



# DEPARTMENT OF BIOTECHNOLOGY UNIVERSITY OF KASHMIR

**(NAAC Accredited Grade A<sup>+</sup>)**

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

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 (14 credits) / Discipline Centric Courses (8 credits)**, 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.

**One Credit: 16 hours of teaching/32 hours of practical or tutorial**

**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, 2019**

# Courses offered under Choice Based Credit system in M.Sc BIOTECHNOLOGY

## CORE COURSES (COMPULSORY 14 CREDITS EACH SEMESTER)

Sr. No.	Course Code	Course Title	Credit distribution			Total Credits	SEE	IA	Total Marks	Semester
			L	T	P					
1	BT-101-CR	Cell Biology	3	1	0	4	80	20	100	<b>First</b>
2	BT-102-CR	Molecular Biology-I	3	1	0	4	80	20	100	
3	BT-103-CR	Immune Biology	3	1	0	4	80	20	100	
4	BT-104-CR	Laboratory Course I	0	0	2	2	40	10	50	
5	BT-201-CR	Plant Biotechnology	3	1	0	4	80	20	100	<b>Second</b>
6	BT-202-CR	Molecular Biology-II	3	1	0	4	80	20	100	
7	BT-203-CR	Advanced Enzymology	3	1	0	4	80	20	100	
8	BT-204-CR	Laboratory Course II	0	0	2	2	40	10	50	
9	BT-301-CR	Genetic Engineering	3	1	0	4	80	20	100	<b>Third</b>
10	BT-302-CR	Animal Cell Science and Technology	3	1	0	4	80	20	100	
11	BT-303-CR	Bioprocess Engineering and Fermentation Technology	3	1	0	4	80	20	100	
13	BT-304-CR	Laboratory Course III	0	0	2	2	40	10	50	
13	BT-401-DCE	Proposal writing	0	1	0	1	0	25	25	<b>Fourth</b>
14	BT-402-CR	Research based Project	0	0	14	14	280	70	350	
15	BT-403-DCE	Seminar and Journal Club	0	2	0	2	40	10	50	
16	BT-404-DCE	Project presentation	0	3	0	3	60	15	75	
17	BT-405-DCE	Project Viva-Voce	0	2	0	2	50	0	50	

## Discipline Centric Electives (DCE)

Sr. No.	Course Code	Course Title	Credit distribution			Total Credits	SEE	IA	Total Marks	Semester
1	BT-105-DCE	Biotechniques	2	0	0	2	40	10	50	<b>First Semester</b>
2	BT-106- DCE	Microbiology	2	0	0	2	40	10	50	
3	BT-107-DCE	Biostatistics	2	0	0	2	40	10	50	
4	BT-108-DCE	Biomolecules	2	0	0	2	40	10	50	
5	BT-205-DCE	Chromatin and Epigenetics	2	1	0	3	60	15	75	<b>Second Semester</b>
6	BT-206-DCE	Intermediary Metabolism	2	1	0	3	60	15	75	
7	BT-207-DCE	Spectroscopy and Microscopy	2	0	0	2	40	10	50	
8	BT-305- DCE	Non-coding RNAs: features and functions in Neuronal Stem cells	2	0	0	2	40	10	50	<b>Third Semester</b>
9	BT-306- DCE	Introduction to Systems Biology: Networks and Noise;	2	1	0	3	60	15	75	
10	BT-307- DCE	Human and Medical Genetics	2	1	0	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-001-GE	Biochemical Techniques	1	1	0	2	40	10	50	First Semester
2	BT-002-OE	Basics in Immunology	1	1	0	2	40	10	50	
3	BT-003-GE	Oxidant signalling	1	1	0	2	40	10	50	Second Semester
4	BT-004-OE	Introduction to Protein Science	1	1	0	2	40	10	50	
5	BT-005-GE	Molecular Mechanisms of Plant Life	1	1	0	2	40	10	50	Third Semester
6	BT-006-GE	Cancer Immunology	1	1	0	2	40	10	50	
7	BT-007-GE	Bioethics	1	1	0	2	40	10	50	Fourth Semester

## **1<sup>st</sup> Semester**

### **Core papers**

<b>1</b>	<b>BT-101-CR</b>	<b>Cell Biology</b>
<b>2</b>	<b>BT-102-CR</b>	<b>Molecular Biology-I</b>
<b>3</b>	<b>BT-103-CR</b>	<b>Immune Biology</b>
<b>4</b>	<b>BT-104-CR</b>	<b>Laboratory Course I</b>

**Course No: BT-18101-CR**

**Maximum marks**

**100**

**Course title: Cell Biology**

**Credits: Four**

**Course Objectives:**

- Students will be introduced to history of Cell Biology, Microscopy, types and significance in understanding and unraveling mechanistic aspects of Cell Biology.
- Students will understand the basics and advanced aspects of Cellular Communication involving different mechanisms.
- Students will be introduced and explained about cell cytoskeleton network, higher order Structure and its Significance.
- Regulation of cell number, mechanisms involved in checking excessive proliferation including apoptosis will be discussed.

**UNIT-I:** Cellular diversity: An Overview. Structural features of Prokaryotic and Eukaryotic cells. Mycoplasmas. Viruses: Structure and types of viruses. Structural and functional details of Plasma membrane (different models), endoplasmic reticulum (smooth and rough endoplasmic reticulum), ribosomes (Prokaryotic and Eukaryotic) and Golgi complex, Lysosomes, Cell wall, Mitochondria, Chloroplast, Nucleus: organization of chromatin from nucleosomes to chromosomes, relationship between organization and function of chromatin, nuclear lamins, nuclear pores, nucleolus, cajal bodies, nuclear speckles and polycomb clusters.

**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. Mitochondrial membranes, TIM-TOM complexes, oxidative phosphorylation. Transmitter- gated ion channels. Electrical properties of membranes. Neurotransmission and its regulation. 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. Autophagy. Autophagy mechanisms. Cellular Communication; Cell adhesion, Role of different adhesion molecules. Gap junction, Tight junctions, Extracellular matrix and Integrins.

**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. EGFR and PDGFR operated pathways. JAK-STAT pathway. Notch and Wnt signaling pathways. 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. 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.

**Learning Outcomes:**

- *Students will be in know-how of the Microscopy, Cellular Organelles and their function.*
- *Students will acquire the knowledge on different types of signals, mechanisms and their functional significance.*
- *Students will be able to describe the mechanisms by which receptors are activated by their respective ligands and eventual activation of Signal Transduction pathway.*
- *Students will be able to relate to Cancers, Cell cycle, regulation and mechanistic aspects involved therein.*

**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.
4. Selected Research and Review articles.

<b>Course No:</b>	<b>BT-102-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Molecular biology-I</b>		
<b>Credits:</b>	<b>Four</b>		

**Course Objectives:** To Introduce DNA as molecular component of life and to emphasize the importance of DNA by providing information on its chemical nature, structure, replication and maintenance.

**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 stabilize 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. 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. Telomeres: Function and structure. Telomerase: role in the formation of telomeres and the molecular mechanism involved. Telomere 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 hetero-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:** Transcription General Idea, 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. Lac repressor (structure and function). Role of CAP in lac operon. Trp operon: Structure and regulation. Regulation by attenuation.

**Learning Outcomes:**

- Historical basis of DNA, its composition and structure in both prokaryotes and eukaryotes.
- Importance of DNA in prokaryotes and eukaryotes by providing basic information in DNA replication, key proofreading processes in DNA replication.
- Consequences of different types of mutations and various repair mechanisms operational in prokaryotes, and eukaryotes.
- Transcription system in prokaryotes with specific emphasis on operons to understand mechanism and regulation of transcription.

**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

<b>Course No:</b>	<b>BT-103-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Immune biology</b>		
<b>Credits:</b>	<b>Four</b>		

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

**Unit I:** Overview of the Immune system: Historical perspective, Types of Immunity – Innate and Adaptive Immunity – Cell and Humoral immunity Lymphoid organs – Primary and Secondary Lymphoid Organs. Host-Pathogen Interactions Mechanisms of Pathogenesis , Evasion of Host Defences, Complement system and its regulation

**Unit II:** Antigens and Antigen recognition Molecules –Antigen processing and presentation, Cytokines and their role in immune regulation. Vaccines– Types of Vaccine, Antibody - Structure, types, diversity & function; Major Histocompatibility Complex

**Unit III:** Immune system in Health and Disease: Transplantation, Types of grafts. Immunological tolerance Cell mediated cytotoxicity. Hypersensitivity reaction Type I to V .

**UNIT IV:** Tumor immunology –Introduction to tumour immunology Immunosurveillance Tumor antigens . Tumor immune escape T cell suppression. Chronic inflammation and tumor promotion,. 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



<b>Course No:</b>	<b>BT-104-CR</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Laboratory Course I</b>		
<b>Credits:</b>	<b>Two</b>		

**Learning Objectives**

*The objective of the course is to provide hands on training of basic experiments related to protein chemistry, viz., preparation, estimation, visualization and analysis using different techniques.*

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. Measurement of bacterial population by turbidimetry and serial dilution methods.
4. SDS-PAGE and protein staining with Coomassie
5. Gel Filtration Chromatography

**Learning outcomes:**

- On completion of course the students are able to understand
- Different concepts related to solutes and solutions, and buffers.
- Titrate different amino acids for pKa determination.
- Estimate and analyze protein mixture
- Use Gel-filtration chromatographic techniques.

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

<b>Course No:</b>	<b>BT-105 -DCE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Biotechniques</b>		
<b>Credits:</b>	<b>Two</b>		

### **Course Objectives:**

*The course is aimed to acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles. The course also aims to make students learn about modern instruments for various analytical works.*

**UNIT-I: Electrophoresis and Radioactivity:** 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 and distribution, Dispersion. Chromatographic Resolution. Types:, Paper, thin-layer and partition chromatography, Gel filtration 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.

### **Learning Outcomes**

- *Understand the mechanics of common laboratory assays and how they can be applied to research.*
- *Perform basic biotechnical experiments*
- *To enable the students to learn techniques like Nucleic acid isolation, Immunoprecipitation, SDS-PAGE western blot analysis.*

### **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 Reubsæet, Tyge Greibrokk . WILEY.
5. Basics of Centrifugation. ThermoFisher

<b>Course No:</b>	<b>BT-106 - DCE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Microbiology</b>		
<b>Credits:</b>	<b>Two</b>		

**Course Objectives:**

*The aim of this course is to give fundamental concepts of bacterial growth, mechanism of toxins, retroviral replication, mode of action of antimicrobial agent. Bacterial gene transfer by transformation, transduction and conjugation.*

**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)

**Learning outcomes:** *Students understand the basics of microbial structure and microbial growth requirements and equipped with various methods of growth parameters. They can comprehend the mechanism of gene transfer and gene mapping of bacteria.*

**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.

<b>Course No:</b>	<b>BT-107 - DCE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Biostatistics</b>		
<b>Credits:</b>	<b>Two</b>		

### **Course Objectives**

*The objective of the course is to provide insight in methods of effective data collection, data representation, and use data to make inferences and conclusions about issues faced by biology students.*

**UNIT I:** General Introduction to Statistics, Basic Concepts. Scope of Statistical methods in Biotechnology. **Measures 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. **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.

**UNIT-II: Data representation & Analysis:** 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.

### **Learning outcomes:**

*The student will be able to recognize the importance of data collection and its role in determining scope of inference. The students will be able to Interpret statistical results correctly, effectively, and in context.*

### **Books Recommended:**

4. Introduction to Biostatistics and Research Methods by Sunder Rao and J Richards (Prentice-Hall of India)
5. Medical Statistics by David Machin, Michael J Campbell and Stephen J Walters (John Wiley and Sons)
6. Statistics for Health, Life and Social by Denis Anthony (Denis Anthony & Ventus Publishing)
7. Introductory Biostatistics for the Health Sciences by Michael Chernick and Robert Friss (John Wiley and Sons)

<b>Course No:</b>	<b>BT-108 - DCE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Biomolecules</b>		
<b>Credits:</b>	<b>Two</b>		

**Course objectives:** *The Students will know how the structure and function of molecules that constitute living organisms*

### Unit I

#### **Amino acids, peptides and proteins.**

Water and its properties, 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 ( $\beta$ -hairpins, helix hairpins,  $\beta$ - $\alpha$ - $\beta$ ,  $\alpha$ - $\alpha$  motif). Fibrous protein structure ( $\alpha$ -keratin and collagen). Protein tertiary structures. Forces that stabilize the protein tertiary structures.

### Unit-II

#### **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.

### **Learning Outcomes**

- *know the chemical constituents of cells, the basic units of living organisms.*
- *explain various types of weak interactions between the biomolecules.*
- *know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.*
- *correlate the structure-function relationship in various biomolecules*
- *know the role of biomolecules for orderly structures of the cells/tissues.*

### **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

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

<b>Course No:</b>	<b>BT-001GE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Biochemical Techniques</b>		
<b>Credits:</b>	<b>Two</b>		

**Course Objectives**

*The course is aimed to acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles. The course also aims to make students learn about modern instruments for various analytical works.*

**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.

**Learning Outcomes**

- *Understand the mechanics of common laboratory assays and how they can be applied to research.*
- *Perform basic biotechnical experiments*
- *To enable the students to learn techniques like Nucleic acid isolation, Immunoprecipitation, SDS-PAGE western blot analysis.*

**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 Reubsæet, Tyge Greibrokk . WILEY.
10. Basics of Centrifugation. ThermoFisher

<b>Course No:</b>	<b>BT-001OE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Basics in Immunology</b>		
<b>Credits:</b>	<b>Two</b>		

### **Course Objectives**

*The course is aimed to acquaint the students with basic knowledge of immune system.*

**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 interaction – precipitation, agglutination.

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

### **Learning Outcomes**

- *Understand the basics of immune system*
- *Know various cells involved in defence against microbes*
- *To know about the vaccines and there immunisation scheduled*

### **Books recommended:**

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

## **2<sup>nd</sup> Semester**

### **Core papers**

<b>1</b>	<b>BT-201-CR</b>	<b>Plant Biotechnology</b>
<b>2</b>	<b>BT-202-CR</b>	<b>Molecular Biology-II</b>
<b>3</b>	<b>BT-203-CR</b>	<b>Advanced Enzymology</b>
<b>4</b>	<b>BT-204-CR</b>	<b>Laboratory Course II</b>



<b>Course No:</b>	<b>BT-18201-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Plant Biotechnology</b>		
<b>Credits:</b>	<b>Four</b>		

### **Course Objectives**

*The aim of this course is to provide skilled knowledge of biotechnology in the improvement of plants. The course deals with the concept of plant totipotency and its regulation. How to propagate plants in vitro by using tissue culture, Understanding the mechanism of genetic transformation of plants using agrobacterium system for the production of disease resistant, stress tolerant and to have altered nutrient content.*

**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 fusion and 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 Molecular markers, 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), 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 of 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

**Learning outcomes:**

*Acquired advanced knowledge & understanding of plant biotechnology. Concept of molecular mechanism involved in dedifferentiation & re-differentiation of plant cell using plant hormones to alter cell cycle. Core methodology involved in tissue culture for micropropagation of plants and plant transformation techniques. Applied knowledge how plant can be used as an expression system for production of bioactive compounds at industrial scale. How to address the social and scientific concerns of 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: Tzifira, Tzvi, Citovsky, Vitaly: Springer verlag

<b>Course No:</b>	<b>BT-202-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Molecular biology-II</b>		
<b>Credits:</b>	<b>Four</b>		

### **Course Objectives**

To emphasize on advanced concepts of molecular processes involved in expression of genetic information in eukaryotic cells, including transcription, splicing, translation and post-translational modification, and how these processes are regulated.

**UNIT-I:** Eukaryotic transcription: Eukaryotic RNA polymerases: RNA Pol I, RNA Pol II and RNA pol III. 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. Activation bypass, 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 mechanism. Spliceosome (structure, assembly and function). Alternative splicing. Regulation of splicing. Self-splicing RNAs with reference 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 mechanism 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 riboswitches. 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. Wobble hypothesis and degeneracy. Translation elongation: Three-site ribosome model of tRNA binding. Role of EF-T. Proofreading during translation elongation. Peptidyl transferase reaction. Translocation and role of EF-G. Translation termination: termination codons. Release factors. Ribosome dissociation and the factors involved.

### **Learning Outcomes:**

- Explain and illustrate methods to identify types, structure, and function of different types of eukaryotic polymerases, RNA polymerases, transcription factors and associated factors. Explain the mechanism by which transcription is initiated and elongated in eukaryotic cells.
- Explain and illustrate mechanisms and significance of regulation of Eukaryotic Gene Expression. Illustrate methods to understand key role of regulatory elements, various transcription factors, associated factors, and small regulatory RNAs.
- Explain difference between pre-RNA and mRNA. Various Posttranscriptional events like splicing, capping and polyadenylation.
- The mechanism of translation. Initiation, elongation and termination. Ribosomes and transfer RNAs. Describe RNA post-translational modification and its purpose

### **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.

<b>Course No:</b>	<b>BT-203-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Advanced Enzymology</b>		
<b>Credits:</b>	<b>Four</b>		

**Learning Objectives:** *The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function and kinetics enzymes. Also it deals with current applications and future potential of enzymes.*

**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, Enzyme inhibition and kinetics

**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, Protein engineering. 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, sigmoidal 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 enzymes Immobilized enzymes and their industrial application. Effects of partition on kinetics and performance with special emphasis on changes in pH and hydrophobicity.

**Learning outcomes:**

*The student will be able to describe structure, regulation, functions and the mechanisms of action of enzymes. The student will get exposure of wide applications of enzymes and their future potential, and will learn the basics of drug designing, through ligand binding examples.*

**Books Recommended:**

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

<b>Course No:</b>	<b>BT-204-CR</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Laboratory course II</b>		
<b>Credits:</b>	<b>Two</b>		

### **Course Objectives:**

*The course is aimed to provide basic lab training in techniques like DNA/RNA isolation, protein-protein interactions, SDS-PAGE, western blot and enzyme assay. The students are also provided training in handling of plant tissue culture.*

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

### **Course Outcomes**

- *To enable the students to learn techniques like Nucleic acid isolation, Immunoprecipitation, SDS-PAGE western blot analysis and Plant tissue culture.*
- *Through with basic plant tissue culture handling*

## Discipline Centric Courses (DC) 2<sup>nd</sup> semester

Course No:	BT-205-CR	Maximum marks	75
Course title:	Chromatin and Epigenetics		
Credits:	Three		

### **Course Objectives:**

*This course is designed to familiarize the students with basic and more advanced concepts of an emerging and rapidly evolving field of epigenetics.*

**UNIT-I:** Chromatin, Histones, Nucleosome, Nucleosome Structure, Euchromatin, Heterochromatin, Chromosomes and Chromosomal territories. Histone Variants and complexes involved in their exchange, Role of histone variants in gene regulation, Histone Chaperons, Chromatin assembly, nucleosome positioning.

**UNIT-II:** Modulation of Chromatin Structure, ATP dependent chromatin remodeling, Histone modifications and the enzymes involved (Acetylation, Methylation, Phosphorylation and Ubiquitination), Genome wide analysis of histone modifications, Cross-talk between histone modifications, Histone Code hypothesis, Protein Domains that Bind Chromatin Modifications, Histone Modifications and Transcription, Histone H3K4 Methylation in transcription initiation, Histone H3K36 Methylation and transcription elongation. DNA repair in context of chromatin, Transcription Memory and Maintenance of Genome Integrity DNA Methylation, Interplay of DNA methylation and histone modifications.

**UNIT-III.** Epigenetics, Chromatin Boundaries: *S. cerevisiae* Silencing, *S. pombe* Centromeric Heterochromatin, RNAi-directed Silencing. Epigenetic reprogramming in mammals, Position effect variegation, dosage compensation, X chromosome inactivation. Epigenetic mechanisms regulating ES cell differentiation, Bivalent Chromatin Marks in maintaining stem cell pluripotency, Epigenetics and Human Diseases, Epigenetic Determinants of Cancer: The Importance of Chromatin to Cancer, The Role of DNA Methylation in Cancer, Histone modifications in Cancer. Epigenetic Disorders of Genomic Imprinting: SISTER SYNDROMES: PRADER-WILLI AND ANGEIMAN, RUBINSTEIN-TAYBI SYNDROME, FRAGILE X SYNDROME, Epigenetic Therapy

### **Course Outcomes**

*On Successful Completion of this course the students should have a sound knowledge about the Epigenetic contribution in cellular functions. The students would also learn the critical analysis, thinking of research papers and problem solving skills*

### **Recommended References:**

1. Chromatin Structure and Function by Alan Wolffe.
2. Epigenetics by David Allis, Thomas Jenuwein, Danny Reinberg and Marie-Laure Caparros

<b>Course No:</b>	<b>BT-206-CR</b>	<b>Maximum marks</b>	<b>75</b>
<b>Course title:</b>	<b>INTERMEDIARY METABOLISM.</b>	<b>Credits:</b>	<b>Three</b>

**Learning objectives:** *Our main objective of intermediary metabolism course is to provide fundamental knowledge regarding the various metabolic pathways and their regulation with reference to human cells and tissue.*

**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. NUCLEOTIDE 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 DEREGLATION AND TYPE-II DIABETES. ROLE OF DIET, MEDICATION AND EXERCISE IN TYPE-II DIABETES.

**Learning outcomes:** *By the end of the course, the students get holistic view of the human metabolism and its regulation. The students get to know the role of various food components in metabolism and the molecular mechanism of various metabolic disorders, like diabetes, obesity, etc.*

**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

<b>Course No:</b>	<b>BT-207 -DCE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Spectroscopy and Microscopy</b>		
<b>Credits:</b>	<b>Two</b>		

**Learning Objectives:**

a) to expose the student to high sensitivity and high resolution optical spectroscopic methods and to expose the students to basics of microscopy as well as the cutting-edge microscopy technologies.

**Unit-I :** UV-visible absorption spectroscopy. Principle and applications of Fluorescence spectroscopy; Jablonski diagram, Fluorophores; Intrinsic and extrinsic fluorophores, steady-state fluorescence, time-resolved fluorescence; Time Correlated Single Photon Counting (TSCPC), Fluorescence resonance energy transfer (FRET), Anisotropy. Circular dichroism (far-UV, near-UV). Infrared spectroscopy, Raman spectroscopy and Dynamic light scattering.

**Unit-II:** Principle and applications of; bright-field, confocal (immunofluorescence), and super-resolution microscopy (STORM, STED, PALM), Electron microscopy; Transmission and scanning 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.

**Learning Outcomes:** This course will enable the students to devise the variety of methodologies/experiments for solving the research based problems and hence prepare them to undertake the research programs.



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

Course No:	BT-003GE	Maximum marks	50
Course title:	Oxidant signalling		
Credits:	Two		

### Course Objectives:

- *The goal of this course to let students understand the basics of Oxidant molecules their production and their harmful effects.*
- *Students will acquire knowledge on the significance of understanding the oxidant signaling in human cells.*

**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.

### Learning Outcomes:

- *Students will have clear concepts on basics of oxidants, Oxidative stress, oxidant production and possible effects on cellular systems.*
- *Students will know on different types of antioxidants and mechanism of their action.*
- *Students will know about the physiological role of oxidants.*

### **Books Recommended:**

1. Selected Research and Review Journals.
2. Internet Resources: Pubmed, Google, Google Scholar.

<b>Course No:</b>	<b>BT-004 OE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Introduction to Protein Science</b>		
<b>Credits:</b>	<b>Two</b>		

**Learning Objectives:** *The course will briefly introduce the students to the structural organisation of proteins, structure and properties of the constituent amino acids will be described besides the role and functional diversity of proteins.*

#### **UNIT-I: Introduction**

Brief history of Proteins, Importance of studying Proteins. Building blocks of Proteins: Amino acids: Structure and classifications. Essential and non-essential amino-acids, Derived amino acids, Non protein amino acids, Optical activity and Acid base properties. Peptide bond formation, oligo and poly peptides.  
Level's of protein structures: Primary, Secondary and Super secondary structures, Protein domains and motifs , Tertiary and quaternary structures. Globular and Fibrous Proteins with examples.

#### **UNIT-II: Biological diversity of Proteins.**

Functions of Proteins in body; Blood and Plasma proteins; Haemoglobin, Structure and functions, Sickle cell anaemia; Albumin : Structure and importance, Enzymes : General overview  
Proteins uses, sources and requirements: Nutritional importance of Proteins; Assessment of Nutritional value, Protein efficiency ratio, Biological value of proteins, Net Protein utilization, Chemical score; Protein requirement, Dietary sources of Proteins; Protein deficiency disorders, Protein energy malnutrition, Kwashiorkor, Marasmus, Industrial uses of Proteins.

**Learning Outcome:** By the end of the course the students will know about the structural and functional aspects of Proteins

Recommended Texts:

Biochemistry by Donald Voet and Judith G Voet, John Wiley & Sons

Biochemistry by U. Satyanarayana

## **3<sup>rd</sup> Semester**

### **Core papers**

<b>1</b>	<b>BT-301-CR</b>	<b>Genetic Engineering</b>
<b>2</b>	<b>BT-302-CR</b>	<b>Animal cell Science and Technology</b>
<b>3</b>	<b>BT-303-CR</b>	<b>Bioprocess Engineering and Fermentation technology</b>
<b>4</b>	<b>BT-304-CR</b>	<b>Laboratory Course III</b>

<b>Course No:</b>	<b>BT-301-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Genetic engineering</b>		
<b>Credits:</b>	<b>Four</b>		

**Learning objectives:** *The objective of genetic engineering course is to familiarise students with fundamentals of DNA recombinant technology and advanced aspects of genetic engineering.*

**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 ( $\lambda$ -gt10,  $\lambda$ -gt11). Replacement lambda phage vectors ( $\lambda$ EMBL 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 Desorption 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 mutagenesis: 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. Heterologous 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 pastoris* 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. Importance 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. Reporter assays: Reporter genes and applications (Chlorophenicol acetyl 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: Antisense 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 targeting. CRISPR-Cas9, variants and applications, 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.

**Learning outcomes:** *After successful completion of the course, the students are expected to gain knowledge in genetic engineering concepts. The academic knowledge provides them a strong platform for performing various research-based endeavours in genetic engineering*

**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

<b>Course No:</b>	<b>BT-302-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Animal cell science and technology</b>		
<b>Credits:</b>	<b>Four</b>		

**Course Objectives:**

- This Course will help students to familiarize themselves with Animal cell, their culturing and significance of growing and maintaining them as *in vitro* cultures.
- Goal is to provide theoretical knowledge on animal cells for *in vitro* studies, manipulation of animal cells in vitro and application of molecular techniques to *in vitro* situations.

**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 CO<sub>2</sub>, 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.

Cloning of Animals. Strategies for Transgenic animal production using Microinjection, Somatic cell nuclear transfer technique, embryonic stem cells and using Viruses. Legal and ethical aspects of Animal Cloning. Application of Transgenic animals.

**Learning Outcomes:**

By the end of this course students will be able to:

- Comprehend the fundamental concepts of animal cell culture and its importance.
- Discuss significance of culturing by carrying out various assays and experiments in cultured cells.
- Discuss transgenic animals and their advantages and disadvantages.

**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.

4. Transgenic Animal Technology, 3rd Edition, A Laboratory Handbook by Carl Pinkert, Elsevier Press.
5. Selected Research and Review articles.

<b>Course No:</b>	<b>BT-303-CR</b>	<b>Maximum marks</b>	<b>100</b>
<b>Course title:</b>	<b>Bioprocess engineering and Fermentation technology</b>		
<b>Credits:</b>	<b>Four</b>		

### **Learning Objectives**

*The objective of the course is to provide students with the knowledge of fermentation, bioreactor technology, and thus applications of the chemical engineering principles in biological systems.*

**UNIT-I:** 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-II:** 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-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.

### **Learning outcomes:**

*After completing this course, the students will be able to analyze kinetics of cell and product formation under different types of culture conditions. The students will be able to develop control strategies for bioprocess operations, and will be able to select the appropriate methods for product purification.*

### **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).

<b>Course No:</b>	<b>BT-18304-CR</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Laboratory course III</b>	<b>Credits:</b>	<b>Two</b>

**Course Objectives:** *To acquaint students with principles, working and applications of genetic engineering techniques.*

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.

**Learning Outcomes:**

- Students will acquire the knowledge on different techniques related to gene cloning, PCR amplification, Protein Purification and basic culture handling.
- *Development of an ability to design and conduct genetic engineering experiments, as well as to analyze and interpret data.*



## Discipline Centric Courses (DC) 3<sup>rd</sup> semester

<b>Course No:</b>	<b>BT-305-CR</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Non-coding RNAs</b>		
<b>Credits:</b>	<b>Two</b>		

**Course Objective:** To emphasize regulatory roles of noncoding RNAs in development and stem cells.

### UNIT-I

**General Introduction:** 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 (lncRNA) and their importance in gene regulation and disease pathogenesis. MicroRNA (miRNA) and lncRNA pathways in Neurodevelopmental and Neurodegenerative 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.

**Learning outcome:**

- Explain various types of ncRNA, their biogenesis, and features. Illustrate their roles in posttranscriptional gene control and epigenetics. Explain developmental importance of ncRNA.
- Explain basic concepts of Neuronal stem cells. Exemplify and illustrate regulatory roles of miRNA, and lncRNA in stem cell self-renewal, maintenance, and differentiation.

<b>Course No:</b>	<b>BT-306-DCE</b>	<b>Maximum marks</b>	<b>75</b>
<b>Course title:</b>	<b>Introduction to Systems Biology: Networks and Noise</b>		
<b>Credits:</b>	<b>Three</b>		

**Learning Objectives:**

- to introduce the concepts of systems biology to student.
- to expose the students to high through put methods like proteomics and next generation sequencing based methods

**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).

**Learning Outcome:** *This advanced course will enable the students to think in terms of systemic/holistic perspective and understand the biological processes in a more realistic context. The students will also get familiar with proteomics and genomics based methods.*

<b>Course No:</b>	<b>BT-307 -DCE</b>	<b>Maximum marks</b>	<b>75</b>
<b>Course title:</b>	<b>Human and Medical Genetics</b>		
<b>Credits:</b>	<b>Three</b>		

**Course Objective:** *To explain and emphasize importance of basic Human and Molecular genetics in medical practice including recognizing common genetic anomalies, genetic counseling, testing and screening, and plans for management and treatment.*

**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: Complications to the basic pedigree patterns. Factors affecting gene frequencies. Nonmendelian characters. Human gene expression and Instability of the human genome: Overview of gene expression in human cells. Overview of mutation, polymorphism. 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. Genetic and physical mapping of the human genome. Other genome projects. Available genetic data, and functional genomics in laboratory organisms.

**UNIT-III:** Medical Genetics and Diagnostic techniques: Overview. Modern molecular and cytogenetic methods (Modern PCR methods, FISH, MLPA, arrayCGH, Parent of Origin Effects, Prenatal Diagnosis, chorionic villus sampling (CVS), Preimplantation Genetic Diagnosis (PGD). Emerging technologies (Personalized Medicine, Gene Therapy, Stem Cells). Clinical case studies illustrating Genetic Principles and diagnostics.

**Learning Outcome:**

- *Explain and illustrate the organization of the human genome. Explain and illustrate the patterns of inheritance and clinical manifestations of genetic diseases; chromosomes, chromosomal abnormalities, and the clinical features of common chromosomal disorders.*
- *Sequencing technology in post Human genome project era, Describe methods and tools used in molecular genetics, and their potential applications to medical practice. Explain ethical aspects of medical genetics.*

**Recommended references:**

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

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

<b>Course No:</b>	<b>BT-005GE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Molecular Mechanisms of Plant Life</b>		
<b>Credits:</b>	<b>Two</b>		

### **Course Objectives**

*The aim of this course is to study the organisation root apical meristem and shoot apical meristem, floral development, mode of action of new plant hormones.*

**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, Salicylic acid, Nitric oxide) biosynthesis storage, breakdown and transport: physiological effects and mechanism of action. Changing the genome of plants-transgenic plants (methods, advantages & concerns).

### **Learning outcomes**

*Demonstrate the molecular mechanism of regulating the stem cells in plant meristems. Elucidates the role new hormones in plants*

### **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

<b>Course No:</b>	<b>BT-006GE</b>	<b>Maximum marks</b>	<b>50</b>
<b>Course title:</b>	<b>Cancer Immunology</b>		
<b>Credits:</b>	<b>Two</b>		

**Course Objectives:** *The objective of this course is to introduce current concepts and advances in the area of cancer biology. The Students will understand the role of oncogenes and suppressor genes and get knowledge on cancer related mutagens and pathways and cancer therapy*

**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.

#### **Learning Outcomes**

- *comprehend pathogenesis, molecular mechanisms and identification of cancer*
- *explain cancer metastasis microenvironment and cancer therapy*

#### **Books Recommended:**

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

## 4<sup>th</sup> Semester

### Core papers

<b>1</b>	<b>BT-401-DC</b>	<b>Proposal writing</b>
<b>2</b>	<b>BT-402-CR</b>	<b>Research based Project</b>
<b>3</b>	<b>BT-403-DC</b>	<b>Seminar and Journal Club</b>
<b>4</b>	<b>BT-404-DC</b>	<b>Project presentation</b>
<b>5</b>	<b>BT-405-DC</b>	<b>Project viva</b>

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.

<b>Course No:</b>	<b>BT-401-DCE</b>	<b>Maximum marks: 25</b>
<b>Course title:</b>	<b>Proposal writing</b>	<b>Credits: One</b>

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.

<b>Course No:</b>	<b>BT-402-CR</b>	<b>Maximum marks: 350</b>
<b>Course title:</b>	<b>Research based Project</b>	<b>Credits: Fourteen</b>

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.

<b>Course No:</b>	<b>BT-18403-DCE</b>	<b>Maximum marks:</b>	<b>250</b>
<b>Course title:</b>	<b>Seminar and journal club</b>	<b>Credits:</b>	<b>2</b>

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

<b>Course No:</b>	<b>BT-18404-DCE</b>	<b>Maximum marks:</b>	<b>75</b>
<b>Course title:</b>	<b>Project presentation</b>	<b>Credits:</b>	<b>Three</b>

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.

<b>Course No:</b>	<b>BT-18405-DCE</b>	<b>Maximum marks:</b>	<b>50</b>
<b>Course title:</b>	<b>Project viva-voce</b>	<b>Credits:</b>	<b>Two</b>

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-007GE	Maximum marks	50
Course title:	Bioethics		
Credits:	Two		

### Course Objectives:

- Aim is to introduce students to Bioethics, its meaning, its philosophical foundations and bioethics principles.
- Imparting knowledge and skills that will enable students to develop ethical answers to these various issues especially related to research discoveries made in the field of biology.
- Identify the basic concepts of modern biology and explain how recent advancements in these areas have influenced current bioethical issues.

### 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.

### Learning Outcomes:

- Students will be able to understand basics of bioethics, importance of this course, its relevance in research, publishing field and healthcare.
- Students will be able to understand the goal behind transgenic plants and animals, Ethical concerns and analysis.
- Students will understand various ethical issues pertaining to animal use in research, growth hormone usage, Surrogacy and cloning.
- Students will understand the tools and approaches needed to make a bioethical decision and to communicate that decision in rationally informed way.

### **Textbook:**

1. Title: Bioethics, an introduction for the biosciences Author: Ben Mephram Publisher: Oxford University, UK

Year: 2013 Edition: 2<sup>nd</sup>

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

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