOLECULAR BIOLOGY AND ENZYMOLOGY (PRACTICAL 2)

**Paper- Sixth**

**L030805P**

1. Laboratory design setup for PTC unit.
2. Preparation, sterilization of media (Liquid & solid).
3. Surface sterilization, sealing of cultures, sources of contamination and their check measures.
4. Organ explant culture and micropropagation techniques.
5. Callus induction, propagation and differentiation.
6. Histological study of callus cells.
7. Suspension cultures.
8. Nurse culture techniques.
9. To observe practically various forms of undesirable characteristics in cultures such as:
i) Vitrification ii) Stunting of shoots iii) Abnormal embryoids. iv) Etiolated shoots.
10. Preparation of synthetic seeds and their shelf life studies.
11. Micrografting Techniques.
12. Acclimatization of in vitro raised plantlets.
13. Comparison of ex vitro and in vitro rooting with respect to % survival.
14. To culture shoots on liquid media and derive a comparative account with reference to solid media grown cultures.
15. Preparation of plasmid DNA by alkaline lysis method
16. Genomic DNA isolation from bacteria
17. Isolation of DNA from plants by Hexadecyl trimethyl-ammonium bromide (CTAB) method
18. RNA isolation from plant tissues
19. Enzyme assay; activity and specific activity determination of amylase.
20. Enzyme Kinetics: Effect of varying substrate concentration on enzyme activity, determination of Michaelis-Menten constant (Km) and Maximum Velocity (Vmax.) using Lineweaver-Burk plot.
21. Effect of temperature/pH and on enzyme activity. **22.** Immobilization of enzyme.

# THIRD SEMESTER

## CELLULAR AND MOLECULAR IMMUNOLOGY

**Paper- First**

**L030901T**

**Course Objectives:** To Prepare a foundation for students in Immunology and the Immunotechniques, able to define innate and adaptive immunity, detail information about Lymphoid organs, Structure of antibody, concept of vaccines and vaccination, autoimmunity and applied immunology.

**UNIT – I: Cells and Organ of Immune System**

Components of innate and acquired immunity; Haematopoiesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT & CALT)

**Unit-II: Antigen and Antibody**

Antigens – immunogens; haptens; nature of antigens; Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; antigen-antibody interactions.

**Unit – III: MHC, B Cells and T Cells**

Major Histocompatibility Complex – Immune responsiveness and disease susceptibility; B-cell receptor; Immunoglobulin superfamily; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell receptors and T-cell maturation, activation and differentiation; Functional T Cell Subsets; Complement system.

**Unit – IV: Regulation of immune response**

Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens, generation of humoral and cell mediated immune responses; Cytokines and their role in immune regulation; Immunological tolerance.

**Unit-V: Cytotoxicity, Hypersensitivity and Autoimmunity**

Cell mediated cytotoxicity: Mechanism of T cells and NK cell mediated lysis; Antibody dependent cell mediated cytotoxicity; Macrophage mediated cytotoxicity; Immunity to Infection: Bacteria, viral, fungal and parasitic infections; Hypersensitivity – Type I-IV; Autoimmunity- MHC and TCR in autoimmunity

**Suggested Reading:**

1. Abbas, A.K., Litchman, A.H. (2006-2007). Basic Immunology: Functions and Disorders of the Immune System, 2nd Ed. (updated edition), Philadelphia, Pennsylvania: W.B. Saunders Company Publishers.
2. Benjamini, E., Coico, R. and Sunshine, G. (2009). Immunology: A Short Course, 6th Ed., New York, Wiley-Blackwell.
3. Roit, I.M., Delves, P. Seamus M. and Burton D. (2006). Essential Immunology, 11th Ed., Willey-Blackwell.
4. Roitt, I., Brostoff, J. and Male, D. (2001). Immunology, 7th Ed., Mosby

5. Kanfmann S.H.E., Sher, A., Ahmed, R. (2002). Immunology of Infections Diseases, ASM Press, Washington.
6. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2005). Kuby Immunology, 5 th Ed., W.H. Freeman and Company, New York.

## PRINCIPLE AND APPLICATION OF GENETIC ENGEENERING

**Paper- Second**

**L030902T**

**Course Objectives:** The Objective of this paper are to tech students to various approaches to conducting genetic engineering and their applications, utilise this application in human welfare and solving problems in society. This paper highlights the concept of genetic basis for modifying cellular functions, creating genetic modifications in a cell or organism.

**UNIT-I: Restriction Enzymes**

DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes.

**UNIT-II: Plasmids, Phagemids and Expression Vectors**

M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Yeast vectors, Shuttle vectors, siRNA technology.

**UNIT-III: Expression strategies for heterologous genes**

vector engineering, codon optimization, host engineering, in vitro transcription & in vitro translation, expression in bacteria, expression in yeast, Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

**UNIT-IV: Linkers and Adaptors**

Homopolymeric tailing, strategies for cDNA libraries; Transformation; Northern, Southern and Colony hybridization, Southwestern and Far-western cloning; Phage display; cloning differentially expressed genes (mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay; DNasel footprinting)

**UNIT-V: PCR and Its Applications**

Primer design; Fidelity of thermostable enzymes (Taq & Pfu polymerases); DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in gene recombination; SOEing; Site specific mutagenesis; deletion; addition.

**Suggested Reading:**

1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

## GENOMICS AND PROTEOMICS

**Paper- Third**

**L030903T**

**Course Objectives:** The objective of this paper is to train students in the analysis of genomics and proteomics data. The course covers topics related to molecular biology, genome analysis, functional and structural genomics, recombinant DNA technology, and DNA & protein sequence data analysis. Students will learn several experiments in wet-lab and computational methodologies.

**UNIT - I: Whole genome analysis**

Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries, comparative genomes (Arabidopsis, rice and panda)

**UNIT – II: DNA sequencing**

Conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing, automated sequencing, translation to large scale projects, epigenomics, cancer genomes. FISH, Comparative Genomic Hybridization (CGH), SKY (Spectral Karyotyping).

**UNIT – III: DNA Microarrays**

Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips. Gene Identification and Expression Analysis: DNA microarrays, ESTs, SAGE, MPSS.

**UNIT – IV: Proteome analysis**

Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarrays, differential display proteomics, yeast 2-hybrid system, FRET, bimolecular fluorescence complementation assay.

**UNIT – V**

Advantages and disadvantages of DNA and protein microarrays. Total expression vs functional proteomics, oligosaccharide microarrays for glycomics, pharmacogenomics, introduction to metabolomics.

**Suggested Reading:**

1. Peruski, L.F. Jr. and Peruski, A.H. (1997). The Internet and New Biology: Tools for Genomic and Molecular Research ASM.
2. Schena, M.ed. (1999). DNA Microarrays: a practical approach. Oxford University Press.

3. Hunt, S. and Livesey, F. ed. (2000). Functional Genomics: A practical approach. Oxford University Press.
4. Sharma, T.R. (2009). Genome analysis and Bioinformatics. A practical approach, IK International Publishers, New Delhi.
5. Recent articles in journals

## FUNDAMENTAL IN BIOSTATISTICS AND BIOMATHS

### Paper- Third

### L030904T

**Course Objectives:** This paper is an introduction to statistical methods used in biological and medical research. Elementary probability theory, basic concepts of statistical inference, regression and correlation methods, and sample size estimation are covered. Emphasis on applications to medical problems.

**Unit – I**

Binomial Theorem, Pascal rule and Pascal triangle.

**Unit-II**

Scientific notation, significant digits, rounding off. Scientific notation, Sampling, problem identification, design of experiment, factorial designs: full factorial design, fractional factorial design, concept of population and sample, random sampling, Data collection.

**Unit-III**

Measures of central tendency, mean, arithmetic mean, geometric mean & harmonic mean, medium, mode, quartile, decile, percentile, dispersion, mean deviation, standard deviation, geometric standard deviation, standard error, coefficient of variation, variance, coefficient of determinant and coefficient of non-determinant, moments, distribution of data, normal distribution, skewness and kurtosis

**Unit-IV**

Pearson's correlation coefficient, linear correlation and regression, correlation and regression analysis of exponential curve. Power function, log function, logarithmic regression, Dose response curve, coefficient of determination, Reciprocal regression analysis, double reciprocal regression analysis, logistic regression analysis, monomolecular regression, Gompertz growth function and Gompertz decay function and its analysis.

**Unit-V**

Probability, Testing of hypothesis, Null and alternative hypothesis, Type-I and Type-II errors, level of significance, two tailed and one tailed tests, Z-score, chi-square (X2 ) test, student 't' test, 'F' test, Probability distribution function, standard normal distribution, Poisson distribution function, binomial distribution, student 't' distribution, chi square (X2 ) distribution, Analysis of variance, ANOVA-one way ANOVA and two way ANOVA. Non parametric statistics: Wilcoxon test: Wilcoson signed rank test, Wilcoxon rank sum test, Spearman rank coefficient, Kruskal-Wallis test, Kendall's coefficient of Concordance (w).

**Suggested Reading:**

1. Kothari, C.R. (2004) Research Methodology Methods and Techniques, New Age International Publications, New Delhi
2. P.S.S. Sundar Rao, P.H. Richard, An Introduction to Biostatistics, Prentice Hall of India (P.) Ltd. New Delhi 2003.
3. Jerrold H. Zar, Biostatistical Analysis, Tan Prints (I) Pvt. Ltd., New Delhi, 2003.

## ANIMAL CELL CULTURE AND MEDICAL BIOTECHNOLOGY

**Paper- Fourth**

**L030905T**

**Course Objectives:** This paper give emphasis on Identification and characterization of animal breeds, Developing DNA - based diagnostics and genetically engineered vaccines for animals, studying animal genomics and its varied applications, Developing embryo - transfer technology, cloning, transgenic animals

**UNIT I: Animal Tissue/cell culture**

History of animal cell culture, Different types of cell cultures: Development of cell lines Primary and Continuous cell cultures, Cell culture media: media composition, serum, antibiotics, supplements, physiochemical properties, Cell culture laboratory setup and instrumentation.

**UNIT II: Cell culture techniques**

Cell separation methods, characterization and maintenance of cell lines. Trypsinization, cryopreservation. Common cell culture contaminants. Good Laboratory Practices

**UNIT III: Stem cell research**

Different types of stem cells. Stem cell culture, stem cell differentiation, current status and application in medicine. Embryo culture, somatic cell nuclear transfer (SCNT), IVF. Artificial blood.

**UNIT IV: Gene transfer technology in animals**

Viral and non-viral methods, Production and status of transgenic animals, molecular pharming, Animal & Human cloning: Techniques, relevance and ethical issues.

**UNIT V: Application of cell culture technology**

Production of human and animal vaccines and pharmaceutical proteins. Molecular diagnostics: techniques and relevance, detection of animal pathogen in environmental systems, animal imaging, molecular medicine, isotopes and their usage in diagnosis and therapy.

**Suggested Reading:**

1. Freshney, I. R. (2010). Culture of Animal Cells, 5th Edition, Wiley-Liss.
2. Masters, J.R.W.(2000). Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press,
3. Clynes, M. (2008) Animal Cell Culture Techniques., Springer.
4. Hafez, B., Hafez, E.S.E. (2010) Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell. Turksen, K. 2004. Adult Stem Cells. Humana Press, Inc.
5. Thomson, J et al. 2004. Handbook of Stem Cells: Embryonic/ Adult and Fetal Stem cells (Vol. 1 & 2). Academic Press.

6. Houdebine, L.M. (2010). Transgenic Animals: Generation and Use, 1st Edition, CRC Press

## COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

**Paper- Fourth**

**L030906T**

**Course Objectives:** Will be able to differentiate the output of different diseases with their correlation in a particular population. Survey to identify correlation with a particular disease in a defined population.

**UNIT-I**

Aim scope and elementary idea of statistics in Biology, Tabulation and diagrammatic representation of statistical data. Concepts of statistical population and sample, elementary account of sampling methods, frequency distributions. Measures of central location and dispersion, measures of skewness and Kurtosis.

**UNIT-II**

Probability – definition simple theorems on probability, conditional probability Discrete and continuous variables, Standard distributions- Binominal, Poisson normal.

**UNIT-III**

Correlation and regression – Least square method of fitting linear and quadratic regression, standard errors of estimate, correlation coefficient.

**UNIT-IV**

Basic ideas of sampling distribution Statistical estimation and Test of significance, confidence limit. Some commonly used tests of significance. Normal tests student's 't' test, $x^2$ and F tests. Analysis of variance.

**UNIT-V**

History and development of computer, computer peripherals and hardware description, operating system, office application, logic development, basic knowledge of computer software and scientific application packages.

**Suggested Reading:**

1. Research Methodology and Biostatistics: A comprehensive Guide for Health Care Professionals. By Sharma Suresh.
2. Biostatistics and Computer Applications by G.N. Rao, N. K. Tiwari
3. Biostatistics: Basic Concepts and Methodology for the Health Sciences. By Wayne W. Oaniel

## LAB IN IMMUNOLOGY AND GENETIC ENGEENERING (PRACTICAL 3)

**Paper- Fifth**

**L030907P**

1. Total leukocyte count

2. Differential leukocyte count
3. Haemagglutination assay
4. Isolation of mononuclear cells from peripheral blood and viability test by dye exclusion method
5. Separation of serum from blood
6. Double immunodiffusion test using specific antibody and antigen Dot Immuno blot assay (DIBA)
7. ELISA
8. Polyacrylamide gel electrophoresis
9. Isolation of genomic DNA from plant tissues.
10. Isolation of genomic DNA from E. coli cells.
11. Spectrophotometric analysis of DNA.
12. Restriction digestion of DNA.
13. Separation of digested fragments by agarose gel electrophoresis.
14. Transfer of resolved DNA fragments from agarose gel to nylon/nitrocellulose membrane.
15. Hybridization of nylon/nitrocellulose blots.
16. Isolation of plasmid. Making competent cells of E. coli.
17. Transformation of competent E. coli cells.
18. Cloning of foreign DNA insert in plasmid (PET Vector).
19. Isolation of total RNA.
20. Expression of fusion protein (His-tagged/MBD-tagged)
21. PCR.

# FOURTH SEMESTER

## BIOPROCESS TECHNOLOGY
**Paper- First**
**L031001T**

**Course Objectives:** This course is designed for familiarizing students with basic idea of microbial kinetics, upstream processing, bioreactor design and operation, and downstream processing. At the end of the course, the students would have learnt about fermentation processes, kinetics of microbial growth and all the steps involved upstream and downstream processing for any production process. The course also helps to understand the industrial applications of bioprocess engineering.

**UNIT I: Introduction to Bioprocess technology and basic mode of fermentation**

Isolation, screening and maintenance of industrially important microbes; Outline of an integrated bioprocess: upstream and downstream, unit operations involved in bioprocesses, generalized process flow sheets; Concepts of basic modes of fermentation - batch, fed batch and continuous; Microbial growth and death kinetics.

**UNIT II: Principles of upstream processing**

Medium formulation: Carbon sources, Nitrogen sources, Minerals, Chelators, Growth factors, Antifoams, Introduction to media optimization; Inoculum development: criteria for the transfer of inoculum, development of inocula for bacterial processes; Sterilization: batch and continuous heat sterilization of liquid media, filter sterilization of liquid media.

**UNIT III: Design of novel bioreactors**

Introduction to ideal and non-ideal bioreactors; Design and components of various bioreactors: Stirred tank (CSTR), packed bed bioreactors, Bubble-column bioreactors, fluidized bed bioreactors, trickle bed bioreactors, airlift loop bioreactors, photo bioreactors. Methods of measuring process variables, online and offline analytical methods.

**UNIT IV: Introduction to downstream processing**

Bio separation processes – filtration (conventional and microfiltration), centrifugation (settling of solids and centrifugal filtration), cell disruption (Chemical and mechanical); Isolation Processes: batch extraction and adsorption; Product purification: precipitation with salt and nonsolvent, ultrafiltration and chromatographic techniques; Polishing: crystallization, drying, storage and packaging.

**UNIT V: Application of bioprocess engineering in industries**

Fermented foods and beverages (Baker yeast production), Environmental industry (Biological waste water treatment), medical applications of bioprocess engineering (Tissue engineering, Gene therapy).

**Suggested Reading:**

1. Stanbury, P.F., Hall S. J. and Whitaker A. 2003. Principles of Fermentation Technology. 2nd ed. Science & Technology Books.

2. Doran P. 2012. Bioprocess Engineering Principles, 2nd ed. Academic Press

3. Nielsen, J. and Villadsen, J. 2007. Bioreaction Engineering Principles. 2nd ed. Springer science and business media.

## ONCOTECHNOLOGY
## Paper- Second
## L031002T

**Course Objectives:** This course will explore foundational concepts in cancer biology, provide a survey of the hallmarks of cancer, learn the molecular and genetic basis of cancer, and understand the challenges of translating basic science discoveries into effective therapeutic agents.

**UNIT I: Basics of Cancer**

Type of cancers, Cancer genomics, Causes of cancer, Risk factors, Cancer cell properties, In vitro and in vivo models of cancer research, Current methodology in cancer research.

**UNIT II: Signalling Mechanisms in Cancer**

Oncogenes such as Ras, Src, etc., Tumor suppressor genes such as APC, p53 and Rb-E2F interaction, CDK-Cyclin-CDKI and CDC regulation in cancer progression, EGFR and IGFR signalling, Epigenetic mechanisms: DNA and histone modification, and micro RNA in Cancer, Mechanism of chemical, viral and radiation induced cancer.

**UNIT III: Mitochondria and Cancer**

Warburg Hypothesis, Mitochondrial dysfunctions in cancer, mitochondrial genetics, metabolic alterations in cancer, oxidative stress, Apoptosis, Autophagy

**UNIT IV: Cancer Diagnosis and therapeutic approaches**

Cancer statistics, Cancer Screening Overview, Molecular diagnostics for detection of tumor, cancer specific markers, Types of Treatment, Side Effects, Clinical Trials, Cancer Drugs, Alternative Medicine.

**Suggested Reading:**


1. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz Springer. (2007).2nd edition
2. Biology of Cancer by Robert Weinberg (2013). 2nd edition
3. Chemoprevention of Cancer and DNA Damage by Dietary Factors by S. Knasmuller, David M. DeMarini, Ion Johnson, and Clarissa Gerhauser Willey- Blackwell Publisher. (2009). 1st edition
4. Mitochondria Practical Protocols Editors: Leister, Dario, Herrmann, Johannes M. (Eds.) 2007 Publisher: Springer ISBN 978-1- 59745-365- 3
5. Mitochondrial DNA: Methods and Protocols Editors: Stuart, Jeffrey A (Ed.) 2009 Springer Protocols Publisher: Springer ISBN 978-1- 59745-521- 3


## NANOTECHNOLOGY
## Paper- Third
## L031003T

**Course Objective:** The aim of this course is to provide basic knowledge in the interface between chemistry, physics and biology on the nanostructure level with a focus on biotechnological usage.

**UNIT I: Introduction to Nanobiotechnology**

Nanotechnology definition and concepts; Cellular Nanostructures; Nanopores; Bimolecular motors; Criteria for suitability of nanostructures for biological applications

**UNIT II: Basic characterization techniques**

Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy.

**UNIT III: Nano structures**

Thin films; Colloidal nanostructures Nano vesicles; Nano spheres; Nano capsules.

**UNIT IV: Nanostructures for drug delivery**

Nanostructures for drug delivery, concepts, targeting, routes of delivery and advantages.

**UNIT V: Applications of nano structures**

Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; Nano devices for sensor development.

Prof. B.N.Mishra (Online)

18/5/22 Prof. Neelam Pathak (Online) Prof Ram Narain (Online)

**Suggested Reading:**

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401

2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss ISBN: 047141719X

3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-8247-2579- 4

## NEUROSCIENCES AND TECHNOLOGY
## Paper- Fourth
## L031004T

**Course Objectives:** To give students a basic understanding of how our nervous system is organized and how it functions. To acquaint the students with different sense organs and their functions. To promote students for integrative thinking about the brain, behaviour, learning & memory and how disorders of the brain impact us at different levels. To help students understand about different neurological disorders at different levels.

**Unit I: Organization of the nervous system**

Basics about the nervous system, Different types of the nervous system, Anatomy and functions of the Central Nervous System and Peripheral Nervous System, Different parts of the brain and their functions, Structure, functions and types of Neurons, Non- neuronal cells in the nervous system, Blood Brain Barrier.

**Unit II: Neural signalling**

Ion transport, Resting potential, Action potential, Synaptic transmission at excitatory and inhibitory synapses, Neurotransmitters.

**Unit III: Sensory systems**

Anatomy, biochemistry and functioning of Vision, Olfaction, Auditory and Motor system.

**Unit IV: Brain and Behaviour**

Chemical control of brain, Mental disorders like anxiety, mood disorders, depression, bipolar disorder, PTSD, Schizophrenia, Neurodegenerative diseases like Alzheimer's, Parkinson's, Huntington's, Multiple sclerosis, Amyotrophic lateral sclerosis, Neurotechnology.