**PRAVARA INSTITUTE OF MEDICAL SCIENCES**
**(DEEMED TO BE UNIVERSITY)**
**College of Biosciences and Technology**
**Loni- 413736, Dist. Ahmednagar, Maharashtra, India**
NAAC Reaccredited with 'A' Grade (CGPA 3.17)

# B.Sc. (HONS./ HONS. WITH RESEARCH) IN MEDICAL BIOTECHNOLOGY

## SYLLABUS

## AS PER

## NATIONAL EDUCATION POLICY-2020

| No | Programme | Duration | Credits Earned in that year | Total Credits Earned |
|---|---|---|---|---|
| 1 | UG Certificate in Life Sciences | 1 year (I-II Sem) | 44 | 44 |
| 2 | UG Diploma in Biomedical Sciences | 2 years (III-IV Sem) | 44 | 88 |
| 3 | UG Degree in Medical Biotechnology | 3 years (V-VI Sem) | 40 | 128 |
| 4 | B.Sc. (Hons.) in Medical Biotechnology | 4 years (VII-VIII Sem) | 40 | 168 |
| | B.Sc. (Hons. with Research) in Medical Biotechnology | | | |

**Approved by Academic Council Resolution No: AC/2023(1)/D-17(vii); Dated: 20/06/2023**

**IMPLEMENTED FROM 2024-2025 A.Y.**

# Pravara Institute of Medical Sciences
## (Deemed to be University)

**University Established under section (3) of UGC Act,1956.**
**NAAC Acreditated with 'A' Grade (CGPA 3.17)**

LONI - 413736, (Near Shirdi), Tal. Rahata,
Dist. Ahmednagar (Maharashtra), India.
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- Dr. Balasaheb Vikhe Patil Rural Medical College
- Rural Dental College
- Dr. APJ Abdul Kalam College of Physiotherapy
- Smt. Sindhutai Eknathrao Vikhe Patil College of Nursing
- Centre for Bio-Technology
- School of Public Health and Social Medicine
- Dr. Vitthalrao Vikhe Patil Pravara Rural Hospital


Ref. No.:PIMS/R/2024/78 Date :- 08/01/2024

## NOTIFICATION No. 4(i) / 2024

**Subject: Notification regarding Conversion of 3-year B. Sc. Medical Biotechnology programme to 4 Year B. Sc. (Hons) Medical Biotechnology Programme.**

**Reference: 1) Academic Council Meeting dated 20th June, 2023.**
**2) Executive Council Meeting dated 29th December, 2023.**

It is hereby notified for information to all concerned that as per resolution passed by Academic Council vide Resolution No. AC/2023(1)/D-17(vii), dated 20th June, 2023 and Executive Council vide Resolution No. EC/25/2023 dated 29th December, 2023 it has been decided to convert the ongoing 3 year B.Sc Medical Biotechnology Programme into 4 Year B. Sc. (Hons) Medical Biotechnology Programme. Accordingly the revised "Rules, Regulations and Curriculum for B.Sc. (Hons) Medical Biotechnology Programme has also been approved with Semester Pattern and Credit and Outcome Based System.

The Director, College of Biosciences & Technology, Loni and the Dean, Faculty of Allied Health Sciences are authorised to follow & implement the said Programme with effect from Academic Year 2024-25 onwards.

**Registrar**

Registrar
Pravara Institute of Medical Sciences
(Deemed to be University)
Loni-413736, Tal.Rahata, Dist.Ahmednagar
(M.S.India)

**Copy for information:**
1. Hon'ble President, PIMS (DU), Loni
2. Hon'ble Vice-Chancellor, PIMS (DU), Loni

**Copy for information & necessary action :**
3. The Director, College of Biosciences & Technology, Loni.
4. Dean, Faculty of Allied Health Sciences.
5. Controller of Examination, PIMS (DU), Loni.

**PRAVARA INSTITUTE OF MEDICAL SCIENCES**
**(DEEMED TO BE UNIVERSITY)**
**Loni, Tal. Rahata, Dist. Ahmednagar 413736**
**NAAC Re-accrediated with 'A' Grade**
**COLLEGE OF BIOSCIENCES AND TECHNOLOGY**

# B. Sc. (Hons./Hons. with Research) in Medical Biotechnology

# SYLLABUS

## FIRST YEAR: SEMESTER-I

## BIOCHEMISTRY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101DSC** | **Discipline Specific Core** | **Biochemistry** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to explore the chemical processes and molecular mechanisms underlying biological systems, focusing on the structure, function, and interactions of biomolecules to understand their roles in health and disease.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the fundamental principles of biochemistry.

**LO2:** Describe the structure and function of key biomolecules, including proteins, lipids, and carbohydrates.

**LO3:** Describe the structures of DNA and RNA, including nucleotide composition, base pairing, and double helix model.

**LO4:** Discuss the properties and classification of enzymes.

**LO5:** Understand the role, sources and dietary requirements of vitamins and minerals.

**LO6:** Understand the biochemical basis for the dietary requirements of essential nutrients (vitamins, minerals, amino acids and fatty acids) and the health consequences of deficiencies or excesses.

**LO7:** Discuss the role of specific nutrients in maintaining health and preventing disease, including how imbalances or deficiencies contribute to various health conditions.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Biochemistry** | Definition, importance and applications of biochemistry. Molecular organization of cells. Chemical basis of life. Elements of importance in biochemistry (H, C, N, O, P and S). Water as biological solvent: bonds, thermal properties and solvent properties. Weak acids and bases, pH and its calculation, Handerson-Hasselbalch equation and physiological buffers. Bioenergetics: types and energy of bonds and interactions (ionic, covalent, coordinate, H-bonds, van der Waals, hydrophobic interactions). Laws of thermodynamics, Gibbs free energy, relevance of entropy and enthalpy in biological systems and reactions: first and second-order reactions. Biological oxidation and high energy compounds. | 8 |
| **Unit II** | **Introduction to Carbohydrates** | Definition and classification of carbohydrates. Importance of carbohydrates in biological systems. Definition and examples of monosaccharides, disaccharides, oligosaccharides and polysaccharides. Physiologically important disaccharides. Structural isomerism and chirality and biological functions of monosaccharides. Structural diversity and functions of polysaccharides. | 7 |
| **Unit III** | **Amino Acids, Proteins and Enzymes** | Structure, classification and properties of amino acids. Role of amino acids in protein structure and functions. Definition, classification and importance of proteins in biological systems. Primary structure: Sequence of amino acids. Secondary structure: Alpha helix, beta sheet, and turns. Tertiary structure of myoglobin: three-dimensional folding of a single polypeptide chain. Quaternary structure of hemoglobin: arrangement of multiple polypeptide chains. | 10 |

| | | | |
|---|---|---|---|
| | | Enzymes: Definition, properties and functions of enzymes. Enzyme classification and nomenclature. Factors affecting enzyme activity. Enzyme inhibition. | |
| **Unit IV** | **Lipids** | Definition, classification and functions of lipids. Structural diversity of lipids: fatty acids, triglycerides, phospholipids, steroids, and waxes. Structure of fatty acids: saturated vs. unsaturated fatty acids. Structure and functions of triglyceride and phospholipids. | 5 |
| **Unit V** | **Nucleic Acids** | Definition classification and functions of nucleic acids. Structure and chemistry of nucleotides. DNA vs. RNA. Double helix structure of DNA: Watson-Crick model. RNA structure and types: mRNA, tRNA and rRNA. | 6 |
| **Unit VI** | **Vitamins and Minerals** | Vitamins: definition and classification. Fat-soluble vs. water-soluble vitamins. Functions of vitamins: Coenzymes, antioxidants, hormone precursors. Sources, dietary requirements and disease associated with vitamins deficiency. Minerals: Definition, classification and functions. Major vs. trace minerals. Structural components, electrolyte balance and cofactors. Sources, dietary requirements and disease associated with minerals deficiency. | 12 |
| **Unit VII** | **Nutritional Biochemistry** | Introduction, nutrition and energy supply, utilization of energy, nutritional importance of carbohydrates, lipids, proteins, vitamins and minerals, fiber in nutrition, Recommended Dietary Allowances (RDA) of minerals and vitamins, Basal Metabolic Rate, specific dynamic action, balance diet, nutritional imbalance and disorders, therapeutic diets, nutritional status and clinical practice. Nutrigenomics. | 12 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Biochemistry. U. Satyanarayana, U. Chakrapani. Indian edition, Books and Allied (P) Ltd.
2. Lehninger Principles of Biochemistry. David L. Nelson, Michael M. Cox (Indian edition, Publisher: Macmillan Learning)
3. Textbook of Medical Biochemistry. MN Chatterje, Rana Shinde (Publisher: Jaypee Brothers Medical Publishers)
4. Conn E.E., Stumpf P.K., Bruening G. and Doi R.H. (1997). Outlines of Biochemistry. John Willey and Sons Inc. New York and Toronto.
5. Voet D., Voet J.G. and Pratt C.W. (2013), Principles of Biochemistry, 4th Edition John Wiley and Sons Inc., New York.
6. Elliott W.H. and Elliott D.C. (1997), Biochemistry and Molecular Biology. Oxford University Press Inc. New York.
7. Metzler D.E. (2001), Biochemistry (Vol I and II) Academic Press, London and New York.
8. Berg J.M., Tymoczko J.L. and Stryer L (2012), Biochemistry, 7th Edition W.H. Freeman Publishers, New York.
9. Garret R.H. and Grisham C.M (2010). Biochemistry, 4th Edition. Brooks/Cole, Boston.

# CELL BIOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| BT 24102DSC | Discipline Specific Core | Cell Biology | 4 | 0 | 0 | 60 | 4+0=4 |

**Objective:**

This course aims to provide students with a comprehensive understanding of cellular structure, function, and processes, including how cells interact with their environment and contribute to the overall functioning of multicellular organisms.

**Learning Outcomes:**

Upon successful completion of the course, students will be able to:

**LO1:** Identify and describe the key components of eukaryotic and prokaryotic cells, including organelles, membranes, and cytoskeletal elements, and understand their specific functions.

**LO2:** Explain the mechanisms of cell signaling, including the roles of receptors, second messengers, and signal transduction pathways in regulating cellular responses and interactions.

**LO3:** Understand the stages of the cell cycle, including mitosis and meiosis, and the regulatory mechanisms controlling cell division and differentiation.

**LO4:** Understand the molecular and structural organization of chromosomes.

**LO5:** Demonstrate proficiency in basic laboratory techniques used in cell biology.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Cell** | Introduction, classification of cell types, cell theory. Structural organization of prokaryotes and eukaryotes. Organization of plant and animal cells. | 5 |
| **Unit II** | **Cell Organelles** | Structure and functions of cell organelles: plasma membrane (Fluid Mosaic Model), endoplasmic reticulum, golgi complex, mitochondria, chloroplasts, ribosomes, lysosomes, peroxisomes, nucleus, cell wall, vacuole, cytosol and cytoskeleton. | 8 |
| **Unit III** | **Protein Sorting** | Compartmentalization of cell, sorting signals, types of transport. Protein sorting to different organelles: nucleus, endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, peroxisomes and lysosome. Vesicular transport. Diseases associated with impaired transport processes. | 11 |
| **Unit IV** | **Chromosomes** | Discovery, structure, features and types of chromosomes, chromosomal numbers, chromosomal banding, molecular organization of eukaryotic chromosome, structural organization of centromeric region, kinetochore and telomere. Effects of radiations on chromosomes. Techniques to study chromosomes and their applications. | 11 |
| **Unit V** | **Cell Division and Cell Cycle** | Definition. Cell division: process and errors, comparison between mitosis and meiosis, Cell cycle and its phases: G1, S, G2 and M. Cell cycle checkpoints and regulation. Cyclins and cyclin-dependent kinases (CDKs). Cell growth and its regulation. Apoptosis (programmed cell death): mechanisms, role in development, regulation and related diseases. | 14 |
| **Unit VI** | **Tools and Techniques in Cell Biology** | Microscopy techniques: principles, components, working principle and uses of light, phase contrast, fluorescence and electron (SEM and TEM) microscopy. Cell fractionation techniques, immune cytochemistry, immunostaining and immunofluorescence. | 11 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:

1. Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter (Indian Edition: Garland Science).
2. Cell and Molecular Biology. Gerald Karp (Indian Edition: Wiley India).
3. Essential Cell Biology. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter (Indian Edition: Garland Science)
4. Cell Biology: A Short Course. Stephen R. Bolsover, Jeremy S. Hyams, Elizabeth A. Shephard, and Hugh A. White (Indian Edition: Wiley India).
5. Cell Biology and Histology. V. Subhadra Devi (Indian Edition: S. Chand and Company).

# INTRODUCTION TO BIOTECHNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101OE** | **Open Elective** | **Introduction to Biotechnology** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide students with a foundational understanding of the principles, techniques, and applications of biotechnology, including its role in research, industry, and medicine.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Understand concept of biotechnology and describe important milestones in the history of biotechnology.

**LO2:** Understand the diverse applications of biotechnology in fields such as medicine (e.g., gene therapy, vaccine development), agriculture (e.g., GMOs, crop improvement), and environmental science (e.g., bioremediation).

**LO3:** Apply biotechnological principles and techniques to address real-world problems, design experiments, and interpret data within the context of research and industrial applications.

**LO4:** Discuss the ethical, legal, and social issues associated with biotechnological advancements, including concerns related to genetic privacy, biosafety, and the impact on society.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Scope and Introduction to Biotechnology** | History and introduction to biotechnology, traditional and modern biotechnology, different aspects of biotechnology, Recombinant DNA Technology and its prime role in various fields. | 3 |
| **Unit II** | **Animal Biotechnology** | Important animal models used to understand different aspects of animal biotechnology, Concept of cell plasticity, types of stem cells and animal tissues. Introduction to animal tissue culture: types of cultures. Applications of animal tissue culture. Artificial breeding methods: artificial insemination and IVF. Introduction to transgenic animals: concept, basic methods and examples. | 6 |
| **Unit III** | **Microbial Biotechnology** | Types of microorganisms, culturing microorganisms, microorganisms and their products. Primary and secondary metabolites. Microbes as insecticides. Relevance of microbiology in biotechnology. | 4 |
| **Unit IV** | **Medical Biotechnology** | Introduction, biotechnological applications in health care, genomics and genetic engineering: Human Genome Project, Gene Editing techniques and Gene therapy. Diagnosis and biomarkers: Next Generation Sequencing and disease detection. Regenerative medicine and Stem Cell technology: tissue engineering, stem cell biology and tissue repair and regeneration. | 7 |
| **Unit V** | **Environmental Biotechnology** | Introduction, pollution and its control. Pollution indicators. Waste management: fundamentals, methods and strategies of Bioremediation. Applications of bacteria and fungi in bioremediation. Fundamentals and methods of phytoremediation. Biofuels, bioleaching of metals, bioplastics and bioemulsifiers. | 5 |
| **Unit VI** | **Pharmaceutical Biotechnology** | Scope and applications of biotechnology in pharmaceutical industry. Enzyme Biotechnology: methods of enzyme immobilization and applications. Use of microbes in industry. Production of Penicillinase. Application of rDNA technology and genetic engineering in the production of vaccines (Hepatitis- B) and hormones (Insulin). | 5 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED


1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing.
2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing.
3. Singh, B. D., and Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.
4. Stanbury, P.F., Whitaker, A., and Hall, S.J. (2013). Principles of fermentation technology. Elsevier.
5. Casida, L. E. (1968). Industrial microbiology. Industrial microbiology.
6. Okafor, N., and Okeke, B. C. (2017). Modern industrial microbiology and biotechnology. CRC Press.
7. P.K. Gupta, Biotechnology and Genomics, Rastogi Publications, Meerut.
8. H. D. Kumar, Modern Concepts of Biotechnology, Vikas Publishing House, New Delhi.
9. J.E. Smith, Biotechnology, Cambridge University Press.
10. R.P. Singh, Introductory Biotechnology, Central Book Depot, Allahabad. 5. K. Trehan, Biotechnology, Wiley Eastern Ltd., Delhi.
11. Ritmann B. and. McCarty, P. L (2000). Environmental Biotechnology: Principle andApplications, 2nd Edition, McGraw Hill Science.
12. Scragg A., (2005). Environmental Biotechnology. Pearson Education Limited. ISBN: 0199268673, 9780199268672

# CANCER BIOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| BT 24102OE | Open Elective | Cancer Biology | 2 | 0 | 0 | 30 | 2+0=2 |

**Objective:**

This course aims to provide a comprehensive understanding of the molecular and cellular mechanisms underlying cancer development, progression, and treatment, as well as the latest advancements in cancer research and therapy.

**Learning Objectives**:

Upon completion of this course, students should be able to:

**LO1:** Describe basic and molecular mechanisms underlying cancer development, progression, and metastasis.

**LO2:** Identify various diagnostic techniques used in the detection and characterization of cancer.

**LO3:** Understand pharmacological and non-pharmacological treatment modalities for cancer.

**LO4:** Discuss recent advancements in cancer research and their implications for diagnosis and treatment.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Cancer Biology** | Definition, historical perspective and milestones. Etiology of cancer: genetic, occupational, environmental and lifestyle factors. Incidence, prevalence and mortality rates. Types of cancers. Diet and cancer. | 4 |
| **Unit II** | **Principles of Carcinogenesis** | Chemical carcinogenesis. Metabolism of carcinogenesis. Principles of physical carcinogenesis. X –ray radiation: mechanisms of radiation carcinogenesis. | 3 |
| **Unit III** | **Molecular Mechanisms of Cancer** | Hallmarks of cancer: cell proliferation, apoptosis, angiogenesis, invasion and metastasis. Oncogenes and tumor suppressor genes, cell cycle regulation, modulation and checkpoints in cancer. DNA damage and repair mechanisms. Signaling pathways in cancer: PI3K/Akt, MAPK, Wnt/β-catenin etc. | 6 |
| **Unit IV** | **Screening and Diagnostic Techniques in Cancer** | Cancer screening and early detection. Biopsy, histopathological and immunohistochemical examination. Detection using biochemical assays, tumour markers and molecular tools for early diagnosis (PCR, FISH and NGS) of cancer. Liquid biopsy and circulating tumor cells. Imaging techniques: X-ray, CT scan, MRI and PET scan. | 7 |
| **Unit V** | **Pharmacological and Non-pharmacological Treatment Modalities** | Different forms of therapy: chemotherapy (types of drugs, mechanisms of action and side effects), radiation therapy (external beam, brachytherapy and side effects), immunotherapy (checkpoint inhibitors, CAR-T cell therapy) and targeted therapy (monoclonal antibodies and small molecule inhibitors). Gene therapy. Tobacco cessation, vaccination (e.g., HPV vaccine), lifestyle modifications and integrative therapies (acupuncture, hypnosis and music therapy). | 10 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Cancer Biology. Raymond Ruddon (Wiley-Blackwell).
2. The Biology of Cancer. Robert A. Weinberg (Garland Science).
3. Principles of Cancer Biology. Lewis J. Kleinsmith (Pearson Education).
4. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Lauren Pecorino.
5. Understanding Cancer: A Patient's Guide to Diagnosis, Treatment, and Recovery. C. Norman Coleman and C. Dean Buckner (Johns Hopkins University Press) - Indian Edition.

# CALCULATIONS IN BIOTECHNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24103OE** | **Open Elective** | **Calculations in Biotechnology** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of the this course is to equip students with the necessary mathematical skills to effectively perform and interpret quantitative analyses related to molecular techniques, experimental design, and biotechnological applications, ensuring accurate and reliable results in research and development.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Apply mathematical skills to analyze experimental data, ensuring accurate interpretation of results in biotechnology and molecular biology contexts.

**LO2:** Perform data normalization and utilize software tools for data analysis and visualization.

**LO3:** Use mathematical models to solve complex problems related to gene expression, enzyme kinetics, and other molecular processes.

**LO4:** Interpret experimental data and make informed decisions in biotechnological research and development.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Calculations in Biotechnology** | Importance and role of calculations in biotechnology. Molarity, molality, and normality. Preparing solutions and serial dilutions. Types of data visualization: charts, graphs, histograms and tables. Graphical Presentation of data: tools and graphical presentation in excel. | 3 |
| **Unit II** | **Scientific Notation and Metric Prefixes** | Significant digits: rounding off and its guidelines. Scientific notation: arithmetic operations, expressing numbers and scientific notation to decimal notation conversion. Metric prefixes: conversion factors and canceling terms. | 3 |
| **Unit III** | **Solutions, Mixtures, and Media** | Calculating dilutions, concentrations by a factor of x, preparing and diluting percent solutions. Molarity and diluting molar solutions, molarity to percent and percent to molarity. Normality and titrimetric analysis. | 4 |
| **Unit IV** | **Microbial Cell Growth Kinetics** | Bacterial growth curve. Manipulating cell concentration. Bacterial growth kinetics using linear and semilog graph: time, cell concentration, cell growth, generation time and cell density. Fluctuation test. Counting cells by hemocytometer. Calculations and working with bacteriophages. | 5 |
| **Unit V** | **Enzyme Kinetics** | Calculation of kinetic parameters: Vmax and Km. Lineweaver-Burk plots. Calculations for inhibition constants (Ki) and their impact. Calculation of turnover number (kcat) and measurement of catalytic efficiency (kcat/Km). Methods for measuring enzyme activity. | 3 |
| **Unit VI** | **Centrifugation and Protein Estimation** | Relative centrifugal force (RCF). Calculating sedimentation time. RCF to RPM Conversion. Protein quantification (280nm and 205nm). Estimation of protein concentration by absorbance and extinction coefficients. Protein concentration by Bradford assay. The isoelectric point (pi) of a protein. | 4 |
| **Unit VII** | **Nucleic Acid Quantification** | Quantification of dsDNA, ssDNA and RNA using UV spectroscopy. Oligonucleotide quantification. Determination of molecular weight and nucleic acid length. Estimating DNA concentration on an EtBr stained gel. | 4 |
| **Unit VIII** | **Polymerase Chain Reaction** | Template and amplification. Exponential amplification. Polymerase Chain Reaction efficiency. Calculating the Tm of the target sequence. Primers and Primer Tm. Deoxynucleoside triphosphates (dNTPs). DNA polymerase. | 4 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:

1. Calculations for Molecular Biology and Biotechnology- 2nd Ed. Frank H. Stephenson. Academic Press. 2010.
2. Mathematics for the Life Sciences. Erin N.B., Suzanne L. and Louis J.G. Princeton University Press. 2014.

# IMMUNODIAGNOSTICS

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24104OE** | **Open Elective** | **Immunodiagnostics** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to equip students with a comprehensive understanding of the principles, techniques, and applications of immunodiagnostic assays and impart skills about the production and engineering of antibodies used for the accurate diagnosis and monitoring of diseases.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Identify immune reactions to form the basis for application in immunodiagnostics.

**LO2:** Understand the fundamental principles and mechanisms behind various immunodiagnostic methods, including ELISA, immunofluorescence and western blotting.

**LO3:** Design, develop, and optimize immunodiagnostic assays for detecting specific antigens, antibodies, or immune complexes, including understanding assay sensitivity, specificity, and reproducibility.

**LO4:** Apply immunodiagnostic methods to diagnose and monitor whole spectrum of immune-mediated disorders.

**LO5:** Understand how immunodiagnostic techniques are applied in clinical settings to diagnose diseases, monitor immune responses, and guide treatment decisions, including the use of these methods in infectious diseases, autoimmune disorders, and cancer.

**LO6:** Comprehend the ethical and regulatory issues associated with immunodiagnostic testing, including concerns related to patient privacy, test validation, and the implications of test results for patient care.

**LO8:** Describe and apply the methods for producing and characterizing antigens and antibodies, including hybridoma technology and recombinant DNA techniques, to generate specific reagents for research and clinical applications.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Antigen** | Definition and characteristics of biological antigens. Chemical nature (proteins, polysaccharides, lipids, nucleic acids), structure, types (exogenous, endogenous, autoantigens), and properties of antigens. Epitopes and antigenic determinants, antigenic specificity and cross-reactivity. Factors influencing immunogenicity: foreignness, size, complexity, dose and route of administration. Adjuvants and their role in enhancing immune responses. | 5 |
| **Unit II** | **Antibody** | Definition and significance. History and discovery of antibodies. Basic structure (light and heavy chains), variable and constant regions (Fc region), Antigen-binding sites (Fab region) and its functions. Immunoglobulins: structure, types (IgG, IgA, IgM, IgE and IgD) and functions. Isotypes, allotypes, and idiotypes. Principles of antigen-antibody binding. Factors affecting antigen-antibody affinity and avidity. Monoclonal, polyclonal and multispecific antibodies and their applications. Monoclonal vs. polyclonal antibodies. Half- life of antibodies. | 7 |
| **Unit III** | **Antigen and Antibody Production** | Production and purification of antigens and antibodies. Hybridoma technology. Factors affecting antigen and antibodies production. Labelling and characterization of antibodies: Flow Cytometry, FACS, MACS and immunoaffinity chromatography. Applications of antigen and antibody and its uses in vaccine development. | 7 |

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|---|---|---|---|
| **Unit IV** | **Immunodiagnostic Techniques** | Agglutination test, immunoprecipitation, immunofixation, immunoturbidimetry, radioimmunoassay (RIA), ELISA, immunonephlometry, immunoblotting, immunodiffusion, rocket electrophoresis, immunoelectrophoresis, counter current electrophoresis, immunohistochemistry, immunofluorescence techniques and immunoarrays. | 7 |
| **Unit V** | **Applications of Immunodiagnostics** | Diagnostic applications of antigens in immunoassays. Immunodiagnostics in oncology, infectious diseases, environmental pollution, proteomics, and food technology. Uses of recombinant antigens. | 4 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Peter J Delves, Seamus J Martin, Dennis R. Burtn and Ivan M. Roitt., Roitts Essential Immunology, 13th Edition, Wiley -Blackwell, 2016.
2. Kuby, J., Immunology, WH Freeman and Co. 2000.
3. Janeway, C.A and Paul Travers, 1994. Immunobiology, Current Biology Ltd., Garland Publishing Inc. Churchill Livingstone.
4. Roitt, I.M., J. Brestoff and D.K Male, 1996. Immunology, Mosby-Year Book Europe Limited, London.
5. Sulabha Pathak and UrmiPalan, Immunology - Essential and
6. Fundamental, Capital Publishing Company, 301 W. Harrison Guthrie. 2005.
7. Tizard, I.R, Immunology, an Introduction, Saunders College Publishing, New York. 1995.
8. Weir, D.M, Immunological Techniques, Blackwell Scientific Publications, London. 1992.
9. Goding, Monoclonal antibodies, Academic Press. 1985.

# SKILL ENHANCEMENT COURSE

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101SEC** | **Skill Enhancement Courses** | **(To be chosen from basket)** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of skill enhancement courses for students is to equip them with practical, industry-relevant skills and knowledge that enhance their academic performance and prepare them for professional success by bridging the gap between theoretical learning and real-world application.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop technical and practical skills that align with current industry standards and job market demands.

**LO2:** Learn to approach and solve complex problems using innovative and effective methods.

**LO3:** Grasp the core theories and principles underlying specific skills and their applications in real-world contexts.

**LO4:** Master strategies for managing time efficiently to balance academic, personal, and professional responsibilities.

**LO5:** Assess the strengths, limitations, and applicability of various strategies within different professional and academic contexts.

**LO6:** Gain proficiency in verbal, written, and digital communication necessary for effective interaction in professional settings.

**LO7:** Cultivate the ability to analyze situations, evaluate information critically, and make informed decisions.

**LO8:** Experience working in teams to develop cooperative skills and learn to leverage diverse perspectives for better outcomes.

**LO8:** Learn to adapt to changing environments and new challenges, demonstrating resilience and a proactive mindset.

**LO9:** Acquire competencies in using various digital tools and technologies relevant to academic and professional tasks.

**LO10:** Develop the ability to establish and maintain professional relationships that can support career growth and opportunities.

**LO11:** Reflect on personal strengths and interests to create a clear, actionable career plan aligned with individual goals and aspirations.

| Sr. No. | List of Skill Enhancement Courses (Basket) |
|---|---|
| 1. | Computer Basics and Applications |
| 2. | Web Development |
| 3. | Introduction to R Programming |
| 4. | Programming in Python |
| 5. | Data Science Using Python |
| 6. | 3D Printing and Additive Manufacturing |
| 7. | Cybersecurity |
| 8. | Mushroom Culture and Technology |
| 9. | Functional Foods and Nutraceuticals |

| | |
|---|---|
| 10. | Plant Biochemistry and Biotechnology |
| 11. | Pharmacognosy and Metabolic Engineering |
| 12. | Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products |
| 13. | Microbial Technology |
| 14. | Food Laws and Standards |
| 15. | Food Packaging Technology |
| 16. | Nutrition and Dietetics |
| 17. | Industrial Pharmacy |
| 18. | Patent Drafting for Beginners |
| 19. | Alternative Therapies |
| 20. | Healthcare Administration |
| 21. | Industrial Automation |
| 22. | Sustainable Agriculture |
| 23. | Understanding Tribals |
| 24. | Renewable Energy Systems |
| 25. | Corporate Social Responsibility |
| 26. | Wastewater Treatment and Recycling |
| 27. | Disaster Management |
| 28. | Cooperatives and Farmer's Organizations |
| 29. | Economics of Health and Health Care |
| 30. | Introduction to NGO Management |
| 31. | Business Planning and Project Management |
| 32. | Innovation in Laboratory Instruction - Infrastructure Material Laboratory |
| 33. | Strategic Management – The Competitive Edge |
| 34. | Rural Local Governance |
| 35. | Administration and Public Policy |
| 36. | Banking and Insurance |

**Note:** The list provided is not exhaustive; students are encouraged to select other courses that are deemed appropriate under SEC by discussing with the mentor.

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

# INDIAN KNOWLEDGE SYSTEM

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101IKS** | **IKS** | **Indian Knowledge System** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to explore the contributions of India's scientific heritage, ancient knowledge and arts to modern science and technology by communicating the principles of ayurveda, yoga, and health practices for achieving and maintaining health.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand and appreciate the rich scientific heritage and contributions of ancient India to modern science and technology.

**LO2:** Gain knowledge of traditional Indian arts, creative practices, and their cultural significance.

**LO3:** Comprehend the fundamental principles of Indian health systems such as Ayurveda and yoga for achieving and maintaining health.

**LO4:** Apply traditional health practices related to diet, air, water, and sunlight to achieve and ensure healthy lives.

**LO5:** Implement traditional methods for body cleansing and yogic exercises for purifying mind, body and spirit to maintain internal balance for disease-free life.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **History of Indian Knowledge System** | Overview, genesis, scope, and significance of bhartiya knowledge system. Historical context: timeline and key milestones in Indian scientific and technological advancements. | 3 |
| **Unit II** | **India's Characteristic Knowledge and Epistemology** | Philosophical Foundations: Ancient Indian philosophies and their impact on knowledge systems. India's Epistemology. Knowledge Frameworks and Classification. | 3 |
| **Unit III** | **Ancient Scriptures and Education** | Ancient scriptures, ancient education and educating sciences. | 6 |
| **Unit IV** | **Scientific Approaches of IKS and Torch-bearers** | Vastukala (architecture), ayurveda and krishi vijnana (agricultural) practices. Ganita: mathematics (e.g., zero, decimal system) in India, yuddha vidhya (military sciences), niyuddha kala (martial arts), environmental sciences, astronomy, metallurgy, and other sciences. | 8 |
| **Unit V** | **Literary Aspects of IKS and Torch-bearers** | Chandashastra (prosody), bhasa va vyakarana (language and grammar) and bharata's natyashastra (science of drama, dance and music). | 4 |
| **Unit VI** | **Governance in IKS and Way Forward** | Anviksiki (logic and disputation), governance and public administration and IKS way forward | 4 |
| **Unit VII** | **Integrative Approaches and Modern Relevance** | Contributions of IKS to science and technology. Integration of traditional practices in modern healthcare. Current trends and future prospects of IKS. Ethical and sustainable practices of IKS. | 2 |

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

**BOOKS RECOMMENDED:**


1. Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.
2. Introduction to Indian Knowledge System: Concepts and Applications, Mahadevan, B.Bhat, Vinayak Rajat, Nagendra Pavana R.N.
3. Glimpse into Kautilya's Arthashastra Ramachandrudu P. (2010). Sanskrit Academy, Hyderabad
4. Introduction in Studies in Epics and Purāṇas, (Eds.), KM Munshi and N Chandrashekara Aiyer Bhartiya Vidya Bhavan.
5. Indian Knowledge Systems. Kapur K and Singh A.K (Eds) 2005). Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust, Bombay.
6. Vedic Science and History - Ancient Indian's Contribution to the Modern World, Swami BB Vishnu, Gosai publication, 2015.
7. The Nyaya Theory of Knowledge. Chatterjee, S.C. Calcutta: University of Calcutta Press, 1950.
8. History of Indian Philosophy. Dasgupta, Surendra. Delhi: Motilal Banarsidass, 1991.Vol. III and IV
9. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan.
10. Upanishads with the Commentary of Sankarachrya. Gambirananda, Swami, Tr. Kolkata: Advaita Ashrama publication Department, 2002.
11. The Massage of the Upanishads. Ranganathananda, Swami. Bharathya Vidya Bhaven, 1985.
12. J Auboyer, Daily Life in Ancient India from Approx. 200 BC to AD 700, Munshi Ram Manoharlal Publication, 1994.

# CO-CURRICULAR

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101CC** | **Co-Curricular** | **To be chosen from basket** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The objective of co-curricular activities is to complement academic learning by providing opportunities for personal growth, skill development, and social engagement, thereby fostering a well-rounded educational experience that enhances leadership, teamwork, and creative abilities.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop the ability to lead, motivate, and manage teams through active participation in various co-curricular activities.

**LO2:** Strengthen skills in working effectively with others, learning to navigate group dynamics and achieve common goals.

**LO3:** Practice and refine verbal, written, and non-verbal communication through presentations, discussions, and collaborative projects.

**LO4:** Learn to balance multiple responsibilities and commitments, improving organizational and prioritization skills.

**LO5:** Engage in creative activities that encourage original thinking and problem-solving in diverse contexts.

**LO6:** Gain exposure to different perspectives and cultures, enhancing understanding and empathy through diverse interactions and experiences.

**LO7:** Increase self-assurance and resilience by stepping out of comfort zones, taking on new challenges, and achieving personal goals.

**LO8:** Participate in community service and outreach programs, fostering a sense of social responsibility and engagement with societal issues.

| Sr. No. | List of Co-Curricular Activities (Basket) | Evidence |
|---|---|---|
| 1 | Webinars related to the specialization of the student/ program. | Attendance certificate |
| 2 | Participation in Seminar/Conference/Workshop /Symposium/ Training Programs (related to the specialization of the student) | Participation certificate issued by the organizers |
| 3 | Presentation of papers/posters in Conference/ Workshop/ Symposium (related to the specialization of the student) | Participation certificate issued by the organizers |
| 4 | Publication of research paper in indexed (Scopus or Web of Science) journals as first author | Acceptance letter from the journal |
| 5 | Publication of research paper in indexed (Scopus or Web of Science) journals as Co-author | Acceptance letter from the journal |
| 6 | Publication of popular articles in college magazines/ newspapers/ bulletins/wall magazines | Proof of publication |
| 7 | Participation in Sorts/Cultural/Yoga Activities Conducted by State/ National/Regional/Local Agencies | Participation certificate |
| 8 | Academic/Research/Cultural/Sports Award from State/National/Regional/Local Agencies | Award certificate |
| 9 | Academic Award/Research Award from International Agencies | Award certificate |
| 10 | Participation in NSS/NCC activities of the Institute/ university | Certification by NSS/NCC coordinator |
| 11 | Participation in Swachh Bharat Internship | Participation certificate |
| 12 | Participation in Health and Wellness Programme | Participation certificate |

**Note:** The list provided is not exhaustive; students are encouraged to select other co-curricular activities that are deemed appropriate under CC by discussing with the mentor.

# BIOCHEMISTRY PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101DSP** | **Discipline Specific Practical** | **Biochemistry (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

To provide hands-on experience in applying biochemical techniques and methods to investigate the structure, function, and interactions of biomolecules, enhancing students' practical skills and understanding of laboratory procedures.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop proficiency in conducting qualitative and quantitative biochemical tests for biomolecules.

**LO2:** Acquire practical skills in estimating concentrations of various analytes using standard methods.

**LO3:** Understand the principles behind each test and their relevance in biochemical analysis.

**LO4:** Interpret test results accurately and apply them to analyze biological samples effectively.

**LO5:** Ensure adherence to safety protocols and maintain precision in experimental procedures.

| Sr. No. | List of Experiments |
|---|---|
| 1. | To detect reducing sugars by the Benedict's test. |
| 2. | To detect reducing sugars using Fehling's solution. |
| 3. | To perform qualitative tests for proteins/amino acids |
| 4. | Test for the presence of starch using iodine solution. |
| 5. | To perform solubility test for lipids |
| 6. | To perform qualitative tests for lipids (Sudan III stain test, Emulsion test and Saponification test). |
| 7. | To estimate blood glucose by Anthrone method |
| 8. | To determine protein concentration using the Biuret method |
| 9. | To detect the activity of the enzyme amylase by observing the breakdown of starch. |
| 10. | To determine amino acid concentration by Ninhydrin reagent |
| 11. | To determine DNA concentration using the diphenylamine |
| 12. | To determine RNA concentration using the Orcinol reagent |
| 13. | To estimate vitamin C by DCPIP dye |
| 14. | To perform estimation of minerals from given samples |
| 15. | To perform qualitative test for uric acid using phosphotungstic acid method. |

## TEXT / REFERENCE BOOKS

1. S. K. Thimmaiah, Standard methods of Biochemical Analysis, Kalyani publisher
2. David T. Plummer (1990) An Introduction to Practical Biochemistry,179 Third Edition

# CELL BIOLOGY PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24102DSP** | **Discipline Specific Practical** | **Cell Biology (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

To provide students with hands-on experience in techniques for studying cellular structures, functions, and processes, enabling them to apply theoretical knowledge to experimental observations and analyses.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Gain practical skills in microscopy and sample preparation techniques.

**LO2:** Identify and differentiate cellular structures using staining methods.

**LO3:** Acquire proficiency in preparing slides and performing microscopic observations.

**LO4:** Understand and apply techniques for isolation and quantification proteins.

**LO5:** Study cell membrane permeability using experimental approaches.

| Sr. No. | List of Experiments |
|---|---|
| 1. | To study the compound and phase contrast microscope. |
| 2. | To study prokaryotic cells by gram staining. |
| 3. | To visualize prokaryotic and eukaryotic cells (plant and animal). |
| 4. | To study membrane permeability assay. |
| 5. | To identify the presence of Barr's body in the female buccal cavity. |
| 6. | To identify the blood cell types in human blood smear. |
| 7. | To study cell counting and viability |
| 8. | To study osmosis and membrane permeability. |
| 9. | To perform binary fission of yeast/amoeba. |
| 10. | To study the polytene and diplotene chromosomes through Drosophila larvae. |
| 11. | To perform mitochondria staining by Janus Green stain. |
| 12. | To prepare a temporary mount of onion peel to observe and study epidermal cells. |
| 13. | To study divisional stages in mitosis from onion root tips. |
| 14. | To observe the different stages of meiosis using permanent slides of grasshopper’s testes. |
| 15. | To perform protein extraction and quantification from cell lysates. |
| 16. | To study cell membrane permeability using various techniques. |
| 17. | To familiarize the technique of sample preparation for transmission electron microscopy |
| 18. | To prepare permanent slides using sections like stem, root, and leaf. |

## TEXT / REFERENCE BOOKS


1. Practical Cell Biology by C.P. Malhotra and A.P. Malhotra (Publisher: S. Chand and Company Ltd.)
2. A Manual of Practical Biochemistry by V. K. Malhotra (Jaypee Brothers Medical Publishers)
3. Practical Microbiology by R.C. Dubey (Publisher: S. Chand and Company Ltd.)
4. Textbook of Practical Physiology by A.K. Jain (Publisher: Arya (Medi) Publishing House)
5. Practical Histology by K. M. V. Nair (Publisher: CBS Publishers and Distributors)
6. Practical Biochemistry by R. Kapoor (Publisher: Jaypee Brothers Medical Publishers)

## FIRST YEAR: SEMESTER-II

# MICROBIOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24111DSC** | **Discipline Specific Core** | **Microbiology** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to equip students with a thorough understanding of microbial biology, pathogenesis, and disease mechanisms, as well as diagnostic and therapeutic approaches for managing infectious diseases.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Define microbiology and describe historical concept of spontaneous generation and the experiments performed to disprove.

**LO2:** Describe the diversity of microorganisms, including bacteria, viruses, fungi, and protozoa, and their classification based on morphology, physiology, and genetics.

**LO3:** Recognize and compare structure and function of microbes and factors affecting their growth aspects.

**LO4:** Demonstrate aseptic microbiological techniques in the microbiology laboratory and identify sources of microbial contamination and their control.

**LO5:** Understand the mechanisms by which pathogens cause disease, including virulence factors, host-pathogen interactions, and the principles of microbial pathogenicity.

**LO6:** Identify and characterize a wide range of pathogenic microorganisms, including bacteria, viruses, fungi, and parasites, and understand their roles in human diseases.

**LO7:** Apply microbiological knowledge and techniques in practical applications, such as clinical diagnostics, industrial microbiology (biotechnology, food production), environmental microbiology, and bioremediation.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **History, Types of Microorganisms and Microbial Taxonomy** | Introduction to microbiology. History on development and scope of microbiology. Biogenesis and abiogenesis. Pre golden era. Golden era. Post golden era and germ theory. Major path breaking discoveries. Prokaryotes and eukaryotes. Morphology, cell structure and major characteristics of cellular (bacteria, fungi, algae and protozoa) and acellular (viruses) organisms. Classification of microorganisms: classical and modern approaches. Numerical taxonomy and molecular approaches: Polyphasic bacterial taxonomy. | 10 |
| **Unit II** | **Microscopy and Staining Techniques** | Bright field and dark field microscopy. Observation of microorganisms: wet mount and dry mount. Stains and types of stains, mordants, intensifiers, accentuators and decolourizer. Staining techniques: simple, differential and special staining. | 4 |
| **Unit III** | **Sterilization and Disinfection** | Definition and concept of sterilization and disinfection. Sterilization: physical and chemical agents. Mode of action and factors affecting various sterilization techniques. Disinfection: characteristics of an ideal disinfectant, example of disinfectants with their mode of action. Antibiotics: definition, types based on target sites, examples and their mode of action. | 6 |
| **Unit IV** | **Nutrition, Growth, Cultivation and** | Nutritional and physical requirements of microorganisms. Nutritional classification of microorganisms. Environmental factors affecting growth. Types of culture media. Enumeration of microbial | 8 |

| | | | |
|---|---|---|---|
| | **Maintenance of Microorganisms** | populations. Concept of pure culture. Methods of cultivation and isolation, identification of bacteria. Microbial Growth and Reproduction: Binary fission, bacterial growth curve, factors affecting growth and growth kinetics. Gene transfer mechanisms: transformation, transduction and conjugation. Maintenance and preservation of microbial cultures and its importance. Microbial culture collection centers. | |
| **Unit V** | **Medically Important Microorganisms-Bacteria** | Classification, morphology, cultural and antigenic characteristics of bacteria. Epidemiology, pathogenesis, clinical symptoms, diagnosis, treatment, prevention and control of diseases caused by: *B. anthracis, C. tetani, C. botulinum, C. diphtheriae M. tuberculosis, M. leprae, E. coli, N. gonorrhoea, N. meningitidis, S. typhi, S. dysenteriae, Y. pestis, H. influenzae, V. cholera, M. pneumoniae* etc. | 9 |
| **Unit VI** | **Medically Important Microorganisms-Fungi** | Morphological features, classification, structure and properties of medically important fungi. Epidemiology, pathogenesis, clinical symptoms, laboratory diagnosis, treatment, prevention and control of diseases caused by: *Aspergillus flavus, Candida albicans, Histoplasma capsulatum, Pneumocystis carinii, Blastomyces ermatitidis, Paracoccidioidomycosis brasiliensis, Trichophyton rubrum,* and *Cryptococcus neoformans.* | 7 |
| **Unit VII** | **Medically Important Microorganisms-Viruses** | General properties, classification, structure, and properties of viruses. Epidemiology, pathogenesis, clinical symptoms, laboratory diagnosis, treatment, prevention and control of diseases caused by: Hepatitis viruses, Rabies viruses, Orthomyxo and paramyxo viruses, Pox, Herpes viruses, HIV and Influenza virus. | 6 |
| **Unit VIII** | **Medically Important Microorganisms-Protozoa and Helminths** | Morphological features, classification, structure and properties of Protozoa and Helminths. Epidemiology, pathogenesis, clinical symptoms, laboratory diagnosis, treatment, prevention and control of diseases caused by Protozoa: *Entamoeba histolytica, Giaradia lambia, Leshmania spp., Cryptosporadium spp., Plasmodium spp., Toxoplasma gondii, Trypanosoma spp.* and *Trichomaonas vaginalis.* Epidemiology, pathogenesis, clinical symptoms, laboratory diagnosis, treatment, prevention and control of diseases caused by Helminths: *Echinococcus spp, Taenia spp, Hymenolepis spp. Schistosoma spp. Ascaris lumbricoides, Wuchereria bancrofti* and *Toxocara canis.* | 10 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 1998. Microbiology. Tata, McGraw-Hill.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. 1999. Microbiology. 4th Edition, McGraw-Hill.
3. Schlegel, H.G. 2006. General Microbiology. 7th edition, Cambridge University Press.
4. Slonczewski, J.L. and Foster, J.W. 2009. Microbiology: An evolving Science. Library of Congress Cataloguing-in-Publication Data.
5. General Microbiology: Roger Y Stanier, John L Ingraham, and Mark L Wheels Macmillan Press Ltd, V Edition (International Edition). 1999.
6. Ananthanarayan and Paniker, Textbook of Microbiology. Orient Blackswan, 2006.
7. Microbiology Michael J Pelczar, J R Chan ECS, Noel R Krieg Tata McGraw-Hill Education Pvt. 2013.
8. Harley, Klein. Microbiology Prescott, McGraw Hill Seventh Edition.1996.
9. Black J, Microbiology: Principles and Explorations, 7th Edn. John Wiley and Sons, USA. 2010.

# BIOENERGETICS AND METABOLISM

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24112DSC** | **Discipline Specific Core** | **Bioenergetics and Metabolism** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to provide students with a detailed understanding of the biochemical processes involved in energy production and utilization within cells, including the regulation of metabolic pathways and their impact on overall physiological function.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the concept of free energy change, coupled reactions, high energy compounds and redox reactions and their applications to the study of metabolism.

**LO2:** Grasp the principles of bioenergetics, including the concept of Gibbs free energy, ATP synthesis, and thermodynamics of biochemical reactions.

**LO3:** Describe and illustrate the various anabolic and catabolic pathways and their regulation.

**LO4:** Explain how metabolic pathways are regulated by various factors, including enzyme activity, allosteric regulation, and hormonal control.

**LO5:** Connect biochemical principles to health and disease, including understanding the biochemical basis of genetic disorders, metabolic diseases, and the mechanisms of drug action.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Bioenergetics** | Definition, Gibbs free energy and its significance, Nernst equation, measurement of standard reduction potentials; calculation of ΔG from standard reduction potentials. Endergonic and exergonic reactions. Biological oxidation: enzymes involved in oxidation and reduction (oxidases, dehydrogenases, hydroperoxidases and Oxygenases). ATP and high-Energy compounds: synthesis, structure and properties, coupled reactions and ATP hydrolysis. High-energy compounds in metabolism. Electron carriers in energy transfer, Redox reactions and energy transfer. | 10 |
| **Unit II** | **Carbohydrate Metabolism** | Definition, catabolism and anabolism. Carbohydrate absorption, mechanism and regulation. Carbohydrate metabolism: Glycolysis, Gluconeogenesis, Glycogenesis and Glycogenolysis. TCA Cycle and its regulation. Amphibolic and anaplerotic reactions, Electron Transport Chain, Oxidative Phosphorylation and ATP production. Balance Sheet of Glucose Oxidation, Pentose Phosphate Pathway (HMP Shunt) and its regulation. Disorders of carbohydrate metabolism: causes, symptoms, and management. | 12 |
| **Unit III** | **Lipid Metabolism** | Introduction to lipid metabolism, absorption of dietary lipids, Beta-oxidation of saturated and unsaturated fatty acids. Ketone bodies: production, metabolism and associated disorders. Biosynthesis of fatty acids: Acetyl-CoA carboxylase reaction, fatty acid synthase complex. Biosynthesis of palmitate and its energetics. Regulation of fatty acid biosynthesis. Biosynthesis of cholesterol and its regulation. Disorders: hyperlipidemia, dyslipidemia, lipid storage disorders, atherosclerosis and obesity. | 12 |

| | | | |
|---|---|---|---|
| **Unit IV** | **Amino Acids Metabolism** | Protein digestion and absorption. General reactions of amino acid metabolism: transamination, oxidative and non-oxidative deamination, and decarboxylation reactions. Role of glutamine in ammonia transport, Glucose-Alanine Cycle, Urea Cycle, and metabolic breakdown of individual amino acids (essential and non-essential). Amino acid biosynthesis: biosynthesis of non-essential and essential amino acids. Regulation of amino acid biosynthesis. Amino acids as biosynthetic precursors of various compounds. Disorders related to amino acid metabolism: Phenylketonuria (PKU), Maple syrup urine disease (MSUD), Alkaptonuria, Albinism, Homocysteinuria and Cystinuria. | 14 |
| **Unit V** | **Nucleotide Metabolism** | *De Novo* biosynthesis and regulation of purine and pyrimidine nucleotides: enzymatic steps involved in the *de novo* synthesis of purine and pyrimidine nucleotides. Regulation and mechanism controlling the rate of nucleotide biosynthesis. Salvage Pathways of purines and pyrimidines: overview of salvage pathways for recycling nucleotide bases. Role of salvage pathways in nucleotide homeostasis and energy conservation.<br>Catabolism of purine and pyrimidine nucleotides: breakdown pathways for purine nucleotides (e.g., uric acid pathway). Degradation pathways for pyrimidine nucleotides (e.g., orotic acid pathway). Disorders of nucleotide metabolism: Lesch-Nyhan syndrome, Xanthinuria, Hyperuricemia, Gout, Orotic aciduria and Adenosine deaminase deficiency. | 12 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Lehninger: Principles of Biochemistry, 7th edition, David L. Nelson and M.M. Cox (2017) Maxmillan/ Worth publishers/ W. H. Freeman and Company.
2. Fundamentals of Biochemistry, 3rd edition, Donald Voet and Judith G Voet (2004), John Wiley and Sons, NY
3. Biochemistry, 7th edition, Jeremy M. Berg (2015). W.H. Freeman and Co., NY.
4. Harper's Biochemistry, 31st edition, R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V. W. Rodwell (2018). Prentice Hall International.
5. Biochemistry (2004) by J. David Rawn, Panima Publishing Corporation, New Delhi.

# HUMAN PHYSIOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| BT 24111MI | Minor | Human Physiology | 2 | 0 | 0 | 30 | 2+0=2 |

**Objective:**

The objective of this course is to provide students with a comprehensive understanding of the physiological mechanisms and processes that maintain homeostasis and support the function of the human body systems.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Describe the structure and function of major human body systems, including the cardiovascular, respiratory, gastrointestinal, endocrine, nervous, and musculoskeletal systems.

**LO2:** Explain key physiological processes such as muscle contraction, signaling, hormone regulation, and nutrient absorption, and their impact on overall body functions.

**LO3:** Understand how different body systems interact and coordinate to perform complex functions and respond to internal and external changes, maintaining overall health and equilibrium.

**LO4:** Apply physiological concepts to understand common clinical conditions and diseases, including their pathophysiology, symptoms, and effects on body systems.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Gastrointestinal System** | General structure and functions of alimentary canal. Composition and secretion of bile, saliva, pancreatic, gastric, and intestinal juice. Gastrointestinal hormones and disorders of gastrointestinal tract. | 3 |
| **Unit II** | **Muscle Physiology and Osmoregulation** | Structure of cardiac, smooth and skeletal muscle, threshold stimulus, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical and electrical events of the mechanism of muscle contraction. Excretion: Mechanism of urine formation and acid-base balance. | 5 |
| **Unit III** | **Respiratory System** | Hemoglobin and myoglobin. Overview of respiratory system. Respiration: Exchange of gases, Regulation and transport of $O_2$ and $CO_2$, Oxygen dissociation curve and chloride shift. Disorders of respiratory system. | 4 |
| **Unit IV** | **Circulatory System** | Functional anatomy and conducting system of heart, pressure changes during cardiac cycles, capillary circulation, arterial and venous blood pressure. Disorders of circulatory system. | 5 |
| **Unit V** | **Reproductive System** | Male and female reproductive organs. Spermatogenesis and oogenesis. | 3 |
| **Unit VI** | **Endocrine System** | Nature, function and classification of hormones. Role of hormone secretions and its mechanism of action. Structure and functions of Pituitary, Thyroid and Parathyroid (PTH and Calcitonin) gland. Pineal gland: structure and its influence on reproduction and pigmentation. Thymus gland: structure and thymic hormones and their functions. Gastrointestinal hormones: secretion, control and function of insulin and glucagon. Adrenal gland: structure and its function. Adrenal hormones and stress management. Aldosterone and the rennin- angiotensin system. Catecholamines as emergency hormones and their role in the regulation of carbohydrate, | 10 |

| | | | |
|---|---|---|---|
| | | protein and lipid metabolism. Hormonal regulation of ovarian cycles in mammals: folliculogenesis, ovulation, corpus luteum formation and regression. Hormones in pregnancy and lactation. Role of hormones in sex accessory gland growth and functions. | |

**METHODOLOGY**

The course would be taught through lecture sessions.

**BOOKS RECOMMENDED:**

1. Guyton, A.C. and Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia Pte Ltd. /W.B. Saunders Company.
2. Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy and Physiology. XI Edition. John Wiley and sons,Inc.
3. Ganong, H. 2003, Review of Medical Physiology, 21st Edition, McGraw Hill.
4. Strand Fleur , 1978, Physiology ( A regulatory system approach ) McMillan Pub. Co.
5. David Shier, Jakie, Butler and Lewis, 1996, Human Anatomy and Physiology, WCB , USA

# BIOETHICS AND BIOSAFETY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24111OE** | **Open Elective** | **Bioethics and Biosafety** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide students with an understanding of the ethical principles and safety practices essential for conducting research and handling biological materials, while addressing the broader implications for society and the environment.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand and apply fundamental ethical principles in biological research, including respect for persons, beneficence, and justice, to ensure responsible conduct in research involving human and animal subjects.

**LO2:** Familiar with national and international regulations and guidelines governing biosafety, including those related to the handling, storage, and disposal of biological materials, and the use of genetically modified organisms.

**LO3:** Conduct risk assessments and implement appropriate biosafety practices to minimize the risks associated with working with hazardous biological agents and ensure a safe laboratory environment.

**LO4:** Critically evaluate and address ethical issues related to biotechnological advancements, such as genetic modification, cloning, and stem cell research, considering their potential impact on society and individuals.

**LO5:** Handle ethical dilemmas and crises that may arise in biological research and clinical settings, including responding to breaches of biosafety and addressing ethical concerns in experimental design and implementation.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Foundation of Bioethics** | Definition, historic evolution, codes and guidelines of bioethics and universal principles. Ethical conflicts in biological sciences. CCSEA guidelines and ethical considerations. Outline of WHO guidelines for health-related research. Bioethics in health care: euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy and transplantation. Bioethics in cloning and stem cell research. Social and ethical implications of bioterrorism and convention on biological weapons. | 8 |
| **Unit II** | **Introduction to Biosafety** | Definition and historical background of biosafety. Biotechnology and biosafety concerns at different levels. Introduction to biological safety cabinets (Level, I, II III, IV and international bylaws) and other primary containment devices for biohazards. Guidelines for working with pathogenic and infectious microorganisms, infected animals, animal workstations and dissection units. International dimensions in biosafety. | 8 |
| **Unit III** | **Biosafety Regulations and Guidelines** | National and international biosafety regulations and guidelines: Recombinant DNA technology, Genetically modified organisms (GMOs) and living modified organisms (LMOs). Role of institutional biosafety committee. Review committee on genetic manipulation (RCGM). genetic engineering approval committee (GEAC) for GMO applications in food and agriculture. Environmental release of GMOs. | 5 |

| | | | |
|---|---|---|---|
| **Unit IV** | **Handling and Transportation of Biomaterials** | Risk analysis, risk assessment, risk management and communication. Overview of national regulations and relevant international agreements including Cartagena Protocol. Handling, transportation, and biosafety levels for chemical, biological and radioactive materials. | 5 |
| **Unit V** | **GCP and GLP** | Good Clinical Practices (GCP): definition, general information and need to conduct clinical trials. Ethics in clinical biotechnology. GLP: introduction, national Good Laboratory Practices (GLP) and the GLP authority functions. Good Laboratory Practices: necessity, aspiration and responsibility. National and international regulations for food and pharma products. | 4 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:

1. Safety Assessment. Thomas, J.A., Fuch, R.L. (2002), Academic Press.
2. Biological Safety Principles and practices) by Fleming, D.A., Hunt, D.L., (2000). ASM Press.
3. Biotechnology - A comprehensive treatise. Legal economic and ethical dimensions VCH. Bioethics by Ben Mepham, Oxford University Press, 2005.
4. Bioethics and Biosafety by R Rallapalli and Geetha Bali, APH Publication, 2007
5. Bioethics and Biosafety by Sateesh M K (2008), I K International Publishers
6. Biosafety and Bioethics. Rajmohan Joshi, Gyan Publishing House, 2006.

# MARINE BIOPROSPECTING

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24112OE** | **Open Elective** | **Marine Bioprospecting** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to explore the potentials of marine organisms as sources of novel bioactive compounds and technologies and understand the methods and ethical considerations involved in their exploration and commercialization.

**Learning Outcomes:**

Upon successful completion of this course, students will be able to:

**LO1:** Identify and characterize diverse marine organisms with potential for bioprospecting, including microorganisms, algae, and marine invertebrates, and understand their ecological roles.

**LO2:** Understand and apply methods for extracting and screening bioactive compounds from marine organisms, including techniques such as chromatography, spectroscopy, and bioassays.

**LO3:** Explain the potential applications of marine-derived compounds in various fields, including pharmaceuticals, biotechnology, agriculture, and environmental science.

**LO4:** Understand the ethical issues and environmental impacts related to exploitation of marine resources in drug development and commercialization, including conservation concerns, intellectual property rights, and sustainable practices.

**LO5:** Understand the processes involved in the commercialization of marine bioproducts, including regulatory requirements, market considerations, and strategies for translating research into viable products.

| No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Biodiversity and Bioprospecting** | Biodiversity: definition, genetic diversity, species diversity, structural and functional aspects of ecosystem diversity. Conservation biology: IUCN Red List, value of biodiversity and conservation. Current practices in conservation, conservation of genetic diversity, species diversity and ecosystem diversity. Bioprospecting: definition, introduction, types of bioprospecting (chemical prospecting, bionic prospecting and gene prospecting). Bioresources mapping, inventorisation and monitoring of biological diversity. Biodiversity prospecting: the INBio experiences, contracts for bioprospecting, natural products research partnerships in global diversity hotspots. Bioprospecting act: introduction, phases of bioprospecting and exemption to act. Fields of bioprospecting. | 6 |
| **Unit II** | **Marine Bioprospecting** | Marine ecosystem and its functioning: natural (intertidal, estuarine, salt marsh, mangrove, coral reef, coastal and deep sea and hydrothermal vents) and artificial reefs. Sources of marine planktons and their bioprospecting. Methods of sampling, isolation and cultivation of marine bioresources. Marine microbial community: algal, fungal, bacterial and viral. Approaches for the assessment of microbial diversity: culture dependent and independent. Biotechnologically relevant microorganisms. Isolation of marine yeast and its industrial applications. Seaweeds Bioactive chemicals and their applications. | 5 |
| **Unit III** | **Marine Drugs and Enzymes** | Cultivation of marine bioresources: plating, enrichment and extinction culturing. Conventional and High throughput screening strategy, common extraction methods and bioassay guided fractionation. Isolation and separation techniques. Isolation of microbial metabolites and their biological applications (enzymes, therapeutics, antimicrobials, | 10 |

| | | | |
|---|---|---|---|
| | | biotransformations and biofuels). Endophytic microbial products as antibiotics. Extremophiles as source of bioactive compounds. Potential of seaweeds as pharmaceuticals and antifouling agents. | |
| **Unit IV** | **Marine Functional Foods and Nutraceuticals** | Marine functional foods: sources, ingredients and biological properties. Marine nutraceuticals: marine bioactives as potential nutraceuticals, functional carbohydrates, polyunsaturated fatty acids (omega 3 oils), carotenoids, soluble calcium, marine-derived collagen, gelatin and probiotics for human health. | 4 |
| **Unit V** | **Marine Bioresources and Cosmetics** | Marine secondary metabolites. Proteins and lipids for cosmetics. Cosmetics and cosmeceuticals from marine sources. Composition of cosmetics, target organs and cosmetics delivery systems. Functions of components in cosmetics and cosmeceuticals. Products based on marine resources. Regulations and safety. | 5 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Atta-ur-Rahman, Iqbal Choudhary, M., and Thomsen, W.J. Eds. 2005. Bioassay Techniques for Drug Development (Taylor and Francis).
2. Seethala, R., and Fernandes, P.B. Eds. 2001. Handbook of Drug Screening (Marcel Dekker Inc).
3. Zhang, L., and Demain, A.L. Eds. 2005. Natural Products Drug Discovery and Therapeutic Medicine. Humana Press.
4. Lansing Taylor, D., Harkins, J.R., and Giuliano, K.A. Eds. 2007. Methods in Molecular Biology, Volume 356. Humana Press.
5. Braga, P.C., and Ricci, D. Eds. (2005). Methods in Molecular Biology, Volume 242.
6. Hammes, G.G. ed. 2005. Spectroscopy for the biological sciences. Wiley Interscience.
7. Kastin, A.J. ed. 2006. Handbook of biologically active peptides. Elsevier.
8. D.S. Bhakuni and D.S. Rawat 2005 Bioactive Marine Natural Products (Springer and Anamaya Publishers, New Delhi, India
9. Ehrlich, Hermann Ed 2010. Biological Materials of Marine Origin. Invertebrates (Springer).
10. Singh, Joginder and Sharma, Deepansh and Kumar, Gaurav and Sharma, Neeta. (2018). Microbial Bioprospecting for Sustainable Development. 10.1007/978-981-13-0053-0.
11. Paterson RRM, Lima N (2017b) Bioprospecting. Success, potential and constraints. Springer, Cham.

# COMMUNICATIVE ENGLISH

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24111AEC** | **Ability Enhancement Course** | **Communicative English** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to develop students' ability to effectively communicate in English through enhancing their skills in speaking, listening, reading, and writing, thereby enabling them to engage confidently in various real-life situations, preparing them for employment, enhancing their presentation abilities and professional contexts.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Engage effectively in everyday conversations using appropriate phrases and expressions, demonstrating improved speaking and listening skills.

**LO2:** Gain knowledge, thoughts, and concepts on the technicalities of accurate pronunciation, structure, appropriate use, and style of the English language.

**LO3:** Develop the ability to deliver clear and structured public speeches and presentations, showcasing their public speaking skills.

**LO4:** Enhance their reading comprehension by accurately identifying main ideas, key details, and summarizing texts.

**LO5:** Improve their writing skills by crafting coherent paragraphs, essays, and formal documents, while applying proper grammar and style.

**LO6:** Gain an understanding of cultural nuances in communication, including idiomatic expressions and professional language use, to interact effectively in diverse contexts.

| No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Communication** | Introduction, theory of communication, types of communication and modes of communication. The theoretical side of the four skills (reading, listening, speaking and writing). | 4 |
| **Unit II** | **Reading Skills** | Passive skill and its importance. Ten important reading strategies and their benefits. | 3 |
| **Unit III** | **Listening Skills** | Importance and benefits of listening skills. Different types of listening and strategies for improving listening. | 3 |
| **Unit IV** | **Speaking Skills** | Importance of speaking as an active skill. Fundamentals of grammar and phonetics. Tools of communicative English: grammar, vocabulary and phonetics. Strategies for effective communication and speaking skills. | 5 |
| **Unit V** | **Public Speaking** | Techniques for effective public speaking. Group discussion and interview skills. Role and importance of English as a means of communication. | 4 |
| **Unit VI** | **Presentation and Academic Writing** | Presentation skills. People skills. Academic and creative writing. Different styles of writing. Tips to improve writing skills. Fundamentals of English usages. Making notes and resume. Fundamentals of intonation. Correspondence writing. Means to enhance vocabulary and IELTS score. Three levels of English language proficiency and close reading. | 8 |
| **Unit VII** | **Professional Communication** | Professional communication and jargons. English as a global language. English for careers. Business English. Comprehension, summary and paraphrasing. | 3 |

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

## BOOKS RECOMMENDED:


1. Adler B. Ronald and Russell F. Proctor II. Looking Out, Looking In. Cengage Learning.2017.
2. Dianna L.Vanblerkom. College Study Skills.Wadsworth.2003
3. Aggarwal, R. (2003). Effective Communication Skills. Jaipur: Sublime Publications
4. Davies, F. 1995, Introducing Reading. Penguin Books.
5. Downs, Lisa. Listening Skills Training. USA; ASTD, 2008. Print.
6. Brown, G and G. Yule. Listening to Spoken English. Cambridge U P, 1983.
7. Andrew D.Wolvin, Carolyn Gwynn Coakley. Listening. W.C.Brown, 1985.
8. Davidson G., New Methods of Teaching English. 323, Ivy Publishing House Delhi.
9. Seely, John. The Oxford Guide to Writing and Speaking. OUP.1998
10. Kahn, John Ellison. How to Write and Speak Better. The Reader's Digest Association. 1991.
11. Dawes, L. The Essential Speaking and Listening. Routledge, 2008.
12. Cornbleet, S., and Carter, R. The Language of Speech and Writing. Routledge, 2001.
13. Harvey, I. (1951). The Technique of Persuasion. London: The Falcon Press.
14. Anderson, A and Lynch, T. (1988) Listening, Oxford: Oxford University, Press.
15. Riggenbach, Heidi. Perspectives on Fluency. University of Michigan Press, 2000.
16. Dianna L. Vanblerkom. College Study Skills.Wadsworth.2003
17. Crystal, D. (2003). English as a Global Language. 2nd ed. Cambridge: Cambridge University Press
18. Anderson, Marilyn, Pramod K. Nayar. Critical Thinking, Academic Writing and Presentation Skills. Dorling Kindersley. India 2010
19. Crystal, David (2003). The Cambridge Encyclopedia of the English Language (2nd Ed.). Cambridge University Press.

# CONSTITUTIONAL GOVERNMENT AND DEMOCRACY IN INDIA

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24111VEC** | **Value Education Course** | **Constitutional Government and Democracy in India** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide a comprehensive understanding of the principles, structures, and functioning of the Indian political system including its constitution, democratic processes and governance mechanisms.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Explain the fundamental principles, structure, and key provisions of the Indian Constitution.

**LO2:** Describe the functioning of democratic institutions, including the roles of the Executive, Legislature, and Judiciary.

**LO3:** Assess the effectiveness and challenges of governance and public administration in India.

**LO4:** Analyze the impact and significance of major constitutional amendments on the Indian political system.

**LO5:** Apply constitutional principles to contemporary issues in Indian politics and society.

**LO6:** Understand and critique the electoral process, including the role of political parties and electoral process.

**LO7:** Discuss and examine the protection of fundamental rights and the role of the judiciary in safeguarding democracy.

**LO8:** Evaluate the challenges and opportunities for democratic governance in contemporary India.

**LO9:** Compare India's democratic practices with those of other democratic nations to identify strengths and areas for improvement.

| No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Constitutional Government** | Historical context, compositions, functions and critical evaluation of constituent assembly. | 2 |
| **Unit II** | **The Indian Constitution** | Preamble to the constitution of India. Features of Indian constitution. Introduction to fundamental rights. Equality before law and right to freedom. Position of some democratic rights. Right against exploitation. Right to freedom of religion and right to constitutional remedies. | 4 |
| **Unit III** | **The Legislature** | Directive principles. The Rajya Sabha and Lok Sabha. Lok Sabha vs. Rajya Sabha. | 2 |
| **Unit IV** | **The Executives of Union Government** | President of India, speaker and parliamentary committees. Powers and functions of the President. Emergency powers and the position of the President. Union council of ministers and the Prime Minister. Legislative procedure. | 4 |
| **Unit V** | **The Judiciary of India** | The structure and the High Court. The Supreme Court. Role of the Supreme Court. Judicial activism in India. Basic Structure Doctrine and Public Interest Litigation (PIL). | 3 |
| **Unit VI** | **Federalism and Decentralization** | Origin and development of federalism in India. Nature of Indian federalism: constitutional structure and institutional practices. Federalism and identity of states in India. Centre-State legislative, administrative and financial relations. Cooperative federalism in India. Indian federalism and the Supreme Court. Federalism and emergency provisions. Federalism and Regionalism in India. Federalism and evolution of party system. Federalism and role of national and regional parties. Comparing Federations. Indian | 8 |

| | | | |
|---|---|---|---|
| | | federalism: issues and challenges. The 5th and 6th Schedules. | |
| **Unit VII** | **Panchayati Raj and E-governance** | Indian Municipality: history, organization and functions. Panchayat: Ghandhi's Idea of Panchayat. Panchayati Raj in India. Local governance and decentralized planning in India. Local Self - Government and the mandates of the 73rd and 74th Amendment Act. E-governance at the Local Government level. Digitization and urban Governance. Practices of good Governance in Local Government. Women's Representation in Local Self Government. Challenges to Women's Representation in Local Self Government in India. Role of PRIs in the implementation of MGNREGAs. Panchayat and the PESA Act | 7 |

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

## BOOKS RECOMMENDED:


1. Basu, Durga Das, Shorter constitution of India, New Delhi, Prentice Hall of India, 1988
2. Basu, Durga Das, Introduction to the constitution of India, New Delhi: Prentice Hall of India,1993.
3. Pylee, M.V., India's Constitution, New Delhi, S. Chand and Company, 1999
4. Bakshi, P.M., The Constitution of India, Universal Law Publishing Co., Delhi,2008.
5. Pylee, M.V., India's Constitution., New Delhi, S. Chand and Co. 1997.
6. Constitution Of India, Bare Act, Universal Law Publishing Co. Pvt. Ltd. New Delhi, 2010।
7. Deogaonkar, S.G. Parliamentary system in India, New Delhi, Concept Pub. 1997.
8. Iyengar T.S.Rajagopala, Indian Parliament: a critical study, Mysore, University of Mysore, 1972.
9. Jain R.B. The Indian Parliament: Innovations, reforms and development, Calcutta, Minerva Associate, 1976.
10. Vidya Bhushan and Vishnoo Bhagwan--- Indian Administration (S. Chand, 2011)
11. S. R. Maheswari. Indian Administration (Orient Blackswan, 2001)
12. A. Avasthi and A.P. Avasthi - Indian Administration (L.N. Agarwal Educational Publishing, 2017).

# CO-CURRICULAR

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101CC** | **Co-Curricular** | **To be chosen from basket** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The objective of co-curricular activities is to complement academic learning by providing opportunities for personal growth, skill development, and social engagement, thereby fostering a well-rounded educational experience that enhances leadership, teamwork, and creative abilities.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop the ability to lead, motivate, and manage teams through active participation in various co-curricular activities.

**LO2:** Strengthen skills in working effectively with others, learning to navigate group dynamics and achieve common goals.

**LO3:** Practice and refine verbal, written, and non-verbal communication through presentations, discussions, and collaborative projects.

**LO4:** Learn to balance multiple responsibilities and commitments, improving organizational and prioritization skills.

**LO5:** Engage in creative activities that encourage original thinking and problem-solving in diverse contexts.

**LO6:** Gain exposure to different perspectives and cultures, enhancing understanding and empathy through diverse interactions and experiences.

**LO7:** Increase self-assurance and resilience by stepping out of comfort zones, taking on new challenges, and achieving personal goals.

**LO8:** Participate in community service and outreach programs, fostering a sense of social responsibility and engagement with societal issues.

| Sr. No. | List of Co-Curricular Activities (Basket) | Evidence |
|---|---|---|
| 1 | Webinars related to the specialization of the student/ program. | Attendance certificate |
| 2 | Participation in Seminar/Conference/Workshop /Symposium/ Training Programs (related to the specialization of the student) | Participation certificate issued by the organizers |
| 3 | Presentation of papers/posters in Conference/ Workshop/ Symposium (related to the specialization of the student) | Participation certificate issued by the organizers |
| 4 | Publication of research paper in indexed (Scopus or Web of Science) journals as first author | Acceptance letter from the journal |
| 5 | Publication of research paper in indexed (Scopus or Web of Science) journals as Co-author | Acceptance letter from the journal |
| 6 | Publication of popular articles in college magazines/ newspapers/ bulletins/wall magazines | Proof of publication |
| 7 | Participation in Sorts/Cultural/Yoga Activities Conducted by State/ National/Regional/Local Agencies | Participation certificate |
| 8 | Academic/Research/Cultural/Sports Award from State/National/Regional/Local Agencies | Award certificate |
| 9 | Academic Award/Research Award from International Agencies | Award certificate |
| 10 | Participation in NSS/NCC activities of the Institute/ university | Certification by NSS/NCC coordinator |
| 11 | Participation in Swachh Bharat Internship | Participation certificate |
| 12 | Participation in Health and Wellness Programme | Participation certificate |

**Note:** The list provided is not exhaustive; students are encouraged to select other co-curricular activities that are deemed appropriate under CC by discussing with the mentor.

# MICROBIOLOGY PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24111DSP** | **Discipline Specific Practical** | **Microbiology (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The aim of this course is to equip students with practical skills and knowledge necessary for the study and utilization of major laboratory instruments, aseptic techniques, culture techniques, and biochemical characterization methods in microbiology.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop hands-on skills in essential microbiological techniques, including aseptic technique, microbial culture, streak plating, and gram staining.

**LO2:** Accurately identify and characterize microorganisms using various methods, such as biochemical tests, microscopy, and molecular techniques.

**LO3:** Perform microbial colony analysis and observe strain morphology.

**LO4:** Understand how to cultivate, maintain, and manipulate microbial cultures in different media and conditions, and interpret growth patterns and colony morphology.

**LO5:** Perform and interpret antimicrobial susceptibility tests, such as disk diffusion and broth dilution assays, to assess the effectiveness of antibiotics and other antimicrobial agents.

**LO6:** Analyze experimental data, including microbial growth, test results, and contamination, and draw meaningful conclusions based on their observations and results.

| Sr.No | List of Experiments |
|---|---|
| 1 | To learn the principles and operations of commonly used the sterilization techniques |
| 2 | To study the principles, parts and function, operation of microscopy. |
| 3 | To prepare the microbial culture media (liquid and solid). |
| 4 | To perform streak plate, spread plate and pour plate techniques of given sample. |
| 5 | To perform staining techniques for identification of bacteria (Gram, acid fast, capsule and endospore staining) |
| 6 | To perform staining techniques for identification of fungi (lactophenol and cotton blue staining). |
| 7 | To perform the motility determination of the bacteria by soft agar deeps and hanging drop method. |
| 8 | To perform biochemical characterization of bacteria by IMViC test. |
| 9 | To perform enzyme based biochemical characterizations by catalase, oxidase and urease test. |
| 10 | To perform triple sugar iron agar test for $H_2S$ production. |
| 11 | To perform casein and starch hydrolysis test of bacteria. |
| 12 | To perform carbohydrate fermentation test (glucose, lactose and sucrose). |
| 13 | To perform bacterial hemolysis on blood agar. |
| 14 | To determine the bacterial growth curve. |
| 15 | To perform antibiotic susceptibility test by Kirby-Bauer assay and MIC of a selected bacterium. |
| 16 | To isolate and identify bacteria from urine/pus sample. |
| 17 | To perform screening for MRSA and *Staphylococcus aureus.* |

## TEXT / REFERENCE BOOKS


1. Microbiology: An Introduction by C.P. Baveja (Publisher: Arya Publications).
2. Practical Microbiology. R.C. Dubey (Publisher: S. Chand and Company Ltd.).
3. Practical Microbiology for Students. N.C. Dey (Publisher: New Central Book Agency).
4. Practical Handbook of Microbiology. M. A. Akhtar (Jaypee Brothers Medical Publishers).
5. Microbiology: A Laboratory Manual. C.P. Baveja (Publisher: Arya Publications).
6. Laboratory Manual in Microbiology –2nd Edition. Kumudu Karunaratne. The Sri Lanka College of Microbiologists.

# BIOENERGETICS AND METABOLISM PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24112DSP** | **Discipline Specific Practical** | **Bioenergetics and Metabolism (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

To provide students with hands-on experience in experimental techniques used to study metabolic pathways and energy transformations, enabling them to analyze biochemical processes and interpret their physiological significance.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the principles behind each biochemical assay for analyzing metabolic processes.

**LO2:** Prepare reagents, pipette efficiently, calibrate instruments, and perform assays accurately.

**LO3:** Handle instruments such as spectrophotometer and perform experiments to construct standard curve.

**LO4:** Interpret assay results, including data analysis, calculations, and comparisons with reference values.

| Sr. No. | List of Experiments |
|---|---|
| 1. | To estimate blood sugar using o-toluidine reagent. |
| 2. | To estimate reducing sugars using 3,5-dinitrosalicylic acid. |
| 3. | To quantitatively estimate reducing sugars using Nelson-Somoyogi's method. |
| 4. | To quantitatively estimate total carbohydrate by phenol sulphuric acid method |
| 5. | To perform quantitative estimation of proteins using Lowry's method. |
| 6. | To perform quantitative estimation of proteins using Bradford method. |
| 7. | To estimate urea in a given blood sample. |
| 8. | To estimate creatinine in a given serum sample. |
| 9. | To estimate serum albumin by BCG Method |
| 10. | To estimate serum cholesterol using Zak's method. |
| 11. | To quantitatively estimate uric acid in a given serum sample. |
| 12. | To determine serum proteins and the albumin-globulin ratio using the Biuret method. |
| 13. | To detect the presence of glycerol in a given sample using the acrolein method. |
| 14. | To characterize lipids by determining acid value, saponification value, and iodine number. |
| 15. | To determine ketone bodies by Rothera's Method. |

## TEXT / REFERENCE BOOKS

1. Layne, E. Spectrophotometric and Turbidimetric Methods for Measuring Proteins. Methods in Enzymology 10: 447-455. 1957.
2. S. K. Thimmaiah, Standard methods of Biochemical Analysis, Kalyani publisher.
3. David T. Plummer (1990) An Introduction to Practical Biochemistry, Third Edition.

## SECOND YEAR: SEMESTER-III

# GENETICS AND MOLECULAR BIOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201DSC** | **Discipline Specific Core** | **Genetics and Molecular Biology** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to provide students with a comprehensive understanding of genetic principles and molecular mechanisms, emphasizing how genetic information is inherited, expressed and regulated in living organisms.

**Learning Outcomes:**

After successful completion of this course, students will be able to:

**LO1:** Explain the principles of inheritance, genetic variation, and the role of DNA, RNA, and proteins in genetic processes.

**LO2:** Understand the autosomal, mitochondrial and multifactorial genetic inheritance and diseases.

**LO3:** Understand the structure and functions of nucleic acids.

**LO4:** Emphasize the molecular mechanism of DNA replication, repair, transcription and translation in prokaryotes and eukaryotes.

| No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Classical Genetics** | Fundamental principles of genetics. Mendel's principles and experiments, gene interaction, multiple alleles, sex linked inheritance. Chromosomal basis of heredity: extra-chromosomal inheritance. Linkages and crossing over. Hardy-Weinberg equilibrium and extensions of Hardy-Weinberg equilibrium. | 8 |
| **Unit II** | **Applied Genetics** | Population and human genetics: pedigree structure, autosomal, mitochondrial and multifactorial inheritance and diseases. Genetic counseling and prenatal diagnosis. Human chromosomes and ISCN nomenclature. Epigenetics and genomic imprinting. Role of genes in cancer. | 5 |
| **Unit III** | **Genetic and Hormonal Control of Sex Determination** | Theories of sex determination: chromosome theory and genic balance theory of sex determination. Genetic basis of sex differentiation (genes located on sex chromosomes and autosomes), single gene control of sex. Hormonal control of sex, sex reversal and gynandromorphy, human sex anomalies (Klinefelter's syndrome and Turner's syndrome). Dosage compensation and Lyon's hypothesis. | 5 |
| **Unit IV** | **Genetics and Speciation** | Genetic variation in natural population. Phenotypic variation, species concept and reproductive isolation. Modes and speciation: allopatric, sympatric, parapatric and quantum speciation. | 6 |
| **Unit V** | **Structure and Properties of Nucleic Acids** | DNA and RNA as genetic material. Structure and physicochemical properties of DNA and RNA. Types of DNA and RNA and their biological importance. DNA replication in prokaryotes and eukaryotes, rolling circle mode of replication, mechanism of DNA replication in eukaryotes and Okazaki fragments. Inhibitors of DNA replication. | 8 |
| **Unit VI** | **Repair Mechanism** | Genetic exchange in bacteria: transformation and transduction (generalized and specialized) and conjugation. DNA repair mechanisms: excision, SOS and UV repair. Gene mutations: types, point mutation, transition, transversion, frame shift, insertion and deletion. | 8 |

| | | | |
|---|---|---|---|
| **Unit VII** | **Transcription** | Central Dogma in molecular biology: structure and functions of mRNA, rRNA tRNA and microRNAs. Characteristics of promoters and enhancers. RNA synthesis: initiation, elongation and termination in prokaryotes and eukaryotes. Proteins of RNA synthesis, inhibitors of transcription and post transcriptional modifications. Differences in prokaryotic and eukaryotic transcription. | 10 |
| **Unit VIII** | **Translation** | Introduction to genetic code: elucidation of genetic code, codon degeneracy, Wobble hypothesis and its importance. Prokaryotic and eukaryotic ribosomes. Steps and mechanism of translation in prokaryotes and eukaryotes: initiation, elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance. | 10 |

## METHODOLOGY

The course will be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. D.P. Snustard and M.J. Simmons- 6th Edition. Principles of Genetics. John Wiley and Sons, Singapore, 2012.
2. Lewin B., Genes XI, International Edition, Jocelyn Krebs, Stephen Kilpatrick and Elliott Goldstein, Jones and Bartlett Learning, 2017, ISBN 978-1-4496-5985-1.
3. Tropp, Burton E., Molecular Biology: Genes to Proteins, 3 rd Edition, Jones and Bartlett, 2008.
4. Glick B.R. and Pasternak J.J., Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition. ASM, 2010.
5. Weaver, Robert F., Molecular Biology, 2nd Edition, Tata McGraw Hill, 2003.
6. De Robertis E.D.P. and De Robertis, E.M.F., Cell and Molecular Biology. 8th Edition, Lippincott Williams and Wilkins, Philadelphia, 2006.
7. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losick R., Molecular Biology of the Gene, 6th Edition, Cold Spring Harbour Lab. Press, Pearson Publication, 2008.
8. Primrose S.B. and Twyman R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing, 7th Edition, 2006, ISBN 1-4051-3544-1.
9. Gardner E.J., Simmons M.J. and Snustad D.P., Principles of Genetics, 8th Edition, John Wiley and Sons, Singapore, 2003.

# BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201MI** | **Minor** | **Bioanalytical Techniques and Instrumentation** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to equip students with the skills to use and interpret various analytical methods and instruments for the precise measurement and analysis of biological samples.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Acquire skills to calculate and prepare solutions with various concentrations.

**LO2:** Demonstrate proficiency in key bioanalytical techniques, such as chromatography, mass spectrometry, and spectroscopy etc., for the separation, identification, and quantification of biomolecules.

**LO3:** Effectively operate and troubleshoot various laboratory instruments, including HPLC, GC, and spectrophotometers etc., to analyze biological samples.

**LO4:** Implement procedures for method validation and ensure the accuracy, precision, and reliability of results.

**LO5:** Interpret complex analytical data, including spectra and chromatograms, to make informed conclusions about the composition and concentration of biological substances.

**LO6:** Describe the types of radiation, effects, occupational protection and safety measures along with applications of radioisotopes in medicine, industry and other areas.

**LO7:** Apply the principles of bioanalytical techniques in biomedical research and diagnostics.

**LO8:** Recognize and apply relevant regulatory and quality control standards in the context of bioanalytical testing and instrumentation.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Basics of Biophysical Techniques** | Definition and concept of molarity (M) and normality (N), calculation of molarity and normality, relationship between molarity and normality, applications of molarity and normality in biochemical analysis. Homogenization techniques for biological samples, Extraction methods for biomolecules (e.g., proteins, nucleic acids, lipids). pH and its calibration. Buffers and its importance. Titrations: interaction of an acid with a base. Viscosity: factors affecting viscosity, applications of viscometry, significance of viscosity in biological systems. | 6 |
| **Unit II** | **Basic Separation Techniques** | Separation techniques: based on size by micro, ultra and nano membrane filters and reverse osmosis. Filtration: principle and applications in sample preparation. Dialysis: principle and applications in biomolecule purification. Centrifugation: principle of sedimentation and principle and types (differential, analytical and density gradient). | 6 |
| **Unit III** | **Microscopy** | Overview and principle of microscopy, basic principle and components of light and dark-field microscopy. Principle and applications of phase contrast and fluorescence microscopy in cellular imaging. Confocal Microscopy: principle and applications. Principle and applications of Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). | 10 |
| **Unit IV** | **Spectroscopy** | Overview and types of spectroscopic techniques. Electromagnetic radiation and interactions with matter. Principles of molecular excitation, Jablonski diagram, fluorescence and phosphorescence mechanisms. Beer-Lambert's Law and its limitations. Principle, theory, instrumentation and applications: UV-Visible, Fluorescence, IR/Raman, X-ray diffraction, Mass and NMR Spectroscopy. | 11 |

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|---|---|---|---|
| **Unit V** | **Chromatography** | Definition, classification and principle of chromatography. Principle, basic setup, operating characteristics and applications: paper chromatography, Thin-Layer Chromatography (TLC) and HPTLC, Column chromatography, Ion Exchange chromatography, Size Exclusion chromatography, Affinity chromatography, Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC). | 12 |
| **Unit VI** | **Electrophoresis** | Definition, types and principle of electrophoresis. Principle, basic setup, operating characteristics, visualization methods and applications: Agarose gel electrophoresis, Native PAGE, SDS-PAGE. Capillary Electrophoresis (CE), Pulse-Field Gel Electrophoresis and Isoelectric focusing (IEF). Two- and three-dimensional (2 and 3D) gel electrophoresis. | 10 |
| **Unit VII** | **Radiolabeling Techniques** | Introduction and types of radioisotopes. Radioactive decay. Detection and measurement: Geiger Counters and Liquid Scintillation Counting. Counting efficiency and autoradiography. Safety aspects. Use of isotopes as tracers in biological sciences. Biotechnological applications of radioisotopes. | 5 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Biological Spectroscopy. I. D. Campbell, Publisher: Benjamin/Cummings Pub. Co
2. Experimental Biochemistry. R. L. Switzer, Publisher: W. H. Freeman and Co
3. Modern Experimental Biochemistry. R. F. Boyer, Publisher: Benjamin Cummings
4. Biochemistry Laboratory: Modern Theory and Techniques. R.F. Boyer, Publisher: Prentice Hall.
5. Analytical Techniques in Biochemistry and Molecular Biology. R. Katoch, Publisher: Springer.
6. Modern Analytical Chemistry. D. Harvey, Publisher: McGraw-Hill
7. Basic Methods in Microscopy: Protocols and Concepts from Cells: A Laboratory Manual. D. L. Spector, R. D. Goldman, Publisher: Cold Spring Harbor Laboratory Press
8. Principles and Techniques of Biochemistry and Molecular Biology edited. K. Wilson, J. M. Walker, Publisher: Cambridge University Press.

# BIOMEMBRANES

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201OE** | **Open Elective** | **Biomembranes** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

This course provides students with an in-depth understanding of the structure, function, and dynamics of biological membranes to make them understand how a cell functions and communicates with the extracellular environment.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Describe the components and organization of biological membranes, including lipids, proteins, and carbohydrates**.**

**LO2:** Describe the significance of membrane asymmetry and dynamics.

**LO3:** Detail the various methods of molecular transport across membranes, including passive diffusion, active transport, and vesicular trafficking.

**LO4:** Explore the mechanisms of membrane fluidity, flexibility, and the impact of environmental conditions on membrane behavior.

**LO3:** Explain the diverse functions of biomembranes, such as transport, signaling, and energy conversion.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Biomembranes** | Biomembrane: physicochemical properties, structure and composition. Prokaryotic, eukaryotic, neuronal, and subcellular membranes. Gorter and Grendel's experiment. Overview of sandwich model (lamellar model) and fluid mosaic model. Membrane asymmetry: lipids, proteins and carbohydrates and their lateral diffusion. Biogenesis of lipids and proteins. Biogenesis of sub-cellular organelles. | 5 |
| **Unit II** | **Membrane Structures** | Polymorphic structures of amphiphilic molecules: micelles and bilayers. Critical Micelles Concentration (CMC) and critical packing parameter. Macro and microdomains in membranes. Regulation and roles of lipid rafts, caveolae and tight junctions. Membrane lipids and protein turnover. RBC membrane architecture. | 5 |
| **Unit III** | **Membrane Dynamics** | Membrane fluidity and factors affecting membrane fluidity. Lateral, transverse, and rotational motion of lipids and proteins. Methods of study of membrane structure: lipid transfer proteins, phospholipases, chemical methods, amino-phospholipid translocation, freeze fracture and freeze etching. Lipid vesicles: liposome preparations and applications. Function of sterols in membranes. Techniques used to study membrane dynamics: FRAP, FRET, TNBS labeling, single particle tracking, EM of membranes, calorimetry and confocal microscope. Transition studies of lipid bilayer. Cell fusion and shedding of membrane. | 8 |
| **Unit IV** | **Membrane Transport** | Laws of diffusion across membranes. Transport of metabolites across the plasma membrane: simple diffusion, facilitated diffusion and active transport, symport, uniport and antiport systems. Glucose transporters. ATP-powered pumps: $Na^+/K^+$ ATPases and $Ca^{2+}$ ATPases (structure and mechanism of action). Secondary active transporters and ABC family of transporters. Ion channels: gated, non-gated and aquaporin channel. | 7 |

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|---|---|---|---|
| **Unit V** | **Vesicular Transport and Membrane Fusion** | Types of vesicle transport and their functions: clathrin, COP I, and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Endocytosis, receptor mediated endocytosis (LDL via the LDL receptor and iron via transferrin) and exocytosis. | 5 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Lehninger: Principles of Biochemistry (2013) 6th edition, Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / I SBN : 10:1-4641- 0962-1.
2. Molecular Cell Biology (2013) 7th edition, Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P. W.H. Freeman and Company (New York), 1SBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th edition, Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3th edition., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley and Sons, Inc. (New York), ISBN:13: 978-0470-23396-2.
5. Wardhan R, Mudgal P. 2017. Textbook of membrane biology. Singapore: Springer. pp. 49–60. DOI:org/10.1007/978-981-10-7101-0_3.
6. Ginsburg, H. (1988) in Biomembranes: Basic and Medical Research (Benga, Gh., and Tager, J. M., eds) pp. 188 –203, Springer-Verlag, Berlin.
7. Gurtovenko, A.; Vattulainen, I. In Biomembrane Frontiers, Collective Dynamics in Lipid Membranes: From Pore Formation to Flip-Flops; Jue, T., Risbud, S., Longo, M., Faller, R., Eds.; Humana Press: New York, 2009; Chapter 5, pp 121– 139.
8. Shinitzky, M. (2008). Biomembranes: Signal Transduction Across Membranes.

# DRUG DELIVERY SYSTEM

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24202OE** | **Open Elective** | **Drug Delivery System** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to equip students with knowledge of the design, development, and application of various drug delivery methods to optimize therapeutic outcomes and improve patient compliance.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the significance of drug delivery systems in medicine.

**LO2:** Explain the basic principles of pharmacokinetics and pharmacodynamics.

**LO3:** Understand the principles of controlled and targeted drug delivery.

**LO4:** Evaluate the use of polymers in drug delivery.

**LO5:** Explore the delivery systems for monoclonal antibodies and vaccines.

**LO6:** Analyze the drug delivery strategies for specific diseases.

**LO7:** Evaluate the effectiveness of various drug delivery systems in treating diseases.

**LO8:** Understand the ethical considerations and regulatory landscape for drug delivery systems.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Overview of Drug Delivery Systems** | Basic principles of pharmacokinetics (absorption, distribution, metabolism and excretion) and pharmacodynamics (drug-receptor interactions). Factors influencing drug delivery and absorption (physicochemical properties and biological barriers). | 3 |
| **Unit II** | **Conventional Drug Delivery Systems** | Oral drug delivery systems: introduction, approaches (tablets, capsules, and solutions), advantages and disadvantages. Parenteral drug delivery systems: introduction and injections (intravenous, intramuscular and subcutaneous) and infusions. Topical drug delivery systems: creams, ointments, and gels. Transdermal drug delivery systems: permeation through the skin, factors affecting permeation, permeation enhancers, basic components and formulation approaches. Gastro retentive drug delivery systems: introduction, approaches (floating, high-density systems, inflatable and gastroadhesive systems), advantages and disadvantages. Nasopulmonary drug delivery system: introduction, formulation of inhalers (dry powder and metered dose), nasal sprays and nebulizers. Ocular drug delivery systems: introduction, intraocular barriers and methods to overcome. Intrauterine drug delivery systems: introduction, advantages and disadvantages. Development of intrauterine devices (iuds) and applications. | 10 |
| **Unit III** | **Advanced Drug Delivery Systems** | Controlled release systems: definitions, rationale, selection of drug candidates, advantages and disadvantages. Approaches to design-controlled release formulations. Physicochemical and biological properties of drugs used in controlled release formulations. Targeted drug delivery: active and passive targeting strategies. Nanotechnology in drug delivery: nanoparticles, liposomes, and dendrimers. Biodegradable and non-biodegradable polymers. Microencapsulation: definition, advantages and disadvantages, microspheres/ microcapsules, microparticles, methods of microencapsulation and applications. | 7 |

| | | | |
|---|---|---|---|
| **Unit IV** | **Biopharmaceuticals in Drug Delivery** | Drug delivery of biopharmaceuticals: proteins, peptides, and nucleic acids. Gene therapy and RNA interference (RNAi) delivery systems. Monoclonal antibodies and their delivery. Vaccine delivery systems. | 3 |
| **Unit V** | **Drug Delivery in Specific Diseases** | Drug delivery systems for cancer therapy, neurological disorders, cardiovascular diseases and infectious diseases. | 4 |
| **Unit VI** | **Regulatory and Ethical Aspects of Drug Delivery** | Regulatory requirements for drug delivery systems (FDA and EMA guidelines). Clinical trials for drug delivery systems. Ethical issues in drug delivery research and development. | 3 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:

1. Y W. Chien, Novel Drug Delivery Systems, 2nd edition, revised and expanded, Marcel Dekker, Inc., New York, 1992.
2. Robinson, J. R., Lee V. H. L, Controlled Drug Delivery Systems, Marcel Dekker,Inc., New York, 1992.
3. Encyclopedia of controlled delivery, Editor- Edith Mathiowitz, Published. Wiley Interscience Publication, John Wiley and Sons, Inc, New York! Chichester/Weinheim
4. N.K. Jain, Controlled and Novel Drug Delivery, CBS Publishers and Distributors, New Delhi, First edition 1997 (reprint in 2001).
5. S.P.Vyas and R.K.Khar, Controlled Drug Delivery - Concepts and Advances, Vallabh Prakashan, New Delhi, First edition 2002

# ENVIRONMENTAL SCIENCE

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201VEC** | **Value Education Course** | **Environmental Science** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide students with a comprehensive understanding of ecological principles, environmental issues, and sustainable practices to foster informed decision-making and stewardship of natural resources.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Gain knowledge of ecosystems, biodiversity, and the interactions between organisms and their environment.

**LO2:** Develop an awareness of global and local environmental challenges such as climate change, pollution, and resource depletion.

**LO3:** Analyze the complexity and interrelated nature of environmental problems on local, regional, national, and global levels.

**LO4:** Critically evaluate various sustainable solutions to current global environmental crises.

**LO5:** Learn about sustainable development principles and practices aimed at conserving natural resources and minimizing environmental impact.

**LO6:** Demonstrate an understanding of the framework of sustainable development and its application to environmental issues.

**LO7:** Understand the ethical implications of human activities on the environment and develop a sense of stewardship towards natural resources.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Environmental Concerns, Population Growth, and Resource Consumption** | Definition and types of environmental concerns. Major environmental issues: deforestation, biodiversity loss, and pollution. Population growth: historical population growth trends, factors influencing population growth and impact of population growth on the environment. Types of natural resources: renewable and non-renewable. Patterns of resource consumption and sustainable resource management. | 3 |
| **Unit II** | **Principles of Sustainable Development** | Definition and history. Brundtland Commission and the concept of sustainable development. Evolution of sustainable development goals. Key principles: Inter and Intra-generational equity, Precautionary principle and Polluter pays principle. Implementation strategies: integrating sustainability into policy and practice. Role of education and public awareness. | 2 |
| **Unit III** | **Pollution** | Air Pollution: Sources and types of air pollutants. Natural and anthropogenic sources. Primary and secondary pollutants. Health and environmental impacts. Monitoring and control: air quality standards and monitoring techniques, pollution control technologies and policies. Sources and types of noise pollution: industrial, transportation, and community noise. Measurement and monitoring of noise levels. Health and environmental impact. Noise Control Measures: engineering controls (sound barriers, silencers) and policy and regulatory measures. | 4 |

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|---|---|---|---|
| **Unit IV** | **Climate Change: Scientific Basis, Mitigation and Adaptation** | Greenhouse gases and global warming. Evidence of climate change: temperature records, ice cores and sea level rise. Mitigation: reducing greenhouse gas emissions, renewable energy technologies and carbon sequestration and storage. Adaptation: strategies for adapting to climate change impacts, building resilient communities and infrastructure. Role of policy and international agreements. | 3 |
| **Unit V** | **Renewable Energy** | Solar energy: photovoltaic systems and solar thermal systems. Applications of solar energy. Advantages and limitations. Wind energy: wind turbine technologies, onshore and offshore wind farms. Environmental and economic considerations. Geothermal energy: types of geothermal power plants. Applications and benefits. Ocean energy: wave energy, tidal energy, and ocean thermal energy conversion. Hydroelectricity:<br>types of hydroelectric power plants (run-of-the-river, reservoir, pumped storage). Environmental impacts and mitigation measures. Bioenergy: biomass and biofuels, production processes and applications. Sustainability and environmental impacts. | 7 |
| **Unit VI** | **Industrial and Circular Economy** | Principles of industrial ecology. Life cycle assessment and material flow analysis. Circular economy: concepts and principles, strategies for waste reduction, reuse, and recycling. | 2 |
| **Unit VII** | **Water Quality, Reuse and Recycling** | Parameters of water quality: physical, chemical and biological. Sources of water pollution. Water treatment technologies. Water Reuse and Recycling: methods of water reuse (greywater and blackwater treatment), benefits and challenges of water recycling. | 3 |
| **Unit VIII** | **Solid Waste Management** | Types and sources of solid waste. Waste management hierarchy: reduce, reuse and recycle. Landfills, incineration, and composting. E-waste management: Definition and sources of e-waste, environmental and health impacts, recycling and disposal methods. | 2 |
| **Unit IX** | **Ecology and Soil Pollution** | Basic principles of ecology, ecosystem structure and function. Biodiversity and conservation. Soil pollution: sources and types of soil pollutants, effects on soil health and productivity and soil remediation techniques. | 2 |
| **Unit X** | **Environmental Policies and Legislation** | International environmental agreements: key treaties and conventions (Kyoto Protocol and Paris Agreement). Role of international organizations (UNEP and IPCC). National environmental policies: environmental laws and regulations, enforcement and compliance mechanisms. Local and regional initiatives: community-based environmental management, role of NGOs and civil society in environmental governance. | 2 |

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

## BOOKS RECOMMENDED:


1. Environmental Science (16$^{th}$h Edition). G. Tyler Miller, Jr. and Scott E. Spoolman (2017)
2. Living in the Environment: Concepts, Connections and Solutions (19$^{th}$ Edition) by G. Tyler Miller, Jr. and Scott E. Spoolman (2017).
3. Introduction to Engineering and the Environment. Edwards S. Rubin (2001).
4. Introduction to Environmental Engineering and Science. Gilbert M. Masters and Wendell P. Ela. 2020.
5. Principles of Environmental Engineering and Science. M. L. Davis and S. J. Masten (2013).
6. Introduction to Environmental Sciences. R. S. Khoiyangbam and N. Gupta (2015).

# SKILL ENHANCEMENT COURSE

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201SEC** | **Skill Enhancement Course** | **(To be chosen from basket)** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of skill enhancement courses for students is to equip them with practical, industry-relevant skills and knowledge that enhance their academic performance and prepare them for professional success by bridging the gap between theoretical learning and real-world application.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop technical and practical skills that align with current industry standards and job market demands.

**LO2:** Learn to approach and solve complex problems using innovative and effective methods.

**LO3:** Grasp the core theories and principles underlying specific skills and their applications in real-world contexts.

**LO4:** Master strategies for managing time efficiently to balance academic, personal, and professional responsibilities.

**LO5:** Assess the strengths, limitations, and applicability of various strategies within different professional and academic contexts.

**LO6:** Gain proficiency in verbal, written, and digital communication necessary for effective interaction in professional settings.

**LO7:** Cultivate the ability to analyze situations, evaluate information critically, and make informed decisions.

**LO8:** Experience working in teams to develop cooperative skills and learn to leverage diverse perspectives for better outcomes.

**LO8:** Learn to adapt to changing environments and new challenges, demonstrating resilience and a proactive mindset.

**LO9:** Acquire competencies in using various digital tools and technologies relevant to academic and professional tasks.

**LO10:** Develop the ability to establish and maintain professional relationships that can support career growth and opportunities.

**LO11:** Reflect on personal strengths and interests to create a clear, actionable career plan aligned with individual goals and aspirations.

| Sr. No. | List of Skill Enhancement Courses (Basket) |
|---|---|
| 1. | Computer Basics and Applications |
| 2. | Web Development |
| 3. | Introduction to R Programming |
| 4. | Programming in Python |
| 5. | Data Science Using Python |
| 6. | 3D Printing and Additive Manufacturing |
| 7. | Cybersecurity |
| 8. | Mushroom Culture and Technology |
| 9. | Functional Foods and Nutraceuticals |

| | |
|---|---|
| 10. | Plant Biochemistry and Biotechnology |
| 11. | Pharmacognosy and Metabolic Engineering |
| 12. | Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products |
| 13. | Microbial Technology |
| 14. | Food Laws and Standards |
| 15. | Food Packaging Technology |
| 16. | Nutrition and Dietetics |
| 17. | Industrial Pharmacy |
| 18. | Patent Drafting for Beginners |
| 19. | Alternative Therapies |
| 20. | Healthcare Administration |
| 21. | Industrial Automation |
| 22. | Sustainable Agriculture |
| 23. | Understanding Tribals |
| 24. | Renewable Energy Systems |
| 25. | Corporate Social Responsibility |
| 26. | Wastewater Treatment and Recycling |
| 27. | Disaster Management |
| 28. | Cooperatives and Farmer's Organizations |
| 29. | Economics of Health and Health Care |
| 30. | Introduction to NGO Management |
| 31. | Business Planning and Project Management |
| 32. | Innovation in Laboratory Instruction - Infrastructure Material Laboratory |
| 33. | Strategic Management – The Competitive Edge |
| 34. | Rural Local Governance |
| 35. | Administration and Public Policy |
| 36. | Banking and Insurance |

**Note:** The list provided is not exhaustive; students are encouraged to select other courses that are deemed appropriate under SEC by discussing with the mentor.

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

# FUNCTIONAL MARATHI

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201AEC** | **Ability Enhancement Course** | **Functional Marathi** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to develop students' proficiency in spoken and written Marathi, enabling them to effectively communicate in diverse real-life contexts.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Read and write basic Marathi script, including vowels and consonants, and construct simple sentences.

**LO2:** Gain the ability to engage in everyday conversations in Marathi, using common phrases and vocabularies.

**LO3:** Develop a functional vocabulary that allows them to describe daily activities and other related situations.

**LO4:** Enhance their reading comprehension and writing skills by working with simple texts, composing short paragraphs, letters, and emails.

**LO5:** Gain an understanding of Marathi culture and traditions, and apply this knowledge to participate in advanced conversations, role-playing exercises, and group discussions.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **मराठी भाषेची ओळख** | मराठी भाषेचा इतिहास, ऐतिहासिक पार्श्वभूमी, भौगोलिक विस्तार, समकालीन समाजातील महत्त्व, मराठी लिपीची तोंडओळख, देवनागरी लिपीची ओळख, स्वर आणि व्यंजनांचे उच्चारण, मूलभूत शब्द आणि वाक्यलेखन, मूलभूत व्याकरण, नाम, सर्वनाम आणि क्रियापदे, वाक्यरचना आणि निर्माण. | 6 |
| **Unit II** | **दैनंदिन संवाद** | शुभेच्छा आणि ओळख, सामान्य वाक्ये शुभेच्छांसाठी, स्वतःची आणि इतरांची ओळख करणे, संवादी मराठी, दैनंदिन परिस्थितींमध्ये मूलभूत संवाद (उदा. खरेदी, मार्ग विचारणे), आवड, नावड, आणि प्राधान्ये व्यक्त करणे, संख्या आणि वेळ मराठीत मोजणी, वेळ सांगणे आणि तारखा सांगणे. | 7 |
| **Unit III** | **कार्यात्मक शब्दसंग्रह आणि वाक्ये** | दैनंदिन क्रियाकलापांसाठी शब्दसंग्रह, अन्न आणि भोजन, घरातील वस्तू, सामान्य ठिकाणे (उदा. बाजार, शाळा, रुग्णालय) प्रवास आणि वाहतूक, वाहतुकीच्या प्रकारांचे शब्दसंग्रह, मार्ग विचारणे आणि देणे, आरोग्य आणि आपत्कालीन परिस्थिती, मूलभूत आरोग्य संबंधित शब्दसंग्रह आणि आपत्कालीन परिस्थितीत संवाद साधणे. | 8 |
| **Unit IV** | **वाचन आणि लेखन कौशल्ये** | वाचन समज, साधे मजकूर आणि लघुकथा, उतार्‌यांमधून माहिती काढणे, लेखन सराव, लघुपरिच्छेद लेखन, साधे पत्र आणि ई-मेल तयार करणे, ऐकणे आणि बोलणे सराव, नोंदवलेले संवाद ऐकणे आणि जोड्या/गटांमध्ये बोलण्याचा सराव. | 4 |
| **Unit V** | **सांस्कृतिक संदर्भ आणि प्रगत सराव** | मराठी संस्कृती आणि परंपरा, सण आणि उत्सव, महत्त्वाच्या ऐतिहासिक व्यक्ती आणि घटनाक्रम, प्रगत संवाद, भूमिकानिर्माण सराव, चर्चासत्रे आणि गटचर्चा, प्रकल्प कार्य, मराठीत सादरीकरण तयार करणे, दिलेल्या विषयावर लघुनिबंध लेखन आणि मूल्यमापन. | 5 |

**METHODOLOGY**

The course would be taught through online/offline lecture sessions.

**BOOKS RECOMMENDED:**

1. Learn Marathi in 30 Days. Balasaheb Keskar 2008. 1st Edition. Publisher: B. Keskar.
2. Teach Yourself Marathi by Rupert Snell 2007 1st Edition. Publisher: Teach Yourself Books.
3. Marathi Made Easy: A Step-by-Step Guide to Learning Marathi. Anil Prakashan 2013. 1st Edition. Publisher: Anil Prakashan.
4. Marathi Vyakaran ani Lekhan by H. S. Apte, 2012. 2nd Edition. Publisher: Shubhada Prakashan.
5. Spoken Marathi: A Beginner's Guide. Madhuri Deshmukh. 2015. 1st Edition. Publisher: Madhuri Deshmukh Publications.

# CO-CURRICULAR

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101CC** | **Co-Curricular** | **To be chosen from basket** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The objective of co-curricular activities is to complement academic learning by providing opportunities for personal growth, skill development, and social engagement, thereby fostering a well-rounded educational experience that enhances leadership, teamwork, and creative abilities.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop the ability to lead, motivate, and manage teams through active participation in various co-curricular activities.

**LO2:** Strengthen skills in working effectively with others, learning to navigate group dynamics and achieve common goals.

**LO3:** Practice and refine verbal, written, and non-verbal communication through presentations, discussions, and collaborative projects.

**LO4:** Learn to balance multiple responsibilities and commitments, improving organizational and prioritization skills.

**LO5:** Engage in creative activities that encourage original thinking and problem-solving in diverse contexts.

**LO6:** Gain exposure to different perspectives and cultures, enhancing understanding and empathy through diverse interactions and experiences.

**LO7:** Increase self-assurance and resilience by stepping out of comfort zones, taking on new challenges, and achieving personal goals.

**LO8:** Participate in community service and outreach programs, fostering a sense of social responsibility and engagement with societal issues.

| Sr. No. | List of Co-Curricular Activities (Basket) | Evidence |
|---|---|---|
| 1 | Webinars related to the specialization of the student/ program. | Attendance certificate |
| 2 | Participation in Seminar/Conference/Workshop /Symposium/ Training Programs (related to the specialization of the student) | Participation certificate issued by the organizers |
| 3 | Presentation of papers/posters in Conference/ Workshop/ Symposium (related to the specialization of the student) | Participation certificate issued by the organizers |
| 4 | Publication of research paper in indexed (Scopus or Web of Science) journals as first author | Acceptance letter from the journal |
| 5 | Publication of research paper in indexed (Scopus or Web of Science) journals as Co-author | Acceptance letter from the journal |
| 6 | Publication of popular articles in college magazines/ newspapers/ bulletins/wall magazines | Proof of publication |
| 7 | Participation in Sorts/Cultural/Yoga Activities Conducted by State/ National/Regional/Local Agencies | Participation certificate |
| 8 | Academic/Research/Cultural/Sports Award from State/National/Regional/Local Agencies | Award certificate |
| 9 | Academic Award/Research Award from International Agencies | Award certificate |
| 10 | Participation in NSS/NCC activities of the Institute/ university | Certification by NSS/NCC coordinator |
| 11 | Participation in Swachh Bharat Internship | Participation certificate |
| 12 | Participation in Health and Wellness Programme | Participation certificate |

**Note:** The list provided is not exhaustive; students are encouraged to select other co-curricular activities that are deemed appropriate under CC by discussing with the mentor.

# GENETICS AND MOLECULAR BIOLOGY PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201DSP** | **Discipline Specific Practical** | **Genetics and Molecular Biology (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

To provide hands-on experience with experimental techniques and methodologies to reinforce theoretical concepts and develop skills in genetic analysis and molecular manipulation.

**Learning Outcomes:**

Upon completion of the course, student will be able to:

**LO1:** Demonstrate the principles, working and applications of important techniques in molecular biology**.**

**LO2:** Understand pedigree construction and analysis.

**LO3:** Demonstrate theoretical aspects of genetic counseling.

**LO4:** Demonstrate the laboratory experiments in molecular biology and interpret the results.

| Sr. No. | List of Experiments |
|---|---|
| 1 | To isolate polytene chromosome/ lamp brush chromosomes in Drosophila. |
| 2 | To perform human karyotyping. |
| 3 | To construction and perform the pedigree analysis of given chart. |
| 4 | To study the communication process of genetic counseling for genetic testing. |
| 5 | To study survival response of *E.coli* on UV irradiation. |
| 6 | To perform probability and Chi-square test for genetics analysis. |
| 7 | To determine linkage and cross-over analysis. |
| 8 | To isolate plasmid DNA by alkaline lysis method. |
| 9 | To isolate the genomic DNA from bacteria cells. |
| 10 | To estimate DNA content in the given sample by spectrophotometer. |
| 11 | To determine DNA melting point and GC content. |
| 12 | To perform agarose gel electrophoresis for quantification of DNA |
| 13 | To perform PAGE and staining of DNA. |
| 14 | To isolate plant genomic DNA by CTAB method. |
| 15 | To isolate the total RNA from bacterial/mammalian cells by Trizol method. |
| 16 | To perform spin column method of RNA isolation by acid guanidinium thiocyanate–phenol–chloroform extraction. |
| 17 | To analyze RNA quality and integrity by spectrophotometer. |
| 18 | To estimate RNA by Orcinol reaction. |

## TEXT / REFERENCE BOOKS

1. Sambrook, Joseph and David W. Russell, The Condensed Protocols: From Molecular Cloning: A Laboratory Manual, Cold Spring Harbor, 2006.
2. Worku Negash Mhiret. (2020). Laboratory Manual for Principles of Genetics. Publisher: Lap Lambert Academic Publishing.
3. Thomas R. Mertens and Robert L. Hammersmith (2015). Genetics Laboratory Investigations, 14th Ed. Published by Pearson.

# BIOANALYTICAL TECHNIQUES PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24201VSC** | **Vocational Skill Course** | **Bioanalytical Techniques Practical** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

To provide hands-on experience with various analytical methods and instrumentation used for the precise measurement and analysis of biological samples, reinforcing theoretical knowledge through practical application.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Gain competency in operating and calibrating laboratory equipments necessary for precise measurement and experimental procedures.

**LO2:** Prepare standard solutions of known concentrations, enabling accurate calibration and analysis.

**LO3:** Apply Beer-Lambert's law to analyze the relationship between absorbance, concentration, and path length in spectrophotometry.

**LO4:** Handle different analytical instruments and also will be able to separate and quantify biomolecules.

| Sr. No. | List of Experiments |
|---|---|
| 1. | To prepare standard solutions of known concentrations. |
| 2. | To prepare buffers and measurement of pH |
| 3. | To calibrate a pH meter and perform titration of a weak acid using a pH meter. |
| 4. | To demonstrate the working principle, types and parts of centrifuge and demonstration of sedimentation principle. |
| 5. | To verify Beer-Lambert's law colorimetrically and spectrophotometrically. |
| 6. | To partially purify an enzyme by ammonium sulphate fractionation. |
| 7. | To construct a standard curve and quantify nucleic acid/protein concentration using UV-Visible spectrophotometry. |
| 8. | To identify amino acids by paper chromatography. |
| 9. | To identify carbohydrates by paper chromatography. |
| 10. | To identify lipids/amino acids by TLC (Thin-Layer Chromatography). |
| 11. | To demonstrate column chromatography |
| 12. | To separate protein mixture by gel filtration column chromatography. |
| 13. | To separate proteins by Native PAGE (Polyacrylamide Gel Electrophoresis). |
| 14. | To separate proteins by SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis). |
| 15. | To separate DNA by Agarose Gel Electrophoresis |

## TEXT / REFERENCE BOOKS


1. Practical Biochemistry by Wilson and Walker (Cambridge University Press, Indian Edition: Jaypee Brothers Medical Publishers)
2. Practical Biochemistry for Medical Students by Sudha Rani (Jaypee Brothers Medical Publishers)
3. Practical Manual of Biochemistry by Geetha Damodaran (Jaypee Brothers Medical Publishers)
4. A Textbook of Practical Biochemistry by Vishwanatha (CBS Publishers and Distributors, Indian Edition: Jaypee Brothers Medical Publishers)
5. Practical Biochemistry" by Shakuntala Mahapatra (Jaypee Brothers Medical Publishers)

## SECOND YEAR: SEMESTER-IV

# IMMUNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211DSC** | **Discipline Specific Core** | **Immunology** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

This course provides the students to describe various cellular, tissue, and chemical mediator components of the immune system and comprehend mechanism and consequences of immunodeficiencies, hypersensitivities, autoimmunity, and transplant rejection.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Describe the structure and function of the immune system, including its cells, organs, and molecules.

**LO2:** Explain the mechanisms of innate and adaptive immune responses.

**LO3:** Understand the processes of antigen recognition and presentation.

**LO4:** Apply immunological principles to understand disease mechanisms, including infections, autoimmune diseases, allergies, and cancer.

**LO5:** Comprehend the biology behind developments of vaccines.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to the Immune system** | Introduction to immunology, Innate and adaptive immunity. Interrelationship between innate and adaptive immunity. Humoral and cell-mediated immune responses. Overview of primary and secondary immune responses. | 4 |
| **Unit II** | **Cells and Organs of Immune System** | Haematopoiesis. Structure and functions: macrophages, granulocytes, NK cells. T and B lymphocytes: origin, development and differentiation. Immune organs: primary and secondary. | 6 |
| **Unit III** | **Antigen and Antibody Structure and Diversity** | Antigen: Definition and types. Properties: antigenicity, immunogen and immunogenicity, epitope, hapten and adjuvants. Antibody: structure, types and functions. Clonal selection theory. Antibody diversity generation. Somatic gene rearrangements during B-lymphocyte differentiation, allelic exclusion and class switching. | 12 |
| **Unit IV** | **Immune Responses** | Major Histocompatibility Complexes: class I and class II MHC antigens, antigen processing and presentation. Complement system: structure, properties and functions. Immuno-tolerance: central and peripheral. Role of cytokines, lymphokines and chemokines. | 10 |
| **Unit V** | **Transplantation Immunology** | Terminology, Autograft, Isograft, Allograft and Xenograft. Immunological basis of transplantation reactions, GVH reaction, Immuno suppression and its mechanism. Immune suppressive drugs: azothioprine, methotrexate, cyclophosphamide, cycosporin-A and steroids. | 6 |
| **Unit VI** | **Immune System in Health and Disease** | Tumor immunology: tumor antigens and immune response to tumor. Vaccine and its types: live attenuated vaccines, killed vaccines, purified polysaccharide vaccines, toxoid vaccines, recombinant vaccines and DNA vaccines. Passive and active immunization. | 10 |
| **Unit VII** | **Allergic Responses and Immunodeficiencies** | Allergic responses in host defense: Gell and Coombs classification. Hypersensitivity: types and related disorders. Anaphylaxis and Autoimmune diseases. Primary immunodeficiency disorders: defects in lymphoid, myeloid and complement system. Secondary immunodeficiencies: AIDS and other acquired immunodeficiencies. | 12 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts Essential Immunology, 13th Edition, Wiley -Blackwell, 2016.
2. Kuby, J., Immunology, WH Freeman and Co. 2000.
3. Janeway, C.A and Paul Travers, 1994. Immunobiology, Current Biology Ltd./Garland Publishing Inc. Churchill Livingstone.
4. Roitt, I.M., J. Brestoff and D.K Male, 1996. Immunology, Mosby-Year Book Europe Limited, London.
5. Sulabha Pathak and Urmi Palan, Immunology - Essential and Fundamental, Capital Publishing Company, 301 W. Harrison Guthrie. 2005.
6. Tizard, I.R, Immunology, an Introduction, Saunders College Publishing, New York. 1995.
7. Weir, D.M, Immunological Techniques, Blackwell Scientific Publications, London. 1992.

# ENZYMOLOGY AND ENZYME TECHNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211MI** | **Minor** | **Enzymology and Enzyme Technology** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The aim of this course is to provide a comprehensive understanding of enzyme function, kinetics, and applications, including the development and optimization of enzyme-based technologies for various industrial and research purposes.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1**: Describe the biochemical mechanisms of enzyme action, including enzyme-substrate interactions, active site dynamics, and catalytic mechanisms.

**LO2:** Apply principles of enzyme kinetics to measure and interpret enzyme activity, including the use of models such as Michaelis-Menten and Lineweaver-Burk plots.

**LO3:** Examine how enzymes are regulated by various factors, including allosteric effects, covalent modifications, and environmental conditions.

**LO4:** Describe the principle behind isolation and purification of enzymes from various sources.

**LO5:** Understand the principles and methods for immobilization of enzymes to solid supports, optimizing their stability, reusability, and activity for various industrial and research applications.

**LO6:** Design and optimize enzyme-based processes and technologies for industrial applications, including drug development and diagnostics.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Enzymes** | Definition, nomenclature and classification of enzymes. Properties of enzymes, enzyme activity, units and specific activity. Factors affecting enzyme activity, catalytic power, Cofactors and vitamins as coenzyme. Role of enzymes in pharma, food and beverages industry, textile processing, clinical and agricultural applications. | 6 |
| **Unit II** | **Enzyme Catalysis and Mechanism** | Enzyme specificity: absolute, group, linkage and stereochemical. Active site: Salient features and determination. Catalysis: Acid-base, covalent, Nucleophilic and electrophilic and metal ion catalysis. Mechanism of enzyme action: Lock and Key model, Induced fit theory and Transition state hypotheses. Mechanism of serine proteases: trypsin and chymotrypsin. Mechanism of action and regulation of lysozyme, carboxypeptidase A, Ribonuclease and DNA polymerase. Mechanism of action and regulation of pyruvate dehydrogenase complex and fatty acid synthase. | 12 |
| **Unit III** | **Enzyme Kinetics and Inhibition** | Enzyme Kinetics: single substrate and bisubstrate reactions, factors affecting velocity of enzyme catalyzed reactions. Michaelis-Menten hypothesis. Michealis-Menten Equation: Km, Vmax, L.B plot, Hanes Woolf equation, Eadie Hofstee equation and turnover number (kcat). Kinetics and factors affecting the enzyme activity: substrate, pH and temperature. Types of enzyme inhibition: reversible (competitive, non-competitive, uncompetitive and mixed substrate inhibition), irreversible, allosteric and product inhibition. Allosteric enzymes. | 10 |
| **Unit IV** | **Enzyme Regulation** | Enzyme regulation: feedback and allosteric regulation. Sigmoidal kinetics and their physiological significance. Symmetric, MWC (Monod–Wyman–Changeux model) and sequential models of allosterism. Reversible and irreversible covalent modification of | 8 |

| | | | |
|---|---|---|---|
| | | enzymes. Mechanisms of enzyme degradation, lysosomal and non-lysosomal pathways. | |
| **Unit V** | **Extraction, Separation and Purification of Enzymes** | Choice of sources: soluble enzymes and membrane bound enzymes. Extraction, purification and characterization of enzymes: nature of extraction medium, separation of enzymes, purification procedure of enzyme, criteria of purity and determination of molecular weight. Methods of production of enzymes. | 6 |
| **Unit VI** | **Immobilization of Enzymes** | Enzyme immobilization. Methods of immobilization of enzymes: physical and chemical techniques (adsorption, matrix entrapment, encapsulation, cross-linking and covalent bonding). Properties and Kinetics of immobilized enzymes. Application of immobilized enzymes. Mass transfer effect on immobilization and intra-particle diffusion. Limitation of immobilized enzymes. | 6 |
| **Unit VII** | **Production of Industrial Enzymes and Clinical Applications** | Types of reactors for enzymatic processing, steady state analysis of mass transfer and biochemical reaction in enzyme reactors. Large scale production of enzymes: glucose isomerase, proteases, amylase, pectinase, cellulases and lipases. Applications of industrial enzymes: thermophilic enzymes (Reverse transcriptase), amylase, lipases, proteolytic enzymes in meat and leather industry, cellulose degrading and metals degrading enzymes. Applications of clinically important enzymes: Enzymes as thrombolytic agent, anti-inflammatory agents, streptokinase, asparaginase, LDH, transaminases (ALT and AST), amylases, phosphatases and cholinesterases. Biosensors: Components of enzyme biosensor: eg. Glucose oxidase. | 12 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn and Paul Stump; John Wiley and Sons, USA
2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voetand Judith Voet, John Wiley and Sons, Inc. USA
3. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA
4. Biochemistry:7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company,NY
5. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson and Michael Cox, W.H. Freeman and company, NY.
6. Biochemistry. 5th Edition, (copyright 2013), Reginald Garett and Charles Grisham, Brook/Cole, Cengage Learning, Boston, USA.
7. Enzymes: Biochemistry, Biotechnology and Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
8. Biochemistry: 7th Edition, (2012), Jeremy Berg, LubertStryer, W.H.Freeman and company, NY.
9. Enzyme inhibition and activation. Enzymes 3 Dixon, M., and E. C. Webb. (1979): 126-136.
10. Understanding Enzymes, 4th ed., Palmer, T. Prentice Hall/Ellis Horwood, London (1995).
11. Fundamentals of Enzymology. Price, Nicholas C., and Lewis Stevens.Oxford Science Publications. Second edition. New York, 2001.
12. Biocatalysts and enzyme technology. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. John Wiley and Sons, 2012.
13. Enzymes: a practical introduction to structure, mechanism, and data analysis. Copeland, Robert A. John Wiley and Sons, 2004.
14. Enzyme technology. Chaplin and Bucke. Cambridge University Press.
15. Palmer, Enzyme, Horwood Publishing Series, 2001.
16. Price and Stevens, Fundamental of Enzymology, Oxford University Press, 2002.
17. Prasad N.K., Enzyme Technology: Pacemaker of Biotechnology Paperback, 2011.
18. Khan M.Y. and Farha Khan, Principles of Enzyme Technology, 2015.
19. Helmut Uhling, Enzyme technology, John Wiley, 1998.

# PLANT TISSUE CULTURE

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211OE** | **Open Elective** | **Plant Tissue Culture** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide fundamental knowledge of basic requirements, secondary metabolite elicitation and cell transformation techniques of plant tissue culture applied for plant propagation, genetic modification, research and commercial purposes.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Explain the organization of plant tissue culture laboratory.

**LO2:** Describe the media formulations and supplements for *in vitro* culturing of various plants.

**LO3:** Understand the tools and techniques required for different plant cell cultures.

**LO5:** Develop the methodology for the regeneration of various plant species.

**LO6:** Acquire the knowledge of plant tissue culture techniques to produce transgenic plants.

**LO7:** Become a successful entrepreneur and generate technically trained human resources.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Plant Tissue Culture** | Definition, history and development. Concept of cell theory and cellular totipotency (dedifferentiation, redifferentiation and regeneration). Laboratory requirements, organization and safety procedure. Lab area: washing, media preparation, transfer, culture and green house. Principle and working of equipments and instruments. Washing, packing and sterilization of glassware, plastic ware and instruments. Methods of sterilization: moist, dry, filter, chemical and physical. Media sterilization. Surface sterilization of plant material. Importance of aseptic transfer, LAF and autoclave. Control and preventive measures of laboratory contaminants and maintenance of aseptic conditions. | 6 |
| **Unit II** | **Media Composition and Preparation** | Media composition. Role of macronutrients, micronutrients, vitamins, amino acids and carbon source in media. Types of media: natural and synthetic. Media preparation: pH, temperature and solidifying agents. Preparation of Murashige and Skoog (MS) and B5 media. Plant growth regulators (cytokinins, auxins, gibberellins, abscisic acid and ethylene) and their roles for growth and development. Maintenance of cultures and environmental conditions. | 5 |
| **Unit III** | **Callus Induction and Organogenesis** | Callus formation: definition, types (friable and compact) and induction. Explants characteristics. Factors affecting callus induction: genotype, age and type of explant, composition of media and environmental conditions. Applications of callus culture. Organogenesis: definition, mechanism, direct and indirect organogenesis. Role of plant growth regulators in organogenesis. Somatic embryogenesis: stages, induction, development and maturation of somatic embryos. Factors affecting somatic embryogenesis. Advantages and disadvantages. | 5 |
| **Unit IV** | **Micropropagation** | Techniques and various steps involved in micropropagation (initiation, multiplication, rooting, and acclimatization). Meristem and shoot-tip culture. Production of disease-free plants. Limitations, advantages and applications of micropropagation. Germplasm | 3 |

| | | | |
|---|---|---|---|
| | | conservation, cryopreservation of plant cell and tissue cultures. Establishment of gene banks. Clonal propagation of elite germplasm and clonal propagation strategies for commercial exploitations. | |
| **Unit V** | **Haploid Production and Somatic Hybridization** | Haploid production: definition and types (anther, pollen and ovule culture). Methods for haploid induction: androgenesis and gynogenesis. Factors affecting androgenesis and gynogenesis. Advantages and limitations. Production of homozygous lines, significance and uses of haploids. Production of triploids through endosperm culture. Embryo culture, embryo rescue and its applications. Somatic hybridization: isolation, culture, regeneration and fusion of protoplasts. Selection and applications of somatic hybrids and cybrids. | 4 |
| **Unit VI** | **Secondary Metabolites Production** | Primary vs secondary metabolites. Significance of secondary metabolites. Types of elicitors. Suspension cultures, production of secondary metabolites and other compounds. Cell culture growth vs secondary metabolite production. Bioreactors and scaling up of secondary metabolite production. Hairy root culture: maintenance, scaling and advantages. Immobilized cell system. | 4 |
| **Unit VII** | **Applications of Plant Tissue Culture** | Germplasm conservation, somaclonal variation, protoplast culture and fusion. Synthetic seed production. Environmental and ecological applications. Medicinal plant propagation. Applications of transgenics: edible vaccines, designer foods, molecular farming, human therapeutics etc. Establishment of plant tissue culture laboratory and commercialization of products. | 3 |

## METHODOLOGY

The course will be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008) 2nd ed.
2. Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003) 2nd ed.
3. Dr. U. Sathyanarayana Biotechnology. Books and Allied Publications.
4. Chawla H.S., Introduction to Plant Biotechnology, 2nd Edition, Oxford and IBH Press, 2003.
5. Bhojwani S.S., Razdan M. K (2005) Plant tissue culture: Theory and practice, Studies in plant science 5, North Holland, Elsevier, New Delhi.
6. Adrian Slater, Nigel Scott, and Mark Fowler, Plant Biotechnology, Oxford University Press, NewYork, 2008.
7. Jha T B and Ghosh B (2017) – Plant tissue culture: Basic and applied (Universities Press, Hyderabad) and latest editions.
8. Plant Tissue culture (2010) – Kalyan Kumar De (New central Book Agency Calcutta).
9. Methods In Plant Tissue culture – (2003) U Kumar Agrobios India.
10. Plant Cell Culture Technology—MM Yeomen (2012) Blackwell.
11. Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk.
12. Plant Tissue Culture By Akio Fujiwara.
13. Frontiers of Plant Tissue Culture By Trevor A. Thorpe.
14. *In vitro* Haploid Production in Higher Plants by S. Mohan Jain, S.K. Sopory, R.E. Veilleux.
15. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard.

# OMICS TECHNOLOGIES

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24212OE** | **Open Elective** | **Omics Technologies** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to equip students with comprehensive knowledge and practical skills in various omics approaches such as genomics, proteomics, and metabolomics to analyze and interpret complex biological data at multiple levels of molecular organization.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Describe the principles and methodologies of genomics, transcriptomics, proteomics, metabolomics, and other omics technologies used to study biological systems comprehensively.

**LO2:** Design and execute omics experiments, considering factors such as sample preparation, data acquisition, and quality control to ensure accurate and reproducible results.

**LO3:** Interpret and integrate data from various omics platforms to uncover insights into gene expression, protein function, and metabolic pathways.

**LO4:** Utilize bioinformatics tools and software for data analysis, visualization, and interpretation in the context of omics research.

**LO5:** Assess the applications of omics technologies in fields such as personalized medicine, disease research, and biotechnology, and recognize their potential ethical and societal impacts.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Omics Technologies** | Introduction, history and concept of omes and omics. Overview and principles of genomics, transcriptomics, proteomics and metabolomics. High-throughput screening techniques in omics. | 3 |
| **Unit II** | **Genomics** | Genome structure and organization: chromosome structure and packaging, genome size and complexity and repetitive DNA elements (transposons and satellite DNA). Major genome sequencing projects. Genome sequencing techniques: Sanger sequencing, Next-generation sequencing (NGS) (e.g., Illumina sequencing, and Ion Torrent sequencing) and Third-generation sequencing (TGS) (e.g., PacBio sequencing and Oxford Nanopore sequencing). Genome assembly and annotation. Overview of functional genomics, medical genomics and evolutionary genomics. | 6 |
| **Unit III** | **Transcriptomics** | Gene expression profiling: microarray technology and RNA-Seq (RNA sequencing). Detection and analysis of alternative splicing events. Transcript quantification: differential gene expression analysis, microRNAs (miRNAs) and long non-coding RNAs (lncRNAs). Functional annotation: gene ontology analysis and single-cell transcriptomics. | 6 |
| **Unit IV** | **Proteomics** | Protein separation and characterization techniques: gel electrophoresis (SDS-PAGE, and 2D-PAGE), liquid chromatography, mass spectrometry (MALDI and ESI), mass analyzers (TOF and Orbitrap) and fragmentation techniques (CID and HCD). Protein identification: database searching and *de novo* sequencing. Quantitative proteomics: label-based methods (SILAC and iTRAQ) and label-free methods. | 5 |
| **Unit V** | **Metabolomics** | Metabolite extraction, separation and identification techniques. Metabolite identification: database searching and structural elucidation. Metabolic pathway analysis: pathway databases | 5 |

| | | | |
|---|---|---|---|
| | | (KEGG and MetaCyc) and flux balance analysis. Metabolomics profiling: targeted metabolomics and untargeted metabolomics. Metabolomics data analysis. | |
| **Unit VI** | **Applications of Omics Technologies** | Genomics: genome-wide association studies (GWAS), personalized medicine, pharmacogenomics, genetic screening and diagnostics. Proteomics: biomarker discovery and validation, drug target identification and validation and disease mechanism elucidation. Transcriptomics: gene expression profiling in health and disease, single-cell transcriptomics and RNA-based therapeutics. Metabolomics: metabolic profiling in disease diagnosis, nutrigenomics and metabolomics in environmental and microbial studies. | 5 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:

1. Introduction to Proteomics: Principles and Applications. Randy D. Isaacson and Terence Wu (Indian Edition: CRC Press)
2. Genomics and Personalized Medicine: What Everyone Needs to Know. Michael Snyder (Indian Edition: Oxford University Press)
3. Transcriptomics and Gene Regulation. Chittaranjan Kole and Albert G. Abbott (Indian Edition: CRC Press)
4. Metabolomics: From Fundamentals to Clinical Applications. Ute Roessner (Indian Edition: Springer)
5. Omics Technologies: Tools for Food Science. Raj K. Gupta and Amarjeet Kaur (Indian Edition: Academic Press)

# SKILL ENHANCEMENT COURSE

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211SEC** | **Skill Enhancement Course** | **(To be chosen from basket)** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of skill enhancement courses for students is to equip them with practical, industry-relevant skills and knowledge that enhance their academic performance and prepare them for professional success by bridging the gap between theoretical learning and real-world application.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop technical and practical skills that align with current industry standards and job market demands.

**LO2:** Learn to approach and solve complex problems using innovative and effective methods.

**LO3:** Grasp the core theories and principles underlying specific skills and their applications in real-world contexts.

**LO4:** Master strategies for managing time efficiently to balance academic, personal, and professional responsibilities.

**LO5:** Assess the strengths, limitations, and applicability of various strategies within different professional and academic contexts.

**LO6:** Gain proficiency in verbal, written, and digital communication necessary for effective interaction in professional settings.

**LO7:** Cultivate the ability to analyze situations, evaluate information critically, and make informed decisions.

**LO8:** Experience working in teams to develop cooperative skills and learn to leverage diverse perspectives for better outcomes.

**LO8:** Learn to adapt to changing environments and new challenges, demonstrating resilience and a proactive mindset.

**LO9:** Acquire competencies in using various digital tools and technologies relevant to academic and professional tasks.

**LO10:** Develop the ability to establish and maintain professional relationships that can support career growth and opportunities.

**LO11:** Reflect on personal strengths and interests to create a clear, actionable career plan aligned with individual goals and aspirations.

| Sr. No. | List of Skill Enhancement Courses (Basket) |
|---|---|
| 1. | Computer Basics and Applications |
| 2. | Web Development |
| 3. | Introduction to R Programming |
| 4. | Programming in Python |
| 5. | Data Science Using Python |
| 6. | 3D Printing and Additive Manufacturing |
| 7. | Cybersecurity |
| 8. | Mushroom Culture and Technology |

| | |
|---|---|
| 9. | Functional Foods and Nutraceuticals |
| 10. | Plant Biochemistry and Biotechnology |
| 11. | Pharmacognosy and Metabolic Engineering |
| 12. | Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products |
| 13. | Microbial Technology |
| 14. | Food Laws and Standards |
| 15. | Food Packaging Technology |
| 16. | Nutrition and Dietetics |
| 17. | Industrial Pharmacy |
| 18. | Patent Drafting for Beginners |
| 19. | Alternative Therapies |
| 20. | Healthcare Administration |
| 21. | Industrial Automation |
| 22. | Sustainable Agriculture |
| 23. | Understanding Tribals |
| 24. | Renewable Energy Systems |
| 25. | Corporate Social Responsibility |
| 26. | Wastewater Treatment and Recycling |
| 27. | Disaster Management |
| 28. | Cooperatives and Farmer's Organizations |
| 29. | Economics of Health and Health Care |
| 30. | Introduction to NGO Management |
| 31. | Business Planning and Project Management |
| 32. | Innovation in Laboratory Instruction - Infrastructure Material Laboratory |
| 33. | Strategic Management – The Competitive Edge |
| 34. | Rural Local Governance |
| 35. | Administration and Public Policy |
| 36. | Banking and Insurance |
| **Note:** The list provided is not exhaustive; students are encouraged to select other courses that are deemed appropriate under SEC by discussing with the mentor. | |

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

# CO-CURRICULAR

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24101CC** | **Co-Curricular** | **To be chosen from basket** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The objective of co-curricular activities is to complement academic learning by providing opportunities for personal growth, skill development, and social engagement, thereby fostering a well-rounded educational experience that enhances leadership, teamwork, and creative abilities.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop the ability to lead, motivate, and manage teams through active participation in various co-curricular activities.

**LO2:** Strengthen skills in working effectively with others, learning to navigate group dynamics and achieve common goals.

**LO3:** Practice and refine verbal, written, and non-verbal communication through presentations, discussions, and collaborative projects.

**LO4:** Learn to balance multiple responsibilities and commitments, improving organizational and prioritization skills.

**LO5:** Engage in creative activities that encourage original thinking and problem-solving in diverse contexts.

**LO6:** Gain exposure to different perspectives and cultures, enhancing understanding and empathy through diverse interactions and experiences.

**LO7:** Increase self-assurance and resilience by stepping out of comfort zones, taking on new challenges, and achieving personal goals.

**LO8:** Participate in community service and outreach programs, fostering a sense of social responsibility and engagement with societal issues.

| Sr. No. | List of Co-Curricular Activities (Basket) | Evidence |
|---|---|---|
| 1 | Webinars related to the specialization of the student/ program. | Attendance certificate |
| 2 | Participation in Seminar/Conference/Workshop /Symposium/ Training Programs (related to the specialization of the student) | Participation certificate issued by the organizers |
| 3 | Presentation of papers/posters in Conference/ Workshop/ Symposium (related to the specialization of the student) | Participation certificate issued by the organizers |
| 4 | Publication of research paper in indexed (Scopus or Web of Science) journals as first author | Acceptance letter from the journal |
| 5 | Publication of research paper in indexed (Scopus or Web of Science) journals as Co-author | Acceptance letter from the journal |
| 6 | Publication of popular articles in college magazines/ newspapers/ bulletins/wall magazines | Proof of publication |
| 7 | Participation in Sorts/Cultural/Yoga Activities Conducted by State/ National/Regional/Local Agencies | Participation certificate |
| 8 | Academic/Research/Cultural/Sports Award from State/National/Regional/Local Agencies | Award certificate |
| 9 | Academic Award/Research Award from International Agencies | Award certificate |
| 10 | Participation in NSS/NCC activities of the Institute/ university | Certification by NSS/NCC coordinator |
| 11 | Participation in Swachh Bharat Internship | Participation certificate |
| 12 | Participation in Health and Wellness Programme | Participation certificate |

**Note:** The list provided is not exhaustive; students are encouraged to select other co-curricular activities that are deemed appropriate under CC by discussing with the mentor.

# SCIENTIFIC WRITING

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211AEC** | **Ability Enhancement Course** | **Scientific Writing** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide essential knowledge of writing, drafting and organizing scientific content including formatting, proofreading and editing to enhance clarity to the scientific community and beyond.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Present information accurately, supported by evidence and in a clear, understandable manner.

**LO2:** Encourage critical evaluation of methods, results and conclusions.

**LO3:** Ensure that the content is clear, coherent and logically organized, improving overall readability.

**LO4:** Refine the style and the tone of writing, ensuring consistency and appropriateness for the intended audience.

**LO5:** Identify and correct spelling, grammar, punctuation and typographical errors to enhance clarity and readability.

**LO6:** Check and maintain the consistency in formatting, terminology and referencing style through-out the document.

**LO7:** Verify facts, figures, and references for accuracy and relevance to support the author's arguments or findings.

**LO8:** Improve the structure of the document, including paragraph and sentence structure, transitions between sections, and overall flow of ideas.

**LO9:** Clearly convey the findings, methods and implications of scientific research.

**LO10:** Give a final polish to the manuscript before publication, ensuring it meets professional and editorial standards.

**LO11:** Undergo scrutiny by peers for validation and improvement of research quality.

**LO12:** Ensure adherence to academic standards, avoiding plagiarism and accurately attributing sources.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Scientific Writing** | Introduction, importance of clarity and precision in scientific writing. Scientific writing as an art, principles, types and stages of scientific writing. Argument matrix. Setting the background of an article. | |
| **Unit II** | **Components of a Scientific Paper** | Literature review. Writing research papers and reports: title, abstract, introduction, methods, results, discussion and conclusion. Writing literature reviews, presenting data and results. Data sharing policy. | |
| **Unit III** | **Referencing and Citations** | Importance and types of referencing. Using citation styles: APA, MLA, Chicago, etc. Managing references with software: EndNote, Mendeley and Zotero. | |
| **Unit IV** | **Technical Writing** | Technical writing and documentation, writing standard operating procedures (SOPs) and creating technical manuals and guidelines. | |
| **Unit V** | **Ethics and Plagiarism in Scientific Writing** | Understanding authorship and acknowledgments. Data fabrication and falsification. Ethics in scientific writing. Committee on publication ethics (COPE). Avoiding plagiarism and plagiarism software's. | |

| | | | |
|---|---|---|---|
| **Unit VI** | **Submission of Manuscript** | Selection of a journal for submission. Journal type. Open access publishing and subscribe to open. Journal specific author guidelines. Communicating with a journal. | |
| **Unit VII** | **Editing and Proofreading** | Editing process: understanding the stages of editing (content, copy, and line editing), techniques for improving clarity and readability and revising for consistency and tone. Proofreading: identifying and correcting common errors (grammar, punctuation and spelling), proofreading strategies and tools. Finalizing content for publication. | |

## METHODOLOGY

The course would be taught through online/offline lecture sessions.

## BOOKS RECOMMENDED:


1. Trisha Greenhalgh. How to read a paper. https://www.bmj.com/about-bmj/resources-readers/publications/how-read-paper
2. Guidance on Scientific Writing- Equator Network. https://www.equator-network.org/library/guidance-on-scientific-writing/
3. Kotz D, Cals J. Scientific writing and publishing in medicine and health sciences: A quick guide in English and German. Berlin, Boston: De Gruyter; 2021.
4. Handley, A. (2014). Everybody writes: Your go-to guide to creating ridiculously good content (1st ed.). Wiley.
5. Hofmann, A.H. (2016). Scientific writing and communication: Papers, proposals, and presentations (3rd ed.). Oxford University Press.
6. Vora, P. (2018). Content writing handbook (1st ed.). Notion Press.
7. Gerson, S.J., and Gerson, S. M. (2013). Technical writing: Process and product (7th ed.). Pearson Education.
8. Mitra, B.K. (2006). Effective technical communication: A guide for scientists and engineers (1st ed.). Oxford University Press, India.
9. Kothari, C.R. (2008). A handbook for academic writing and composition (2nd ed.). New Age International Publishers.
10. Chandrasekhar, S. (2017). Write right: A handbook of effective writing (2nd ed.). McGraw Hill Education.

# COMMUNITY ENGAGEMENT PROGRAM

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211CEP** | **Community Engagement Program** | **To be chosen from basket** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objectives:**

The objective of this program is to cultivate a sense of civic responsibility and leadership in students by involving them in impactful service projects to gain practical experience, develop empathy, and build stronger connections within their communities.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the importance of active participation in community service and its impact on societal well-being.

**LO2:** Gain practical experience in leading and organizing community-based projects, including problem-solving and decision-making.

**LO3:** Build empathy through direct interaction with diverse community groups and understand various cultural perspectives.

**LO4:** Practice effective verbal and written communication through collaboration with community members, organizations, and peers.

**LO5:** Learn to work collaboratively with others, manage group dynamics, and contribute to collective goals.

**LO6:** Analyze community needs, develop strategic solutions, and assess the outcomes of service initiatives.

**LO7:** Establish connections with community leaders, organizations, and peers that can support future academic and career aspirations.

| Sr. No. | List of Community Engagement Program | Activity |
|---|---|---|
| 1. | **Community Outreach Programs** | a. Volunteer Programs in Local Communities |
| 2. | **Health Education and Healthcare Support** | a. Health Education and Awareness Programs<br>b. Assisting at Hospitals or Clinics<br>c. Organizing Blood Donation Drives |
| 3. | **Educational Initiatives** | a. Tutoring and Mentoring Programs for Underprivileged Students<br>b. Adult Education Programs |
| 4. | **Environmental Conservation Projects** | a. Tree planting campaigns<br>b. Waste management and clean-up drives<br>c. Conservation of natural resources |
| 5. | **Social Welfare Campaigns** | a. Awareness Campaigns on Social Issues<br>b. Fundraising for Charitable Causes |
| 6. | **Disaster Relief and Preparedness** | a. Training Programs for Disaster Preparedness<br>b. Participation in Disaster Relief Efforts |
| 7. | **Adopt-a-School Programs** | a. Partnering with Local Schools for Support and Improvement<br>b. Providing Resources and Infrastructure |

| | | |
|---|---|---|
| 8. | **Elderly Care and Support** | a. Visits to Old Age Homes<br>b. Support Drive for Elderly |
| 9. | **Animal Welfare Projects** | a. Shelters and Care for Stray Animals<br>b. Awareness Campaigns on Responsible Pet Ownership<br>c. Participating in Animal Adoption Events. |
| 10. | **Cultural Exchange Programs** | a. Connecting with Neighboring Communities<br>b. Celebrating Local Festivals |
| 11. | **Digital Literacy Initiatives** | a. Teaching Digital Skills to Underprivileged Communities |
| 12. | **Legal Aid Clinics** | a. Offering Legal Advice and Support to the Community<br>b. Conducting Legal Awareness Campaigns |
| 13. | **Cultural and Art Organization** | a. Volunteer at Museums, Theaters or Community Art Centres. |
| 14. | **Community Outreach Programs** | a. Volunteer Programs in Local Communities |
| **Note:** The list provided is not exhaustive; students are encouraged to select other programs that are deemed appropriate under community engagement program by discussing with the mentor. | | |

# IMMUNOLOGY AND IMMUNODIAGNOSTICS PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211VSC** | **Vocational Skill Course** | **Immunology and Immunodiagnostics Practical** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objectives:**

To provide hands-on experience to design and perform common immunological experiments to identify and interpret different antigens involved in a wide spectrum of immune mediated disorders.

**Learning Outcomes:**

On completion of the course, students will be able to:

**LO1:** Understand the basic concepts of blood grouping and Rh typing.

**LO2:** Identify the morphology of cells of the immune system.

**LO3:** Perform and diagnose diseases using Ag-Ab reaction.

**LO4:** Perform different immunological techniques and understand the applications of immunological principles and antigen-antibody reactions.

| Sr. No. | List of Experiments |
|---|---|
| 1 | To perform blood withdrawal and blood grouping. |
| 2 | To perform total WBC and RBC count. |
| 3 | To perform Osmotic fragility of RBC. |
| 4 | To perform a differential count of leukocyte. |
| 5 | To perform immune electrophoresis. |
| 6 | To perform Rocket Electrophoresis |
| 7 | To perform a Radial Immunodiffusion test |
| 8 | To perform a Double Immunodiffusion test |
| 9 | To perform Coomb's test |
| 10 | To perform Rheumatoid Arthritis test. |
| 11 | To perform DOT-ELISA |
| 12 | To perform Widal test |
| 13 | To perform VDRL test |
| 14 | To isolate and purify IgG from serum. |
| 15 | To perform plate ELISA assay by direct/indirect method |

## TEXT / REFERENCE BOOKS

1. Hay, F.C. and M.R. Westwood, Practical Immunology. Blackwell Science Publishers, London. 2004.
2. Janeway, C.A., and P. Travers, Immunobiology. Current Biology Ltd., Garland Publishing Inc. Churchill Livingstone. London.

# METHODS IN ENZYMOLOGY PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24211DSP** | **Discipline Specific Practical** | **Enzymology and Enzyme Technology** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

To offer hands-on experience with experimental techniques and assays for analyzing enzyme activity, kinetics, and characterization, thereby reinforcing technological aspects of enzymes in industry, agriculture and medicine.

**Learning Outcomes:**

On completion of the course, student will be able to:

**LO1:** Extract and detect enzymes from different sources.

**LO2:** Demonstrate the effect of substrate, temperature, pH and enzyme concentration on enzyme activity.

**LO3:** Analyze and interpret the parameters such as $K_m$, $V_{max}$, and enzyme inhibition constants.

**LO4:** Assess the suitability of various methods of enzyme immobilization for specific industrial applications.

**LO5:** Select the appropriate enzyme and apply the principles of enzyme technology to enhance the properties of enzymes to facilitate their use in industrial processes.

| Sr. No. | List of Experiments |
|---|---|
| 1 | To qualitatively detect enzymes from different sources. |
| 2 | To extract enzyme and determination of specific activity amylase/lipase. |
| 3 | To study the effect of substrate concentration on amylase activity. |
| 4 | To study the effect of temperature on enzyme activity. |
| 5 | To study the effect of pH on enzyme activity. |
| 6 | To study of effect of metal ions/concentration on enzyme activity. |
| 7 | To study the kinetics of alpha amylase enzyme and determination of Vmax and Km using Michaelis - Menten equation and Line-Weaver-Burk plot |
| 8 | To study the effects of inhibitor on invertase enzyme and to find the type of inhibition. |
| 9 | To immobilize the alpha amylase enzyme by gel entrapment method and to determine the radius of the immobilized bead. |
| 10 | To extract the enzyme and determine the enzyme activity from yeast (*Saccharomyces cerevisiae*). |
| 11 | To immobilize yeast cells in alginate beads and to determine the invertase activity in the immobilized cells. |
| 12 | To study the cross-linked gelatin gel entrapment technique of enzyme immobilization. |
| 13 | To find the orders and rate constant for the reaction between non – equimolar quantities of sodium hydroxide and ethyl acetate in a batch reactor. |
| 14 | To study the hydrolysis of sucrose by yeast β-Fructofuranosidase and its determination by Benedict method. |
| 15 | To estimate (Indirect) lactate dehydrogenase in yeast. |

## TEXT / REFERENCE BOOKS


1. R. Eisenthal and M.J. Dansen. Enzyme Assays –A Practical Approach, (2002). Oxford University Press.
2. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu. Pvt. Ltd. New Delhi, India.
3. Practical Enzymology. 3rd Edition (2019). Bisswanger, Hans. Weinheim: Wiley-Blackwell Publisher.
4. Practical Manual for Enzymology. Singh, Singh and Khan. Mahi Publication.
5. Protocols and Applications in Enzymology. (2021). Seema Belorkar and Sudisha. Academic Press.
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. Robert A. Copeland (2000). Wiley-VCH, Inc.
7. Standard Methods of Biochemical Analysis, S. K. Thimmaiah, Kalyani Publisher.

## THIRD YEAR: SEMESTER-V

# GENETIC ENGINEERING

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24301DSC** | **Discipline Specific Core** | **Genetic Engineering** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to impart knowledge about techniques involved in recombinant DNA technology, gene manipulation, molecular cloning, gene editing and protein engineering to design novel products for application in the different health care sectors.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Evaluate the proper host and vector utilized for gene cloning.

**LO2:** Identify the appropriate method for DNA delivery into the host.

**LO3:** Perform screening of desired gene sequences or proteins using a gene library.

**LO4:** Understand the gene transfer ethics and the process of recombinant protein expression.

**LO5:** Utilize genetic engineering knowledge in a variety of fields, including environmental science, biotechnology, medicine, and agriculture.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Genetic Engineering** | Definition, scope, historical overview and applications of genetic engineering. Organization of genes in the genome. Importance and outline of recombinant DNA technology. Isolation and purification techniques of DNA and RNA from different sources (plants, animals, microorganisms and plasmids). Methods for quantification and characterization of nucleic acids. | 6 |
| **Unit II** | **Molecular Tools for Gene Cloning** | Nucleases: Exonucleases and Endonucleases. Restriction Enzymes (Type I, Type II, Type III, Type IV and Type V). RNases. Methylases: CpG Methylase, Dam Methylase, Dcm Methylase. Polymerases: DNA Pol I, Klenow Fragments, Reverse Transcriptase, *Taq* and *Pfu* Polymerases. Ligases: T4 DNA Ligase, *E. coli* DNA Ligase, T4 RNA Ligase. Topoisomerases: Type I (A, B) and Type II (A, B). End Modifying Enzymes: Terminal Transferase, T4 Polynucleotide Kinase and Alkaline Phosphatases. Ligation (cohesive and blunt end ligation): linkers, adaptor and homopolymer tailing. | 11 |
| **Unit III** | **Vectors and Gene Cloning** | Introduction, types and ideal properties of vectors. Role of promoters and terminators. Prokaryotic and eukaryotic expression systems (constitutive and inducible). Plasmid vectors (pBR322, pUC18 and pGEM3Z). Phage Vectors (λ and M13). Cosmid vectors and Phagemids. Expression vectors: BAC, YAC and MAC. Lentiviral vectors, Adenoviral vectors, *Agrobacterium tumifaciens* (Ti plasmid), plant virus-based vectors and shuttle vectors. | 8 |
| **Unit IV** | **Gene Transfer Techniques** | Preparation of competent cells of bacteria. Physical (microinjection, electroporation, biolistic and ultrasound), chemical (calcium phosphate precipitation method, PEI and dendrimers) and biological methods (liposome mediated, transfection, electroporation and transformation of protoplasts) of gene transfer. | 6 |

| | | | |
|---|---|---|---|
| **Unit V** | **Selection and Screening of Recombinants** | Screening and selection of recombinants. Genetic selection and identification of recombinants: insertional inactivation and screening for recombinants (*Lac* selection and screening for blue white colonies). Marker genes: endogenous selectable marker genes, dominant selectable marker genes and reporter genes. | 7 |
| **Unit VI** | **Advanced Techniques in Genetic Engineering** | Polymerase chain reaction (PCR) and its applications. Types of PCR and their applications: multiplex, RT-PCR and qPCR. Primer designing strategies. Gel Electrophoresis: AGE and PAGE. Labelling of DNA, RNA and proteins by radioactive isotopes, non-radioactive labelling and autoradiography. Methods of hybridization: Southern, Northern and Western blotting. Construction of genomic and cDNA libraries. DNA Sequencing (Maxam and Gilbert, Sanger's chain-termination and shotgun method). Protein engineering: Site-directed mutagenesis and reporter gene assays. DNA protein interactions: EMSA, RNase A protection assay, DNA Footprinting assay, microarrays and chromatin immunoprecipitation assay. Protein-protein interactions: Y2H, Y3H, B1H and B2H. Molecular markers: RAPD, RFLP, AFLP and SNPs. | 13 |
| **Unit VII** | **Applications of Genetic Engineering** | Strategies in plant and animal genetic engineering. Use of *Agrobacterium tumefaciens* and *A. rhizogenes*. Gene therapy and its types. Production of recombinant proteins (Insulin and Blood clotting factor VIII). Production of recombinant vaccines (Hepatitis B). Antisense technology. DNA fingerprinting. Gene knockouts. Transgenic animals and Bio-pharming. GMOs: Overview, ethics and safety. Chromosome engineering and targeted gene replacement. | 9 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Singh B.D., 2005, Molecular biology and Genetic Engineering, Kalyani publishers.2005.
2. Primrose, S.B. Molecular Biotechnology. Panima Publishing House, New Delhi, India. 2001.
3. Winnacker, E.L., Genes to Clones. Panima Publishing House, New Delhi, India. 2003.
4. Brown T.A., Gene cloning and DNA analysis, 6th edition, Wiley Blackwell science.2010.
5. Watson, Molecular Biology of the gene, 5th edition Person Education, Singapore. 2004.
6. Kreuzer-Massey, Recombinant DNA and Biotechnology, ASM Press. 2001.
7. Glick, B.R. and J.J. Pasternak, Molecular Biotechnology. Panima Publishing House, New Delhi, India. 2002.
8. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
9. Dubey R.C., A Text Book of Biotechnology. S. Chand and Co Ltd, New Delhi

# GENE REGULATION

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24301 DSE** | **Discipline Specific Elective** | **Gene Regulation** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to extend the student's knowledge on principles and concepts of molecular mechanisms underlying gene expression and regulation and able to exploit achieved knowledge in the areas of disease diagnosis, prevention and their therapies where effects on gene expression are of importance.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Explain the fundamental principles of gene expression and regulation in prokaryotes and eukaryotes.

**LO2:** Compare and contrast the spatial, temporal, and conditional type of gene regulation.

**LO3:** Differentiate among positive and negative gene regulation, enhancers and silencers, activators and repressors, and inducers and co-repressors.

**LO4:** Analyze various mechanisms involved in transcriptional, post-transcriptional, translational, and post-translational regulation of gene expression.

**LO5:** Demonstrate an understanding of the role of epigenetic modifications in gene regulation.

**LO6:** Comprehend the significance of gene regulation in various biological processes and critically evaluate the impact of gene regulation on human health and disease.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Overview of Gene Regulation** | Definition and significance of gene expression. Evidences and experimental designs of gene regulation. Structure of prokaryotic and eukaryotic gene, role of promotor, operator, enhancer and silencer. Inducible and repressible systems. House-keeping genes. Levels of gene regulation: transcriptional, post-transcriptional, translational and post-translational regulation. Role of genetic analysis in understanding gene function and regulation. | 6 |
| **Unit II** | **Regulation of Gene Expression in Prokaryotes** | Operon concept: definition and significance. Jacob-Monod model and types of operons (inducible, repressible, and constitutive). Lac operon: structure and components (Lac Z, Lac Y and Lac A genes). Regulation by the Lac repressor (Lac I) and catabolite activator protein (CAP). Positive and negative regulation of the Lac operon. Trp operon: structure and components (Trp E, Trp D, Trp C, Trp B and Trp A genes). Regulation by the Trp repressor (Trp R) and attenuation. Indoleglycerol phosphate (IGP) and tryptophan regulation. Regulation of Arabinose operon (Ara operon). Small Regulatory RNAs (sRNAs): role in post-transcriptional gene regulation and mechanisms of sRNA-mediated regulation. | 12 |
| **Unit III** | **Regulation of Gene Expression in Eukaryotes** | Britten and Davidsons model. Cis- acting elements and transacting factors. Structural and functional motifs: Leucine Zipper and Zinc finger motifs, Helix-turn-Helix and Helix-loop-Helix. RNA processing (splicing, capping and polyadenylation). microRNAs and small interfering RNAs. RNA stability regulation. Chromosome organization and long-range control: transcription in lampbrush and polytene chromosomes, chromatin loops, puffs and domains, matrix attachment regions and remodeling of chromatin structure. Translational control of gene expression. Environmental impact on transcription: heat shock genes and Rubisco. | 12 |

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|---|---|---|---|
| **Unit IV** | **Post-translational Regulatory Mechanism in Eukaryotes** | Protein folding and modification. Protein degradation pathways (ubiquitin-proteasome system and lysosomal degradation pathways). Post-translational modifications (phosphorylation, ubiquitination, acetylation). Protein trafficking and localization. | 6 |
| **Unit V** | **Epigenetic Regulation** | Concept and definition of epigenetics. Molecular basis of epigenetics: epigenome and epigenotypes. DNA methylation: mechanism, enzymes and significance of DNA methylation. CpG islands and genomic imprinting. Histone modifications: acetylation, methylation, phosphorylation, ubiquitination and sumoylation. Chromatin remodeling: ATP-dependent chromatin remodeling complexes (e.g., SWI/SNF, ISWI, etc.), nucleosome positioning and remodeling. Role of chromatin remodeling in gene regulation. Non-coding RNAs (ncRNAs). | 12 |
| **Unit VI** | **Gene Regulation via Cell Surface and Intracellular Receptors** | Introduction to signal transduction pathway. cAMP mediated gene regulation. Gene regulation by second messengers other than cAMP. Gene regulation by protein kinase C, growth factors and cytokines. Regulation of gene expression by steroid hormones and type II nuclear receptors. Nuclear receptors mediated transcriptional activation. | 6 |
| **Unit VII** | **Applications of Gene Regulation** | Gene therapy. Pharmacogenomics. Gene Editing (CRISPR/Cas9). RNA interference (miRNA and siRNA). RNA and RNPs in disease and therapeutics. Synthetic Biology. Stem cell therapy. Viral vector design. | 6 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:

1. Molecular Biology of the Gene. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (Indian Edition: Pearson Education India)
2. Gene Regulation and Metabolism: Post-Genomic Computational Approaches. Julio Collado-Vides, Richard D. Huskey, David E. Galas (Indian Edition: Narosa Publishing House)
3. Epigenetics: How Environment Shapes Our Genes by Richard C. Francis (Indian Edition: Wisdom Tree Publishers)
4. Transcriptional Regulation in Eukaryotes: Concepts, Strategies, and Techniques. Michael Carey, Craig Peterson, Kevin Struhl (Indian Edition: Oxford University Press India)
5. Post-Transcriptional Gene Regulation by Jeffrey Wilusz, Ruth Serra-Moreno (Indian Edition: Alpha Science International Ltd.)

# DEVELOPMENTAL BIOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24301MI** | **Minor** | **Developmental Biology** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to comprehend the principles and sequential transitions in the development of multicellular organisms from a single-cell including the genetics, signaling pathways, and environmental factors in shaping growth, differentiation, and morphogenesis contributes to the basis for the design of organisms.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Learn the importance of embryology and developmental biology as an emerging discipline in science.

**LO2:** Discover the mechanisms and processes of early embryonic development in vertebrates and invertebrates.

**LO3:** Compare the development stages of different invertebrates and vertebrates to understand the similarities.

**LO4:** Understand the basic principles and sequential transitions in the development of multicellular organisms, role of genes and environmental factors in the development.

**LO5:** Highlight the implications of developmental biology in health and diseases.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Developmental Biology** | Definition, history and principle. Basic concepts: potency, commitment, specification, induction, competence, determination and differentiation. Mechanisms of development: asymmetric cell division, inductive signals, lateral inhibition and positional value. Primordial germ cells. Production of gametes: spermatogenesis (origin and physiological ripening of sperm) and oogenesis (previtellogenesis and vitellogenesis). Role of cytoplasmic determinants. Ethical considerations in developmental biology. | 7 |
| **Unit II** | **Cell- Cell Communication in Development** | Cell signaling. Epithelial-mesenchymal interactions. Cell surface receptors and their signal transduction pathways: JAK-STAT, Hedgehog family, Wnt family, TGF-β superfamily and Notch pathway. Paracrine and juxtacrine signaling and cell patterning. | 12 |
| **Unit III** | **Developmental Biology of Model Organisms** | Vertebrates model organism- Zebrafish (*Danio rerio*): embryogenesis, pharyngula stage, larval stage, juvenile stage and adult stage. African Clawed Frog (*Xenopus laevis* and *Xenopus tropicalis*): embryogenesis, tadpole stages, metamorphosis and adult stage. Chicken (*Gallus gallus*): embryogenesis, hatching, chick stage and adult stage. Invertebrate model organism- Fruit Fly (*Drosophila melanogaster*): embryogenesis, larval stages (first, second, and third instar larvae), pupal stage and adult stage. Nematode (*Caenorhabditis elegans*): embryogenesis, larval stages (L1, L2, L3 and L4) and adult stage. | 8 |
| **Unit IV** | **Early Embryonic Development** | Early mammalian development: production and structure of human gametes. Mechanism and molecular events during mammalian fertilization, acrosome reaction, zygote and prevention of polyspermy. Patterns and molecular mechanism of mammalian cleavage. Formation of blastula: mid blastula transition, determinate and regulatory embryos. Gastrulation: mechanisms and types, neural | 9 |

| | | | |
|---|---|---|---|
| | | tube and differentiation of neurons. Formation of primary germ layers, anterior-posterior, dorsal-ventral and left-right axis formation. | |
| **Unit V** | **Later Embryonic Development** | Vertebrates: implantation of embryo in humans. Formation of human placenta: structure, physiology, types and functions. Differentiation of germ layers and fate of germ layers. Organogenesis: formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments). Extraembryonic membranes in birds and human. Invertebrates: vulval formation in *C. elegans*. | 9 |
| **Unit VI** | **Post-Embryonic Development and Ageing** | Larval formation. Metamorphosis: changes and hormonal regulation in insects and amphibians. Regeneration: modes of regeneration (epimorphosis), regenerative ability in different animal groups, factors stimulating regeneration and biochemical changes associated with regeneration. Ageing: concepts, theories and model (*C. elegans*). Telomeres and Telomerase. Ageing of stem cells: programmed cell death. Role of genes, epigenetics and nutrients in ageing process. | 8 |
| **Unit VII** | **Implications of Developmental Biology** | Nature of human syndromes: pleiotropy, genetic heterogeneity, phenotypic variability and mechanism of dominance. Gene expression and human disease: inborn errors of nuclear RNA processing and translation. Teratogenesis: environmental assaults on human development and teratogenic agents (alcohol, retinoic acid etc.). Amniocentesis. Embryonic stem cells and their applications. Cryopreservation of gametes/embryos and ethical issues in cryopreservation. | 7 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Leon. W. Browder, Developmental Biology; Springer, 2012Sastry and
2. Shukla, Developmental Biology, Rastogt Publication, 2017
3. Gilbert, Scott's. 10th edition (2014). Developmental biology.Sinauer Association, Inc., Publishers.
4. Chattopadhyay.S. 2016. An Introduction to Developmental Biology, Books are allied (P) Ltd, Kolkata. First Edition.
5. Verma, P.S., Agarwal, V.K., and Tyagi., 1995. Chordate embryology, S. Chand and Co., New Delhi.
6. Berril, N.T., Karp, G., 1998. Development. Tata McGraw Hill Co., New York.
7. Balinsky, B.I. (2012) An Introduction to Embryology, Cengage, Boston.
8. Principles of Development - Lewis Wolpert, 4th edition, 2011.
9. Kalthoff, Analysis of Biological Development, II Edition, McGraw-Hill Professional (2000).
10. Majumdar, N.N Text books of vertebrate embryology. Tata Mc-Graw-HiII Publishing Company Ltd, New Delhi. 1990.
11. Slack, J.M.W. (2012) Essential Developmental Biology, Wiley Blackwell Publishers, New Jersey.
12. Kanungo, M.S. (2005) Genes and Aging, Cambridge University Press, Cambridge.
13. Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi.
14. Tyler, MS. 2000. Developmental Biology -A Guide for Experimental Study, Sunderland..
15. Subramoniam, T. 2011. Molecular Developmental Biology (2nd Edn), Narosa Publishers, India.

# FIELD PROJECT

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24301FP** | **Field Project** | **Field Project** | **0** | **0** | **4** | **120** | **0+4=4** |

**Objective:**

The objective of undertaking field projects is to provide practical, hands-on experience that allows them to apply theoretical knowledge in real-world settings, enhancing their problem-solving skills, research abilities, and understanding of complex concepts while fostering critical thinking and professional development.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Utilize classroom concepts and theories in real-world scenarios to bridge the gap between academic learning and practical application.

**LO2:** Gain experience in designing, conducting, and analyzing research or investigations relevant to the project's focus area.

**LO2:** Tackle real-world challenges by identifying problems, developing solutions, and implementing effective strategies.

**LO3:** Analyze data and evaluate outcomes to make informed decisions and draw meaningful conclusions.

**LO4:** Acquire and refine technical skills related to the project's field, such as data collection, analysis, or specific tools and technologies.

**LO5:** Learn to plan, organize, and manage project activities, including setting goals, deadlines, and resources.

**LO6:** Work effectively with peers and stakeholders, developing collaboration, communication, and leadership skills.

**LO6:** Practice articulating findings, presenting results, and writing reports in a clear, professional manner.

**LO7:** Gain insights into industry practices and standards, building connections and understanding career opportunities within the field.

**LO8:** Reflect on project experiences to assess personal growth, identify areas for improvement, and apply lessons learned to future endeavors.

# GENETIC ENGINEERING PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24301VSC** | **Vocational Skill Course** | **Genetic Engineering** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

This course aims to familiarize students with basic skills pertaining to recombinant DNA technology and equip with different molecular techniques involved in isolation and manipulation of genetic material to achieve a desired product.

**Learning Outcomes:**

On completion of the course, students will be able to:

**LO1:** Perform different methods of DNA isolation and quantification.

**LO2:** Obtain practical knowledge in analyzing various enzymes used for gene manipulation.

**LO3:** Understand and apply techniques involved in recombinant DNA technology namely cloning, restriction digestion and analysis by gel electrophoresis and documentation, PCR, transformation techniques, and protein analysis.

| Sr. No. | List of Experiments |
|---|---|
| 1 | To perform DNA extraction from different sources (e.g., bacteria, plant, animal). |
| 2 | To perform Agarose Gel Electrophoresis |
| 3 | To perform quality assessment and quantification of nucleic acids (spectrophotometry) |
| 4 | To perform isolation of plasmid DNA. |
| 5 | To perform Restriction Digestion. |
| 6 | To perform ligation reaction. |
| 7 | To perform competent cell preparation. |
| 8 | To perform the transformation of E. coli. cells (color selection of transformants – with or without inserts) X – gal and IPTG. |
| 9 | To perform Southern Blotting |
| 10 | To perform Poly acrylamide gel electrophoresis and protein analysis. |
| 11 | To perform western blotting |
| 12 | To demonstrate primer designing |
| 13 | To demonstrate PCR. |
| 14 | To demonstrate DNA Fingerprinting |
| 15 | To demonstrate northern blotting |

## TEXT / REFERENCE BOOKS

1. Principles of Gene Manipulation and Genomics (2016) 8th edition, Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (2019) 7th edition, Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3. Essential Molecular Biology: Volume I: 001 (Practical Approach Series), Terry Brown, 2009, John Wiley and Sons, USA.

# PLANT TISSUE CULTURE PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| BT 24301DSP | Discipline Specific Practical | Plant Tissue Culture | 0 | 0 | 2 | 60 | 0+2=2 |

**Objective:**

This course aims to provide basic understanding to define the concepts, recognize the importance of tissue culture, and practice various techniques used in plant tissue culture for research and commercial applications.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Perform sterile techniques to prevent contamination during tissue culture procedures.

**LO2:** Gain skills in preparing and sterilizing culture media, including the selection of appropriate nutrients and hormones for different plant species and tissue types.

**LO3:** Learn how to select, prepare plant explants (tissue samples) for inoculation onto culture media and maintenance.

**LO4:** Understand the processes of somatic embryogenesis to regenerate whole plants from cultured tissues.

**LO5:** Learn techniques for the clonal propagation of plants through tissue culture.

**LO6:** Develop skills to identify and resolve common issues in plant tissue culture, such as contamination and abnormal growth.

**LO7:** Learn how to collect, analyze, and interpret data from tissue culture experiments.

| Sr. No. | List of Experiments |
|---|---|
| 1. | To study the requirements for plant tissue culture laboratory. |
| 2. | To prepare stock solutions of media components and prepare MS medium. |
| 3. | To study various sterilization techniques and sterilization of media. |
| 4. | To perform aseptic inoculation of various explants. |
| 5. | To perform callus induction and plant regeneration through nodal explants. |
| 6. | To perform anther culture for haploid production. |
| 7. | To perform embryo and endosperm culture. |
| 8. | To produce synthetic seed from germinating embryos. |
| 9. | To perform micropropagation of medically important plants and hardening / acclimatization of regenerated plants. |
| 10. | To isolate and culture protoplast from leaf sample. |
| 11. | To perform the initiation and establishment of cell suspension cultures. |
| 12. | To produce secondary metabolites from the callus culture. |
| 13. | To produce disease free plants from meristem culture. |
| 14. | To perform hairy root culture. |
| 15. | To study somatic embryogenesis. |

## TEXT / REFERENCE BOOKS


1. Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003) 2nd edition.
2. U. Sathyanarayana Biotechnology. Books and Allied Publications.
3. Bhojwani S.S., Razdan M. K (2005). Plant tissue culture: Theory and practice, Studies in plant science 5, North Holland, Elsevier, New Delhi.
4. Plant Tissue culture (2010). Kalyan Kumar De (New central Book Agency Calcutta).
5. Methods In Plant Tissue culture (2003). U Kumar Agrobios India.

## THIRD YEAR: SEMESTER-VI

# ANIMAL TISSUE CULTURE

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24311DSC** | **Discipline Specific Core** | **Animal Tissue Culture** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to provide insights into mammalian cell culture and develop a comprehensive understanding of current cell culture techniques and their applications in biotechnology, animal sciences, and the biomedical field.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Understand cell structure, function, and behavior of a cell in a controlled environment.

**LO2:** Practice sterile techniques to prevent contamination and maintain cell cultures.

**LO3:** Culture various cell types such as adherent cells, suspension cells, primary cells and continuous cell lines.

**LO4:** Understand factors influencing cell growth (e.g., media composition, pH, temperature) and their optimization.

**LO5:** Understand procedure of proper handling and disposal of cell lines and ethical guidelines for using cell cultures.

**LO6:** Implement quality control measures to ensure reproducibility and reliability of experimental results.

**LO7:** Explore the diverse applications of cell culture techniques in biomedical research, drug development, tissue engineering, and biotechnology.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Animal Cell Culture** | Overview of cell culture, definition and historical perspective. Rules and regulations of cell culture laboratory. Components of a cell culture system: cells, media and supplements. Culture environment and cell culture growth parameters. Laboratory equipments and setup/layout. Washing, packing and sterilization of different materials used in animal cell culture. Aseptic concepts and maintenance of sterility. Aseptic techniques: objectives, elements, sterile handling and biosafety. Detection, prevention, determination and eradication of contamination. Characteristics of cells *in vitro*. Importance of cell culture in research and applications. Ethical issues in cell culture. | 6 |
| **Unit II** | **Sterilization Techniques and Cell Culture Media** | Sterilization: dry heat (hot air oven), wet heat (autoclaving), chemical agents and irradiation techniques (UV and Gamma ray). Types of cell culture media. Defined media and supplements: physicochemical properties, $CO_2$ and bicarbonates, buffering, oxygen, osmolarity, temperature, surface tension and foaming. Balanced salt solutions. Selection of medium and serum. Ingredients of media and essential nutrients for cell growth. Chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide, serum and other supplements. Advantages and disadvantages of serum. Serum free media and its preparation. Animal protein free media and protein free defined media and their applications. | 8 |
| **Unit III** | **Types of Cell Culture and Cell Lines** | Sources of cells and tissues. Primary cell culture techniques: initiation of primary cell culture, isolation of tissue, types of primary culture, mechanical and enzymatic disaggregation, separation of viable and | 8 |

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|---|---|---|---|
| | | non-viable cells. Secondary cell culture: subculture and propagation, routine maintenance, subculture of monolayer and suspension cultures. Growth parameters: measurement of viability, cytotoxicity and apoptosis in cell culture. Monitoring for contamination: microbial, mycoplasma and viral contamination and its eradication. Types of cell lines: immortalized cell lines, primary cell lines, continuous cell lines, stem cell lines, hybridomas, transgenic cell lines and viral cell lines. Characteristics of various cell lines. Establishment and maintenance of cell lines. Cryopreservation. | |
| **Unit IV** | **Cell Characterization, Separation and Applications** | Growth characterization and kinetics. Cell characterization techniques: morphological analysis, viability and proliferation assays, genetic analysis, immunophenotyping, functional assays (assessing cellular functions -metabolism, secretion, and signaling pathways), authentication (DNA profiling or isoenzyme analysis), contamination testing and characterization of specific properties. Cell separation techniques: FACS, MACS, density gradient centrifugation, microfluidic cell sorting, dielectrophoresis, immunomagnetic separation, filtration and sedimentation. Selection of cell lines: species, finite or continuous cell lines, normal or transformed cells, availability, growth characteristics, stability and phenotypic expression. Applications of animal tissue culture: *In vitro* testing, production of viral vaccines and pharmaceutical proteins, monoclonal antibodies, mass production of biologically important compounds and propagation of viruses. Limitations of cell culture technique. | 12 |
| **Unit V** | **Cloning, Organ Culture and Stem Cell Technology** | Cloning and selection: stimulation of plating efficiency, conditions, conditioned medium and feeder layer, suspension cloning, isolation of clones, selective inhibitors and isolation of genetic variants. Organ culture: methods, behavior of organ explant and applications. Methods and applications of histotypic and organotypic cultures. Introduction to organ transplants, tissue engineering, bio-artificial organs culture of embryonic organs, whole embryo culture and culture of adult organs. Stem cell culture: definition, overview and characteristics. Identification, purifications and assessment of proliferation of adult stem cells, embryonic stem cells, embryonic carcinoma cells and induced pluripotent stem cells. Haematopoiesis and bone marrow culture. Long term maintenance and characterization of stem cells. Molecular mechanisms of stem cell self-renewal and pluripotency. Cell cycle regulation in stem cells. Concept of stem cell niche: neural, hematopoietic and mesenchymal stem cells. Applications of stem cells in therapeutics: regenerative medicine, cell-based assays, tissue engineering and organ regeneration. Regulatory considerations. | 12 |
| **Unit VI** | **Advanced Cell Culture Techniques** | 3D cell culture techniques: principle, types of 3D scaffolds and matrices. Organ-on-a-chip technology: principles and benefits. Induced pluripotent stem cells (iPSCs): generation and applications. Advanced imaging techniques: Fluorescence microscopy techniques (confocal microscopy and super-resolution microscopy) and live-cell imaging. | 8 |
| **Unit VII** | **Scale-up in Cell Culture** | Introduction to bioreactors. Criteria of scale up and scale down of bioreactor. Equipment design and process optimization. Scale–up in suspension: stirred suspension, static suspension, continuous flow and air-lift fermenter culture. Other systems for suspension culture: rotating chambers and perfused suspension culture. Scale–up in monolayer: roller bottle and perfused monolayer cultures. Challenges of scaling up from laboratory to industrial levels. Applications of scaling laws and principles. Regulatory requirements. | 6 |

## METHODOLOGY

The course will be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Culture of Animal Cells- A manual of basic techniques. R.I. Freshney.
2. Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited.
3. Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press.
4. Animal Biotechnology, M.M. Ranga, 2000. Agrobios, India.
5. Biotechnology, Satyanarayana, U., 2006. Books and Allied (P) Ltd.
6. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, Oxford.
7. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
8. Animal Cell Culture Techniques. Ed. Martin Clynes, springer
9. Cell Culture Lab Fax. Eds. M Butler and M. Dawson, Bios Scientific Publications Ltd. Oxford.
10. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications
11. Cell Growth and Division: a Practical Approach. Ed. R. Basega, IRL Press.

# BIOINFORMATICS

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24311DSE** | **Discipline Specific Elective** | **Bioinformatics** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

This course aims to acquire competency in gathering information from databases and critically analyze, interpret data and apply tools of bioinformatics for protein structure prediction and computer-based drug designing.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Develop skills in gathering and retrieving data from biological databases to store, manage, analyze and integrate biological data for generating new knowledge.

**LO2:** Proficiently use various bioinformatics tools for sequence alignment, structure prediction and visualization.

**LO3:** Implement computational logic, learn programming languages, develop algorithms and software for progressive computer aided drug discovery.

**LO4:** Understand the role of various computational methods in the drug discovery.

**LO5:** Apply the interdisciplinary nature of bioinformatics in various sectors of biotechnology.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Essentials of Bioinformatics** | Introduction, overview and applications of bioinformatics. Biological databases and data formats. Database search engines: Text-based search engines (Entrez, DBGET/Link DB) and sequence file formats. File formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF etc. Conversion between formats. Basics of object-oriented programming like ($C^{++}$ /JAVA), JavaScript, R programming, Python/Perl and Linux. | 07 |
| **Unit II** | **Biological Databases** | Definition, goals, scope and applications in biological sciences and limitations. Types of databases. Genomic Sequencing. Sequence assembly. Submission of sequences. Sequence accuracy. Sequence databases. Introduction to CORBA architecture. Database applications: NCBI and EMBL databases. Protein sequence databank: NBRF, PIR and SWISSPROT. Structural databases: protein data Bank (PDB). Metabolic pathway data bank: Pub gene, microbial genomic database (MBGD), cell line database (ATCC), virus data bank (UICTVdb), EST databases and SNP databases. Annotation and Archival. Cloud concept of data warehousing. | 10 |
| **Unit III** | **Sequence Alignment** | Sequence alignment: uses, choice to be made for alignment, definitions of homologues, orthologues and paralogues. Gap penalties and scoring matrices. Pairwise sequence alignment: dot matrix. sequence homology vs. similarity vs. identity. Dynamic programming alignment: Needleman-Wunsch algorithm, Smith-Waterman algorithm, BLAST and FASTA. Multiple sequence alignment: uses and methods (Iterative Heuristic alignment and progressive alignment (ClustalW and T-Coffee)). Profile methods: Gribskov profile, PSI-BLAST, PHI-BLAST, HMM, Clustering and Phylogeny. Phylogenetics basics: principles of molecular evolution and phylogenetics, terminology and types of phylogenetic trees and challenges in tree reconstruction. Phylogenetic tree construction methods and programs: distance-based and character-based methods. Tree evaluation programs. | 12 |

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|---|---|---|---|
| **Unit IV** | **Motifs and Domains** | Motif and domain databases. Identification of Motifs and domains in multiple sequence alignment. Motif and domain databases statistical models. Protein family databases. Motif and Domain analysis tools. Motif discovery in unaligned sequences. Sequence logos. Gene and promoter prediction: promoter and regulatory elements in prokaryotes and eukaryotes. Algorithms for promoter and regulatory element prediction. Gene prediction in prokaryotes and eukaryotes. Categories of gene prediction programs. Prediction algorithms. | 7 |
| **Unit V** | **Predictive Methods** | Predicting DNA framework and masking of repetitive DNA. Predicting RNA secondary structure: reading frames, codon usage analysis, transcriptional, translational signals and splice site identification. Gene prediction methods: RNA fold analysis and compositional analysis. Prediction of scalar parameters: composition, molecular weight, charge, iso-electric point, molar extinction co-efficient, hydrophobicity and amphiphilicity detection using Kyte-Dolittle plot. Secondary structure prediction methods: helical wheel, helical net and moment analysis. Protein secondary structure prediction using Chou-Fassman method. Programs (J Pred and Garnier) for protein secondary structure prediction: antigenic sites, active sites, folding classes, specialized and tertiary structures. *In silico* primer designing and developing Restriction Maps. Gene expression analysis: gene expression data analysis, pre-processing and normalization of gene expression data. | 13 |
| **Unit VI** | **Structural Bioinformatic, Molecular Modelling and Drug Designing** | Introduction to structural bioinformatics. Protein structure conformation and visualization tool (RASMOL, PYMOL and Swiss PDB Viewer). Domain databases: CDD, SMART and ProDom. Introduction to protein-ligand interactions and drug discovery. Analysing molecular surfaces, cavities, and intermolecular interaction. Target identification and validation, identifying the lead compound, optimization of lead compound and chemical libraries. Pharma informatics, pharmacogenomics and population genomics. Ethical considerations in bioinformatics research. | 11 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. T. A. Attwood and D. J. Parry–Smith, 2001, Introduction of Bioinformatics.
2. David W, 2005, Bio-informatics; sequence and Genome Analysis, 2nd Edn by Mount CBS publishers.
3. Pevsner, J., 2003, Bioinformatics and Functional Genomics by John Wiley and Sons, , USA.
4. Andreas D Baxevanis. Bioinformatics – A practical Guide to the Analysis of Genes and Proteins. Wiley Interscience, 2004.
5. David R. Westhead. Instant Notes: Bioinformatics. BIOS Scientific Publishers Ltd., 2003
6. Jin Xiong. Essential Bioinformatics: Cambridge University Press.
7. Lukas K. Buehler Hooman H. Rashidi. Bioinformatics Basics: Applications in Biological Science and Medicine. Tylor and Francis (CRC) 2005.
8. Andreas D. Baxevanis. Current Protocols in Bioinformatics Wiley 2003
9. Paul G. Higgs, Teresa K. Attwood. Bioinformatics and Molecular Evolution Blackwell publishing 2005.
10. David Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press 2004.
11. Zahoor Ahmad and S. Mohan Jain (Editors) (2012). "Bioinformatics: Concepts, Skills, and Applications". Springer.
12. S. Bateman and J. A. Rawlings (Editors) (1998). "Bioinformatics: A Practical Approach". Publisher: Oxford University Press.

# MOLECULAR BIOPHYSICS

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24311MI** | **Minor** | **Molecular Biophysics** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to provide students with a thorough understanding of physical principles and experimental techniques to analyze and comprehend the structural and dynamic aspects of biological macromolecules and their interactions.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Integrate concepts from physics, chemistry, and biology to appreciate the interdisciplinary nature of molecular biophysics.

**LO2:** Appreciate the effect of various forces in shaping the molecular conformation and correlate the biomolecular structure to its specific functions.

**LO3:** Appreciate the significance of thermodynamics, kinetics and cooperatively to define the function of biological macromolecules.

**LO4:** Solve complex biological problems using computational and experimental techniques to analyze biomolecular interactions and mechanisms at the molecular level.

**LO5:** Understand the chemical structure of various macromolecules and comprehend the influence of macromolecular three-dimensional structure involved in propagation of life.

| No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Molecular Biophysics** | Overview, principles and scope of molecular biophysics. Nature of chemical bonds: forces responsible for molecular conformation, e.g. hydrogen bonds, ionic/electrostatic interactions, Van der Waals interaction, hydrophobic interaction and stereo-chemical factors. Small-molecule solutes. Thermodynamics and kinetics in molecular interactions. Ethical considerations, legal and regulatory aspects of molecular biophysics. | 4 |
| **Unit II** | **Physical Properties of Carbohydrates and Other Biomolecules** | Carbohydrates: formation of glucosides and the cyclic structure of D-glucose, structure and conformation of disaccharides and polysaccharides. Glycosidic bond rotation, backbone torsional angles and steric hindrance, sugar ring conformations, C3' endo, C2'endo and their energies. Lipids: types, triglycerides, ester bonds, fatty acids, fats and oils, phospholipids, glycolipids and lipoproteins. Structure, function and localization of lipids. Vitamins and hormones: structure, classification and functions. | 7 |
| **Unit III** | **Physical Properties of Amino Acids and Proteins** | Physical properties of amino acids: polarity and discrimination function. Primary structure of proteins: cross links, sequence comparison and mutant proteins. Secondary structure: α helix, β sheet, β turns and polypro helices. Prediction method, tertiary structure and packing density. Conformational analysis, Φ Ψ angles and Ramachandran plot. Energy terms: Van der Waal's, repulsive (non-bonded), dipolar (bonded) and torsional. Result of energy calculations, experimentally observed values of Φ Ψ angles. Hydrogen bonding, hydrophobic interactions, ionic interactions and disulphide bonds. Mechanism underlying protein folding and misfolding. Protein lipid interactions and membrane proteins. | 8 |
| **Unit IV** | **Physical Properties of Nucleic Acids** | Purine and pyrimidine bases, nucleosides and nucleotides. Differences in structure and function of RNA and DNA. Polymorphism in DNA: A, B, Z family of structures and super helical forms. Base pairing (Hoogstein and Waston-Crick), energetics, electronic complementarity and base stacking. Structure of t-RNA molecule and model of tertiary interactions. Nucleic | 7 |

| | | | |
|---|---|---|---|
| | | acid dynamics: protein-nucleic acid interactions, energetic basis of protein structure, stability, dynamics and function. Protein-protein and protein-ligand interactions. Protein-DNA/RNA interactions: recognition, binding and regulation. | |
| **Unit V** | **Biomolecular Structure Determination Techniques** | X-ray Crystallography: principle, basics of X-ray diffraction, instrumentation, crystallization of biomolecules, structure determination and refinement of protein and nucleic acids. Nuclear Magnetic Resonance (NMR) spectroscopy: principle, basics of NMR theory, instrumentation, multidimensional NMR experiments and structure calculation and refinement. Protein folding and dynamics studies using NMR. Electron Microscopy (EM): introduction, principle, instrumentation, single particle analysis. Cryo-EM and tomography, data processing and 3D reconstruction. Mass spectrometry: introduction, principle, instrumentation, peptide and protein analysis and structure determination approaches, data processing and analysis. Structure-function relationships in biomolecules. | 10 |
| **Unit VI** | **Techniques for Biomolecular Interactions** | UV-Visible spectroscopy: principle, applications in biomolecular interactions and quantitative analysis of binding constants. Fluorescence spectroscopy: fluorescence principle, probes and applications in studying binding events and conformational changes. Size exclusion and affinity chromatography in studying biomolecular interactions. Isothermal titration calorimetry (ITC): principle of heat release/absorption upon binding and quantitative analysis of binding affinity and stoichiometry. Differential Scanning Calorimetry (DSC): principle and applications in studying protein stability and ligand binding. Surface Plasmon Resonance (SPR): principle, detection and quantification of biomolecular interactions in real-time and kinetic analysis of association and dissociation rates. Gel and capillary electrophoresis in analyzing biomolecular interactions. NMR in studying interactions: chemical shift perturbation analysis and mapping binding interfaces and dynamics. Mass spectrometry in interactomics: identification of interacting partners and structural characterization of complexes. | 12 |
| **Unit VII** | **Techniques for Membrane Biophysics** | Introduction to biological membranes. Patch clamp technique and fluorescence-based assays (fluorescent dyes and probes) for measuring membrane permeability. Transport assays: measurement of ion and molecule fluxes across membranes. Fluorescence Recovery after Photobleaching (FRAP): measurement of membrane fluidity and lateral diffusion. Electron Spin Resonance (ESR): membrane dynamics and order analysis. Electrophysiology techniques: voltage-clamp and current-clamp techniques. Patch clamp electrophysiology: principle and applications in studying ion channels and membrane potential. X-ray crystallography, Cryo-EM and NMR for determining membrane protein structures. Confocal microscopy: visualization of membrane structure and dynamics. Super-resolution microscopy: high-resolution imaging of membrane components. Vesicle fusion assays: studying membrane fusion events. Atomic Force Microscopy (AFM): visualization and manipulation of membrane structures. | 12 |

## METHODOLOGY:

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Biophysics - An Introduction by Rodney Cotterill (Wiley).
2. Molecular Biophysics: Structures and Dynamics by Michel Daune (Oxford Univ. Press).
3. The Biophysical Chemistry of Nucleic Acids and Proteins by Thomas E. Creighton (Helvetica Press).
4. The Physical and Chemical Basis of Molecular Biology by Thomas E. Creighton (Helvetica Press).

5. Molecular Biophysics by M.V. Volkenstein (Academic press).
6. Biophysics by W. Hoppe W. Lohmann, H. Markl, H. Ziegler (Springer).
7. Sinden, R.R., DNA structure and function, Academic Press.
8. Blackburn, G.M. and Giat, M.J. Nucleic acids in chemistry and biology, IRL press.
9. Cantor, C.R. and Schimmel P.R., Biophysical chemistry Part-I and Part-III, WH Freeman.
10. Govil, G. and Hosur, R.V. Conformation of biological molecules NMR, Vol. 20, Springer Verlag.
11. Schulz, G.E. and Schirmer, R.H., Principles of protein structure, Springer Verlag.
12. Creighton, T.E. Protein structure: a practical approach. 2nd edition, Oxford University Press.
13. Marrink, S. J., and Sansom, M. S. P. (2015). Biological membranes: A molecular perspective from computation and experiment. Royal Society of Chemistry.
14. Verkleij, A. J., and Berliner, L. J. (Eds.). (1994). Biological membranes: Structure, biogenesis and dynamics. CRC Press.
15. Pain, R. H. (1988). Biophysics of the cell surface. Edward Arnold.
16. Dill, K. A., and Bromberg, S. (2011). Molecular driving forces: Statistical thermodynamics in biology, chemistry, physics, and nanoscience (2nd ed.). Garland Science.
17. Marsh, D., and Mason, J. C. (Eds.). (1991). Lipid bilayers: Structure and interactions. CRC Press.
18. Tien, H. T., and Jelley, J. (Eds.). (1985). Membrane biophysics: Planar lipid bilayers (BLMs) and their applications. Academic Press.
19. Han, X. (2016). Lipidomics: Comprehensive mass spectrometry of lipids. Wiley.

# INTERNSHIP

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24311IN** | **Internship** | **Internship** | **0** | **0** | **4** | **120** | **0+4=4** |

**Objective:**

The objective of an internship undertaking for students is to provide immersive, practical experience in a professional setting that enhances their industry-specific skills, deepens their understanding of career paths, and builds valuable networks while applying academic knowledge to real-world challenges.

**Learning Outcomes:**

Upon completion of the course, student will be able to:

**LO1:** Use theoretical concepts and skills acquired in the classroom to address real-world tasks and challenges within a professional environment.

**LO2:** Gain hands-on experience with industry-specific tools, techniques, and best practices, enhancing technical and practical competencies.

**LO3:** Learn about organizational structures, workplace cultures, and the roles and responsibilities within a professional setting.

**LO4:** Practice effective communication with colleagues, supervisors, and clients through written reports, presentations, and verbal interactions.

**LO5:** Establish professional relationships with industry professionals, mentors, and peers that can support future career opportunities.

**LO6:** Explore various career paths, roles, and industry trends to make informed decisions about future career goals and aspirations.

**LO7:** Develop the ability to identify problems, analyze solutions, and implement effective strategies based on real-world scenarios and feedback.

Internships includes working with government or private organizations, higher education institutions, universities, research and development, labs/research organizations/non-government organizations, enterprises, centres involved in research, innovativeness and entrepreneurship, business organizations, local industry, artists, craftspeople and similar other entities for providing opportunities to students for active engagement in on-site experiential learning.

It helps students get direct experience in using tools, software, techniques, equipment used, gain experience in data collection from the relevant field, conducting surveys etc. in a live environment and experience the work culture. Internships can be mutually beneficial for the intern as well as the internship providing organization. The internship providing organizations provide training with an objective to create a pipeline of great future employees.

# ANIMAL TISSUE CULTURE PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24311VSC** | **Vocational Skill Course** | **Animal Tissue Culture Practical** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The objective of this course is to emphasis the students to obtain practical knowledge in various animal and mammalian *in vitro* cell culturing, maintenance and preservation which will facilitate to produce vaccines, therapeutic proteins, antibodies and undertake research for novel drug discovery.

**Learning Outcomes:**

Upon completion of the course, student will be able to:

**LO1:** Understand the basics of laboratory layout and equipment, sterilization techniques and maintenance of sterility along with prevention and eradication of contamination in tissue culture laboratory**.**

**LO2:** Develop skill in handling, establishing and maintaining of various animal cell lines.

**LO3:** Develop proficiency in isolation, maintenance and growth of cells from animal or human tissues to grow them in artificial environment.

**LO4:** Know the importance of cryopreservation to preserve the cell culture.

**LO5:** Perform techniques involved in revival of cell lines to be utilized for the cytotoxicity, anticancer and apoptotic studies and undertake research for novel drug discovery.

| Sl. No. | List of Experiments |
|---|---|
| 1 | To study layout of animal tissue culture laboratory. |
| 2 | To study the guidelines for handling tissues, chemicals, equipments and other reagents. |
| 3 | To perform various sterilization techniques of animal tissue culture laboratory. |
| 4 | To manually prepare various animal cell culture media and perform the sterility checking. |
| 5 | To perform isolation, maintenance and growth using chick embryo under aseptic condition. |
| 6 | To develop secondary growth or established cells from primary culture by repeated subculture. |
| 7 | To perform thawing and culturing of cell lines. |
| 8 | To perform cell counting and cell viability assay. |
| 9 | To preserve the cells in viable condition. |
| 10 | To prepare single cell suspension from spleen and thymus. |
| 11 | To perform cytotoxicity of a given drug using MTT assay. |
| 12 | To perform fixation and staining of cells. |
| 13 | To isolate and culture peripheral blood lymphocytes. |
| 14 | To perform preservation of cell lines by freeze-drying. |
| 15 | To evaluate the radical scavenging activity of the tissue hydrolysate against the DPPH free radical. |
| 16 | To prepare single cell suspensions from animal tissue. |
| 17 | To adapt and propagate new castle disease virus in chicken embryo. |
| 18 | To prepare suitable cell culture for the adaptation of animal virus and to study its cytopathic effects. |
| 19 | To set up an animal tissue culture laboratory. |

## TEXT / REFERENCE BOOKS


1. Experiments with Normal and Transformed cells. R. Crowe., H. Ozer and Rifkin. Cold Spring Harbour Laboratory (1978).
2. Handbook of cell and organ culture. D.J. Merchant, R.H. Kahn and W.H. Murphy., Burgess Publishing, 1969.
3. Culture of Animal Cells. R. Ian Freshney and R. Alan., Liss. Inc. (1987).
4. Microcarrier culture: Principles and Methods, Pharmacia Fine chemicals.
5. Growth of cells in Hormonally defined media, Book A and B. G. H. Sato., A. B. Pardee and D. A. Sirbasku. Cold Spring Harbor Laboratory (1982).

# BIOINFORMATICS PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24312VSC** | **Vocational Skill Course** | **Bioinformatics (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The aim of this course is to develop skills in querying, extracting, visualizing, analyzing results and interpreting biological data from complex biological datasets through high-throughput technologies and apply tools of bioinformatics for protein structure prediction and computer-based drug designing.

**Learning Outcomes:**

On completion of the course, students will be able to:

**LO1:** Gain knowledge about the commonly used databases to retrieve biological information.

**LO2:** Comprehend the strategies of text- and sequence-based search, retrieve, store, and protect molecular data.

**LO3:** Explain pairwise and multiple sequence alignment, construct and execute sequence alignment by dynamic programming to compare the biological macromolecules.

**LO4:** Construct the phylogenetics of different sequences to understand the population lineage.

**LO5:** Comprehend structural bioinformatics tools use to predict, edit and visualize secondary and tertiary structures of bio-macromolecules.

**LO6:** Comprehend the molecular modeling tools to develop structural models for drug design.

| Sr. No. | List of Experiments |
|---|---|
| 1 | To use of different biological databases and Bioinformatics search engines (e.g., NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt). |
| 2 | To retrieve DNA and protein sequences from various online databases. |
| 3 | To analyze sequence properties such as length, GC content and amino acid composition of various biomacromolecules. |
| 4 | To perform sequence similarity searches using BLAST. |
| 5 | To perform multiple sequence alignment of DNA and protein sequences using ClustalW/MUSCLE. |
| 6 | To analyze gene structure using ORFfinder and GenScan. |
| 7 | To identify conserved regions or motifs within the alignment. |
| 8 | To analyze molecular interactions, intra and inter molecular interactions, salt bridges and crystal contacts in secondary and tertiary structure of protein. |
| 9 | To predict genes within a DNA sequence using GeneMark/Glimmer/ GRAIL/Genscan. |
| 10 | To evaluate and visualize 3D structure of biomolecules. |
| 11 | To construct, interpret and visualize phylogenetic trees using neighbor-joining/maximum likelihood to understand evolutionary patterns. |
| 12 | To understand Kyto Encyclopedia of Genes and Genome (KEGG) database for biological pathways, metabolism, cellular process and genetic information processing. |
| 13 | To visualize gene expression patterns by heatmap. |
| 14 | To perform RNA structure prediction by SQUARNA |
| 15 | To perform various primer designing and restriction site prediction. |
| 16 | To perform protein structure prediction using PDB, SCOP and CATH. |
| 17 | To construct, visualize and study the protein structures using Deepview/PyMol. |
| 18 | To perform homology modelling of proteins. |
| 19 | To use mutation tools and analyze the energy minimization of protein structures. |
| 20 | To perform miRNA prediction, designing and target prediction using various tools. |

## TEXT / REFERENCE BOOKS

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis , B.F. Francis Ouellette, 2009.
2. Fundamentals of Bioinformatics, S. Harisha, I. K. International Pvt Ltd, 2013

## FOURTH YEAR: SEMESTER-VII

## MOLECULAR DIAGNOSTICS

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24401DSC** | **Discipline Specific Core** | **Molecular Diagnostics** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to familiarize students with the basic principles and clinical applications of the emerging technologies of molecular diagnostics for early diagnosis and prognosis of human diseases.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Understand the disease types and their early diagnosis.

**LO2:** Learn the technical aspects of various diagnostic tools and techniques to design and develop new clinical tests.

**LO3:** Demonstrate knowledge of the principles and applications of key molecular diagnostic techniques such as PCR, sequencing, and hybridization**.**

**LO3:** Interpret results of molecular diagnostic testing and integrate results into clinical decision making.

**LO4:** Obtain comprehensive knowledge about disease occurrence and progression at molecular level.

**LO5:** Identify and describe the use of molecular diagnostics in various clinical settings, such as infectious diseases, genetic disorders, and oncology.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Disease and Diagnostic Testing** | Definition, history and diseases: infectious, physiological errors, metabolic errors, genetic basis of diseases and inherited disorders. Normal microbial flora of the human body. Host-Parasite relationship. Introduction and history of diagnostics of diseases, mode of infection, factors predisposing to microbial pathogenicity. Types of infectious diseases: bacterial, viral, fungal, protozoans and other parasites. Principles of diagnostic testing: sensitivity and specificity, predictive values and factors influencing test performance. Introduction to point-of-care testing and its applications. Types of diagnostic tests: screening, diagnostic, prognostics and monitoring. Role of diagnostics in disease prevention, early detection and treatment. Clinical specimens: types, method of collection, handling, transport, processing of samples, personal and laboratory safety. GLP for handling highly infectious samples and documentation. Guidelines for sample collection and transportation. | 10 |
| **Unit II** | **Diagnosis Methods for Infectious Diseases** | Overview of laboratory techniques: microscopy, culture and molecular techniques. Diagnosis of infection caused by bacteria: *Streptococcus*, *Coliforms*, *Salmonella*, *Shigella*, *Vibrio*, and *Mycobacterium*. Diagnosis of fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses: Pox viruses, Adenoviruses, Rhabdo viruses, Hepatitis viruses and retroviruses. Diagnosis of protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis and Leishmaniasis. Study of helminthic diseases: Fascioliasis (*Fasciola hepatica*) and Ascariasis (*Ascaris lumbricoides*). Study of parasitic diseases: Filariasis and Schistosomiasis. | 12 |

| | | | |
|---|---|---|---|
| **Unit III** | **Diagnosis of Metabolic and Genetic Disorders** | Major metabolic disorders and its causes. Diagnostic methods for metabolic errors: glycogen storage disorders, G6PD deficiency syndrome, mucopolysaccharidosis, alkaptonuria, maple syrup urine disease, phenylketonuria and albinism. Muscle disorders: Becker's muscular dystrophy and spinal muscular atrophy. Cancer and its diagnostics: types and genetic basis of cancer (oncogenes and tumour suppressor genes). Identifying human disease genes. Genetic disorders and its diagnostics: sickle cell anemia, Duchenne muscular dystrophy, retinoblastoma, cystic fibrosis and sex- linked inherited disorders. Blood disorders and its diagnostics: haemoglobinopathies, thalassemia and hemophilia. | 14 |
| **Unit IV** | **Neonatal, Prenatal and Other Disease Diagnostics** | Neonatal and prenatal disease diagnostics. Gender identification by amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance. Molecular diagnosis for early detection of cerebral palsy. Bone disorders and its diagnostics: Osteogenesis imperfecta and Rheumatoid arthritis. Eye disorder and its diagnostics: Retinitis pigmentosa. | 8 |
| **Unit V** | **Molecular Techniques for Disease Diagnosis** | Isolation and purification of nucleic acids: principles and methods. PCR based assays: Real-time PCR, ARMS, allele specific and multiplex. Methylation analysis, single-stranded conformational polymorphism analysis, EST and SAGE. Molecular markers: 16S rRNA typing. Hybridization techniques: Southern, Northern and *in-situ* (including FISH). Microarrays: types and applications. Protein extraction and analysis: PAGE and Western Blot. | 10 |
| **Unit VI** | **Applications of Molecular Diagnostics** | HLA typing: RFLP and PCR based methods (SSO, SSP and SBT). Molecular diagnostics in bone marrow and organ transplantation. Automated DNA sequencing. Functional protein identification and paternity testing. Regulations, ICMR and other guidelines. | 6 |

## METHODOLOGY

The course will be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Tietz textbook of clinical chemistry and molecular diagnostics. Carl Burtis, Edward Ashwood, David Bruns, Elsevier Press. 5th Edition 2012.
2. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker. 2010.
3. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. Lela Buckingham and Maribeth L. Flaws. 2011.
4. Modern Blood Banking and Transfusion Practices. Denise M. Harmening. 2018.
5. Fundamentals of Molecular Diagnostics. David E. Bruns MD (Author), Edward R. Ashwood MD (Author), Carl A. Burtis PhD. 2007.
6. Proteomics in Diagnostics. Veenstra, T.D. 2004.
7. Biomolecules: Structure, function in Health and Disease-CEC (Online).
8. Fabrication Techniques for MEMs-based sensors: clinical perspective- NPTEL.
9. Economics of Health and Healthcare- NPTEL.

# INDUSTRIAL BIOTECHNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24402DSC** | **Discipline Specific Core** | **Industrial Biotechnology** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide students with integrated scientific and technological knowledge necessary to work in the Biotechnology industry, from research to application and from raw materials to products.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the fundamental concepts and principles of industrial biotechnology with particular emphasis on the technological aspects of manufacturing and design.

**LO2:** Gain proficiency in bioprocess engineering principles, bioreactor design, downstream processing, and bioprocess monitoring.

**LO3:** Develop knowledge of microbial biotechnology, including microbial diversity, fermentation processes, and genetic engineering techniques.

**LO4:** Gain proficiency in bulk production of commercially important products such as modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures.

**LO5:** Use overall industrial bioprocess for products development on the cell and process level by manipulating the process based on the industrial needs to map the biobased economy.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Industrial Bioprocess** | Commercial potential of biotechnology in India: Scope and applications. Fundamental concepts of fermentation and bioprocess technology. Biochemistry of fermentation. Types of bioprocesses. Design and formulation of media for industrial bioprocess. Criteria for medium design, carbon/nitrogen sources, nutrients and sterilization of media. Characteristics of industrially important microbes. Industrial fermentation: bacterial, fungal and yeast. | 5 |
| **Unit II** | **Bioreactors-Design, Types and Operation** | Definition, importance of bioreactors in industrial process. Basic instrumental components of a bioreactor. Types and modes of operation of bioreactors: batch, continuous and fed-batch bioreactors, stirred tank, air lift, packed bed bioreactors, photo bioreactors and membrane bioreactors. Reactors for plant cells and animal cells. Immobilized reactors. Basic concepts of upstream and downstream processing and product recovery. Optimization techniques for enhancing fermentation efficiency and productivity. Regulation and safety measures. | 9 |
| **Unit III** | **Production of Primary Metabolites** | Production of commercially important primary metabolites: organic acids (citric acid and lactic acid), amino acids (lysine and glutamic acid) and ethanol. | 5 |
| **Unit IV** | **Production of Secondary Metabolites** | Production processes for various classes of secondary metabolites: antibiotics (penicillin and streptomycin), vitamin B12 and transformation of steroids and sterols. | 4 |
| **Unit V** | **Production of Enzymes and Other Bioproducts** | Production of industrial enzymes: amylase, protease and lipase. Production of biopreservatives (Nisin), biopolymers (xanthan gum and PHB), biodiesel, cheese and SCP. | 7 |

**METHODOLOGY:**

The course would be taught through lecture sessions.

**BOOKS RECOMMENDED**:

1. Industrial Microbiology by L. E. Casida Jr. (John Wiley and Sons).
2. Bioprocess Engineering: Basic Concepts by Michael L. Shuler and Fikret Kargi (Prentice Hall).
3. Industrial Biotechnology: Principles and Applications by Larry Erickson (Science Publishers).
4. Principles of Fermentation Technology. P. F. Stanbury, A. Whitaker, and S. J. Hall (Butterworth-Heinemann).
5. Bioprocess Engineering Principles by Pauline M. Doran (Academic Press).
6. Okafor, N., and Okeke, B.C. (2017). Modern Industrial Microbiology and Biotechnology (2nd ed.). CRC Press. https://doi.org/10.1201/b22421.
7. Johannes, A.H., Moshfeghian, M., Johannes, T.W.: Natural Gas. In: Kent, J., Bommaraju, T., Barnicki, S. (eds.) Handbook of Industrial Chemistry and Biotechnology, pp. 185–213. Springer, Cham (2017).

# FORENSIC SCIENCE AND BIOTECHNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24401DSE** | **Discipline Specific Elective** | **Forensic Science and Biotechnology** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**
The objective of this course is to provide comprehensive knowledge and skill in applying biotechnological techniques to forensic investigations to solve crimes, identifying individuals, determine paternity and interpret biotechnological findings accurately that form a critical component in contemporary forensic investigations.

**Learning Outcomes:**
Upon completion of this course, students will be able to:

- **LO1:** Describe the symbiotic relationship between biotechnology and forensic science.
- **LO2:** Comprehend in various specimen collection, analysis, and interpretation of data.
- **LO3:** Apply modern biotechnological tools such as DNA extraction, amplification, sequencing and analysis methods used in forensic context.
- **LO4:** Understand and examine different types of poison and drugs and its metabolism.
- **LO5:** Navigate the intricate challenges and opportunities presented to identify the crime and catastrophic victims through forensic biotechnology.
- **LO6:** Understand criminal behavior and psychological factors associated with crime.
- **LO7:** Cope with professional forensic bodies and medico-legal aspects.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Forensic Science** | Definition, history, scope, branches and functions of forensic science. Introduction to criminology, types of crime (physical, chemical and biological), criminal behaviour and psychological factors. Evidences: physical evidence, collection protocols and chain of custody. Forensic ballistics: types, applications, procedures (internal, external and terminal ballistics) and identification of firearms. Photography and digital criminalistics: camera in forensic analysis, computer and phone data analysis and deception detection (polygraph, narcoanalysis and brain-mapping). Organizational set-up, layout, functions and duties of forensic science laboratories: physical science, biological, firearms and document examination unit. Experts involved and procedures in crime scene investigation. Forensic science in national and international perspectives. Criminal investigations and laws. Frye case and Daubert standard. | 9 |
| **Unit II** | **Forensic Biology-Animals, Plants and Microorganisms** | Concept, definition, history and nature of forensic biology. Classification, principles of collection and preservation of biological exhibits. Animals, plants and microorganisms in legal investigation: basic principles, tools and techniques. Forensic entomology: insects of forensic importance, collection of entomological evidence, insect succession on carrion and its relationship to determine time since death. Forensic paleontology: methods of identification and comparison of pollen structure. Microbial forensics: bioterrorism, pathogen detection and typing (e.g., PCR, Sequencing), database and infectious microorganisms. Biocrimes and Physician. Diatoms: nature, location, structure, extraction from various body tissues, preparation of slides, methods of identification and comparison and forensic significance. Hair: morphology of animal and human hair, phases of hair growth, cuticle cortex and medulla area of hair. | 12 |
| **Unit III** | **Forensic Chemistry** | Introduction, chemical evidences sampling, presumptive, screening (colour/spot test) and inorganic analysis. Chemistry and importance of detective dyes: fluorescent dyes, starch, phenolphthalein and anthracene powder. Arson chemistry: searching fire scene, collection, preservation and examination of arson evidences. Adulteration in petroleum products. Alcoholic, nonalcoholic and other beverages: examination procedures and | 7 |

| | | | |
|---|---|---|---|
| | | constituent analysis. Forensic analysis of fertilizers, insecticides, pesticides and biocides. | |
| **Unit IV** | **Forensic Serology** | Blood and body fluid identification. Biological markers of forensic significance. Forensic characterization of blood and preservation of suspected blood. Presumptive tests (e.g., Kastle-Meyer, Luminol), confirmatory tests (e.g., Takayama, Hematrace) and blood typing. Nature, analysis and characterization of saliva, semen and other fluids (e.g., amylase, P30). Tissue identification and analysis. Hair and fiber analysis (morphology, medullary index and cuticle patterns). | 7 |
| **Unit V** | **Forensic Toxicology** | Definition, scope and significance. Common poisoning in India. Poisons: types, routes of administration, toxicity, sign, symptoms, factors affecting the effect of poison and analysis (e.g., colorimetric, mass spectrometry). Plant poison: nature (cardiac, deliriant and spinal), active constituents, mode of action, isolation and identification. Medico-legal aspects of poisoning cases. Pesticides: types and their formulations, identification and analysis of pesticides. Toxins: types of toxins (e.g., narcotics, heavy metals), effects, routes of exposure and toxicokinetics. Drug analysis: screening and detection techniques. Guidelines for poisoned sample collection. Post-mortem examination, analysis of poisons in body tissues/fluids and interpretation of toxicological results. | 10 |
| **Unit VI** | **Forensic DNA Profiling** | Sample collection and preservation. DNA extraction methods: organic, Chelex and silica-based. Separation methods: slab gel and capillary electrophoresis. Detection methods: fluorescent dyes and silver–staining. Quantification techniques: spectrophotometry and qPCR (primer designing and optimization). Introduction to short tandem repeats (STRs), fragment analysis and interpretation of STR profiles. Mitochondrial DNA analysis: PCR and sequencing and applications (maternal lineage and degraded samples). Y-Chromosome analysis: Y-STR markers and haplotypes, methods of analysis and interpretation and applications (paternity testing and sexual assault cases). Next-Generation sequencing (NGS): principle, techniques (Illumina and Ion Torrent), workflow (library preparation, sequencing and data analysis), advantages and applications in forensic sciences. DNA barcoding of plant, fungi and animals and databases of DNA barcode. | 12 |
| **Unit VII** | **Ethics and Applications of Forensic Biotechnology** | Ethics in forensic science. Application and development of a code of conduct and code of ethics. Ethical dilemmas and their resolution. Practical applications of forensic biotechnology: missing persons, disaster victim identification, paternity testing, wildlife forensics etc. | 3 |

**METHODOLOGY**

The course will be taught through lecture sessions.

**BOOKS RECOMMENDED:**


1. Criminalistics: An Introduction to Forensic Science, 11/E, Richard Saferstein
2. Forensic DNA Typing, 2nd Edition, Biology, Technology, and Genetics of STR Markers, J Butler, 2005.
3. Hendry Lee's Crime Scene Handbook, H.C. Lee, T. Palmbach, M.T. Miller (Academic Press), June 2001.
4. Introduction to Forensic Sciences by William G Eckert, CRC Press.
5. Understanding Forensic Digital Imaging by Blitzer, Herbert L. and Stein-Ferguson, Academic Press.
6. Forensic Uses of Digital Imaging by John C. Russ Publisher, CRC Press.
7. Principles of Bloodstain Pattern Analysis: Theory and Practice. Stuart H.J, Paul E.K, Sutton, CRC Press.
8. Principles of Forensic Toxicology by Barry Levine, AACC Press.
9. Textbook of Forensic Medicine and Toxicology. V.V. Pillay, Paras Medical Publishers.
10. Essential Forensic Biology by Alan Gunn, Wiley Blackwell.
11. The Use of Statistics in Forensic Science. C.G.G. Aitken and David A. Stoney Ellis Harwood Series
12. Ethics in Forensic Science: Professional Standards for the Practice of Criminalistics. P.D. Barnett, Tand.
13. Principles of Forensic Medicine by Apurba Nandy, New central book agency Ltd.

# RESEARCH METHODOLOGY, BIOSTATISTICS, AND IPR

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24401RM** | **Minor** | **Research Methodology, Biostatistics, and IPR** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to equip students with essential skills in identifying problem, designing and conducting research, applying appropriate biostatistical methods for data analysis and understanding intellectual property rights relevant to biomedical sciences.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Impart skills to understand the type of research, develop a research topic and design.

**LO2:** Perform literature review to outline the requirements, goals, significance, and methodology.

**LO3:** Formulate a purpose statement, research question or hypothesis, and a research objective.

**LO4:** Designs experiments as per research statement and carry out statistically relevant sampling.

**LO5:** Describe and perform data collection, collate, analyze and interpret data systematically.

**LO6:** Grasp fundamental biostatistical concepts such as probability, hypothesis testing and regression analysis.

**LO7:** Discuss the correlation between different types of data obtained along with related variables.

**LO8:** Acquire skills to perform statistical analysis, construct tables and graphs and interpret data to disseminate effectively.

**LO9:** Analyze, categorize and elaborate the various forms of IPR.

**LO10**: Design and conduct research, analyze and compile data and present research findings to ensure valid conclusions ethically and able to process patent application.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Research Methodology** | Definition, objectives and significance of research. Types of research: basic, applied, and translational. Research process: steps and flowchart. Literature review: importance, types (systematic and narrative) sources, use of databases and techniques. Criteria for good research. Meaning and sources of research problem. Identification, formulation and justification of research problem. Setting research questions and objectives. Empiricism, deductive and inductive theory. Meaning, types and development of research hypothesis. Ethical approval processes. Ethical considerations: informed consent, confidentiality and anonymity. | 7 |
| **Unit II** | **Research Design and Sampling Techniques** | Concepts of research design. Conceptual vs. empirical research. Cross-sectional vs. longitudinal studies. Research design: definition, types (qualitative and quantitative), need, steps and validity. Features of good research design. Sampling and sampling methods: sampling frame, sampling vs. census, characteristics of good sample, types (probability, non-probability and mixed methods). Bias and errors. Sample size: factors influencing sample size and methods for calculating sample size. | 11 |
| **Unit III** | **Data Collection and Analysis** | Types and sources of data. Data collection methods: primary and secondary. Tools for data collection: questionnaires (open-ended, closed-ended, likert and semantic differential scales). Interviews and surveys. Pilot testing and refinement. Reliability and validity in research. Types of validity: construct, internal and external. Ensuring reliability: test-retest and inter-rater. Data collection methods: observations, surveys, interviews (structured, semi-structured, and unstructured), and case studies. Online data collection methods: e-surveys and web analytics. Levels of measurement: nominal, ordinal, interval and ratio. Classification, tabulation and interpretation of data. Graphical representation of data using graphs | 12 |

| | | | |
|---|---|---|---|
| | | and charts: histograms, frequency polygon and frequency curves, bell shaped curve and their properties. Coding and categorization. Data cleaning and preparation. Qualitative data analysis: thematic and content analysis. Quantitative data analysis: descriptive and inferential statistics. Ensuring ethical data collection practices and data protection regulations. Research misconduct: data fabrication, falsification, and plagiarism. | |
| **Unit IV** | **Writing and Reporting Research** | Research reports: structure, components, types and layout of research report and articles. Writing and interpreting research results, figures and graphs. Referencing styles and bibliography: APA, Chicago, MLA, Vancouver, etc. Tools and software for reference management: EndNote and Mendeley. Importance of accurate referencing. Common mistakes in research writing. Ensuring clarity and coherence. Writing thesis and dissertations. Quoting, paraphrasing, and plagiarism. Plagiarism softwares. Components of oral and poster presentations. | 4 |
| **Unit V** | **Introduction to Biostatistics** | Definition and role of statistics in research. Principles of biostatistics in research. Descriptive statistics: measures of central tendency (mean, median, mode) and measures of deviation (standard deviation, variance, and coefficient of variation). Probability theory: basic concepts and rules. Probability distributions: normal, binomial and poisson. Inferential statistics: confidence intervals. Hypothesis testing: simple, composite, null and alternative hypotheses. Two types of errors, critical region, significance level, size and power of the test. *P*-value and its interpretation. | 6 |
| **Unit VI** | **Advanced Biostatistical Techniques** | Small sample tests for means and variances based on chi-square, t and F distributions. Test of significance for correlation coefficient ($\rho = 0$, $\rho = \rho$) (one and two sample problem). Correlation and regression analysis. Analysis of Variance (ANOVA). Non-Parametric tests: Chi-Square, Mann-Whitney U, Kruskal-Wallis, etc. Survival analysis: Kaplan-Meier curve, Log-Rank test, etc. Meta-analysis and systematic reviews. Data interpretation and presentation. Statistical softwares: introduction to SPSS/R/GraphPad Prism. | 10 |
| **Unit VII** | **Intellectual Property Rights** | Introduction and need for intellectual property rights. IPR in India and abroad. Types of IP: patents, trademarks, copyrights, and trade secrets. Geographical indication and plant varieties: genetic resources and traditional knowledge. Patent laws, WHO and TRIPS agreement. IP protection. Contemporary issues in IPR. Plant variety protection. IPR and sustainable development. Criteria for patentability. Patent filing process: national and international. Infringement and enforcement of IPR. Role of IPR in RandD. IPR in biotechnology and healthcare. | 10 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Research Methodology- C.R. KothariGupta S.C. and V.K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand and Sons, 3rd Edition, 2001.
2. McBurney, D.H. (2007). Research methods; New Delhi, India: Thomson Wadsworth
3. Singh, A.K. (2012). Tests, measurements, and research methods in behavioral sciences. B.B. Printer
4. Best and Kahn, Research Methodology, PHI Limited.
5. Neeraj, P and Khusdeep D. Intellectual Property Rights. India, IN: PHI Learning Private Ltd. 2014.
6. Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited. 2019.
7. Property Rights, Law and Practice, Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, 2013.

# PROJECT/DISSERTATION

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24401RP** | **Research Project** | **Project/Dissertation** | **0** | **0** | **4** | **120** | **0+4=4** |

**Objective:**

The objective of this course is to engage students in systematic investigation and analysis of a specific topic or problem, enabling them to develop critical thinking, research methodologies, and data interpretation skills while contributing original insights and solutions to their field of study.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Learn and apply various research methods, including data collection, analysis, and interpretation, to systematically investigate a chosen topic.

**LO2:** Enhance the ability to critically evaluate sources, arguments, and data to draw well-supported conclusions.

**LO3:** Address complex questions or issues through innovative approaches and evidence-based solutions.

**LO4:** Analyze data and research findings effectively to identify patterns, trends, and correlations relevant to the research question.

**LO5:** Develop skills in writing clear, coherent and well-organized research reports or papers that adhere to academic standards and conventions.

**LO6:** Gain proficiency in reviewing existing research and literature to contextualize and support the research project's objectives and findings.

**LO7:** Understand and apply ethical considerations in conducting research, including integrity, confidentiality, and proper citation practices.

# MOLECULAR DIAGNOSTICS AND FORENSIC SCIENCE AND BIOTECHNOLOGY PRACTICAL

| Course Code | Category | Course Name | L | T | P | Total Hr | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24401DSP** | **Discipline Specific Practical** | **Molecular Diagnostics and Forensic Science and Biotechnology (Practical)** | **0** | **0** | **2** | **60** | **0+2=2** |

**Objective:**

The objective of this course is to emphasize the students to gain knowledge of fundamental molecular biology techniques used in diagnostics to detect, monitor and manage various diseases and also to examine various forensic evidence and apply biotechnological tools in forensic investigations, considering ethical, legal, and social implications.

**Learning Outcomes:**

Upon completion of the course, student will be able to:

**LO1:** Develop skills in collection, handling and transportation of infectious samples.

**LO2:** Learn the technique of processing and analysis of various samples using appropriate molecular diagnostics techniques.

**LO3:** Demonstrate the ability to document crime scenes, physical evidence, and scientific process of various samples.

**LO4:** Interpret and analyze forensic evidence, considering ethical, legal, and social implications.

**LO5:** Design and implement laboratory protocols integrating biotechnological tools for forensic investigations.

**LO6:** Perform forensic DNA profiling in clinical and forensic contexts.

**LO7**: Explore the industrial, clinical, and forensic applications of biotechnology, including regulatory and ethical considerations.

| Sr. No. | List of Experiments |
|---|---|
| 1 | To collect, transport, store and process clinical samples from different sources. |
| 2 | To extract and purify DNA from biological samples. |
| 3 | To quantify nucleic acids using spectrophotometry. |
| 4 | To use gel electrophoresis to separate and visualize DNA fragments. |
| 5 | To carry out restriction enzyme digestion and analyze restriction fragment length polymorphisms (RFLPs). |
| 6 | To perform nucleic acid labeling and Southern Hybridization |
| 7 | To isolate and analyze proteins using SDS-PAGE. |
| 8 | To purify proteins through chromatography techniques. |
| 9 | To evaluate the efficacy of antimicrobial agents using microbial culture techniques. |
| 10 | To analyze forensic samples for toxic substances using chromatography. |
| 11 | To perform Polymerase Chain Reaction (PCR) and analyze the amplification results. (D) |
| 12 | To conduct quantitative PCR (qPCR) for gene expression analysis. (D) |
| 13 | To perform DNA sequencing and interpret sequencing data. (D) |
| 14 | To apply DNA fingerprinting techniques for forensic analysis. (D) |
| 15 | To prepare a report on the role of DNA typing in identifying paternity. |
| 16 | To forensically identify hair and fibre morphology. |
| 17 | To prepare slides of scale pattern and examine human hair for cortex and medulla. |

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|---|---|
| 18 | To carry out microscopic examination of pollen grains. |
| 19 | To carry out microscopic examination of diatoms. |
| 20 | To examine blood and blood stains. |
| 21 | To determine the origin of blood by using Cross-over Electrophoresis. |
| 22 | To examine vomit, urine and faecal matter. |
| 23 | To describe the firing mechanisms of different types of firearms with the aid of diagrams. |
| 24 | To identify metallic and organic poisons. |
| 25 | To carry out analysis of gasoline, diesel and kerosene oil. |
| 26 | To isolate and identify microbial communities in various sources. |
| 27 | To separate drugs of abuse by thin layer chromatography. |
| 28 | To identify drug samples using UV-Visible spectroscopy. |
| 29 | To determine blood group and Rh factor from fresh and dried blood samples. |
| 30 | To identify the given stain as saliva and urine. |

## TEXT / REFERENCE BOOKS


1. Sambrook, Joseph and David W. Russell, The Condensed Protocols: From Molecular Cloning: A Laboratory Manual, Cold Spring Harbor, 2006.
2. W.G. Eckert and S.H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).
3. G.T. Duncan and M.I. Tracey in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
4. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of Analytical Chemistry, 6th Edition, Saunders College Publishing, Fort Worth (1992).
5. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991).
6. J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York (1995)
7. J.D. DeHaan, Kirk's Fire Investigation, 3rd Edition, Prentice Hall, New Jersey (1991).
8. L. Stryer, Biochemistry, 3rd Edition, W.H. Freeman and Company, New York (1988).

## FOURTH YEAR: SEMESTER-VIII

# GENE THERAPY

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24411DSC** | **Discipline Specific Core** | **Gene Therapy** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to provide an in-depth understanding of the principles, techniques and ethical considerations involved in using genetic material to treat or prevent diseases.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Grasp the fundamental concepts of gene therapy, including types of vectors used, delivery methods and the underlying molecular mechanisms.

**LO2:** Understand the methodologies, techniques, tools and processes employed in gene therapy.

**LO3:** Define gene therapy and explain its underlying principles, including gene addition, gene editing and gene silencing techniques.

**LO4:** Learn about the current potential applications of gene therapy in treating various genetic disorders, cancer and other diseases.

**LO5:** Develop skills in evaluating experimental design, data interpretation and outcomes from the gene therapy studies.

**LO6:** Discuss ethical considerations in the development and implementation of gene therapy treatments, including patient consent and equitable access.

**LO7:** Evaluate and identify ethical issues and regulatory agencies related to gene therapy.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Overview of Gene Therapy** | Historical development of gene therapy. DNA, RNA, genes, and chromosomes. Gene expression and regulation. Mechanisms of gene therapy. Gene addition, editing and silencing. Types of gene therapy. Somatic vs. germline therapy. Monogenic vs. polygenic disorders. Ethical, legal, and social issues in gene therapy. Patient consent. Limitations of gene therapy. | 5 |
| **Unit II** | **Introduction to Gene Therapy** | Definition and scope of gene therapy. Gene therapy vectors: design and preparation. Viral vectors: retrovirus, adenovirus, lentivirus and adeno associated virus. Non-viral vectors: polymers, liposomes and nanoparticles. Overview of gene editing technologies. CRISPR-Cas9: mechanism, applications and challenges. TALENs and ZFNs: mechanisms and applications. Delivery methods: direct injection, systemic administration, tissue-specific targeting. Safety and efficacy of gene therapy. | 9 |
| **Unit III** | ***In Vitro* Gene Therapy** | Gene therapy in cell cultures. Primary cells vs. cell lines. Transfection methods: physical, mechanical, chemical and viral mediated. *In vitro* models for disease: organoids and induced pluripotent stem cells (iPSCs). *In vitro* gene editing: CRISPR-Cas9 in cell lines, Off-Target effects and optimization. Assessing gene expression and function: qPCR, Western Blotting, flow cytometry, functional assays, reporter gene assays, cell viability and proliferation assays. | 10 |
| **Unit IV** | ***In Vivo* Gene Therapy** | Animal models for gene therapy and ethical considerations: mouse and large animal. Transgenic animal models. *In vivo* gene delivery techniques: intravenous, intramuscular, and intrathecal. Targeted delivery systems. Gene therapy for systemic diseases: hemophilia and metabolic disorders. Gene therapy for organ-specific diseases: lung (cystic fibrosis) and liver (hemophilia). Monitoring and evaluating *in vivo* gene therapy: imaging | 8 |

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| | | techniques and biomarker analysis. Translational research. | |
| **Unit V** | ***Ex Vivo* Gene Therapy** | Definition, principles, advantages and limitations. Cell sources for *ex vivo* therapy: hematopoietic stem cells and mesenchymal stem cells. Genetic modification of cells *ex vivo*: viral and non-viral transduction methods. Gene editing with CRISPR. Expansion and differentiation of modified cells: culture conditions and differentiation protocols. Reintroduction of modified cells into patients. Engraftment and integration. Monitoring and follow-up. | 11 |
| **Unit VI** | **Clinical Applications of Gene Therapy** | Hematologic disorders: gene therapy for hemophilia, sickle cell disease and thalassemia. Genetic disorders: cystic fibrosis and muscular dystrophies. Cancer gene therapy: oncolytic viruses and CAR-T cell therapy. Neurological disorders: gene therapy for Parkinson's disease and spinal muscular atrophy. Ophthalmic disorders: gene therapy for retinitis pigmentosa and Leber's congenital amaurosis. Cardiovascular diseases: gene therapy for heart failure and atherosclerosis. | 12 |
| **Unit VII** | **Regulations and Ethics in Gene Therapy** | Regulatory pathways for gene therapy: FDA and EMA guidelines. IND and BLA submissions. Ethical issues in gene therapy. Informed consent in genetic research. Ethical considerations in germline editing and ethical issues concerning fetal gene therapy. Patenting gene therapy technologies, licensing and commercialization. Data privacy and patient confidentiality. Handling genetic information. Compliance with data protection regulations. Perception and societal impact of gene therapy. Accessibility and equity. | 5 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Principles of Genome analysis- S.B. Primrose and R. M. Twyman (Blackwell Pub), 2010.
2. Genomics: The Science and Technology Behind the Human Genome Project: 6 (John Wiley and Sons) – 2012.
3. Friedman T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor,NY: Cold Spring Harbor Lab.Press.
4. Knipe DM, Howley PM, eds. 2001. Fields Virology. Philadelphia,PA: Lippincott Williams and Wilkins.
5. Hackett NR, Crystal RG. 2000.Adenovirus vectors for gene therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker
6. Gene therapy: Twenty-First Century Medicine. Annu. Rev. Biochem. 2005. 74:711-38
7. Gene therapy: Promises and Problems. Annu. Rev. Genomics Hum. Genet. 2001. 2:177-211.
8. http://www.liebertpub.com/hum
9. www.nature.com/gt/index.html
10. www.nature.com/mt/index.html

# DATA SCIENCE IN HEALTHCARE

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24412DSC** | **Discipline Specific Core** | **Data Science in Healthcare** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to equip students with theoretical foundations and applied learning of data science principles to make data-driven decisions in healthcare and the ability to apply them to real-world challenges.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the fundamental principles of data science and its application in healthcare.

**LO2:** Understand Python programming for data manipulation, visualization, and analysis.

**LO3:** Perform statistical analysis of biological and medical data using appropriate techniques.

**LO4:** Understand machine learning algorithms for predictive modeling and pattern recognition in biological and medical datasets.

**LO5:** Interpret and communicate results obtained from data science analyses in the context of biological and medical research.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction and Working with Data** | Data Science: introduction, definition and applications. Data analytics life cycle. Data science toolkit. Understanding and exploration of data. Types of data: numeric, categorical, graphical and high dimensional data. Classification of digital data: structured, semi-structured and unstructured. Sources of data: time series, transactional data, biological data, spatial data, social network data and data evolution. Introduction to data management and storage: Laboratory Information Management Systems (LIMS), Electronic Data Capture (EDC) Systems, Cloud-based Storage Solutions and Database Management Systems (DBMS). Data preprocessing and quality control (seeing and analyzing). Remediation approaches (filtering, transformations and imputation). Data capture forms and surveys. Introduction to data ethics. | 6 |
| **Unit II** | **Inferential Statistics and Comparative Data Sciences** | Introduction to biostatistics. Getting data into shape: long and wide data. Random variable and probability. Measures of centrality and deviation. Probability distributions: discrete and continuous. Moments of distributions: mean, variance, skewness and kurtosis. Probability density function and cumulative density function. CLT and normal distribution. Sampling distributions: sampling distribution of the mean. Central limit theorem. Histograms, density plots, boxplots and violin plots. Relationship between distributions: normal approximation to binomial. Quantiles and rank statistics. Testing for normality and data transformations. Statistical inference: parametric and non-parametric tests. | 8 |
| **Unit III** | **Modelling and Basic Machine Learning for Healthcare Applications** | Supervised and unsupervised learning. Introduction to linear algebra. Regression: linear and general linear model. Classification: logistic regression and multinomial model. Variable selection: stepwise approaches. Introduction to machine learning and Bayes theorem. High dimensional data: principal component analysis and t-SNE. Machine learning approaches: decision tree, neural networks, SVM, random forest, bayesian networks, overfitting and generalization. Regularization: Lasso, Ridge and Elastic net regression. Unsupervised learning: clustering. | 7 |

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|---|---|---|---|
| **Unit IV** | **Visualization of Healthcare Data** | Introduction to ggplot (R), Matplotlib and seaborn (python). Interactive visualization tools: Tableau, Plotly, D3.js, etc. Advanced visualization strategies: heatmaps, sankey plots, radar charts, sunbursts, word clouds, waterplots and icicle plots. Report generation tools: R Markdown, Jupyter Notebooks and LaTeX. | 5 |
| **Unit V** | **Advanced Data Science Applications in Healthcare** | Introduction and multi-layer perceptron. Introduction to TensorFlow and Feedforward Neural Networks. Activation functions and training neural networks. Learning from images: Convolutional Neural Networks (CNNs). Learning from sequences: Recurrent Neural Networks (RNNs). Introduction to natural language processing. Applications of data science: healthcare care, research and patient care. | 4 |

**METHODOLOGY:**

The course would be taught through lecture sessions.

**BOOKS RECOMMENDED**:


1. Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, John Wiley and Sons, 2014.
2. Nathan Yau, Visualize This: The FlowingData Guide to Design, Visualization, and Statistics, Wiley, 2011.
3. Chandan K. Reddy and Charu C. Aggarwal, Healthcare data analytics, Taylor and Francis, 2015.
4. Hui Yang and Eva K. Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016
5. Python for Data Analysis. Wes McKinney (Indian Edition: O'Reilly Media)
6. Biostatistics: A Foundation for Analysis in the Health Sciences by Wayne W. Daniel and Chad L. Cross (Indian Edition: Wiley India Pvt. Ltd.)
7. Introduction to Machine Learning with Python: A Guide for Data Scientists. Andreas C. Müller and Sarah Guido (Indian Edition: O'Reilly Media)
8. Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten, Eibe Frank, Mark A. Hall, and Christopher J. Pal (Indian Edition: Morgan Kaufmann Publishers).
9. Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools by Vince Buffalo (Indian Edition: O'Reilly Media).

# NANOBIOTECHNOLOGY

| Course Code | Category | Course Name | L | T | P | Total Hr. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24413DSC** | **Discipline Specific Core** | **Nanobiotechnology** | **2** | **0** | **0** | **30** | **2+0=2** |

**Objective:**

The objective of this course is to provide basics of biological/applied sciences in creating new and exciting applications of nanoscience in biotechnology where it can be used to improve our everyday life.

**Learning Outcomes:**

Upon completion of this course, students will be able to:

**LO1:** Describe the fundamental properties of materials at nanometer scale and principles behind modern experimental techniques used to study nanomaterials.

**LO2:** Comprehend the top-down and bottom-up approach for production of nanoparticles by different methods.

**LO3:** Understand the advanced techniques used for characterization of nanomaterials.

**LO4:** Describe the role and significance of nanoparticles in the targeted drug delivery system.

**LO5:** Appreciate the potential of nanobiotechnology in the field of modern bioimaging, diagnostics and biosensors**.**

**LO6:** Express risk assessment strategies in usage of nanoparticles in various healthcare applications.

| Sr. No. | Topic | Detail of syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Introduction to Nanoscience and Nanotechnology** | Nanoscience and nanotechnology: definition, history and types. Basics of nanomaterial: size effect, surface to volume ratio, atomic structure, molecules and phases, energy at the nanoscale and quantum effects. Types of nanoparticles and their properties: magnetic, polymeric, lipid, metal (gold, silver etc.), metal oxide and composite nanoparticles. Natural nanomaterials: cellular nanostructures, nanopores, biomolecular motors and bio-inspired nanostructures. Recent special nanomaterials: graphene-core-shell structures, micro and mesopores materials, organic-inorganic hybrids, ZnO-silicon and DNA-RNA nanoproduct. Applications of nanobiotechnology in chronic and infectious diseases, environment and food science. | 5 |
| **Unit II** | **Synthesis and Characterization of Nanomaterials** | Biomaterials: introduction, types, chemistry, properties and applications. Biodegradable polymers: introduction, examples, properties and uses. Synthesis and applications of polymer nanofibers and thin film. Selection of biomaterials and concept of biocompatibility. Top-down (MEMS and photolithography) and bottom-up (chemical reduction, emulsification and nanoprecipitation) approaches for nanomaterial synthesis. Physical methods: microwave assisted, core-shell nanostructure and quantum dot (QDs) synthesis. Chemical methods: chemical precipitation and coprecipitation, Sol-Gel, microemulsions, hydrothermal and solvothermal synthesis. Biological methods: overview, concept, sources and synthesis of microbial and plant mediated nanoparticle. Advantages and disadvantages. Characterization of nanomaterials: optical (UV-Vis/Fluorescence), X-ray diffraction, imaging and size (electron microscopy, light scattering and zetapotential), surface and composition (ECSA, EDAX, AFM/STM etc.), vibrational (FT-IR and RAMAN), SERS, magnetic, electrical and electrochemical. | 10 |

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|---|---|---|---|
| **Unit III** | **Nanomaterial and Tissue Interactions** | Protein and cell-material interactions. Blood-material interactions. Inflammatory, immune and angiogenic response to biomaterials. Influence of nanoscale properties on cellular interactions: porosity, mechanical strength, surface characteristics and modifications and degradation. | 2 |
| **Unit IV** | **Nanomaterials in Diagnostics/Drug Delivery and Therapeutics** | Functionalized nanoparticles in diagnostics and imaging: quantum dots as an imaging probe and paramagnetic particles for magnetic resonance imaging. Nanomaterials in drug delivery: surface modified nanoparticles, MEMS/NEMS based nanomaterials and peptide/DNA coupled nanoparticles. Nanoparticles for drug delivery: concepts, optimization for suitability, various routes of delivery and advantages. Drug delivery via. lipid, inorganic, metal/metal oxide (antibacterial/antifungal/ antiviral) and anisotropic and magnetic (hyperthermia) nanoparticles. Dendrimers: Dendrimers as nanoparticulate drug carrier, encapsulation and conjugation of drugs in dendrimers. Cytotoxic and genotoxic effects of nanomaterials. | 7 |
| **Unit V** | **Targeted Drug Delivery** | Concept of controlled drug delivery: thermosensitive, pH sensitive and enzyme triggered drug release. Hydrogels: natural and synthetic. Strategies for cellular internalization, long circulation, enhanced permeation and *in vivo* fate of nanoparticles. | 3 |
| **Unit VI** | **Nanobiosensors** | Principle, components, functionalization, fabrication, types and applications of biosensors. Biosensing methods: colorimetric, FRET and electrochemical. Antibodies as biosensors, biosensors for glucose estimation, etc. Impact and ethical considerations of nanobiotechnology on environment, society and healthcare industry. | 3 |

**METHODOLOGY:**

The course would be taught through lecture sessions.

**BOOKS RECOMMENDED**:


1. Christof M. Niemeyer, Chad A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley, 2004
2. A. Goswami, S.R. Choudhury, Nanobiotechnology: Basic and Applied Aspects, Anthem Press, 2017.
3. Tatsuya Okuda, Ben-Shung Chow, Nanobiotechnology: Concepts Applications and Perspectives, Scitus Academics LLC, 2018.
4. Yubing Xie, The Nanobiotechnology Handbook, CRC Press, 2012.
5. David S. Goodsell, "Bionanotechnology", John Wiley and Sons inc., publications, 2004.
6. Shanmugam.S, "Nanotechnology", MJP publishers, 2010.
7. Niemeyer, C.M. Mirking C.A., "Nanobiotechnology concepts, Applications and Perpectives", 2004.
8. Manasi Karkare, "Nanotechnology", I.K. International publishing House Pvt. Ltd, 2008.
9. Sulabha K. Kulkarni, (2009), Nanotechnology; Principals and Practices, NewDelhi, Capital Publishing.
10. Michael A. Stroscio and Mitra Dutta, (2004), Biological Nanostructures and Application of Nanostructures in Biology, Kulwer Academic Publishers.
11. Elisabeth S. Papazoglou, Aravind Parthasarathy, (2007), Bio-Nanotechnology, Morgan and Claypool Publishers' series.
12. Rao N.R., Achim Müller, Anthony K. Cheetham (2004). The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C, Wiley Publisher.
13. Mark Ratner and Daniel Ratner, Nanotechnology: A Gentle Introduction to Next Big Idea, Low Price edition, Third Impression, Pearson Education.
14. Schmidt G., Wiley Weinheim (2004), Nanoparticles: From theory to applications.
15. Geoffrey A. Ozin, Andre C. Arsenault, Ludovico Cademartiri, Chad A. Mirkin (2005), Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge UK.

# CLINICAL RESEARCH, PHARMACOVIGILANCE AND HEALTHCARE ANALYTICS

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24414DSC** | **Discipline Specific Core** | **Clinical Research, Pharmacovigilance and Healthcare Analytics** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to equip students with comprehensive knowledge and practical skills necessary for conducting clinical research, monitoring drug safety effectively, and leveraging data analytics to optimize healthcare practices.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the strategies and techniques involved in drug discovery process.

**LO2:** Gain knowledge of different types of clinical trials, study designs, and ethical considerations.

**LO3:** Understand the importance of use of placebo controls and placebo response in clinical trials.

**LO4:** Learn how to monitor, assess, and prevent adverse effects of pharmaceutical products.

**LO5:** Acquire skills in collecting, organizing, and managing healthcare data for analysis.

**LO6:** Understand the analytical methods and tools used to interpret clinical and patient data.

**LO7:** Understand regulatory frameworks and requirements governing clinical trials and pharmacovigilance.

**LO8:** Develop strategies to identify, assess, and mitigate risks associated with healthcare interventions.

**LO9:** Learn how to measure and evaluate clinical outcomes and their impact on patient care.

**LO10:** Gain insights into improving patient safety and healthcare quality through data-driven approaches.

**LO11:** Enhance skills in working collaboratively with healthcare professionals, researchers, and regulatory bodies.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Drug Discovery and Development** | Definition and scope of drug discovery. Historical perspective and milestones, stages, target and pathways in new drug discovery and development. Combinatorial chemistry and target-centered drug design. Lipinski rule five. Drug targets and biomarkers: identification and validation of drug targets. Role of biomarkers in drug development and strategies for target-based drug discovery. High Throughput Screening (HTS): principle and methodologies, screening libraries, assay development and Hit-to-lead optimization process. Preclinical development: pharmacokinetics and pharmacodynamics. Cell-based assays, *in vitro* and *in vivo* models in preclinical testing and safety assessment. Toxicology studies: acute, sub-acute and chronic toxicity. Organ specific toxicity, mutagenicity, teratogenicity and carcinogenicity. Effect of drug on reproductive system. Drug formulation and delivery: formulation strategies for drug candidates, dosage forms, routes of administration and drug delivery systems. Problems in extrapolating data from animals to humans. | 12 |
| **Unit II** | **Introduction Clinical Trials** | Definition, objectives and scope of clinical research. Clinical research vs clinical trials. Roles and responsibilities of key players in clinical trials. Phases of clinical trials. Phase I: objectives, design, safety, dose escalation and ethical considerations. Phase II: objectives, design, sample size considerations, efficacy testing, study population and regulatory pathways. Phase III: objectives, design (including randomized controlled trials), large-scale efficacy and safety trials, adaptive trial designs and regulatory requirements. Overview and types | 12 |

| | | | |
|---|---|---|---|
| | | of clinical studies: observational studies (cohort, case-control and cross-sectional) and experimental studies (randomized controlled trials (RCTs) and non-randomized trials). Meta-analyses and systematic reviews. Inclusion and exclusion criteria. Clinical trial design: methods of randomization, blinding, screening and recruitment of subjects. Placebo response and biomarkers. Components and structure of protocol development, feasibility assessment and study planning. Conducting clinical trials: site selection and recruitment strategies, informed consent process and participant enrolment. Special populations in clinical trials. Data collection, monitoring and quality assurance. Multicentre clinical trials: requirements, regulations and feasibility. Bias in clinical research. | |
| **Unit III** | **Ethical Issues in Clinical Research** | Definition and importance of ethics in clinical research. Tuskegee experiment, Nuremberg Code, Declaration of Helsinki, Belmont report, Thalidomide tragedy, Drugs and Cosmetics Act 1945 and Schedule Y. ICH, ICH-GCP and WHO guidelines. Ethics on use of Placebo in clinical trials. Establishment of CIOMS, NIH and ICMR guidelines. Negligence, legal, strict and criminal liability in clinical research. Composition, role and functions of IRB/IEC/ERB. Challenges in obtaining informed consent from vulnerable populations. Fraud in clinical research and violations of ethics in research. | 5 |
| **Unit IV** | **National and International Regulations Governing Clinical Trials** | National Regulatory Bodies: CDSCO and ICMR. International Regulatory Bodies: USFDA, USA, EMEA, Europe, MHRA, UK and TGA, Australia. Regulatory toxicology: OECD guidelines. GMP, GLP, GDP, GCP, GAMP and GXP's regulations. Types of audits, inspections and regulatory audits: FDA, MHRA, PMDA, TGA and DCGI. Indian GMP regulations: Drugs and Cosmetics Act-1940, Schedule M requirements, requirements for procuring GMP license (forms, procedures, inspections, import and export requirements). WHO-CoPP. Regulatory requirements of traditional medicines: AYUSH, USFDA, Health Canada, EMEA, and TGA. | 5 |
| **Unit V** | **Clinical Data Management** | Objectives, roles, tools and guidelines for clinical data management (CDM). CDM process. Data management plan (DMP): introduction, need, purpose and framework for creating a DMP. Protocol for informed consent documents, investigator's brochure, case report form and clinical study report. Electronic data capture (EDC) system, verification of EDC setup, implementation and user acceptance testing (UAT). Purpose and techniques for designing CRF/IXRS. Paper CRF vs. electronic CRF. Data entry, data collection, CRF tracking, CRF processing and inventory from site. Data validation and discrepancy management. Data storage and archival. | 5 |
| **Unit VI** | **Pharmacovigilance and Safety Monitoring** | Adverse drug reactions and safety reports: difference between adverse event and adverse drug reaction. Classification of ADR, SAE reporting, side effects and medication errors. Methodologies and assessment of medicines: passive reporting, spontaneous reports and case series. Active surveillance, targeted clinical investigations and descriptive studies. Assessment criteria: expectedness assessment, causality assessment, Naranjo algorithm and Hill's criteria. Pharmacovigilance regulatory bodies: CDSCO, India, FDA, USA, EMEA, Europe, MHRA, UK and TGA, Australia. Pharmacovigilance of herbal medicines: current status, challenges and future directions. Good Pharmacovigilance Practices (GVP). Coordination of pharmacovigilance inspections, guidelines on PV inspections (NMRA), pharmacovigilance audits and regulatory inspections and common findings. | 12 |
| **Unit VIII** | **Healthcare Analytics** | Role, key applications and benefits of analytics in healthcare. Visualizing and understanding healthcare datasets. Basics, data manipulation and analysis of healthcare data using R and Python | 11 |

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|---|---|---|---|
| | | programming. Methods of qualitative data analysis. Applications of artificial intelligence and machine learning in healthcare. Basics of data warehousing and management. Talent acquisition and performance measurement. Strategies for ensuring data security and compliance. Risk management in healthcare. Big data technologies in healthcare (Hadoop and SPARK): applications and challenges. | |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Principles and practice of pharmaceutical medicine, Second edition. Authors:Lionel. D. Edward, Aadrew.J.Flether Anthony W Fos , Peter D Sloaier Publisher:Wiley;
2. Handbook of clinical research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone
3. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
4. Central Drugs Standard Control Organization. Good Clinical Practices- Guidelines for Clinical Trials on Pharmaceutical Products in India. NewDelhi: Ministry of Health.
5. International Conference on Harmonisation of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonised Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996.
6. Ethical Guidelines for Biomedical Research on Human Subjects. Indian Council of Medical Research, New Delhi.
7. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, John Wiley and Sons. 8. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
8. Goodman and Gilman: JG Hardman, LE Limbard, McGraw Hill Publications.
9. Relevant review articles from recent medical and pharmaceutical literature.
10. Principles of Management", PC Tripati, PN Reddy,–Tata Mc Graw Hill
11. Dynamics of Entrepreneurial Development and Management" Vasant Desai Himalaya Publishing House.

# BIOENTREPRENEURSHIP

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24411DSE** | **Discipline Specific Elective** | **Bioentrepreneurship** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The aim of this course is to orient the learner towards comprehensive understanding of the life science sector, entrepreneurship skills, specialized methodological knowledge and behavior for effectiveness at work necessary to innovate, launch, and manage successful ventures within the biotech, pharmaceutical, medical technology or related industries.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Identify and evaluate entrepreneurial opportunities within the biotech and life sciences sectors.

**LO2:** Deal with complex phenomena, issues and situations during project management or business development within the biotech, pharmaceutical, medical technology or related industries.

**LO3:** Navigate the regulatory, ethical, and IP landscape specific to life sciences sectors.

**LO4:** Apply financial management, marketing strategies, and operational principles to biotech startups.

**LO5:** Demonstrate effective leadership and teamwork skills in managing biotech projects.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Innovation and Bio-entrepreneurship** | Introduction and scope in bio-entrepreneurship. Biotechnology in a global scale and in India. Competitive dynamics of pharma and biotech industries. Innovation: types and opportunities for bioentrepreneurship. Major start-ups in biotechnology. Concept and theories of entrepreneurship. Central marketing theories, strategies and instruments for biotechnology firms. Tools for strategic decision. Government schemes for commercialization of technology (eg. Biotech Consortium India Limited). Entreprenuership development and funding programs of public and private agencies (MSME, DBT, BIRAC, Startup and Make in India). Biotechnology based products and services–license and protection. IPR issues in bioentrepreneurships. | 8 |
| **Unit II** | **Biotech Enterprises and Financial Analysis** | Desirables in start-up. Setting-up small, medium and large-scale industry. Quality control in biotech industries. Location of enterprise, steps for starting a small-scale industry, incentives and subsidies. Exploring export possibilities. Ratio analysis, investment process, break even analysis, profitability analysis, budget and planning. | 6 |
| **Unit III** | **Project Management** | Project cycle and its features. Matrixes and tools for project management (Gantt charts, canvas, and other online tools etc.). Data and management flow, stakeholder analysis, scoping, scheduling and costing of projects. Organizational structures and management. Risk assessment and risk management. Reporting and communication. Community engagement and stakeholders in planning and execution of a project. Specifics of research management (writing a data management plan, GDPR, data repositories, etc.). | 9 |
| **Unit IV** | **Product Development in Life Sciences** | Market analysis, SWOT analysis, product development process and types of purchasing. Supply chain and total quality management. Technological tools and methods for life science product development. Cost-effectiveness requirements. New product adoption and product-life-cycle management. Ethical considerations and regulatory requirements in product development. Stanford biodesign process. Intellectual Property Rights. Regulatory process for medical devices. | 7 |

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|---|---|---|---|
| **Unit V** | **Industrial Management** | Industry structure, value chains, and competition in bio-markets. Industrial value creation: technical development as a competition factor, technology-based business models and strategies. Innovation, production and marketing organization. Firm boundaries and the role of mergers and acquisitions. Human resource management and characteristics of leadership. | 7 |
| **Unit VI** | **Finance and Accounting** | Business plan preparation: statutory and legal requirements. Business feasibility study. Financial management issues: procurement of capital and management of costs. Collaborations and partnership. Information technology in bio-business. Product costing, Cost/Income analysis. Investment appraisal. Financial accounting and corporate finance. | 6 |
| **Unit VII** | **Technology Management** | Technology assessment, development and upgradation. Managing technology transfer. Quality control and transfer of foreign technologies. Knowledge centers and technology transfer agencies. Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA and GMP). | 5 |
| **Unit VIII** | **Business Development** | Methods for business intelligence and competitor analysis. Business model canvas. Due diligence of projects and companies. Valuation of projects and companies. Strategies and processes of negotiation with financiers, government and regulatory authorities. Pricing strategies, decision-making and contract design. Partnerships pros and cons and factors influencing outcome of partnerships. Basic contract principles, types, development of agreements and dispute resolution skills. | 7 |
| **Unit IX** | **Marketing and Sales in Life Sciences** | Psychology of buying and buying behaviour. Challenges in marketing bio-business. Marketing technology: communication, brand management, personal selling, sales psychology, marketing and sales automation. Sales methodology and sales processes. Key account management. Sales organization and sales management. Marketing success metrics and methods of data collection. | 5 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Adams, D.J., Sparrow, J.C. 2008. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
2. Shimasaki, C.D. 2014. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press.
3. Onetti, A., Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
4. Jordan, J. F. 2014. Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
5. Desai, V. 2009. Dynamics of Entrepreneurial Development and Management. Himalaya Pub. House.
6. Entrepreneurship Development Institute in India. 1987. Developing New Entrepreneurs, EDII, Ahmedabad.
7. Mancuso, Joseph 1974. The Entrepreneurs Handbook, Vol I and II, Artech House Inc. USA.
8. Patel, V.G. 1987. Entrepreneurship Development in India and its relevant Developing Countries, Entrepreneurship Development Institute of India, Ahmedabad.
9. Mohanty, S.K. 2009. Fundamentals of Entrepreneurship. Prentice Hall of India Pvt. Ltd., New Delhi.
10. Sagar Mondal and Ray, G.L. 2009. Text Book of Entrepreneurship and Rural Development. Kalyani publishers, Ludhiana.
11. Vasanta Desai 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Pub. House.
12. Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
13. Nandan H. 2011. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.
14. A.K.Singh, 2009. Entrepreneurship Development and Management. Lakshmi Publications Ltd.,
15. Chole R.R., Kapse P.S., Deshmukh P.R. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur.

# ON JOB TRAINING

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24411OJT** | **OJT** | **On Job Training (External)** | **0** | **0** | **4** | **120** | **0+4=4** |

**Overview**

On-Job training (OJT) is a practical approach to acquiring new competencies and skills needed for a job in a real, or close to real, working environment. It is often used to learn how to use particular tools or equipment in a live-work practice, simulated, or training environment. OJT exposes students to real-world biotechnology applications and offers invaluable practical experience and effective professionals by bridging the knowledge gap between theory and practice. It enables students to apply the biotechnological skills they have acquired in the classroom to practical scenarios, like carrying out laboratory experiments, making use of specialized tools, and analysing data. Students will gain practical experience in the biotech sector in settings such as research labs, bioprocessing plants, pharmaceutical firms, or healthcare facilities. Interaction between OJT students and seasoned scientists, researchers, and professionals—as well as mentors and supervisors—will improve the students' learning experience by offering advice, their knowledge, and insights into industry best practices. Their exposure not only provides students with the chance to learn about the latest developments in the biotech sector and contribute to practical research, but it also allows them to network with specialists in the industry, which may lead to future partnerships or career prospects.

**Following are the intended objectives of engaging the students in On Job Training program:**

- To provide experience of real work environment with faculty guidance over a specific period.
- To familiarize students with research methods, analytical tools and techniques along with their appropriate usage and troubleshooting.
- To provide exposure to emerging technologies/ automation and how it can support, facilitate, improve, and reinforce work processes/ culture/ job roles/art and craft.
- To promote academic and professional developments.
- To help students identify the career paths.
- To provide an opportunity to jumpstart their professional careers and supplement their courses with hands-on experience making them employment ready.
- To enhance their research potential.
- To improve the professional network.

# Guidelines for On Job Training in Biotechnology-based Industry for B.Sc. (Hons.) Medical Biotechnology:

**1. OJT Program Structure:**

i) The duration of the OJT must be one month or more or as per regulation.

ii) Students are allowed to choose any bio-based/pharmaceutical industry, research/academic institute/ health care hospitals or any other related facility covering different aspects of research and development, production, quality control, and regulatory compliances in the field of life sciences.

**2. How to identify OJT?**

Students with specific objectives and with the help of teachers and alumni need to identify reputable organizations offering OJT opportunity and must ensure the availability. Once after ensuring the availability the student shall apply through proper channel.

**3. Assigning Mentors and Supervisors:** The college need to appoint experienced professionals as mentors/supervisors for the students during the OJT period. They should provide guidance, monitor progress, and facilitate learning experiences.

**4. Regular Progress Review and Record Keeping:** Mentor/Mentor's should conduct periodic evaluations to track the students' progress during the OJT and should maintain a detailed record of the tasks performed, skills learned, and achievements during the OJT.

**5. Evaluation Process:** The CIA for 40% will be based on the periodic evaluation by the mentor. Semester End Examination evaluation for 60% will be based on the report submitted and presentation made by the students.

# CLINICAL RESEARCH AND BIOENTREPRENEURSHIP

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24411DSE** | **Discipline Specific Elective** | **Clinical Research and Bioentrepreneurship** | **4** | **0** | **0** | **60** | **4+0=4** |

**Objective:**

The objective of this course is to equip students with comprehensive knowledge and practical skills necessary for conducting clinical research and inculcate entrepreneurship skills to innovate, launch, and manage successful ventures within the biotech and healthcare sector.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

**LO1:** Understand the strategies and techniques involved in drug discovery process.
**LO2:** Gain knowledge of different types of clinical trials, study designs, and ethical considerations.
**LO3:** Understand the importance of use of placebo controls and placebo response in clinical trials.
**LO4:** Learn how to monitor, assess, and prevent adverse effects of pharmaceutical products.
**LO5:** Acquire skills in collecting, organizing, and managing data for analysis.
**LO6:** Understand the analytical methods and tools used to interpret clinical and patient data.
**LO7:** Understand regulatory frameworks and requirements governing clinical trials and pharmacovigilance.
**LO8:** Identify and evaluate entrepreneurial opportunities within the biotech and life sciences sectors.
**LO9:** Deal with complex phenomena, issues and situations during project management or business development within the biotech, pharmaceutical, medical technology or related industries.
**LO10:** Navigate the regulatory, ethical, and IP landscape specific to life sciences sectors.
**LO11:** Apply financial management, marketing strategies, and operational principles to biotech startups.
**LO12:** Demonstrate effective leadership and teamwork skills in managing biotech projects.

| Sr. No. | Topic | Detail of Syllabus | Hrs. |
|---|---|---|---|
| **Unit I** | **Drug Discovery and Development** | Definition and scope of drug discovery. Historical perspective and milestones, stages, target and pathways in new drug discovery and development. Combinatorial chemistry and target-centered drug design. Lipinski rule five. Drug targets and biomarkers: identification and validation of drug targets. Role of biomarkers in drug development and strategies for target-based drug discovery. High Throughput Screening (HTS): principle and methodologies, screening libraries, assay development and Hit-to-lead optimization process. Preclinical development: pharmacokinetics and pharmacodynamics. Cell-based assays, *in vitro* and *in vivo* models in preclinical testing and safety assessment. Toxicology studies: acute, sub-acute and chronic toxicity. Organ specific toxicity, mutagenicity, teratogenicity and carcinogenicity. Effect of drug on reproductive system. Drug formulation and delivery: formulation strategies for drug candidates, dosage forms, routes of administration and drug delivery systems. Problems in extrapolating data from animals to humans. | 9 |
| **Unit II** | **Introduction Clinical Trials** | Definition, objectives and scope of clinical research. Clinical research vs clinical trials. Roles and responsibilities of key players in clinical trials. Phases of clinical trials. Phase I: objectives, design, safety, dose escalation and ethical considerations. Phase II: objectives, design, sample size considerations, efficacy testing, study population and regulatory pathways. Phase III: objectives, | 10 |

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|---|---|---|---|
| | | design (including randomized controlled trials), large-scale efficacy and safety trials, adaptive trial designs and regulatory requirements. Overview and types of clinical studies: observational studies (cohort, case-control and cross-sectional) and experimental studies (randomized controlled trials (RCTs) and non-randomized trials). Meta-analyses and systematic reviews. Inclusion and exclusion criteria. Clinical trial design: methods of randomization, blinding, screening and recruitment of subjects. Placebo response and biomarkers. Components and structure of protocol development, feasibility assessment and study planning. Conducting clinical trials: site selection and recruitment strategies, informed consent process and participant enrolment. Special populations in clinical trials. Data collection, monitoring and quality assurance. Multicentre clinical trials: requirements, regulations and feasibility. Bias in clinical research. | |
| **Unit III** | **Ethical Issues in Clinical Research** | Definition and importance of ethics in clinical research. Tuskegee experiment, Nuremberg Code, Declaration of Helsinki, Belmont report, Thalidomide tragedy, Drugs and Cosmetics Act 1945 and Schedule Y. ICH, ICH-GCP and WHO guidelines. Ethics on use of Placebo in clinical trials. Establishment of CIOMS, NIH and ICMR guidelines. Negligence, legal, strict and criminal liability in clinical research. Composition, role and functions of IRB/IEC/ERB. Challenges in obtaining informed consent from vulnerable populations. Fraud in clinical research and violations of ethics in research. | 5 |
| **Unit IV** | **National and International Regulations Governing Clinical Trials** | National Regulatory Bodies: CDSCO and ICMR. International Regulatory Bodies: USFDA, USA, EMEA, Europe, MHRA, UK and TGA, Australia. Regulatory toxicology: OECD guidelines. GMP, GLP, GDP, GCP, GAMP and GXP's regulations. Types of audits, inspections and regulatory audits: FDA, MHRA, PMDA, TGA and DCGI. Indian GMP regulations: Drugs and Cosmetics Act-1940, Schedule M requirements, requirements for procuring GMP license (forms, procedures, inspections, import and export requirements). WHO-CoPP. Regulatory requirements of traditional medicines: AYUSH, USFDA, Health Canada, EMEA, and TGA. | 5 |
| **Unit V** | **Clinical Data Management** | Objectives, roles, tools and guidelines for clinical data management (CDM). CDM process. Data management plan (DMP): introduction, need, purpose and framework for creating a DMP. Protocol for informed consent documents, investigator's brochure, case report form and clinical study report. Electronic data capture (EDC) system, verification of EDC setup, implementation and user acceptance testing (UAT). Purpose and techniques for designing CRF/IXRS. Paper CRF vs. electronic CRF. Data entry, data collection, CRF tracking, CRF processing and inventory from site. Data validation and discrepancy management. Data storage and archival. | 5 |
| **Unit VI** | **Innovation and Bio-entrepreneurship** | Introduction and scope in bio-entrepreneurship. Biotechnology in a global scale and in India. Competitive dynamics of pharma and biotech industries. Innovation: types and opportunities for bioentrepreneurship. Major start-ups in biotechnology. Concept and theories of entrepreneurship. Central marketing theories, strategies and instruments for biotechnology firms. Tools for strategic decision. Government schemes for commercialization of technology (eg. Biotech Consortium India Limited). Entreprenuership development and funding programs of public and private agencies (MSME, DBT, BIRAC, Startup and Make in India). Biotechnology | 5 |

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|---|---|---|---|
| | | based products and services–license and protection. IPR issues in bioentrepreneurships and biosafety. | |
| **Unit VII** | **Biotech Enterprises and Financial Analysis** | Desirables in start-up, setting-up small, medium and large-scale industry. Quality control in biotech industries. Location of an enterprise, steps for starting a small-scale industry, incentives and subsidies. Exploring export possibilities. Ratio analysis, investment process, break even analysis, profitability analysis, budget and planning. | 5 |
| **Unit VIII** | **Project Management** | Project cycle and its features. Matrixes and tools for project management (Gantt charts, canvas, and other online tools etc.). Data and management flow, stakeholder analysis, scoping, scheduling and costing of projects. Organizational structures and management. Risk assessment and risk management. Reporting and communication. Community engagement and stakeholders in planning and execution of a project. Specifics of research management (writing a data management plan, GDPR, data repositories, etc.). | 6 |
| **Unit IX** | **Product Development in Life Sciences** | Market analysis, SWOT analysis, product development process, types of purchasing, supply chain management and total quality management. Technological tools and methods for life science product development. Cost-effectiveness requirements. New product adoption and product-life-cycle management. Ethical considerations and regulatory requirements in product development. Stanford biodesign process. Intellectual Property Rights. Regulatory process for medical devices. | 5 |
| **Unit X** | **Industrial Management** | Industry structure, value chains, and competition in bio-markets. Industrial value creation: technical development as a competition factor, technology-based business models and strategies. Innovation, production and marketing organization. Firm boundaries and the role of mergers and acquisitions. Human resource management and characteristics of leadership. | 5 |

## METHODOLOGY

The course would be taught through lecture sessions.

## BOOKS RECOMMENDED:


1. Principles and practice of pharmaceutical medicine, Second edition. Authors:Lionel. D. Edward, Aadrew.J.Flether Anthony W Fos , Peter D Sloaier Publisher:Wiley;
2. Handbook of clinical research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone
3. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
4. Central Drugs Standard Control Organization. Good Clinical Practices- Guidelines for Clinical Trials on Pharmaceutical Products in India. NewDelhi: Ministry of Health.
5. International Conference on Harmonisation of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonised Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996.
6. Ethical Guidelines for Biomedical Research on Human Subjects. Indian Council of Medical Research, New Delhi.

7. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
8. Goodman and Gilman: JG Hardman, LE Limbard, McGraw Hill Publications.
9. Relevant review articles from recent medical and pharmaceutical literature.
10. Principles of Management", PC Tripati, PN Reddy,–Tata Mc Graw Hill
11. Dynamics of Entrepreneurial Development and Management" Vasant Desai Himalaya Publishing House.
12. Adams, D.J., Sparrow, J.C. 2008. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
13. Shimasaki, C.D. 2014. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press.
14. Onetti, A., Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
15. Jordan, J. F. 2014. Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
16. Desai, V. 2009. Dynamics of Entrepreneurial Development and Management. Himalaya Pub. House.
17. Entrepreneurship Development Institute in India. 1987. Developing New Entrepreneurs, EDII, Ahmedabad.
18. Mancuso, Joseph 1974. The Entrepreneurs Handbook, Vol I and II, Artech House Inc. USA.
19. Patel, V.G. 1987. Entrepreneurship Development in India and its relevant Developing Countries, Entrepreneurship Development Institute of India, Ahmedabad.
20. Mohanty, S.K. 2009. Fundamentals of Entrepreneurship. Prentice Hall of India Pvt. Ltd., New Delhi.
21. Sagar Mondal and Ray, G.L. 2009. Text Book of Entrepreneurship and Rural Development. Kalyani publishers, Ludhiana.
22. Vasanta Desai 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Pub. House.
23. Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
24. Nandan H. 2011. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.
25. A.K.Singh, 2009. Entrepreneurship Development and Management. Lakshmi Publications Ltd.,
26. Chole R.R., Kapse P.S., Deshmukh P.R. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur.

# RESEARCH PROJECT (EXTERNAL/ INHOUSE)

| Course Code | Category | Course Name | L | T | P | Total Hrs. | Credits (T+P) |
|---|---|---|---|---|---|---|---|
| **BT 24411RP** | **Research Project** | **Research Project (External/ Inhouse)** | **0** | **0** | **8** | **240** | **0+8=8** |

In the 8th semester, a student must take up a research project in the area of his/her Major subject. Whole process shall be taken up under the supervision of concerned teacher of the subject allotted and approved by the Director. Evaluation of the dissertation shall be done by an Internal and External examiner.

Once the research methodology course is completed in 7th semester, the college shall allot the guide for each of the student to carry out research work. The title and the synopsis should be presented before Institutional Research and Review Board of CBT and finalized based on the comments given. Thereafter, students shall finalize their synopsis as per the guidelines. Timeline for research work to be carried out shall be as follows –

| S. No. | Work to be carried out | Timeline |
|---|---|---|
| 1. | Finalization of title of the research work and Synopsis presentation | In the first 15 days of the semester |
| 2. | Research Work | Next six weeks of the semester |
| 3. | Compilation of Dissertation and Corrections | Third month of the semester |
| 4. | Presentation (CIA) | Fourth month of the semester |
| 5. | Final Presentation and Viva voce | Semester-End Exam (date shall be notified separately by the University) |

## Guideline for Writing Synopsis for the Research Project/Dissertation

**Synopsis:** A student is expected to have a good comprehension of the existing literature in her/his chosen field of research before writing a synopsis. The synopsis must follow the following structure:

**Title Page:** Title of the project, University and College name along with the logo, Student name with PRN no., Guide name and Month and Year of Submission.

**Section 1: Background**

The background section must briefly posit the broad context of the research problem.

**Section 2: Review of the Literature**

The literature should be organized in a thematic structure and not as a listing of summaries of important references. The structure of the literature review shall highlight the issues relevant to the dissertation and shall identify the gaps therein.

**Section 3: Definition, Rationale and Scope of the Study**

This section should clearly define the research puzzle that is being addressed and explain the rationale and scope of the study.

**Section 4: Research Problem/Question and Hypothesis**

A clear statement of the research problem bearing in mind a clear response to the "so-what?" question should be stated in this section. This should be followed by a crisp and cogent statement of your research hypothesis posed in the form of a falsifiable proposition.

**Section 5: Methodology**

This section should clearly describe how research question(s) of the proposed research title shall be answered using rigorous exposition of the research methods to be employed. Statements like "the study is descriptive/ analytical/experimental" will not suffice, a detailed description of the complete methodology shall be included along with appropriate citations.

**Section 6: Proposed Budget**

An approximate budget required for executing the proposed project should be described.

**Section 7: Timeline**

A Gantt chart including all the activities along with the timeline should be prepared.

**Section 8: References: APA style**

Ensure that every reference cited in the text is also present in the reference list (and vice versa). Citation of a reference as "in press" implies that the item has been accepted for publication. Format for Citing the references in text:

1. Single author: Author's name (without initials, unless there is ambiguity) and the year of publication.
2. Two authors: Both authors' names without initials and the year of publication;
3. Three or more authors: First author's name without initial followed by "et al.," and the year of publication.

Format for References in Reference Section All references should be mentioned in Alphabetical order.

**Journal Articles:**

Yogesh, H.S., Chandrashekhar, V.M., Katti, H.R., Ganapaty, S., Raghavendra, H.L., Muchchandi, I.S., Goplakhrishna, B. (2011). Anti-osteoporotic activity of aqueous-methanol extract of Berberis aristata in ovariectomized rats. Journal of Ethnopharmacology 134: 334-338.

**Organization as Author:**

Diabetes Prevention Program Research Group (2015). Hypertension, insulin, and proinsulin in participants with impaired glucose tolerance. Hypertension 679-86.

**Paper or Chapter in a Book:**

Osawa, T. (1994). Novel natural antioxidants for utilization in food and biological systems. In: Uritani, I., Garcia, V.V. and Mendoza, E.M. (Eds.), Postharvest biochemistry of plant food materials in the tropics. Tokyo, Japan: Japan Scientific Societies Press. pp. 241-251.

**Book by Authors:**

Atta-ur-Rahman., Choudhary, M.I., Thomsen, W.J. (2001). Bioassay Techniques for Drug Development. Harwood Academic Publishers, The Netherlands. pp. 142.143.

**Thesis / Dissertation:**

Srichuanchuenskul, W. (1994). Modern Chromatography of Metal Chelates, PhD Thesis, Chiang Mai University, Thailand.

**Patents:**

Haga, T. (1976). Japan Patent No: 50-54628. iii Web Pages Include author, date, title, availability information, and accession date, if needed. URL of the site should be mentioned.

**In-text**

Among many recognized styles, we recommend the author-year style of in-text referencing, where you indicate in the text itself not only the name of the source author but also the year in which the source was published. The author's name may appear in the sentence itself or in parentheses; the year of publication always appears in parentheses.

**The following example illustrates the style:**

A key role of the state is said to be to regulate the conflicts between them in order to realise 'national interest' (Miliband 1977).

OR

Miliband (1977) argues that a key role of the state is to regulate the conflicts between them in order to realise 'national interest'.

In case of citing from a specific page or page range, use one of the following formats (example):

Mattoo and Subramanian expressed India's position at Doha to be 'characteristically but perhaps not unjustifiably defensive', and recommended a proactive stance at future negotiations (Mattoo and Subramanian 2003: 328).

Once again, in a reverse manner, ethnic conflicts broke out in Bhutan in 1990 as a result of exclusivist Drukpa ethno-nationalism, bent on turning Bhutan into a mono-ethnic polity (Baral 1996; Phadnis 1990: 39-40, 79-80, 125-129).

The synopsis should be written using Times New Roman with a font size of 12, line spacing with 1.5, and margins as "normal".

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