# UNIVERSITY OF KASHMIR

**DEPARTMENT OF BIOTECHNOLOGY**

http://biotechnology.uok.edu.in/

(NAAC Accredited Grade "A")

SYLLABI AND COURSE OF STUDY FOR

# M.Sc PROGRAM IN BIOTECHNOLOGY

# BASED ON CHOICE BASED CREDIT SYSTEM

SYLLABI AND COURSE OF STUDY FOR

# M.Sc PROGRAM IN BIOTECHNOLOGY

# BASED ON CHOICE BASED CREDIT SYSTEM

A candidate has to obtain 24 credits in a semester; 22 credits compulsorily are to be opted from **"Core / Discipline Centric Courses**", while the remaining 2 credits can be obtained from the electives in the following manner

- A candidate shall obtain 2 credits from the "**Electives**" offered by the Departments other than his/her own.

**Note: The students are advised in their own interest to contact the Course Advisor in the department before filling up their choices for allied and general electives**

**EFFECTIVE FROM, 2018**

# Choice Based Credit Courses in BIOTECHNOLOGY

**CORE COURSES (COMPULSORY 12 CREDITS EACH SEMESTER)**

| Sr. No. | Course Code | Course Title | Credit distribution | | | Total Credits | SEE | IA | Total Marks | Semester |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | | | | |
| 1 | BT-18101-CR | Cell Biology | 3 | 1 | 0 | 4 | 80 | 20 | 100 | First |
| 2 | BT-18102-CR | Molecular Biology-I | 3 | 1 | 0 | 4 | 80 | 20 | 100 | |
| 3 | BT-18103-CR | Immune Biology | 3 | 1 | 0 | 4 | 80 | 20 | 100 | |
| 4 | BT-18104-CR | Biomolecules | 2 | 0 | 0 | 2 | 40 | 10 | 50 | |
| 5 | BT-18201-CR | Plant Biotechnology | 3 | 1 | 0 | 4 | 80 | 20 | 100 | Second |
| 6 | BT-18202-CR | Molecular Biology-II | 3 | 1 | 0 | 4 | 80 | 20 | 100 | |
| 7 | BT-18203-CR | Advanced Enzymology | 3 | 1 | 0 | 4 | 80 | 20 | 100 | |
| 8 | BT-18204-CR | Spectroscopy and Microscopy | 2 | 0 | 0 | 2 | 40 | 10 | 50 | |
| 9 | BT-18301-CR | Genetic Engineering | 3 | 1 | 0 | 4 | 80 | 20 | 100 | Third |
| 10 | BT-18302-CR | Animal cell Science and Technology | 3 | 1 | 0 | 4 | 80 | 20 | 100 | |
| 11 | BT-18303-CR | Bioprocess Engineering and Fermentation technology | 3 | 1 | 0 | 4 | 80 | 20 | 100 | |
| 13 | BT-18304-CR | Human and Medical Genetics | 2 | 0 | 0 | 2 | 40 | 10 | 50 | |
| 13 | BT-18401-CR | Proposal writing | 1 | 0 | 0 | 1 | 0 | 25 | 25 | Fourth |
| 14 | BT-18402-CR | Research based Project | 0 | 0 | 14 | 14 | 280 | 70 | 350 | |
| 15 | BT-18403-CR | Seminar and Journal Club | 0 | 2 | 0 | 2 | 40 | 10 | 50 | |
| 16 | BT-18404-CR | Project presentation | 0 | 3 | 0 | 3 | 60 | 15 | 75 | |
| 17 | BT-18405-CR | Project viva | 0 | 2 | 0 | 2 | 50 | 0 | 50 | |

## Discipline Centric Electives (DC) offered by the Department under CBCS

| Sr. No. | Course Code | Course Title | Credit distribution | | | Total Credits | SEE | IA | Total Marks | Semester |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BT-18105-DCE | Biotechniques | 2 | 0 | 0 | 2 | 40 | 10 | 50 | First Semester |
| 2 | BT-18106- DCE | Microbiology | 2 | 0 | 0 | 2 | 40 | 10 | 50 | |
| 3 | BT-18107-DCE | Biostatistics | 2 | 0 | 0 | 2 | 40 | 10 | 50 | |
| 4 | BT-18108-DCE | Laboratory Course I | 0 | 1 | 1 | 2 | 40 | 10 | 50 | |
| | | | | | | | | | | |
| 5 | BT-18205-DC | Chromatin and Epigenetics | 2 | 0 | 0 | 2 | 40 | 10 | 50 | Second Semester |
| 6 | BT-18206-DC | Intermediary Metabolism | 2 | 1 | 0 | 3 | 60 | 15 | 75 | |
| 8 | BT-18207-DC | Laboratory Course II | 1 | 0 | 2 | 3 | 60 | 15 | 75 | |
| | | | | | | | | | | |
| 8 | BT-18305- DC | Non-coding RNAs: features and functions in Neuronal Stem cells | 2 | 0 | 0 | 2 | 40 | 10 | 50 | Third Semester |
| 10 | BT-18306- DC | Introduction to Systems Biology: Networks and Noise; | 2 | 1 | 0 | 3 | 60 | 15 | 75 | |
| 11 | BT-18307- DC | Laboratory Course III | 1 | 0 | 2 | 3 | 60 | 15 | 75 | |

## Generic and Open Electives (GE/OE): These courses are open to students of other Departments except Biotechnology

| Sr. No. | Course Code | Course Title | Credit distribution | | | Total Credits | SEE | IA | Total Marks | Semester |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BT-18001-GE | Biochemical Techniques | 1 | 1 | 0 | 2 | 40 | 10 | 50 | First Semester |
| 2 | BT-18002-OE | Basics in Immunology | 1 | 1 | 0 | 2 | 40 | 10 | 50 | |
| | | | | | | | | | | |
| 3 | BT-18003-GE | Oxidant signalling | 1 | 1 | 0 | 2 | 40 | 10 | 50 | Second Semester |
| 4 | BT-18004-OE | Introduction to Protein Science | 1 | 1 | 0 | 2 | 40 | 10 | 50 | |
| | | | | | | | | | | |
| 5 | BT-18005-GE | Molecular Mechanisms of Plant Life | 1 | 1 | 0 | 2 | 40 | 10 | 50 | Third Semester |
| 6 | BT-18006-GE | Cancer Immunology | 1 | 1 | 0 | 2 | 40 | 10 | 50 | |
| | | | | | | | | | | |
| 7 | BT-18007-GE | Bioethics | 1 | 1 | 0 | 2 | 40 | 10 | 50 | Fourth Semester |
| 8 | BT-18008-OE | Bioinformatics | 1 | 1 | 0 | 2 | 40 | 10 | 50 | |

| 1st Semester<br>Core papers | | |
|---|---|---|
| 1 | BT-18101-CR | Cell Biology |
| 2 | BT-18102-CR | Molecular Biology-I |
| 3 | BT-18103-CR | Immune Biology |
| 4 | BT-18104-CR | Biomolecules |

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18101-CR** | **Maximum marks** | **100** |
| **Course title:** | **Cell Biology** | | |
| **Credits: Four** | | | |

**UNIT-I:** Cellular diversity: An Overview. Structural features of Prokaryotic and Eukaryotic cells. Cyanobacteria. Mycoplasmas. Viruses. Structure of Viruses. Microscopy: Fundamentals of Light and electron microscopy. Phase contrast Microscopy. Fluorescence Microscopy. Confocal Microscopy. Structural organization of endoplasmic reticulum, ribosomes and Golgi complex, Plasma membrane, Lysosomes, Cell wall, Mitochondria, Chloroplast, Vacuoles, Nucleus and other organelles.

**UNIT-II:** Membranes. Various membrane models. Membrane lipids. Asymmetry of membranes. Membrane Proteins. Glycosylation of membrane Proteins. Transport of nutrients, ions and macromolecules across membranes. Transmitter-gated ion channels. Facilitated diffusion through cell membrane. Concept of Ficks law. Active transport. Endocytosis. Exocytosis. Phagocytosis and pinocytosis. Vesicular transport and secretory pathways. Protein trafficking across organelles. TIM-TOM complexes. Oxidative phosphorylation and Photophosphorylation.

**UNIT-III:** Molecular signaling: Introduction. Scaffolding proteins. Modular proteins. Classes of receptors. G-proteins. Structure. Signaling through G-protein linked cell surface receptors. Role of cAMP, Diacylglycerol and Inositol. $Ca^{2+}$ in signaling. CaM Kinases. Signaling through Enzyme linked cell surface receptors. PI3K and Shc operated pathways. JAK-STAT pathway. Notch signaling pathway. MAP Kinases in signaling. Signaling through ion-channel linked receptors. Ubiquitination. Signaling through regulated proteolysis. Cell cycle—Molecular events and regulatory controls, with emphasis on animal cells and yeast cell divisions. Role of different Cyclin-dependent Kinases. Regulation by cdc25 phosphatase. Cell cycle checkpoints. G1 and G2 checkpoints. Role of Rb and p53 proteins. Extracellular control of Cell division.

**UNIT-IV:** Cytoskeletal structures: Structure and function of Microtubules, Microfilaments and Intermediary filaments. Dynamic instability and Treadmilling. Regulation of cytoskeletal filaments. Higher order structures of Cytoskeletal filaments. Microtubule motor protein and their significance, microtubules and actin filaments, actin-myosin complex, Mechanism of muscle contraction and motor proteins. Cytoskeletal structures and Cell behavior. Brief introduction to cellular basis and differentiation and development with special reference to Drosophila and Arabidopsis. Control of cell numbers in multi-cellular organisms. Programmed cell death. Caspases. Intrinsic and extrinsic pathways of apoptosis. Role of Bcl2 family of proteins. Cancer: Introduction. Types. Cancer Grades/Stages. Molecular basis of cell proliferation. Viruses and chemicals as a cause of cancers. Oncogenes. Loss of Tumor suppressors. Cancer therapeutics and treatment.

**Books Recommended:**


1. Molecular Biology of the Cell by Alberts et al: Garland Science, Taylor and Francis, New York. USA.
2. Molecular Cell Biology by Lodish et al: W.W Freeman and Company, New York, USA.
3. Cell Biology: Organelle Structure and Function by David Sadava

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18102-CR** | **Maximum marks** | **100** |
| **Course title:** | **Molecular biology-I** | | |
| **Credits:** | **Four** | | |

**UNIT-I: General Features of DNA Replication:** DNA as a genetic material. Building blocks of DNA. Structure of B-DNA, A-DNA and Z- DNA. General biophysical properties of DNA. Forces that stabilizes DNA structure. General features of DNA replication: Semi-conservative versus conservative and dispersive mode of replication. Semi-discontinuous replication. Directionality of DNA replication with examples from prokaryotic and eukaryotic systems. Priming of DNA replication. General features of sigma mode of replication. Rolling circle mode of replication with examples from M13 and lambda phage genome replication. Enzymology of DNA replication (prokaryotic and eukaryotic): Structure and function of various enzymes/proteins involved in DNA replication. DNA helicases: Structure/function and the experimental method to elucidate the DNA helicase activity. Primases: Structure/function. Single stranded binding proteins, Topoisomerases: structure/function and the mechanism/model involved in relieving DNA supercoils during replication. DNA polymerases: Structure and function of various prokaryotic (DNA Pol I, DNA Pol III holoenzyme) and eukaryotic DNA polymerases. Molecular mechanism of DNA polymerization. Role of magnesium during the polymerization of nucleotides. Proofreading activity of DNA polymerases and its molecular mechanism.

**UNIT-II: Mechanism of DNA Replication (prokaryotes and eukaryotes):** Origin of replication. Molecular components involved. Formation of Primosome and origin recognition complex. Various mechanisms involved in the regulation of replication in prokaryotes and eukaryotes. Replication elongation: Processivity of DNA polymerases. Structure and function of beta-clamp and PCNA (proliferating cell nuclear antigen). Structure and function of DNA pol III gamma-complex as clamp loader and unloader. Model for leading and lagging strand synthesis. Replication Termination: Termination in prokaryotes and the molecular components involved. Decatenation of newly replicated circular genomes. End replication of linear genomes. Telomers: Function and structure. Telomerase: role in the formation of telomers and the molecular mechanism involved. Telomer binding proteins. t-loop formation and the proteins involved. Telomerase in ageing and cancer.

**UNIT-III: DNA Repair and Recombination:** DNA damage and Mutation: Physical and chemical DNA damaging agents. Spontaneous hydrolysis and deamination of DNA bases. Alkylating agents and radiations. Base analogues and intercalating agents. DNA repair systems: Direct reversal repair system (examples from prokaryotes and eukaryotes). Excision Repair system: Base excision and nucleotide excision repair mechanisms (examples from prokaryotes and eukaryotes). Mismatch repair system. Double-strand DNA break repair system: Homologous recombination repair and non-homologous end-joining (NHEJ) repair systems. DNA damage by- pass systems: Error-prone bypass in prokaryotes. Molecular Recombination. Homologous recombination: General features: Alignment of homologous DNAs. Generation of double-stranded breaks. Strand invasion and hetro-duplex formation. Holliday junctions and Branch migration. Homologous recombination in Eukaryotes. Molecular mechanism of meiotic recombination and its significance, Molecular mechanism of V(D)J recombination and antibody diversity.

**UNIT-IV: Prokaryotic Transcription:** Promoters: structure and function. RNA polymerases: Molecular composition, structure and function of each subunit. Role of sigma factor in promoter recognition and open promoter formation. Alternative sigma factors and their biological role. Single subunit RNA Polymerases (T3, T7 RNA Polymerases). Molecular events of transcription initiation. Transcription elongation. Elongation core complex: Structure and function. Proofreading during elongation. Transcription termination: Molecular mechanism of Rho dependent and independent termination. Regulation of bacterial transcription: Operons: Lac operon: Basic features. Mechanism of negative control. Lac repressor (structure and function). Role of CAP in lac operon. Trp operon: Structure and regulation. Negative regulation. Regulation by attenuation.

**Books Recommended:**

1. Molecular Biology by Robert F Weaver: McGraw-Hill Higher Education.
2. Molecular Biology of the Gene by James D. Watson, et al: Pearson.
3. Lewins gene XI by Jocelyn E Krebs, et al: Jones and Bartlett Learning

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18103-CR** | **Maximum marks** | **100** |
| **Course title:** | **Immune biology** | | |
| **Credits: Four** | | | |

**Unit I**: **Overview of the Immune system**: Historical perspective, Types of Immunity – Innate and Adaptive Immunity – Cell and Humoral immunity– Haematopoiesis – Cells of Immune System (B cell, T cell, APC, NK Cells) Lymphoid organs – Primary (Thymus, Bone marrow, Bursa of Fabricus), Secondary Lymphoid Organs – Lymph node, Spleen, Payer's patches (GALT), Tonsils (MALT) – Development and maturation of Lymphocytes, Cytokines and their role in immune regulation. Immunological tolerance Cell mediated cytotoxicity, Mechanism of T-cell & NK- cell mediated lysis.

**Unit II: Antigens and Antigen recognition Molecules** – Antigen Characteristics and Antibody Diversity (IgG, IgM, IgA, IgD and IgE) – Structure, properties – Antigen processing and presentation, Detection of antigen – antibody intereaction – precipitation, agglutination, cytolysis, complement fixation, flocculation, opsonisation, immunofluorescence, ELISA – Monoclonal antibody

**Unit III: Immune system in Health and Disease:** Immunization and Immunization schedule – vaccines (attenuated, heat killed vaccines) – Types of Vaccine, Transplantation , Types of grafts, Graft rejection, Graft versus Host Disease , Clinical Transplantation

**UNIT IV:** Hypersensitivity reaction – Type I to V – Tumour immune response – immune diagnosis of tumour, immunotherapy of tumour – Immunodeficiency disorders – primary, secondary – Autoimmunity – localized and systemic autoimmunity, Hybridoma technology

**Books recommended**


1) Kuby, J. 2006. Immunology 4th Edition, Goldsby R.A., Kindt T.J., Osborne B.A., W.H. Freeman and Company
2) Roitt, I.M, 2006. Essential of Immunology 12th edition, ELBS, Blackwell Scientific Publication
3) Abul K. Abbas, Andrew H.L, Shiv Pillai, "Cellular and Molecular Immunology" 7/e Saunders Publications
4) The Immune system– peter Parham Garland science, 2/e, 2001

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18104-CR** | **Maximum marks** | **50** |
| **Course title:** | **Biomolecules** | | |
| **Credits: Two** | | | |

**Unit I**

**Carbohydrates, lipids and hormones**.

Monosaccharides: Structures, classification, configuration and conformation (Hawrath projection formulas). Disaccharide and the glycosidic bond. Polysaccharides: Structural polysaccharide (cellulose and chitin) and storage polysaccharides (glycogen and starch).

Fatty acids and lipids: Physical properties, classification and naming. types of lipids. Triacylglycerides, phospholipids, sphingolipids and steroids (structure and function)

Hormones: Endocrine hormones and their classification. Target cells/organs of various hormones and their physiological functions.

**Unit-II**

**Amino acids, peptides and proteins.**

Physical and chemical properties of standard amino acids. Titration curves of amino acids. Peptide bond and its structure. Torsion angles and conformation of peptide bond groups. Ramachandran diagram and conformation of polypeptides. Protein secondary structures. Helical structures, beta structures and non- repetitive structures (beta bends, loops, random coils). Super secondary structures (β-hairpins, helix hairpins, β-α-β, α-α motif). Fibrious protein structure (α-keratin and collagen). Protein tertiary structures. Forces that stabilize the protein tertiary structures. Quaternary structures of proteins. Determination of subunit composition and subunit interaction. Symmetry in proteins.

**Recommended books.**

1. PRINCIPLES OF BIOCHEMISTRY BY DAVID LEE NELSON, ALBERT L. LEHNINGER, MICHAEL M. COX PUBLISHER: W.H. FREEMAN

2. BIOCHEMISTRY BY DONALD VOET, JUDITH G. VOET

3. BIOCHEMISTRY BY JEREMY M. BERG, JOHN L. TYMOCZKO, LUBERT STRYER

# Discipline Centric Courses (DC) offered by the Department under CBCS in First semester

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18105 -DCE** | **Maximum marks** | **50** |
| **Course title:** | **Biotechniques** | | |
| **Credits: Two** | | | |

**UNIT-I: Electrophoresis and Blotting Techniques:** Basic principles & types of electrophoresis, Agarose gel electrophoresis, PAGE, SDS-PAGE and isoelectric focusing, Pulse field gel electrophoresis, capillary electrophoresis. Electrophoresis in DNA sequencing, electrophoresis and single strand conformational polymorphism ( SSCP), Blotting techniques: Southern, Northern, Western, Far-western, South-western and their applications., ELISA. Isotopes, modes of radioactive disintegration, Radioactive decay, Radiation quantitation and units. Applications of radioactive isotopes in biochemical assays. Radiation hazards and protection.

**UNIT-II: Chromatography and Centrifugation:** Theory of Chromatography; Migration. Dispersion. Chromatographic Resolution. Types: Gel filtration, Paper, thin-layer and partition chromatography. Affinity Chromatography: Ion Exchange chromatography, Basic principles of centrifugation. Types of centrifugation; differential centrifugation and density gradient centrifugation. Determination of Sedimentation Coefficient. Ultra-centrifugation: Design and principles of an analytical ultracentrifugation.

**Books Recommended:**


1. Principles & Techniques Biochemistry & Molecular Biology. Wilson & Walker. Cambridge University Press.
2. Principles of Radioactive Techniques, Use & Handling. BARC
3. Biological Centrifugation (The Basics) by Dr John Graham
4. Chromatography: Basic Principles, Sample Preparations and Related Methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk . WILEY.
5. Basics of Centrifugation. ThermoFisher

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18106 - DCE** | **Maximum marks** | **50** |
| **Course title:** | **Microbiology** | | |
| **Credits: Two** | | | |

**UNIT-I**: Bacteria: Structure, functions & biosynthesis of Cell wall (Peptidoglycan), Outer membrane of Gram Negative bacteria; structure and formation of endospore; Bacterial growth phases & Kinetics. Toxins: Endo & Exotoxins and their mode of action. Antimicrobial agents & their mode of action; Anti-bacterial & anti-Fungal antibiotics, Mechanism of drug resistance. Structure & replication of retroviruses (HIV),General concept of pararetro viruses, Structure & function of viroids and Prions.

**UNIT-II:** Bacteriophage:, Life cycle of lambda phage, Regulation of gene expression in lambda phage (Lysogenic & lytic options). Transformation: Molecular mechanism of natural transformation. Conjugation: formation of F,HFr and F-prime. Transduction: Mechanism of specialized and generalized transduction. Structure of transposons (Composite & non Composite)

**Books Recommended:**


1. Molecular Genetics of Bacteria. Jeremy W. Dale, Simon F. Park: Wiley-Blackwell.
2. Microbiology by Prescott, Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: McGraw-Hill.
3. Fundamental Bacterial Genetics. Nancy Trun, Janine Trempy: Wiley- Blackwell**.**


| | | | |
|---|---|---|---|
| **Course No:** | **BT-18107 - DCE** | **Maximum marks** | **50** |
| **Course title:** | **Biostatistics** | | |
| **Credits: Two** | | | |

**UNIT I:** General Introduction to Statistics, Basic Concepts. Scope of Statistical methods in Biotechnology. **Sampling methods/strategies:** Sample Selection. Simple Random Sampling, Convenience Sampling, Systematic Sampling, Stratified Random Sampling, Cluster Sampling, etc. Data; types & Uses. Medical/Biological Uncertainties: Surveys and Cross-Sectional Studies. Retrospective Studies, Prospective Studies, Experimental Studies and Quality Control Clinical Trials, Epidemiological Studies**. Measurement of central tendencies:** Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean. Measures of Dispersion: Range, Mean Absolute Deviation, Population Variance and Standard Deviation, Sample Variance and Standard Deviation, Calculating the Variance and Standard Deviation from Grouped Data, Coefficient of Variation (CV).

**UNIT-II: Presentation of variation by figures; data representation:** Histogram, Stem-&-Leaf Plot, Line Diagram, Frequency Polygon, Frequency Curve, Pie Diagram, Bar Diagrams, Scatter Diagram, Box-&-Whisker Plot, Bubble Plot, Growth chart, Dendrogram, Nomogram, Partogram, Pedigree Chart, Cartogram**. Confidence Intervals:** Confidence Intervals, Confidence Intervals for a Single Population Mean, Z and t Statistics for Two Independent Samples. Paired t Test. **Principles of test of significance:** One-Tailed Versus Two-Tailed Tests, p-Values, Type I and Type II Errors, The Power Function, Two-Sample t Test (Independent Samples with a Common Variance). **Students t-test, ANOVA:** Comparison of means in one or two groups (student's t-test). Comparison of means in three or more groups (ANOVA), F-test.

**Books Recommended:**


1. Introduction to Biostatistics and Research Methods by Sunder Rao and J Richards

2. Medical Statistics by David Machin, Michael J Campbell and Stephen J Walters, John Wiley and Sons

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18108 - DCE** | **Maximum marks** | **50** |
| **Course title:** | **LABORATORY COURSE I** | | |
| **Credits: Two** | | | |

1. Concept of solute, Solvent, Solution, Amount and Concentration, Units of measurement, preparation of solution, preparation of buffers.
2. Titrimetric and potentiometric analysis: Amino acid titration.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer, Bradford method
4. Measurement of bacterial population by turbidiometery and serial dilution methods
5. Ion-exchange Chromatography/Gel Filtration

## Generic and Open Electives (GE/OE) in First Semester: These courses are open to students of other departments except students of Biotechnology department.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18001GE** | **Maximum marks** | **50** |
| **Course title:** | **Biochemical Techniques** | | |
| **Credits: Two** | | | |

**UNIT-I: Electrophoresis and Radioactivity:** Basic principles & types of electrophoresis, Agarose gel electrophoresis, PAGE, SDS-PAGE and isoelectric focusing. Blotting techniques: Southern, Northern, Western, Far-western, South-western and their applications. Determination of antigen antibody concentration by immunodiffusion, immunoelectrophoresis, ELISA. Isotopes, modes of radioactive disintegration, Radioactive decay, Radiation quantitation and units. Applications of radioactive isotopes in biochemical assays. Radiation hazards and protection.

**UNIT-II: Chromatography and Centrifugation:** Theory of Chromatography; Migration. Dispersion. Chromatographic Resolution. Types: Gel filtration, Paper, thin-layer and partition chromatography. Affinity Chromatography: Ion Exchange chromatography, Purification of specific groups of molecules (Immunoglobulins, GST fusion proteins, Poly (His) fusion proteins, Protein A fusion proteins). Gas Chromatography. Basic principles of centrifugation. Types of centrifugation; differential centrifugation and density gradient centrifugation.

**Books Recommended:**


6. Principles & Techniques Biochemistry & Molecular Biology. Wilson & Walker. Cambridge University Press.
7. Principles of Radioactive Techniques, Use & Handling. BARC
8. Biological Centrifugation (The Basics) by Dr John Graham
9. Chromatography: Basic Principles, Sample Preparations and Related Methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk . WILEY.
10. Basics of Centrifugation. ThermoFisher

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18001OE** | **Maximum marks** | **50** |
| **Course title:** | **Basics in Immunology** | | |
| **Credits: Two** | | | |

**UNIT-I:** Historical perspective, Types of Immunity – Innate and Adaptive Immunity – Cell and Humoral immunity, Primary (Thymus, Bone marrow, Bursa of Fabricus), Secondary Lymphoid Organs – Lymph node, Spleen, antigen – antibody intereaction – precipitation, agglutination.

**UNIT-II:** Immunization and Immunization schedule – vaccines (attenuated, heat killed vaccines) – Types of Vaccine – Vaccination Schedule in India.

**Books recommended:**


1. Basic Immunology: Abul K. Abbas, Andrew H. Lichtman.
2. Janeway's Immunobiology, Garland Sciernce

| 2nd Semester<br>Core papers | | |
|---|---|---|
| 1 | BT-18201-CR | Plant Biotechnology |
| 2 | BT-18202-CR | Molecular Biology-II |
| 3 | BT-18203-CR | Advanced Enzymology |
| 4 | BT-18204-CR | Spectroscopy and Microscopy |

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18201-CR** | **Maximum marks** | **100** |
| **Course title:** | **Plant Biotechnology** | | |
| **Credits: Four** | | | |

**UNIT-I:** General structure, organization & Molecular basis of Shoot Apical Meristem(SAM) & Root Apical meristem (RAM). Totipotency of Plant cell, Plant cell cycle, Role of various hormones in regulating plant cell cycle, Micropropagation (Seed V/S Soma), Stages & methods of micropropagation. Production of virus free plants. Tissue culture media (Composition & preparation),Role of micro, macro nutrients & other components present in tissue culture media, Commonly used media (Murashige and Skoog etc) Initiation and Maintenance of callus and suspension culture, Single cell clones Organogenesis: Basis, applications & control of Somaclonal variation. Somatic embryogenesis- acquisition of embryogenic competency, factors & genes influencing the embryogenic competency of cell during somatic embryogenesis, Synthetic seeds. Embryo rescue.

**UNIT-II:** Protoplast isolation (mechanical & enzymatic methods), maintenance, purification, viability, Culture and fusion (Spontaneous & induced fusion, sodium nitrate, calcium ion, PEG, electrofusion). Identification & Selection of hybrid cells and regeneration of hybrid plants; Symmetric & Asymmetric hybrids, Cybrids-formation and applications. Anther, pollen and ovary culture for the production of haploid homozygous lines, Molecular mapping, Introduction to genetic and physical maps, physical mapping

**UNIT-III:** Plant Transformation Technology; Morphology of Agrobacterium tumefaciens, Features of Ti Plasmids, Opines and its Types, Basis of tumor formation, Factors influencing binding of Agrobacterium to plant, Mechanism of T-DNA transfer & Role of virulent proteins in (Formation of T-DNA strand, movement of T-Complex & Integration of T-DNA into Plant genome), Features of Binary vectors & its Types (pBIN19, pGreen, pCAMBIA, etc), Promoters used in Ti vectors (CaMV 35S and other promoters), Use of reporter genes(Opine synthase, CAT, GUS, LUX, GFP) and selectable markers (antibiotic & herbicide resistant genes, Metabolic intermediates etc) Generation of marker free plants (using Cre-Lox & other Excision techniques), Vector less or direct DNA transfer (Particle bombardment, Electroporation, WHISKERS, Pollen tube entry, Floral dip, Liposome mediated,etc). Plant transformation for productivity and performance with special example of Herbicide resistance (Glyphosate & Phosphinothricin resistance), Insect resistance (Bt based plants), Disease resistance (Role of R-proteins & other molecules), long shelf fruit and flowers, Stress tolerance (water deficit stress, Role of osmoprotectants and other molecules).

**UNIT-IV:** Molecular farming: Methodology involved in the production of Golden rice, Metabolic engineering of carbohydrates (Starch and fructan production), lipids (production of shorter & longer chain fatty acids, Modification of the degree of saturation). Production of Biodegradable plastic, Production Therapeutic protein in plants (Hirudin, Glucocerebrosidase, etc), Purification strategies for proteins-Oleosin partitioning Technology, Plantibodies (full length, scFv, Minibody, Diabody, Bispecific) Edible Vaccines, Manipulation of Shikimate pathway for the production of Vitamin E, Chloroplast Transformation (Mechanism & Advantages), Principle & applications of Gene termination technology, Concerns about Genetically modified plants

**Books Recommended:**


1. Plant Biotechnology: The Genetic Manipulation of Plants Adrian Slater Nigel W. Scott Fowler: Oxford University Press.
2. Introduction to Plant Biotechnology: H S Chawla: Science Publishers, Inc.
3. Plant propagation by Tissue Culture : Edwin F. George,Michael A Hall: Springer-verlag.
4. Agrobacterium: From Biology to Biotechnology: Tzfira,Tzvi,Citovsky,Vitaly: Springer verlag


| | | | |
|---|---|---|---|
| **Course No:** | **BT-18202-CR** | **Maximum marks** | **100** |
| **Course title:** | **Molecular biology-II** | | |
| **Credits: Four** | | | |

**UNIT-I:** Eukaryotic transcription: Eukaryotic RNA polymerases: RNA Pol I, RNA Pol II and RNA pol III (structure and the genes they regulate). Promoters: Class II promoters: Structure and function (core promoter elements, upstream elements, downstream elements, initiator elements). Class II general transcription factors: structure and function. Mechanism of transcription initiation at class II promoters. Pre-initiation complex. Recruitment and holoenzyme model of pre-initiation complex formation. Promoter clearance and RNA Pol II CTD phosphorylation. Class I promoters: Structure and function (core elements, upstream elements). Class I transcription factors. Class III promoters: Structure and function. Class III transcription factors. Transcription elongation: Molecular mechanism. Proofreading and RNA pol II pausing. Transcription termination. Termination signals and the molecular events.

**UNIT-II:** Eukaryotic Gene Regulation: Mechanism of Regulation. Regulatory Elements, Enhancers, Silencer Elements. Transcription Factors, Methods of Studying Transcription Factors. Domain Structure of Transcription factors, –DNA binding domains (Zinc Finger Domains, Leucine Zipper Domains, Homeodomains, Basic Domains). Transcription activation domains. Mechanism of Activator function. Transcriptional coactivators, Mediator Complex. Repressors and their role in Transcription. Chromatin Structure and Transcriptional Gene Regulation. Regulation of Eukaryotic Gene Expression by Small RNAs. Gene Regulation During Development Transcription factor and developmentally regulated gene expression. Gene Regulation during Drosophila Development. Homeobox containing genes of Drosophila. Homeobox like genes in other organisms

**UNIT-III:** Post-transcriptional RNA processing Heteronuclear RNA (hnRNA): Exons, introns, exon-intron junctions and splicing signals. RNA splicing: Molecular mechansim. Splicesome (structure, assembly and function). Alternative splicing. Regulation of splicing. Self-splicing RNAs with refrence to group-I introns and group-II introns. Ribosomal rRNA processing: Eukaryotic and prokaryotic rRNA processing. t-RNA processing and modifications. Trans-splicing. RNA editing and molecular mechanism. Post-transcriptional modifications of mRNA: Capping at 5`end. Structure and types of caps. Function of 5` end capping. Polyadenylation: Polyadenylation signals and mechansim of polyadenylation. Poly(A) polymerase. Functions of poly "A" tail.

**UNIT-IV:** Protein Translation. Translational machinery apparatus mRNA: Structural features of prokaryotic and eukaryotic mRNA Ribosomes: General structural features. Molecular components (prokaryotic and eukaryotic) t- RNA: Secondary and tertiary structure. Amino-acyl tRNA synthetases. Chemistry of tRNA charging with specific aminoacids Translational Initiation in prokaryotes: Molecular details. Formation of 30S and 70S initiation complex. Shine-Dalgarno sequence and its role in initiation complex formation. Translation initiation in eukaryotes: Initiation factors and their function. Role of eIF4E, eIF4G, eIF4A, eIF3, eIF2, eIF1, eIF5, eIF6. Scanning model of initiation. Formation of 48S and 80S initiation complex. Kozak sequence and its significance. Cap-dependent and Cap-independent translation. Role of Internal Ribosome Entry Sites (IRES). Cap-independent translation under stress conditions. Translational regulation: Prokaryotic regulation: Role of secondary structures, small RNAs and riboswithches. Eukaryotic regulation: Role of phosphorylations (stimulatory and inhibitory), Role of 4E-binding proteins in translation regulation. Secondary structures and translation regulation. microRNAs and their role in translation regulation Genetic code: General characteristic features. Breaking of genetic code. Whobble hypothesis and degeneracy. Translation elongation: Three-site ribosome model of tRNA binding. Role of EF-T. Proofreading during translation elongation. Peptidyl transferase reaction (chemistry and molecular components). Translocation and role of EF-G. Translation termination: termination codons. Release factors. Ribosome dissociation and the factors involved.

**Books Recommended:**


1. Transcriptional Regulation in Eukaryotes: Concepts, Strategies, and Techniques by Michael F Carey, Stephen T Smale and Craig L Peterson.
2. Gene Regulation by David S. Latchman fifth edition.
3. Molecular Biology by Robert F Weaver: McGraw-Hill Higher Education.
4. Molecular Biology of the Gene by James D. Watson, et al: Pearson.
5. Lewins gene XI by Jocelyn E Krebs, et al: Jones and Bartlett Learning.


| | | | |
|---|---|---|---|
| **Course No:** | **BT-18203-CR** | **Maximum marks** | **100** |
| **Course title:** | **Advanced Enzymology** | | |
| **Credits:** | **Four** | | |

**UNIT-I:** Properties of enzymes as catalytic power, specificity cofactors, brief nomenclature & classification of enzymes, isoenzymes, Monomeric and oligomeric enzymes, Enzyme localization, Enzyme assay, Direct and coupled assays. Review of uni-substrate enzyme kinetics and factors affecting the rate of enzymes catalyzed reactions. Derivation of Michaelis Menten equation using steady state and equilibrium assumptions. Enzyme constants. Transformation of Michaelis – Menten plot to linear forms. Lineweaver-Burk plot, Eadie-Hofstee plots, Hanes plots, Eisenthal and Cornish-Bowden plot. Merits and demerits of linear plots. Haldane relationship for reversible reactions. King and Altman procedure for derivation of rate equation. Michaelis pH functions and their significance

**UNIT-II:** Classification of multi substrate reactions with examples of each class. Ping-pong bi-bi mechanism, Random order mechanism, compulsory order mechanism, Kinetics of multi substrate reactions. General rate equation of Alberty. Derivation of rate expression for ping-pong & ordered Bi -Bi reaction mechanism. Primary and secondary plots for determination of kinetic constants for Multisubstrate reactions. Investigation of reaction mechanism using steady state methods. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism. Methods of examining enzymes-complex's, trapping E-S Complex, Use of substrate analogs, chemical modifications and protease treatment, Site directed mutagenesis & effect of changing pH. Flexibility & conformational mobility of enzymes

**UNIT-III:** Determination of rate constant for enzymes catalyzed reactions, Protein –Ligand binding including measurement, analysis of binding isotherm. Cooperatively phenomenon . Hill and Scatchard plots Allosteric enzymes, sigmodial kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance

**UNIT-IV:** Multi enzyme system: Occurrence, isolation and properties. Polygenic nature of multi enzyme system. Mechanism of catalysis of serine proteases, Ribonucleases and Triose phosphate isomerase. Enzyme regulation: general mechanism of catalysis viz Acid-base, electrostatic, Covalent and enzymes Immobilized enzymes and their industrial application. Effects of partition on kinetics and performance with special emphasis on changes in pH and hydrophobicity.

**Books Recommended:**


1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer,
2. Horwood Publishing
3. Fundamentals of Enzyme kinetics by Athel Cornish-Bowden, Portland press
4. Fundamentals of Enzymology by Nicholas Price and Lewis Stevens,
5. Oxford University Press
6. Enzyme Structure and Mechanism by Alan Fersht, W. H. Freeman
7. Enzymology by T. Devasena , Oxford University Press
8.


| | | | |
|---|---|---|---|
| **Course No:** | **BT-18204-CR** | **Maximum marks** | **50** |
| **Course title:** | **Spectroscopy and Microscopy** | | |
| **Credits:** | **Two** | | |

## Unit-I

Principle and applications of Fluorescence spectroscopy; Jablonski diagram, steady-state fluorescence, time-resolved, Fluorescence resonance energy transfer (FRET), anisotropy. Circular dichroism (far-UV, near-UV). Infrared spectroscopy, Raman spectroscopy and dynamic light scattering.

## Unit-III

Principle and applications of; bright-field, confocal (immunofluorescence), and super-resolution microscopy (STORM, STED, PALM), Electron microscopy, atomic force microscopy AFM (contact and tapping mode). Force spectroscopy: Principle and applications of AFM cantilevers, optical tweezers and magnetic tweezers in biological research.

# Discipline Centric Courses (DC) 2nd semester

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18205-CR** | **Maximum marks** | **50** |
| **Course title:** | **Chromatin and Epigenetics** | | |
| **Credits:** | **Two** | | |

**UNIT-I**

Chromatin, Histones, Nucleosome, Nucleosome Structure, Histone Variants and complexes involved in their exchange, Modulation of Chromatin Structure, ATP dependent chromatin remodeling, Histone modifications, Histone Code hypothesis, Interplay of DNA methylation and histone modifications**.** DNA repair in context of chromatin

**UNIT-II**

Epigenetics, Chromatin Boundaries: S. cerevisiae Silencing, S. pombe Centromeric Heterochromatin, RNAi-directed Silencing. Epigenetic reprogramming in mammals, Epigenetic mechanisms regulating ES cell differentiation, Bivalent Chromatin Marks in maintaining stem cell pluripotency, Epigenetics and pathologies, Epigenetic therapies.

**Recommended References:**


1. Chromatin Structure and Function by Alan Wolffe.

2. Epigenetics by David Allis, Thomas Jenuwein, Danny Reinberg and Marie- Laure Caparros


| | | | |
|---|---|---|---|
| **Course No:** | **BT-18206-CR** | **Maximum marks** | **50** |
| **Course title:** | **INTERMEDIARY METABOLISM** | **Credits:** | **Two** |

**UNIT I. CARBOHYDRATE METABOLISM***:* GLYCOLYSIS, FERMENTATION, GLUCONEOGENESIS AND THEIR RECIPROCAL REGULATION. GLYCOGEN SYNTHESIS/DEGRADATION AND THEIR REGULATION. TCA CYCLE AND OXIDATIVE PHOSPHORYLATION. PENTOSE PHOSPHATE PATHWAY. CORI-CYCLE

**UNIT II. PROTEIN METABOLISM:** TRANSAMINATION AND DEAMINATION REACTIONS AND THEIR CLINICAL SIGNIFICANCE. UREA CYCLE. INBORN ERRORS OF AMINO ACID METABOLISM. NUCLEIC ACID METABOLISM: PURINE AND PYRIMIDINE SYNTHESIS (DE NOVO AND SALVAGE PATHWAY). SYNTHESIS OF DEOXYRIBONUCLEOTIDES FROM RIBONUCLEOTIDES. FORMATION OF URIC ACID AND ITS CLINICAL SIGNIFICANCE. NUCLEIC ACID SYNTHESIS INHIBITORS AND THEIR CLINICAL SIGNIFICANCE.

**UNIT III. FATTY-ACID METABOLISM:** BETA-OXIDATION OF SATURATED AND UNSATURATED FATTY ACIDS. FATTY ACID SYNTHESIS. KETONE-BODY SYNTHESIS AND THEIR SIGNIFICANCE. PROSTAGLANDIN SYNTHESIS AND THEIR SIGNIFICANCE. BROWN ADIPOSE AND THERMOGENESIS. OBESITY AND BODY MASS. ROLE OF ADIPOSE TISSUE. LEPTIN AND OBESITY. GENES THAT REGULATE BODY MASS. METABOLIC DEREGULATION AND TYPE-II DIABETES. ROLE OF DIET, MEDICATION AND EXERCISE IN TYPE-II DIABETES.

**BOOKS RECOMMENDED:**


**1.** PRINCIPLES OF BIOCHEMISTRY BY DAVID LEE NELSON, ALBERT L. LEHNINGER, MICHAEL M. COX PUBLISHER: W.H. FREEMAN

**2.** BIOCHEMISTRY BY DONALD VOET, JUDITH G. VOET
**3.** BIOCHEMISTRY BY JEREMY M. BERG, JOHN L. TYMOCZKO, LUBERT STRYER

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18207 -DCE** | **Maximum marks** | **75** |
| **Course title:** | **Laboratory Course II** | | |
| **Credits:** | **Three** | | |

1. Media Preparation
2. Isolation of Genomic DNA and RNA.
3. Agarose Gel electrophoresis and Quantification of DNA and RNA.
4. Immunoprecipitation (IP).
5. SDS-PAGE and Western Blotting.
6. Assay of Enzyme activity.
7. Effect of temperature and pH on enzyme activity.
8. Determination of Kinetic constants Km and V max.
9. Preparation of plant tissue culture media.
10. Plant Tissue Culture

# Generic and Open Electives (GE/OE) offered in 2nd Semester

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18003GE** | **Maximum marks** | **50** |
| **Course title:** | **Oxidant signalling** | | |
| **Credits:** | **Two** | | |

**UNIT-I:** Reactive Oxygen Species. Origin, Production, Enzymatic and Non-enzymatic sources of reactive oxygen Species (ROS) production. Mitochondria as a source of ROS. Involvement of cytochrome complexes, Xanthine oxidase and NADPH oxidase. Effects on cell and biomolecules. Lipid peroxidation. Protein oxidation. Inactivation of different proteins. ROS as a secondary messenger. Regulation of signal transduction. Role in cancers. ROS detection in the cells.

**UNIT-II:** Antioxidants. Enzymatic antioxidants. Glutathione Peroxidase. Superoxide dismutase. Catalase. Non-enzymatic antioxidants. Mechanistic involvement of Vitamin C, Vitamin A. Vitamin E. Protective effects on the cell. Aging. Mechanistic players in aging. ROS in aging. Yeast as a model to study aging. C. elegans as a model to study aging. Pathways involved in aging. Role of ROS regulating protein in aging including p53 and p66shc.

**Books Recommended:**

1. Review Journals Like Antioxidant Redox Signaling. Internet Resources: Pubmed, Google, Google Scholar.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18004 OE** | **Maximum marks** | **50** |
| **Course title:** | **Basic Course in Protein Science** | | |
| **Credits:** | **Two** | | |

**UNIT-I:**
Amino acids: Structure and classifications. Standard and non standard amino-acids, Essential amino-acids, Derived amino acids, Non protein amino acids, Optical activity of amino acids, Stereo-chemical representations, D and L system, RS system, Chemical and physical properties, Acid base characteristics, Titration of acidic, basic and neutral amino acids, Analysis of titration graphs. Proteins: Peptide bond formation and characteristics, oligo and polypeptides, Biological roles of small peptides.

**UNIT-II:** Tertiary structure of proteins: Core versus surface, Stabilizing interactions, Physical methods of determining three dimensional structures of proteins, X-ray crystallography and NMR spectroscopy. Quaternary structure: Characteristics, dimensions and complexity, Subunit interactions Advantages: Active site diversity, coupling of metabolic related proteins in time and space, regulation of enzyme activity, stability, enhancing the translational efficiency of proteins. Structure and function of fibrous proteins: Amino acid composition and organization of fibrous proteins, Keratin, Fibroin, Collagen

**Books Recommended:**

1. Biochemistry by Donald Voet and Judith G Voet, John Wiley & Sons
2. Protein Structure and Function by David Whitford, John Wiley & Sons, UK
3. Introduction to Proteins: structure and function and motion by Amit Kessel and Nir-Ben Tal , CRC Press.

| 3rd Semester<br>Core papers | | |
|---|---|---|
| 1 | BT-18301-CR | Genetic Engineering |
| 2 | BT-18302-CR | Animal cell Science and Technology |
| 3 | BT-18303-CR | Bioprocess Engineering and Fermentation technology |
| 4 | BT-18304-CR | Human and Medical Genetics |

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18301-CR** | **Maximum marks** | **100** |
| **Course title:** | **Genetic engineering** | | |
| **Credits: Four** | | | |

**UNIT-I:** Recombinant DNA Technology Tools: Restriction endonucleases: Historical perspective. Nomenclature. Different types of restriction-modification systems and their characteristic features. Blunt end and cohesive end cutters with examples. Four, six and eight cutter restriction enzymes. Restriction enzymes that create 5` and 3` overhangs. Isochizomers and isocaudemers. Restriction modification enzymes and their importance in DNA recombinant technology (Dam, DCM methylases). DNA ligases: E.coli and T4 DNA ligases. Chemistry of T4 DNA ligase reaction. DNA Phosphatases and their role in recombinant DNA technology. DNA Pol I and Klenow fragment and their role in recombinant DNA technology. Vectors: Plasmids: General features of plasmid vectors. Molecular regulation of high and low copy number plasmids. Characteristics features of pBR322, pUC series of plasmid vectors. General scheme of cloning in plasmid vectors. Selectable marker genes used in plasmid vectors and their mechanism of action. Molecular details of blue-white selection. Expression plasmid vectors: transcriptional and translation regulatory elements in expression plasmids. Characteristics feature of inducible plasmid expression vectors. yeast plasmid vectors: General features and mode of selection. Transformation of plasmid DNA in bacterial cells (Physical and chemical methods). Bacteriophages as cloning vectors: lambda- phage vectors: General characteristics features. Insertional lambda phage vectors (λ-gt10, λ-gt11). Replacement lambda phage vectors (λEMBL series). General scheme of cloning in lambda phage vectors and the criteria for recombinant vector selection. In-vitro packaging and its importance. M13 vectors: General features and scheme of cloning in M13 phage. Phagemid vectors: General features and their importance. Cosmid vectors: General characteristics and scheme of cloning in cosmid vectors. YACs: General characteristic features and scheme of cloning in YACs. BACs: General characteristic features and their importance.

**UNIT-II:** Genetic engineering techniques. Polymerase chain reaction: Principle and methodology. Setting of PCR reaction. source of template DNA (genomic DNA, RNA, etc). Features of an ideal primer. Primer design with restriction sites at the ends. Primer design for fusion protein constructs. Degenerate primers and their importance. DNA polymerase for PCR: characteristic features of error prone (Taq) and high fidelity DNA polymerases. different types of PCR (nested, asymmetric, multiplex). Applications of PCR. Reverse Transcription PCR (RT- PCR): Principle and methodology. Different methods of first strand and second strand cDNA synthesis. Characteristic features of different reverse transcriptases (RT) used in RT-PCR. Real-Time PCR: Principle and methodology. Ct value and its importance. Different methods of fluorescent detection and probes (SYBER green, Taqman probe, Molecular beacon probes). Melting curves and their importance. Quantification and normalization of raw data. Applications of Real-Time PCR. DNA microarray: Principle and methodology. Different types of DNA arrays (Spotted microarrays and oligonucleotide arrays) and their characteristic features. Differential gene expression using fluorescent dyes. Application of microarrays. Proteomics: Protein separation by 2D Gel electrophoresis. Protein separation by multi-dimensional chromatography. Mass spectrometry: Electrospray Ionization (ESI), Matrix assisted Laser Desprption Ionization (MALDI), Mass analyzers, MS/MS. Different methods of protein identification. Protein arrays and their applications.

**UNIT-III:** Genomic and cDNA library construction. Different methods of screening. Site-Directed mutageneis: M13 vector based methods, plasmid vector based methods (single primer and double primer methods), PCR based methods. Protein engineering: Different methods and application of protein engineering. Hetrologous expression systems Expression in bacterial systems: Promoters and translation elements used in expression vectors. Inducible promoter systems. Expression and purification of GST fusion proteins. Expression in yeast: Various promoters elements used in expression vectors. Inducible expression systems in yeast (Gal and CUP1 system). Pichia pastroris as yeast expression systems. Expression in Insect cell line (Sf9/21): Baculovirus expression vectors. structure and construction of Basmid vectors. Expression of protein in baculoviral vectors. Expression in mammalian cells. Mammalian expression vectors. Viral and cellular promoter used in expression vectors. Importnace of kozak in expression vectors. Selectable marker genes. Tet-Off/On Inducible systems . Expression of proteins with fusion tags (HA, His, Myc, Flag, GFP) and their significance. In-vitro Transcription and translation and its application

**UNIT-IV:** Studying protein-protein interaction. Yeast Hybrid systems: Two hybrids based on split transcriptional activation, Split ubiquitin system, SOS recruitment system. Reverse two hybrid. Yeast three hybrid systems for protein-protein, protein-RNA interactions. Transfections: Transient and stable transfection in animal cell. Physical, chemical and biological transfection agents. Repoter assays: Repoter genes and applications (Chlorophenicol acety transferase (CAT), Luciferase (Firefly and Renilla), living colours (Green fluorescent, yellow fluorescent and their application in co-localization studies). Dual luciferase assay and its application. Gene knock-downs: Antisence RNA technology with examples from animal and plant systems. RNA interference: Methodology and applications. Transgenics: Gene knock-in: Various methods of making transgenics (animals). Applications of transgenics with reference to animals. Gene knock outs: Methodology based on Cre-LoXp system. Conditional and specific knock-outs. Gene targetting. Insertional mutagenesis: Transposon tagging: Different methods . Use of Plasmid rescue vectors, gene-trap vector, enhance trap vectors. Activation tagging. Different type of transposons used in gene tagging. Tagging with T-DNA (Brief account). Gene Therapy: Different types of gene therapies. Viral vectors and their role in gene therapy. Gene therapy and clinical trials. Success and failure stories.

**Books Recommended:**


1. Principles of Gene Manipulation and Genomics by Sandy B. Primrose, Richard Twyman: Blackwell Publishing Professional.
2. Analysis of Genes and Genomes by Richard J. Reece: Wiley.
3. Molecular Biotechnology - Principles and Applications of Recombinant DNA by Glick, Bernard R.; Pasternak, Jack J.; Patten, Cheryl L: ASM Press.
4. DNA recombinant Technology and molecular techniques by M U Hussain: Black Prints India INC

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18302-CR** | **Maximum marks** | **100** |
| **Course title:** | **Animal cell science and technology** | | |
| **Credits: Four** | | | |

**UNIT-I:** Structure and organization of Animal Cell, Primary and established Cell lines, Setting up of Tissue culture facility; Equipments and facilities needed. Contaminations in cell culture; Types and their eradication/contamination control, Precautions in handling of cell lines. Introduction to balanced salt solutions and simple/complete growth medium, Role of CO2, serum and supplements. Serum components necessary for growth of cells in culture. Serum and serum free defined media. Limitations and applications of serum and serum free media.

**UNIT-II:** Cell Lines: Biology and characterizations of the cultured cells. Cryopreservation. Basic techniques of mammalian cell culture in vitro: Disaggregating of tissue and primary culture. Transfection of cell lines. Types and Methods of Transfection. Transfection applications. Scaling-up of animal cell culture. Equipments and reagents. Advantages and Disadvantages of Scale-up techniques. Cell synchronization, cell cloning and micromanipulation. Application of Animal cell culture.

**UNIT-III:** Cell transformation: Properties of transformed cells. Methods of cell Transformation. Immortalization: Introduction. Methods used to immortalize cells. Mechanisms involved in cell immortalization. Measurements of viability and cytotoxicity assay: Cell viability assays using dye exclusion or dye uptake, MTT, TUNNEL and ELISA based assays. Fluorescence based cell viability assays. Cell culture based vaccines: Introduction to Subunit vaccines, peptide vaccines, recombinant vaccines, genetic vaccines and attenuated vaccines. Advantages and disadvantages of all the types of vaccines.

**UNIT-IV:** Three dimensional culture: Introduction. Multicellular tumour spheroids (MCTS). Spheroid culturing techniques. Tissue engineering: Introduction. Tissue Engineering of Skin, Nerve implants. Tissue engineered Urothelium implants. Design criterion for tissue engineering. Cell substrates and support material. Organ and Histotypic cultures: Introduction. Advantages and limitations. Differences between Organotypic and Histotypic cultures. Factors affecting the growth of Organotypic and Histotypic cultures.

**Books Recommended:**


1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, by, R. Ian Freshney, published by Wiley-Blackwell, UK.
2. Animal Cell Culture: A Practical Approach by JRW Masters, published by Oxford University Press, UK.
3. Basic Cell Culture: A Practical Approach by John M. Davis, published by Oxford University Press, UK.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18303-CR** | **Maximum marks** | **100** |
| **Course title:** | **Bioprocess engineering and Fermentation technology** | | |
| **Credits: Four** | | | |

**UNIT-I:** Basic concepts, Kinetics of Cell Growth: Kinetics of batch culture, Growth kinetics for continuous culture, Material balance for CSTR. Fundamentals of material and energy balance for processes with/without chemical reaction: Biomass Balances (Cells) in a Bioreactor, Material Balance in Terms of Substrate in a Chemostat, Modified Chemostat. Problems & Examples. Metabolic stoichiometry: Biomass and Product Yields, YX/S and YP/S . Overview of biosynthetic mechanisms.

**UNIT-II:** Sterilization: Types of sterilization. Thermal death kinetics of microorganism. Heat sterilization of liquid medium, Batch mode, Continuous mode, Problems & Examples. Air sterilization. Fermentation overview: Inoculum development. Various types of Fermentation: submerged fermentation, aerobic and anaerobic fermentation. Bioreactor operations: Different types of bioreactors, Configuration of Bioreactors and their main components. Modes of bioreactor operation. Important bioreactor accessories.

**UNIT-III:** Whole cell immobilization and their applications. Single cell protein. Cell disruption: mechanical, enzymatic, and chemical methods. Pre-treatment strategies. Solid-liquid separation: filtration, centrifugation, Adsorption, Problems/Examples. Liquid-liquid extraction, Solvent selection, Operating Conditions, Mode of Operation, Extractor Type Design Criteria. Membrane separation: ultrafiltration (Theory, Experimental set-up) reverse osmosis, dialysis, lyophilization. Precipitation of proteins by salting out, isoionic & semisynthetic polyelectrolyte methods.

**UNIT-IV:** Applications of enzymes in food processing. Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Inter-esterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

**Applications of Microbes in food process operations and production.** Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

**Books Recommended:**

1. M.L.Shuler and F.Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall of India Pvt Ltd

2. P.M.Doran, "Bioprocess Engineering Calculations", Elsevier India Pvt Ltd (2008).

3. C. Ratledge & B. Kristiansen, "Basic Biotechnology" 3rd Edn. Cambridge University Press

4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Elsevier India Pvt Ltd.(2007).

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18304-CR** | **Maximum marks** | **50** |
| **Course title:** | **Human Medical Genetics** | **Credits:** | **Two** |

**UNIT-I**

Organization and distribution of the human genome: Overview. Human multigene families and repetitive coding DNA. Extragenic repeated DNA sequences and transposable elements. Genes in pedigrees: Genes in pedigree. Complications to the basic pedigree patterns. Factors affecting gene frequencies. Nonmendelian characters. Overview of mutation, polymorphism, and DNA repair. Pathogenic mutations. Nomenclature of mutations and databases of mutations.

**UNIT-II**

Genomic revolution and Research in the post-genome (sequencing) era: History, organization, goals and value of the Human Genome Project. Modern molecular and cytogenetic methods (Modern PCR methods, FISH, MLPA, array CGH, Parent of Origin Effects, Prenatal Diagnosis, chorionic villus sampling (CVS), Preimplantation Genetic Diagnosis (PGD).

**Recommended references:**


1. Thompsan and Thompsan: Genetics in Medicine, Elsevier publications.
2. Emery's Elements of Medical Genetics. Elsevier

# Discipline Centric Courses (DC) 3rd semester

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18305-CR** | **Maximum marks** | **50** |
| **Course title:** | **Non-coding RNAs: features and functions in Neuronal Stem cells** | | |
| **Credits:** | **Two** | | |

**UNIT-I**

From central dogma to ncRNA and now functional RNA: Overview of ncRNA and their important role in current research. Biogenesis of Small (miRNA, piRNA, esiRNA) and long non-codingRNA (lnRNA) and their importance in gene regulation and disease pathogenesis. MicroRNA (miRNA) and lncRNA pathways in Neurodevelopmental and Neurodegerative disorders will be provided as an example.

**UNIT-II**

Non-Coding RNA (NcRNA) and neural stem cells (NSCs): miRNAs, and self-renewal and proliferation of NSCs. LncRNAs and proliferation of NSCs. NSC survival controlled by ncRNAs. NSC differentiation and cell fate determination mediated by ncRNA. NcRNA as a tool for stem cell based therapy.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18306-DCE** | **Maximum marks** | **75** |
| **Course title:** | **Fundamentals of Systems Biology: Networks and Noise** | | |
| **Credits:** | **Three** | | |

**Unit-I**
Introduction to systems biology, Networks-definition, properties of network, structure of biological networks, Cellular networks; genetic and molecular interaction networks-protein interaction networks, protein-DNA interaction networks, significance of cellular networks (combinatorial-out puts, multitasking), Synthetic networks. Systems biology and future medicine

**Unit-II**
Noise-noise and robustness of cellular processes, Sources of noise; Intrinsic and Extrinsic noise, Noise in gene expression; stochastic gene expression, cell-to-cell variation in gene expression (cell-to-cell variation in number of RNA and protein molecules). Single cell measurements -Methods to study cell-to-cell variability of RNA and proteins. Noise and cellular decision-making (microbes to mammals). Non-genetic cellular heterogeneity and response.

**Unit-III**
Proteomics; LC-MS/MS, identification of proteins in complex mixtures and its role in systems biology. Genome sequencing; library preparations, barcoding and sequencing methods (Mi-seq, Hi-seq), Transcriptomics; RNA-seq (method/analysis (determination of RPKM values) and applications. Chromosome conformation capture (3C, 4C, 5C and HiC). Chromatin-immuno precipitation coupled to sequencing (ChIP-seq)

**Books Recommended:**


1. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon
2. A First Course in Systems Biology by Eberhard Voit

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18307 -DCE** | **Maximum marks** | **75** |
| **Course title:** | **Laboratory Course III** | | |
| **Credits:** | **Three** | | |

1. Competent cell preparation
2. Bacterial Transformation
3. Plasmid Isolation
4. PCR gene amplification.
5. Restriction Digestion
6. Gene cloning
7. GST protein expression and purification
8. Animal Cell Culture.

# Generic and Open Electives (GE/OE) offered in 3rd Semester

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18005GE** | **Maximum marks** | **50** |
| **Course title:** | **Molecular Mechanisms of Plant Life** | | |
| **Credits:** | **Two** | | |

**Unit I:** Organization of Shoot & Root apical Meristem. Molecular mechanism of shoot, Root & Leaf development. Phyllotaxy. Transition of flowering: Induction of flowering, Regulatory Pathways of Flowering. Floral meristem & floral development (Arabidopsis & Antirrhium)

**Unit II:** Plant hormones (Auxin, Gibberellin, Cytokinin, Ethylene, Brassinosteroids, Abscisic acid, Strigolactones, Jasmonates, polyamines, Salicyclic acid, Nitric oxide) biosynthesis storage, breakdown and transport: physiological effects and mechanism of action. Changing the genome of plants-transgenic plants (methods, advantages & concerns).

**Books recommended**

1. Handbook of Plant Science by Keith Roberts (Volume I &II), Wiley-Interscience
2. Molecular life of plants by Russel Jones, Helen Ougham, Howard Thomas, Susan Waaland, Wiley-Blackwell

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18006GE** | **Maximum marks** | **50** |
| **Course title:** | **Cancer Immunology** | | |
| **Credits:** | **Two** | | |

**Unit I: Oncogenes**: Historical aspects, provirus, protovirus and oncogene hypothesis. Functional class of oncogenes (proto-oncogenes) Mechanism of carcinogenic transformation by oncogenes, viral oncogenes. Tumor suppressor genes-properties, mechanism of tumor suppressor genes in cancer induction with special reference to P53 gene. Inherited cancers

**Unit II: Tumor immunology and cancer diagnostics & therapy**: Tumor immunology –Introduction, Mechanism of immune response to cancer, natural killer cells and cell mediated cytotoxicity. Biochemical, histological and radiological methods for cancer diagnosis Chemotherapy and radiotherapy strategies for cancer treatment. Cancer chemotherapeutic drugs. Types of radiation therapy. Immunotherapy of cancer – Rationale of immunotherapy, Tumor necrosis factor, interleukins, cytokines, interferons, vaccines, monoclonal antibodies.

**Books Recommended:**

1. Basic Immunology: Abul K. Abbas, Andrew H. Lichtman.
2. Janeway's Immunobiology, Garland Sciernce
3. Essential Immunology by Delvis, Martin , Burton and Roitt

| 4th Semester<br>Core papers | | |
|---|---|---|
| 1 | BT-18401-DC | Proposal writing |
| 2 | BT-18402-CR | Research based Project |
| 3 | BT-18403-DC | Seminar and Journal Club |
| 4 | BT-18404-DC | Project presentation |
| 5 | BT-18405-DC | Project viva |

The objective of this semester is to expose students with broader needs of Research. Students will choose their project advisor upfront based on interest and their merit in the first two semesters.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18401-DC** | **Maximum marks: 25** | |
| **Course title:** | **Proposal writing** | **Credits:** | **One** |

The students in consultation with their faculty advisor will prepare a synopsis of the project to be pursued. In the following months, the synopsis should include the rationale, objectives, proposed methodology and significance of the study. The students shall make an open presentation of the synopsis during the fourth week of the semester.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18402-CR** | **Maximum marks:** | **350** |
| **Course title:** | **Research based Project** | **Credits:** | **Fourteen** |

The project will be based upon research and actual bench work, carried under the guidance of faculty supervisor and in close collaboration with the research group. The students are expected to put in at least six working hours daily for a maximum of six months. The students will participate in Journal club and Lab meetings of the research group. Project report will be submitted and will be evaluated at the end of 4th semester.

Part 1 of the project will be based upon introduction to the subject and a general review of the literature pertaining to the project. The students should be encouraged to write a review of the problem or on a related topic.

Part 2 of the project will be based on the actual experimental work, presentation and analysis of the data generated. The project report should consist of Abstract, Rationale, Review of literature, Methodology, Results and discussion, and bibliography. Two examiners will evaluate the project reports of the students. The examiners will be nominated by the Head of the department from the panel of examiners proposed by the Project advisor, one of them will be the advisor. The examiners should be either from the department or from allied departments.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18403-DC** | **Maximum marks:** | **250** |
| **Course title:** | **Seminar and journal club** | **Credits:** | **2** |

Each student under the supervision of a faculty advisor will deliver a seminar on a topic related to his/her Project work. The seminars will be conducted in 10th week of the semester. Two faculty members nominated by the Head of the department will evaluate the seminars. The journal club will consist of a research paper presentation to be assigned and evaluated by the Project advisor

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18404-DC** | **Maximum marks:** | **75** |
| **Course title:** | **Project presentation** | **Credits:** | **Three** |

The students should make an open presentation defending their project work. One external expert and two faculty members nominated by the Head of the department will evaluate the presentation. The presentation will be open to all the students, scholars and teachers of the department and other allied departments.

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18405-DC** | **Maximum marks:** | **50** |
| **Course title:** | **Project viva-voce** | **Credits:** | **Two** |

Project viva will be conducted by one expert and all the faculty members of the department

# Generic and Open Electives (GE/OE) offered in Fourth Semester

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18007GE** | **Maximum marks** | **50** |
| **Course title:** | **Bioethics** | | |
| **Credits:** | **Two** | | |

**Unit I**

Introduction to Bioethics. Ethics and Morality. Introduction to subject areas of Bioethics (Poverty, Birth control, ethics and religion, euthanasia, Environmental ethics). Bioethical Principles. Bioethics and boundaries of public and private. Bioethics and conflict of interest. Bioethics in Research.

**Unit II**

Ethical issues concerning Embryonic Stem cells and Cloning. Animal cloning. Controversies regarding Designer babies. Gene therapy. Ethical controversies on Organ Transplantation. Surrogacy. Ethical regulations on Surrogacy. Genetically modified crops. Political and ethical issues involved in GMO,s. Advantages and Disadvantages. Ethical Limits of Animal use. Animal experiments in light of Bioethics.

**Textbook:**

**1.** Title: Bioethics, an introduction for the biosciences Author: Ben Mepham Publisher: Oxford University, UK Year: 2013 Edition: 2nd

**2.** Title: Bioethics: An Anthology (Blackwell Philosophy Anthologies) Paperback. Authors: Helga Kuhse, Udo Schüklenk and Peter Singer Publisher: John Wiley & Sons; Year: 2015 Edition: 3rd Revised edition

**3.** Title: The Biological Foundations of Bioethics Author: Tim Lewens Publisher: OUP, Oxford Year: 2015 Edition: 1st

| | | | |
|---|---|---|---|
| **Course No:** | **BT-18008OE** | **Maximum marks** | **50** |
| **Course title:** | **Bioinformatics** | | |
| **Credits: Two** | | | |

**UNIT-I:** Introduction and Biological databases: Introduction: What Is Bioinformatics? Goal. Scope. Applications. Limitations. Introduction to Biological Databases : What Is a Database? Types of Databases. Biological Databases. Pitfalls of Biological Databases.

**UNIT-II:** Sequence Alignment: Pairwise Sequence Alignment. Sequence Homology versus Sequence Similarity. Sequence Similarity versus Sequence Identity. Methods. Scoring Matrices. Statistical Significance of Sequence Alignment. Database Similarity Searching: Unique Requirements of Database Searching. Heuristic Database Searching. Basic Local Alignment Search Tool (BLAST). FASTA. Database Searching with the Smith–Waterman Method.

**Books Recommended:**

1. Developing Bioinformatics Computer Skills by Cynthia Gibas, Per Jambeck
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette
3. Bioinformatics: Sequence and Genome Analysis by David W. Mount