



**DEPARTMENT OF BIOCHEMISTRY**  
**UNIVERSITY OF KASHMIR**  
**SRINAGAR-190006**

**Choice Based Credit System Syllabus for  
M.Sc. Biochemistry**

**2024 onwards**

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PAPERS, CREDITS, HOURS AND MARKS DETAILS								
SEMESTER I								
Paper			Hrs./Week			Credits	Max Marks	
Code	Name	Category	L	T	P		Ext.	Int.
BCH24-101CR	Biomolecules	Core	4	0	0	4	80	20
BCH24-102CR	Cell Biology	Core	4	0	0	4	80	20
BCH24-103CR	Bioenergetics	Core	2	0	0	2	40	10
BCH24-104CR	Lab. Course-I	Core	0	0	8	4	80	20
BCH24-101DCE	Plant Biochemistry	DCE	3	2	0	3+1=4	80	20
BCH24-102DCE	Biochemical Techniques	DCE	3	2	0	3+1=4	80	20
BCH24-001OE	Fundamentals of Biochemistry	OE	1	2	0	1+1=2	40	10
						<b>Total credits 24</b>	<b>Total Marks 600</b>	
SEMESTER II								
BCH24-201CR	Metabolism	Core	4	0	0	4	80	20
BCH24-202CR	Molecular Biology	Core	4	0	0	4	80	20
BCH24-203CR	Advanced Techniques	Core	2	0	0	2	40	10
BCH24-204CR	Lab. Course-II	Core	0	0	8	4	80	20
BCH24-201DCE	Enzymology	DCE	3	2	0	3+1=4	80	20
BCH24-202DCE	Microbiology	DCE	3	2	0	3+1=4	80	20
BCH24-002OE	Protein Biochemistry	OE	1	2	0	1+1=2	40	10
BCH24-001GE	Chronic Diseases	GE	1	2	0	1+1=2	40	10
						<b>Total Credits 26</b>	<b>Total Marks 650</b>	
SEMESTER III								
BCH24-301CR	Immunology	Core	4	0	0	4	80	20
BCH24-302CR	Biotechnology	Core	4	0	0	4	80	20
BCH24-303CR	Genetics	Core	2	0	0	2	40	10
BCH24-304CR	Lab. Course-III	Core	0	0	8	4	80	20
BCH24-301DCE	Nutritional Biochemistry & Endocrinology	DCE	3	2	0	3+1=4	80	20
BCH24-302DCE	Physiology and Cl. Biochemistry	DCE	3	2	0	3+1=4	80	20
BCH24-303DCE	Chromatin Biology and Cell Signaling	DCE	1	2	0	1+1=2	40	10
BCH24-002GE	Metabolic Disorders	GE	1	2	0	1+1=2	40	10
						<b>Total Credits 26</b>	<b>Total Marks 650</b>	
SEMESTER IV								
BCH24-401CR	Project Dissertation	Core	0	0	20	10	250	0
BCH24-402CR	Project Assessment	Core	0	8	0	4	100	0
BCH24-401DCE	Host-Institute evaluation	DCE	0	0	4	2	50	0
BCH24-402DCE	Journal Club	DCE	0	8	0	4	100	0
BCH21-003OE	Cancer Biology	OE	1	2	0	1+1=2	40	10
BCH21-003GE	Biochemical tests & Interp.	GE	1	2	0	1+1=2	40	10
						<b>Total Credits 24</b>	<b>Total Marks 800</b>	

Total credits required for M. Sc. Biochemistry: 96  
Total Marks for M.Sc. Biochemistry: 2400

**Abbreviations:**

- CR - Core
- DCE - Discipline Centric Elective
- GE - General Elective
- OE - Open elective
- L, T, P - Lectures, Tutorials and Practical, respectively

Session/Year 2024 Onwards

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### Program Objectives

The two-year M.Sc. program in the Department of Biochemistry endeavors to provide students with excellent training in Biochemistry, emphasizing a solid foundation in basic concepts and rapid advancements in the field. Students will be offered advanced-level theory in courses like biomolecules, metabolism, cell biology, genetics, biochemical techniques, immunology, enzymology, molecular biology, human physiology, recombinant DNA technology and advanced biochemical techniques.

In addition to theoretical knowledge, considerable emphasis is given on hands-on bench training in fundamental areas of biochemistry in the first three semesters. In the fourth semester, the students will get the opportunity to work independently in a research laboratory under the supervision of a principal investigator. To develop oratory and writing skills, students will select a recent and advanced scientific paper from high-profile journals in consultation with assigned mentors and present it before the team of evaluators.

In alignment with the objectives of the program, several elective courses have also been included in the syllabus to impart knowledge in fundamentals in biochemistry, chronic diseases, metabolic disorders, protein biochemistry, cell signaling, and biochemical interpretation for the students in the allied disciplines..

The Department aims to accomplish the following program objectives:

- Equip students with a thorough comprehension of the fundamentals of biochemistry
- Impart knowledge to students so they can use biochemical concepts both theoretically and practically
- Promote lifelong learning to meet the ever evolving professional demands by developing ethical, inter personal and team skills
- Train students to critically analyze scientific data, draw objective conclusions, and apply this knowledge for human welfare
- Motivate students for higher education, particularly in research, and provide trained manpower for research institutions and industry

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### Program Outcomes

The Master's program in Biochemistry is typically built upon the foundational undergraduate knowledge in biological sciences and chemistry, aiming to deepen the understanding and proficiency in biochemical principles and research methodologies. Some of the most common program outcomes/applications are briefly discussed below:

1. **Research:** The course content of the program is broad and relevant with the changing technology and research. The students with M.Sc. in Biochemistry serve as unparalleled human resources for the basic or most advanced research in biochemistry and other areas of biological sciences including cell biology, molecular biology, microbiology, immunology, endocrinology, drug design and development, synthetic biology, nanotechnology, cancer biology, medicine and biotechnology.
2. **Health Sector:** The students can join health care setups for management, instructors and services sector. Biochemists perform clinical evaluations that are inevitable for diagnostics or management of patients. They carryout laboratory management by ensuring quality control, minimizing pre and post analytical errors, in proper handling of biological specimens and pathogens and safe bio-waste disposal. Their knowledge in all the important subjects helps them to serve as confident/teachers in medical and paramedical colleges.
3. **Conceptualizing the Problem and Solution:** The local, national and international problems ranging from diseases, environmental issues or food availability are best understood by biochemists and have the potential and training to explore solution by appropriate research design. The biochemist has been playing important roles in confronting infections, addressing population, global warming, food scarcity, and many other unprecedented challenges.
4. **Biomedical engineering:** The development or application of the important biomedical equipment ranging from high end advanced imaging systems to basic analyzers; involve the exploitation of the basic understanding of the difference in the biochemical parameters in disease and normal tissues. Our manpower is playing important role in design or development of such equipment in collaboration with biomedical engineers.
5. **Agriculture:** The understanding of the basic biochemical mechanisms in agricultural plants has enabled us to overcome food scarcity in the world. The science behind the different revolutions in agriculture including developing high-yielding livestock breeds and crops and developing anti-infection agents, disease disease-resistant crop variants helped us improve a lot agricultural produce.
6. **Pharmaceutical industry:** The biochemists play an important role in understanding the pharmacokinetics and dynamics of any potential therapeutic agent. The novel drug targets are identified and their possible interventions are explored by biochemists. Further, the biochemists are the vaccine developers and use their skills in the development of immunological therapies.
7. **Forensic science:** Biochemistry has a major application in this field. The biochemists are well trained to analyze biochemical specimens in order to nab the culprit or to resolve paternity disputes.
8. **Next-generation researchers and scientists:** The six-month internship in different research laboratories across the country prepares and motivates the students to pursue a Ph.D. in the cutting-edge areas of Molecular and Cellular Biology. This eventually contributes to producing a cohort of next-generation researchers and scientists.

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## SEMESTER I

Course Title: BIOMOLECULES  
Course Code: BCH24-101CR

Credits: 04  
Max. Marks: 100 (80+20)

**Course Objective:** To impart detailed knowledge about different classes of Biomolecules like carbohydrates, amino acids, proteins, lipids, Nucleic acids and their classification, their structural and functional aspects in living cells.

**Course Outcome:** On completion of this course, the students become well-versed in the structures and functions of biomolecules (carbohydrates, lipids, amino acids, proteins, nucleotides, and nucleic acids) that form the foundation of understanding living organisms. The students can impart knowledge about the basics of the structure and function of various biomolecules and the functional relationships between different biomolecules in living cells. The students will be able to understand the chemistry of cells/tissues/organisms.

### UNIT-I

#### Carbohydrates

Structure, classification and biological importance of carbohydrates  
Configurational and conformational aspects of carbohydrates  
Stereochemistry: Chirality and optical activity, DL, dl and RS system of classification  
Structure and function of homo- and heteropolysaccharides  
Mucopolysaccharides and proteoglycans  
Chemical reactions of functional groups present in carbohydrates

### UNIT-II

#### Lipids

Classification of lipids  
Nomenclature and properties of saturated and unsaturated fatty acids  
Chemical composition and properties of triglycerides  
Structure, properties and functions of phosphoglycerides and sphingolipids  
Structure and functions of steroids (cholesterol and bile acids)  
Lipoproteins: Composition and biological role  
Eicosanoids: prostaglandins, thromboxanes, leukotrienes

### UNIT-III

#### Proteins

Structure and physicochemical properties of amino acids  
Peptide and Peptide bond  
Chemical synthesis of peptide  
Primary structure of proteins (end group analysis, peptide cleavage and sequence determination)  
Dihedral angles and Ramachandran plot  
Secondary structure of proteins: alpha helical and beta pleated structures, motifs and domains Super secondary structures  
Structures of fibrous proteins like collagen, keratin, and elastin  
Tertiary and quaternary structure of proteins: forces stabilizing the structure of proteins  
Structure and function of hemoglobin and comparison with myoglobin  
Classification of proteins based on the structures like Zn finger, leucine zipper proteins  
Protein folding and stability, folding pathways, role of accessory proteins in protein folding

### UNIT-IV

#### Nucleic Acids

Primary, secondary and tertiary structure of DNA  
Properties of DNA: DNA stability, DNA flexibility, Base conformations, Sugar ring puckering,  
Structural polymorphism of DNA (A, B, C, Z, H, G and I-DNA, Hairpin and Cruciform DNA)  
Denaturation and annealing of DNA, Cot Curves  
DNA as a genetic material  
RNA: Structure, function and types of RNAs

#### Books Recommended:

1. Lehninger Principles of Biochemistry- Nelson DL and Cox MM-WH Freeman and Company.
2. Fundamentals of Biochemistry: Life at the Molecular- Voet D, Voet JG and Pratt CW- John Wiley & Sons.
3. Biochemistry-Berg JM, Tymoczko JL and Stryer L- W.H. Freeman and Co. New York.
4. Biochemistry: The Molecular Basis of Life- McKee T and McKee JR-McGraw-Hill Higher education.
5. Biochemistry and Molecular biology- Elliott WH and Elliott DC- Oxford University Press.
6. Principles of Biochemistry- Zubay Geoffrey -McGraw Hill College.

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**Course Objective:** To introduce students to the fundamentals of cell biology like cell organelles, cell membrane, endomembrane system, cytoskeleton, cellular transport, cell-extracellular matrix interaction and cell division.

**Course Outcome:** After completing this course, the student will have understood the basic and advanced concepts in Cell Biology. The students will develop the clear idea of the functioning of the cell and its organelles in detail. Also the students will develop the concept of role of cell organelles in cellular metabolism and other functions. Further, the students will essentially build the concepts of cell cycle regulation, cell division and intracellular communication.

#### UNIT-I

##### Cell Membrane

Chemical composition, Structure and function of membrane proteins and membrane lipids  
Membrane Fluidity, Membrane potential, Plasma membrane dynamics (endocytosis, exocytosis)  
Transport across membranes (passive and active transport mechanisms)  
Lipid rafts and membrane

##### Organelles

Introduction to organelles and their functions  
Mitochondria - structure and function, Golgi complex - structure and function  
Vesicle transport (introduction to vesicular trafficking), lysosomes, plant vacuoles, and peroxisomes  
Cell wall structure and function in plant cells  
Organelle biogenesis and inter-organelle communication

#### UNIT-II

##### Endomembrane System

Introduction and approaches to study endomembrane, Endoplasmic reticulum: structure and function, ER- stress and unfolded protein response

##### Nucleus and Genetic Material

Structure and function of nucleus and nucleolus, Nuclear envelope and nuclear pores  
Chromosome and chromatin structure  
Structure and composition of a gene

#### UNIT-III

##### Cell Cycle

Introduction to the cell cycle, Cell cycle and its stages, Regulation of cell cycle, Checkpoints in the cell cycle  
Cell cycle and cancer, Apoptosis (programmed cell death)

##### Cell Division

Mitosis - Prophase, prometaphase, metaphase, anaphase, telophase, cytokinesis  
Motor proteins and their role in cell division  
Meiosis - Stages of meiosis, Genetic recombination during meiosis  
Meiosis and its role in genetic diversity and evolution

#### UNIT-IV

##### Extracellular Interactions

Extracellular matrix and extracellular space, Interaction of cells with extracellular material  
Cell-ECM interaction (integrins and focal adhesions)  
Extracellular vesicles and exosomes in cell communication

##### Cell-Cell Interactions

Cell-cell adhesion, Cell junctions (desmosomes, gap junctions, hemidesmosomes, tight junctions)  
Mechanotransduction and cellular responses to mechanical signals

##### Cytoskeleton

Introduction to cytoskeleton and its components, Microtubules, Intermediate filaments, Microfilaments  
Cell motility and migration  
Advanced imaging techniques for cytoskeletal dynamics (e.g., super-resolution microscopy)

#### Books Recommended:

1. Molecular biology of the cells-Albert B, Bray D and Lewis J- Garland Publications, New York.
2. Cell and Molecular Biology: Concepts and experiments- Karp G, John HD-Wiley & sons, New York.
3. The Cell: A Molecular Approach- Cooper GM- Sunderland: Sinauer Associates, Inc.
4. Molecular cell Biology-Lodish H, Arnold B, Zipursky SL, Matsudaira P and Baltimore D- WH. Freeman and company, New York.

Course Title: **BIOENERGETICS**  
Course Code: **BCH24-103CR**

Credits: **02**  
Max. Marks: **50 (40+10)**

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**Course Objective:** To understand the basic concepts of bioenergetics and architecture of electron flow in the electron transport chain and the fundamentals of ATP generation in mitochondria.

**Course Outcomes:** On completion of the course, the student will be able to understand the energy transformation and thermodynamics in biological systems, coupled reactions, high-energy compounds, and the ATP/ADP cycle. Moreover, students will be well versed in the architecture of electron flow in the electron transport chain and the fundamentals of ATP generation in mitochondria.

#### UNIT-I

##### Water

Physical properties and structure of water, hydrogen bonding, solvent properties of water  
Ionization of water

##### Bioenergetics:

Energy transformation by biological systems  
Laws of thermodynamics: first and second laws of thermodynamics  
Concept of free energy and standard free energy change  
Determination of free energy change for a reaction  
Equilibrium constant and standard free energy change  
Standard reduction potential and its relationship with free energy change  
High energy compounds: ATP as universal energy currency in biological systems; ATP/ADP cycle  
Other high-energy compounds  
Coupled reactions: Coupling of energetically unfavorable and favorable reactions

#### UNIT-II

Metabolite transport across mitochondrial membrane

Structural organization of respiratory chain

Electron flow in respiratory chain

Inhibitors and uncouplers of ETC

Oxidative phosphorylation

Coupling of oxidation and phosphorylation

Structure and function of ATP-synthase complex

Short-circuiting of proton gradient

Regulation of rate of oxidative phosphorylation

#### Books Recommended:

1. Principles of Bioenergetics- Skulachev VP, Bogachev AV and Kasparinsky FO- Springer-Verlag Berlin and Heidelberg GmbH & Co. K.
2. Fundamentals of Biochemistry: Life at the Molecular- Voet D, Voet JG and Pratt CW- John Wiley & Sons, In.
3. Biochemistry-Berg JM, Tymoczko JL and Stryer L- W.H. Freeman and Co. New York.
4. Lehninger Principles of Biochemistry- Nelson DL and Cox MM-WH Freeman and Company.
5. Biochemistry-Garrett RH and Grisham CM-Brooks/Cole, Cengage Learning.

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**Course Objective:** The objective of the course is to provide students the knowledge of safety measurements in biochemistry laboratory and to acquaint them with various procedures for quantitative estimation of biomolecules and purification of proteins.

**Course Outcome:** After completing this practical course, the students will have a thorough understanding of the risks that can arise in the Laboratory, the safety precautions that must be taken there, and how to handle various instruments. They will be ready to plan and carry out experiments like quantitative estimation of various carbohydrates, proteins, and cholesterol. The students will also be able to plan and carry out experiments like isolation, purification and identification of proteins, and perform PAGE, SDS-PAGE and gel filtration chromatography. The students can impart the knowledge gained from this practical training in diagnostic setups.

- Safety measures in laboratories
- Handling and disposal of chemicals and biological materials
- Introduction to laboratory equipment and instrumentation
- Preparation of solutions
- Concept of pH and buffers
- Quantitative estimation of proteins by
  - i) Lowry's method
  - ii) Bradford's method
  - iii) UV-Spectrophotometric method
- Isolation and purification of proteins
- Gel filtration chromatography
- Polyacrylamide gel electrophoresis of purified proteins
- Molecular weight determination by gel filtration chromatography and SDS-PAGE
- Quantitative estimation of cholesterol by Zlatki's method
- Quantitative estimation of glucose by Nelson Somogy's method

**Books Recommended:**

1. Biochemical Calculations- Segel IH- John Wiley and Sons Inc.
2. An Introduction to Practical Biochemistry-Plummer DT -Tata McGraw Hill.
3. Principle and Techniques of Biochemistry and Molecular Biology, Wilson K and Walker JM- Cambridge University Press.
4. Molecular Cloning: A Laboratory Manual (volumes I, II & III) - Green and Sambrook- Cold Spring Harbor Laboratory Pub.

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**Course Objective:** To provide in-depth knowledge about photosynthesis, secondary metabolism, nitrogen fixation, plant hormones and response of plants to biotic and abiotic stress.

**Course Outcome:** Students will have enhanced knowledge of the principles of plant biochemistry to analyze and understand the biochemical processes and metabolic pathways involved in crop growth, development, metabolism and stress responses. The students should be able to demonstrate effective communication and extension skills to disseminate knowledge and technologies related to plant biochemistry. The students will be well-versed with the processes of photosynthesis, nutrient requirements of plants, secondary metabolites and growth regulators of plant systems.

#### UNIT-I

##### Photosynthesis

- Photosynthesis in higher plants – general concepts
- Organization of the photosynthetic apparatus
- Mechanism of electron transport in photosynthesis
- Proton transport and ATP synthesis
- Calvin cycle and its regulation
- C4 and CAM pathways
- Repair and regulation of photosynthetic machinery
- Photorespiration and its significance

#### UNIT-II

##### Assimilation of mineral nutrients

- Nitrate and ammonia assimilation and their incorporation into amino acids
- Biochemistry of nitrogen fixation, nitrogenase complex and its functions
- Nitrogen fixation genes and their regulation
- Sulfate reduction and assimilation
- Sulfite oxidation

#### UNIT-III

##### Special features of secondary plant metabolism

- Secondary metabolites – terpenes, phenolics, alkaloids, tannins, lignins, lignans, and surface waxes – their biosynthesis and physiological role
- Plant defense mechanism against biotic (pathogens) and abiotic stress (water, temperature and salt) Translocation of inorganic and organic substances
- Pathways of translocation and mechanism of translocation in the phloem

#### UNIT-IV

##### Plant growth regulators

###### Auxins

- Chemical nature, biosynthesis and metabolism
- Physiological and developmental effects,
- Molecular basis of its action

###### Gibberellins

- Chemical structure, biosynthesis, metabolism and mechanism of its molecular effects

###### Cytokinin

- Properties and biological role
- Cellular and molecular modes of cytokinin action

###### Abscisic acid

- Chemical structure, metabolism and transport
- Molecular effects in the regulation of growth and development

#### Books Recommended:

1. Plant physiology-Taiz L and Zeiger E-Sinauer Associates Inc., Sunderland.
2. Introduction to plant physiology- Hopkins WG and Huner N- John Wiley & Sons, Inc.
3. Plant Biochemistry- Heldt HW and Piechulla B- Academic Press.
4. Plant Biochemistry-Dey PM and Harborne JB- Academic Press.
5. Biochemistry and Molecular Biology of Plants-Buchanan, Grussem and Jones-AAPS.

**Course Objective:** The objective of the course is to make the students familiar with various biochemical techniques used in biological sciences and the emerging areas of biochemistry along with underlying principles.

**Course Outcome:** On completion of this course, the students will have enough knowledge to join the research programs or join the relevant industry in the field of molecular cell biology, genomics, and proteomics. The students will be mature enough to integrate theory with the bench. The students can develop hypotheses, craft novel research proposals and test their hypotheses and research questions on the bench.

#### UNIT-I

##### Centrifugation

- Basic principle of centrifugation
- Factors affecting sedimentation
- Types of centrifugation including differential, density gradient and ultracentrifugation
- Analytical and preparative centrifugation
- Applications of centrifugation

##### Chromatography

- Basic principle and applications of chromatographic techniques:
  - Gel filtration chromatography, Affinity chromatography, Gas chromatography
  - Ion Exchange chromatography, High-pressure liquid chromatography

#### UNIT-II

##### Electrophoresis

- Types of electrophoresis
- Factors affecting electrophoretic mobility
- Uses of electrophoresis
- Isoelectric focusing
- Analysis of biomolecules using UV/visible, fluorescence spectroscopy
- Use of radioisotopes in biology
  - Their detection, measurement and safety guidelines

#### UNIT-III

##### Different blotting techniques

- Northern, Southern
- Polymerase chain reaction
  - Overlap extension PCR
  - RT-PCR
- Principles of - RFLP, RAPD and AFLP techniques
- Site directed mutagenesis
- Preparation and analysis of RNA and DNA probes

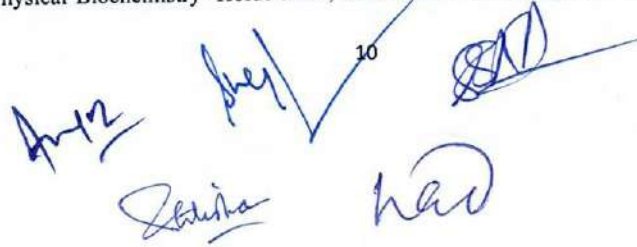
#### UNIT-IV

- Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH
- Methods for analysis of gene expression
- Global gene expression analysis using micro array
- Flow-cytometry
- Microscopy
  - Light, electron (scanning and transmission), Phase contrast, Fluorescence microscopy
  - Immunolectron microscopy and Confocal microscopy
  - Freeze- fracture techniques
- ELISA, RIA, Florescent IA

#### Books Recommended:

- Principles and Techniques of Biochemistry and Molecular biology - Wilson K and Walker J- Cambridge University Press.
- Modern Experimental Biochemistry-Rodney F Boyer- Benjamin Cummings publishing company Inc.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder- W.H. freeman and Company.
- Physical Biochemistry: Principles and Applications-David Sheehan-John Wiley.
- Principles of Physical Biochemistry- Holde KEV, Jhonson WC and ShingHo P-Prentice Hall Inc.

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**Course Objective:** To familiarize students with the general structure, properties and functions of carbohydrates, amino acids, proteins and nucleic acids. In addition this course also imparts basic knowledge on cell biology.

**Course Outcome:** This course is meant for non-biochemistry students. After attending this open elective course, the non-biochemistry students will have the basic understanding of biomolecules, their function and importance in the functioning of cell in living systems.

#### UNIT-I

Water and its role in biological systems  
Introduction and roles of biomolecules of life  
Proteins  
Carbohydrates  
Lipids  
Nucleic acids  
Micronutrients

#### UNIT-II

Cell as a basic unit of life  
Cell components  
Functions of the various components  
Cell division: mitosis and meiosis  
Role of cell division in propagation  
Cell death and its causes

#### Books Recommended:

1. Lehninger Principles of Biochemistry- Nelson DL and Cox MM-WH Freeman and Company.
2. Biochemistry-Garrett RH and Grisham CM- Brooks/Cole, Cengage Learning.
3. Cell and Molecular Biology: Concepts and experiments- Karp G, John HD- Wiley and sons.







## SEMESTER II

Course Title: METABOLISM  
Course Code: BCH24-201CR

Credits: 04  
Max. Marks: 100 (80+20)

**Course Objective:** To understand the fundamentals of cellular metabolism of carbohydrates, lipids, amino acids, and nucleic acids and various associated metabolic disorders.

**Course Outcome:** On completing the course, the students are able to explain/describe major pathways involved in carbohydrate, lipid, amino acid and nucleic acid metabolism and the various types of inborn errors of metabolism and the strategies. The basic concepts from this course are linked to that from other courses so that at the end of the semester the student is able to come up with a clear understanding of the physiological functioning of the cell/organism.

### UNIT-I

Carbohydrate metabolism and its regulation  
Glycolysis and regulation  
Citric acid cycle, its function in energy generation and biosynthesis of energy rich-bonds, regulation  
Pentose phosphate pathway and its regulation  
Alternate pathways of carbohydrate metabolism  
Gluconeogenesis, Glycogenolysis  
Biosynthesis of glycogen and starch  
Disorders of carbohydrate metabolism

### UNIT-II

Lipid metabolism and its regulation  
Fatty acid oxidation-  $\alpha$ ,  $\beta$ ,  $\omega$ , oxidation and lipo-oxidation  
Fatty acid biosynthesis- Acetyl CoA carboxylase, Desaturase and elongase  
Biosynthesis of triacylglycerols, Phosphoglycerates and sphingolipids  
Biosynthetic pathways for terpenes, steroids and prostaglandins  
Ketone bodies- Formation and utilization  
Regulation of lipid metabolism -hormonal/enzymatic  
Interactions between carbohydrate and lipid metabolism -  
Role of insulin and adiponectin  
Disorders of lipid metabolism

### UNIT-III

Amino acid metabolism  
Metabolic fate of amino groups  
Pathways of amino acid catabolism  
Nitrogen excretion and urea cycle  
Biosynthesis of amino acids  
Derivatives of amino acids  
Regulation and disorders of amino acid metabolism

### UNIT-IV

Nucleic Acid metabolism  
Degradation of purines and pyrimidines  
Biosynthesis and regulation of purine and pyrimidine nucleotides  
Denovo and salvage pathways  
Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides  
Structure and regulation of ribonucleotide reductase  
Inhibitors of nucleic acid biosynthesis  
Disorders of nucleic acid metabolism

### Books Recommended:

1. Lehninger Principles of Biochemistry- Nelson DL and Cox MM-WH Freeman and Company.
2. Fundamentals of Biochemistry: Life at the Molecular- Voet D, Voet JG and Pratt CW- John Wiley & Sons, Inc.
3. Biochemistry-Berg JM, Tymoczko JL and Stryer L- W.H. Freeman and Co. New York.
4. Biochemistry-Garrett RH. and Grisham CM-Brooks/Cole, Cengage Learning.
5. Medical Biochemistry-Baynes J and Dominiczak M-Philadelphia: Elsevier Mosby.

**Course Objective:** The objective of the course is to give in-depth information about the mechanisms of DNA replication, transcription and translation together with the regulation of gene expression in prokaryotic and eukaryotic systems.

**Course Outcome:** On completing this course, the students will be able to explain or discuss how the genetic information encrypted in the DNA is trickled down into the proteins to run the cellular physiology. The students will have the thorough concepts of DNA replication, transcription, translation and its regulation in prokaryotes, eukaryotes and viruses.

#### UNIT-I

##### Replication

- Replication in prokaryotes and eukaryotes
- Unit of replication
- Replication Origin and Replication Fork
- Enzymes involved in replication
- Initiation, Elongation and Termination of Replication
- Fidelity of Replication
- Recombination and DNA repairs

#### UNIT-II

##### Transcription

- Transcription in prokaryotes and eukaryotes
- Transcriptional factors and their role
- RNA polymerases
- Formation of initiation complex
- Elongation and termination
- Inhibitors of transcription
- RNA processing, splicing, polyadenylation, capping

#### UNIT-III

##### Regulation of gene expression in

- Prokaryotes (Operon model)
- Eukaryotes (role of chromatin remodeling in transcriptional regulation)
- Viruses
- Transcriptional activators and repressors
- Classes of transcriptional factors
- Different types of RNAs for transcriptional regulation: miRNA, lncRNA, circularRNA

#### UNIT- IV

##### Translation

- Genetic code
  - General characteristics of genetic code
  - Deciphering of genetic code
- Ribosomes as the site of protein synthesis, polysomes
- Activation of amino acids
- Chain initiation, elongation and termination in prokaryotes and eukaryotes
- Control of translation (Role of Guanine nucleotides)
- Translational fidelity, Kinetic proof reading
- Positive and negative regulation of translation
- Inhibitors of protein synthesis

#### Books Recommended:

1. Molecular Biology-Weaver Robert-McRraw-Hill New York.
2. Molecular biology of the cells- Albert B, Bray D and Lewis J- Garland Publications New York.
3. Cell and Molecular Biology: Concepts and experiments- Karp G and John HD- Wiley & sons, New York.
4. Molecular Cell Biology-Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D, and Darnell J- W.H.Freeman and Co Ltd.
5. Molecular Biology of the Gene- Watson JD, Baker TA, Bell SP et al - Pearson publishing
6. Lewin's Genes XI- Krebs JE, Goldstein ES, Kilpatrick-Jones and Bartlett Learning.

**Course Objective:** The objective of this course is to offer advanced knowledge about the various molecular and cell biology techniques to study protein-protein interactions, protein-DNA interactions, gene silencing, genome editing and sequencing.

**Course Outcome:** On completion of this course, the students will have enough knowledge to join the research programs or join the relevant industry in the field of molecular cell biology, genomics, and proteomics. The students will enough knowledge about the various molecular and cell biology methodologies e.g. protein - protein interactions, protein-DNA interactions, gene silencing and genome sequencing.

#### UNIT-I

Protein detection and protein-protein interaction techniques  
Western blotting and its applications, Far-western blotting, dot blotting  
Immunoprecipitation, Co-Immunoprecipitation  
Yeast Two Hybrid screening, FRET  
Eastern Blotting  
Mass spectrometry  
Protein-DNA interaction techniques  
Gel Retardation Assay  
Foot printing analysis  
ChIP, ChIP-Seq  
DNA pull down assays  
Reporter assay (Leuciferase reporter assay)

#### UNIT-II

Gene silencing  
RNA interference  
siRNA, micro RNA and shRNA mediated gene silencing  
Ribozyme mediated gene silencing  
Genome Editing  
Cre-Lox recombination system  
Zinc Finger Nucleases (ZFNs)  
TALEN system  
CRISPR-Cas9  
technology DNA  
Sequencing  
Next generation sequencing  
Sequencing while synthesizing/Pyrosequencing  
Ion Torrent/semiconductor sequencing  
Genome wide sequencing (GWS) and Whole genome gene sequencing (WGS)  
Transcriptome and Exome sequencing

#### Books Recommended:

1. Molecular Biology of the Genes-Watson JD, Hopkins NH, Roberts JW and Weiner AM Benjamin/Cummings Publishing Company Inc.
2. Genomes- Brown TA- Garland Science
3. Genetics: Analysis of Genes and Genomes- Hartl DL and Jones EW- Jones and Bartlett publishers
4. Principles of Gene Manipulations- Old RW and Primrose SB- Blackwell Scientific Publications
5. Molecular Biology- Weaver Robert - McRraw-Hill, New York



**Course Objective:** To provide the hands-on experience in isolation and purification of DNA and RNA, PCR technology and cDNA synthesis.

**Course Outcome:** After completing this practical course, the students will be able to plan and carry out experiments such as isolation and purification of DNA and RNA using various molecular biology methods. In addition, the students will be able to design the primers, amplify any specific gene using PCR technology, confirm PCR product using restriction digestion. Moreover, the students will have expertise in site directed mutagenesis, cDNA synthesis and recombinant protein expression and purification using affinity chromatography technique. In conclusion the course will prepare the students for PhD programme in molecular biology and protein biochemistry fields or help them to set up the diagnostic laboratories after undergoing due procedures with relevant quarters.

- Extraction and assay of enzymes
- Effect of temperature, pH, and time on enzyme activity
- Isolation of DNA: Different Methods, Different sources
- Quantification of DNA using Spectrophotometry
- Amplification of a DNA by PCR
- Purification of PCR product
- Restriction digestion of PCR product
- Isolation of RNA from cells
- cDNA synthesis
- Site directed Mutagenesis
- Expression and purification of recombinant proteins

**Books Recommended:**

1. Molecular Cloning: A Laboratory Manual (volumes I, II & III) - Green and Sambrook- Cold Spring Harbor Laboratory Pub.
2. Principles of Gene Manipulations- Old RW and Primrose SB- Blackwell Scientific Publication, London.
3. An Introduction to Practical Biochemistry-Plummer DT- Tata McGraw Hill.
4. Basic Biochemical Methods- Alexander RR and Griffith JM -Wiley publications.
5. Experimental Biochemistry- Switzer RW and Garrity LF - W.H. Freeman and Co.

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**Course Objective:** To provide in-depth knowledge about enzymes and their mechanism of action, enzyme kinetics, regulation, inhibition and applications of immobilized enzymes.

**Course Outcome:** After completion of the course, the student will be able to understand the thermodynamic and molecular basis of catalysis, the mechanisms of enzyme action, the kinetics of enzyme-catalysed reactions and enzyme inhibitors, enzyme regulation and its physiological importance in the cell, enzyme immobilization, and its applications in industry, biomedicine, and research. The students will be ready to opt for applied biology or medical laboratory sciences as their careers.

#### UNIT-I

- Enzyme classification and nomenclature
- Impact of enzymes on Gibbs free energy ( $\Delta G$ ) and Activation energy ( $\Delta G^\ddagger$ ) of reactions
- Methods of examining enzyme – substrate (ES) complexes
- Enzyme kinetics
  - An introduction, factors influencing enzyme reaction velocity
  - Henri and Michaelis Menten equation, Briggs-Haldane modification
  - Significance of  $K_m$ , Catalytic efficiency and turnover number
  - Determination of  $K_m$  and  $V_{max}$  using Lineweaver-Burk plot, Eadie-Hofstee plot, Hanes-Woolf plot
- Bisubstrate Reactions
  - Random Bi Bi, Ordered Bi Bi and Ping Pong reaction mechanism

#### UNIT-II

- Enzyme inhibition
  - Reversible inhibition- Mechanism and kinetics of competitive, uncompetitive, noncompetitive and mixed inhibition, Determination of inhibitor constants
  - Irreversible inhibition-Group specific, Affinity labels and Suicide inhibitors
- Enzyme assays: Types- Continuous and discontinuous assays
- Mechanism of catalysis of -
  - Serine proteases
  - Triose phosphate isomerases

#### UNIT-III

- Enzyme regulation
  - General mechanism of enzyme regulation
- Allosteric enzymes
  - Sigmoidal kinetics and its physiological significance
  - Structure and functions of ATCase; cooperative binding, homotropic and heterotropic interactions
  - Symmetric and sequential modes for action of allosteric enzymes and their significance
- Feedback inhibition and feed forward stimulation
- Reversible and irreversible covalent modifications of enzymes
- Isoenzymes and their physiological significance

#### UNIT-IV

- Immobilization of enzymes
  - Methods of enzyme immobilization
  - Properties of Immobilized enzymes
    - Effects of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity
  - Applications of immobilized enzymes

#### Books Recommended:

- Enzymes: *Biochemistry, Biotechnology, Clinical Chemistry*- Trevor Palmer and Philip Bonner- Chichester: Horwood, Chicago.
- Lehninger Principles of Biochemistry- Nelson DL and Cox MM- WH Freeman and Company.
- Fundamentals of Biochemistry: Life at the Molecular Level - Voet D, Voet JG and Pratt CW- Wiley Publishing.
- Biochemical calculations- Segel IH-John Wiley and Sons, New York.
- Enzyme Kinetics: Catalysis and Control- Purich DL - Academic Press, Elsevier, UK.



**Course Objective:** The aim of the course is to make students understand the fundamentals of microbiology, like structure and classification of bacteria and viruses; microbial nutrition, growth, and genetics; and antimicrobial agents.

**Course Outcome:** Students graduating with a course in Microbiology will be able to: 1) define/explain within multiple microbiology disciplines the core theories and practices. 2) describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations; 3) explain the theoretical basis of the tools, technologies and methods common to microbiology; and 4) demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.

#### UNIT-I

A brief introduction to microorganisms  
Ultrastructure of bacterial cell wall  
Structure and functions of peptidoglycan in gram positive and gram negative organisms  
Functions of polymeric components in outer membrane and acidic polymers in gram negative organisms  
Microbial growth  
Different phases of microbial growth, Measurement of microbial growth, Growth kinetics  
Factors affecting microbial growth  
Quorum sensing  
Control of microbial growth-physical and chemical methods

#### UNIT-II

Nutritional requirements of microorganism  
Nutritional classification of microorganisms  
Mechanism of bacterial phosphotransferase system (PTS) and ABC transport system  
Transport and uptake of micronutrients  
Microbial culture media  
Isolation, culture, identification and preservation of bacteria  
Microbial genetics  
Modes of genetic exchange in microbes- Conjugation, Transformation, Transduction

#### UNIT-III

Antimicrobial agents-their classification  
Mechanisms of action of antimicrobial agents  
Selective toxicity and therapeutic index  
Mechanism of antibiotic resistance  
Multidrug resistance, Superbugs  
Human microbial flora  
Pathogenicity, virulence factors, bacterial toxigenicity

#### UNIT-IV

Virus classification  
Structure of virus  
Viral proteins and methods of assay  
Virus- host interaction-Lysogeny and lytic cycle  
Emerging and re-emerging viral diseases-  
SARS, Influenza, Dengue, AIDS, Nipah virus disease and Zika virus disease

#### Books Recommended:

1. Prescott's Microbiology- Willey J, Sandman K and Wood D- McGraw-Hill Education.
2. Microbiology: An Introduction- Tortora GJ, Funke BR, Case CL-Pearson Education.
3. Microbiology: Concepts and Applications-Pelczar MJ, Chan ECS and Krieg, NR- McGraw-Hill Education.
4. General Microbiology- Stainier RY, Deudroff M and Adelberg EA- Palgrave Macmillan.
5. Principles of virology-Flint J, Racaniello VR, Rall GF, Hatzioannou T and Skalka AM- ASM Press.

  
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*Course Objective: To familiarize students with the structure, properties and functions of amino acids and proteins. The course will also make the students understand the different levels of protein structure.*

*Course Outcome: This course is meant for non-biochemistry students. After attending this open elective course, the non-biochemistry students will have the basic understanding of amino acids and proteins and their structure, classification and functions.*

#### UNIT-I

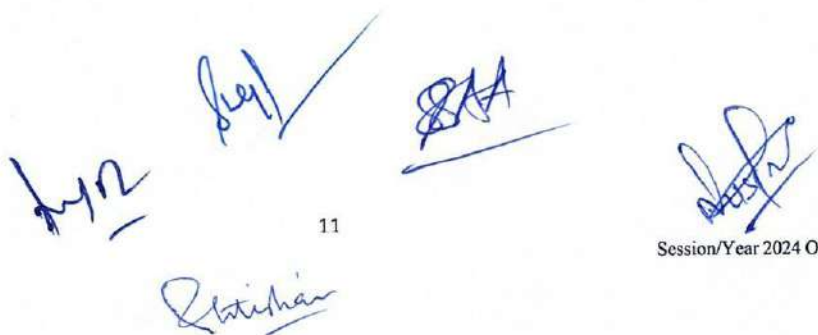
- Amino acids - the building blocks of proteins
- Structure and physiochemical properties of amino acids
- Classification of amino acids: structural, nutritional, polarity and metabolic
- Functions and food sources of amino acids
- Peptide bond: formation and characteristics

#### UNIT-II

- Protein - a molecule with myriad of functions
- Structure of proteins
  - Primary structure of the protein
  - Secondary structure, types
  - Tertiary structure, forces stabilizing tertiary structures
  - Quaternary structures
- Classification of proteins
- Functions of proteins

#### Books Recommended:

1. Lehninger Principles of Biochemistry- Nelson DL and Cox MM-WH Freeman and Company.
2. Biochemistry-Berg JM, Tymoczko JL and Stryer L- W.H. Freeman and Co. New York.
3. Principles and Techniques of Biochemistry and Molecular biology - Wilson K and Walker J- Cambridge University Press
4. Modern Experimental Biochemistry- Rodney F Boyer- Cummings publishing company Inc.



**Course Objective:** To familiarize students with the causes, management and treatment of common chronic diseases such as diabetes mellitus, cardiovascular and neurodegenerative diseases.

**Course Outcome:** At the end of this course, the students will be well versed with chronic disease such as diabetes mellitus, cardiovascular and neurodegenerative diseases. The students will be aware about the causes, symptoms and management of these most common chronic diseases prevalent nowadays.

**UNIT-I**

Diabetes Mellitus

- Types, causes, Symptoms & risk factors
- Long term complications of diabetes mellitus
- Dietary & life style factors for management
- Treatment strategies

Cardiovascular Diseases (CVD)

- Types of CVD
- Prevention and Management of CVD
- Role of obesity and Cholesterol in CVD
- Treatment strategies

**UNIT-II**

Alzheimer's disease

- Causes and symptoms
- Current treatment options

Parkinson's disease

- Causes and symptoms
- Pathophysiology (dopaminergic system dysfunction, Lewy bodies)
- Treatment strategies

**Books Recommended:**

1. Textbook of medical physiology- Hall E and Guyton AC-PA: Saunders/Elsevier.
2. Teitz Fundamentals of Clinical Biochemistry- Burtis CA, Ashwood ER and Bruns DE- Saunders, Elsevier.
3. Harrison's Manual of Medicine, US: McGraw-Hill Professional



## SEMESTER III

Course Title: IMMUNOLOGY  
Course Code: BCH24-301CR

Credits: 04  
Max. Marks: 100 (80+20)

*Course Objective: The objective of the course is to impart knowledge on the components associated with immune system and molecular mechanism of their working, MHC, hypersensitivity, transplantation and hybridoma technology.*

*Course Outcome: On completion of this course, the students will develop critical thinking for various immunological processes. They will be able to clearly state the role of innate and adaptive immune systems, compare humoral versus cell-mediated immune responses, and identify and characterize cytokines of particular immune importance. The students will understand the significance of the MHC complex in terms of immune response and transplantation, be able to describe lymphocyte development and the expression of their receptors, and be able to provide an overview of the host (immune system)-pathogen interactions. The students will have all the theoretical knowledge about the production of monoclonal antibodies using hybridoma technology, antibody fragments, vaccines, and cancer immunotherapy.*

### UNIT-I

Historical perspective, terms associated with immunology  
Antigenicity, Features of antigenicity, super antigens, adjuvants  
Antigen-Antibody interaction and application  
Cells of immune system:  
Myeloid, Mononuclear cells, T-Lymphocytes, B-Lymphocytes, NK-Cells  
Primary and secondary lymphoid organs:  
Thymus, Bursa of fabricus, Payer's Patch, Spleen, Lymph nodes, Mucosal associated and Cutaneous associated lymphoid tissues

### UNIT- II

Immunoglobulin,  
Structure, classes and subclasses  
Multigene organization of Ig gene, variable region gene rearrangements, allelic exclusion Generation of diversity of Ig, Assembly and secretion of Ig, class switch, regulation of Ig transcription  
Humoral and cell mediated immunity: B cell development and activation  
BCR, TCR, T cell development and activation  
Regulation of system: complement cascade, Biological function and its regulation  
Complement fixation test  
Introduction to cytokines

### UNIT- III

Major Histocompatibility Complex: different classes, organization and biological function  
Transcription regulation of MHC  
Hypersensitivity: Type I, II, III, and IV  
Autoimmunity and autoimmune diseases  
Single organ and systemic autoimmune diseases  
Brief introduction to Primary and secondary immunodeficiencies  
Mechanisms of transplantation, Examples of organ transplantation  
Examples of immune response to Viruses, bacteria, protozoa, fungal and helminthic infection

### UNIT-IV

Development of Monoclonal Antibodies using  
Hybridoma Technology  
Monoclonal antibody, Antibody fragments and their application  
Vaccination: Conventional and genetically engineered vaccines  
Lymphokines – production and applications  
Cancer Immunotherapy (Cart-T therapy)

### Books Recommended:

1. Immunology-J Kuby, T.J. Kindt, BA. Osborne and RA. Goldsby. WH Freeman and Co. Ltd.
2. Fundamental Immunology- William E. Paul. Publisher: Lippincott Williams and Wilkins.
3. Essential Immunology- Ivan M. Roitt, Jonathan Brostoff and David Male- Wiley-Blackwell
4. Immunology: An introduction- Ian R. Tizard- Saunders College Publishing.
5. Introduction to Medical Immunology-Gabriel Virella- Marcel Dekker Inc

**Course Objective:** To provide detailed knowledge on recombinant DNA technology, animal and plant cell culture and fermentation biotechnology.

**Course Outcome:** On completion of this course, the students will develop the concepts of the applications of various techniques and the knowledge that we obtain in different areas like Cell Biology, Molecular Biology, Biochemical Techniques etc. The students will have all the theoretical knowledge about gene cloning, animal and plant cell culture, transgenic animals and plants, knockout animals and fermentation biotechnology.

#### UNIT-I

Recombinant DNA Technology:

- Vectors: Plasmids, bacteriophages, phagemids, cosmids, YACs, and BACs
- Methods of creating recombinant DNA molecule
- Transformation and screening of recombinant vector
- Confirmation of insert
- Expression strategies in different hosts, vector and host engineering

#### UNIT-II

- Types of restriction endonucleases
- Library construction
  - Types of libraries:
    - cDNA and genomic libraries
- Primary, secondary and tertiary screening methods
- Site directed mutagenesis

#### UNIT-III

- Animal Cell Culture
  - Primary and established cell lines
  - Types of various cell lines
  - Introduction to balanced salt solutions and simple growth medium
  - Role of CO<sub>2</sub>, serum and supplements, Serum and serum free media
  - Defined media and their applications, antibiotics
- Concept of Plant Cell culture
- Transgenic animals and plants
- Knockout animals
- Cloning of animals

#### UNIT- IV

- Fermentation Biotechnology: definition, scope and industrial importance
- Types of microorganisms used in fermentation: bacteria, yeast Fermentation process development
  - Media formulation and optimization, sterilization and aseptic techniques
- Fermentation kinetics and scale-up considerations
- Bioreactor design and operation: Types of bioreactors (stirred tank, airlift, packed bed)
- Monitoring and control of fermentation parameters
- Downstream Processing: recovery and purification of fermentation products
- Separation techniques (filtration, centrifugation, chromatography)
- Product formulation and packaging
- Industrial Applications: Food and beverage fermentation, Pharmaceutical and biopharmaceutical production, Biofuel production, Enzyme production and applications

#### Books Recommended:

- Gene Cloning and DNA analysis- An Introduction- Brown TA- Wiley Blackwell Publishing.
- Principles of Gene Manipulations- Old R.W. and Primrose, S.B.; Blackwell Scientific Publication, London.
- Molecular Biotechnology: Principles and applications of recombinant DNA- Glick BR, Patten CL and Pasternak JJ- ASM Press, USA.
- Molecular Cloning: A Laboratory Manual (volumes I, II & III)- Green and Sambrook- Cold Spring Harbor Laboratory Pub.
- Principles of Biotechnology- Wiseman Alan- Surrey University Press, USA

**Course Objective:** To acquaint students with the fundamentals of Mendelian genetics, human genetics, population genetics, mutations and chromosomal changes.

**Course Outcome:** After completing the genetics course the students can explain 1) the chemical basis of heredity 2) the genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms 3) the role of genetic mechanisms in evolution 4) Mutations 5) design, execute, and analyze the results of genetic experimentation in animal and plant model systems.

#### UNIT-I

Introduction to Mendelian Genetics

Mendel's Laws of inheritance

Gene interactions

Incomplete dominance

Co-dominance

Epistasis

Pleiotrophy

Concept of alleles

Multiple alleles

Lethal alleles

Pseudoalleles

Linkage

Sex linkage

Sex limited and sex influenced characters, chromosome mapping, tetrad analysis

Mutation and its types

#### UNIT-II

Human Genetics

Normal Human Karyotype

Autosomal inheritance-dominant and recessive

X-linked linked inheritance

Y-linked linked inheritance

Genetic Diseases

Pedigree analysis for the inheritance pattern of genetic diseases

Genetic counseling

Chromosomal Changes

Number variation – Euploidy (auto and allopolyploidy), aneuploidy

Structural variations – duplications, Inversions, translocations

Population genetics - gene pool, gene frequency

Hardy-Weinberg law

Non-random mating-factors influencing, heritability

Genetic polymorphism-transient and stable

Concept of molecular evolution

#### Books Recommended:

1. Concepts of Genetics-Klug WS, Cummings MR, Spencer CA and Palladino MA- Prentice Hall Internationals.
2. Genetics: Analysis of Genes and Genomes- Hartl, DL and Cochrane BJ- Jones and Bartlett Publishers.
3. Principles of Genetics- Garner EJ, Simmons MJ and Snustad DP- John Wiley & Sons Inc, N.Y.
4. Human Genetics-Concepts and Applications- Ricki Lewis-McGraw Hill Publishing.
5. Human Molecular Genetics- Strachan T and Read AP-Garland Science/Taylor and Francis Group.

**Course Objective:** The objective of the course is to provide the hands-on bench training in gene cloning, western blotting, immunoprecipitation, ELISA and biochemical assays to determine the activity of various diagnostic enzymes.

**Course Outcome:** After completing this practical course, the students will be ready to plan and carry out experiments, like gene cloning and preparation of plasmids, western blotting, immune-precipitation and ELISA. Moreover, Students will receive hands on experience of various biochemical assays to estimate the activities of some enzymes for diagnosis of diseases. They can generate and test hypotheses, and analyze data. The students would be able to troubleshoot the experimental challenges they face while doing the Ph.D. or while using their skills in research in industry setups.

- Bacterial culture
- Transformation of bacterial cells with plasmid
- Extraction of plasmid DNA
- Restriction digestion of plasmid DNA
- Gene Cloning
- Western blotting
- Immunoprecipitation
- ELISA
- Diagnostic tests for Apo lipoproteins, HDL cholesterol, LDL cholesterol and triglycerides
- Diagnostic tests for renal and hepatic diseases

**Books Recommended:**

1. Molecular Cloning: A Laboratory Manual (volumes I, II & III) - Green and Sambrook- Cold Spring Harbor Laboratory Pub.
2. Principles of Gene Manipulations- Old RW and Primrose SB- Blackwell Scientific Publication, London.
3. An Introduction to Practical Biochemistry-Plummer DT- Tata McGraw Hill.
4. Basic Biochemical Methods- Alexander RR and Griffith JM -Wiley publications.
5. Experimental Biochemistry- Switzer RW and Garrity LF - W.H. Freeman and Co.

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**Course Objective:** To impart knowledge about body composition parameters, their measurement methods, energy requirements, the role and requirement of carbohydrates, fats, proteins and vitamins to our body. The course will also make the students to understand different endocrine glands and their hormones, their physiological importance in human system.

**Course Outcome:** The students will be able to explain the concepts regarding the biological basis of nutrition and the mechanisms by which diet can influence health. The students can develop research proposals for the study of human nutrition with concepts in nutritional sciences related to diet and disease. The students will be able to explain the psychological or behavioral activities, tissue function, sleep, digestion, respiration, excretion, mood, stress, lactation, movement, reproduction and sensory perception caused by hormones.

#### UNIT-I

Calorific value of foods  
Measurement of energy expenditure, Direct and indirect calorimetry  
BMR and SDA and factors affecting them, Energy requirements of man and woman  
Factors affecting energy requirements  
Recommended allowances, Balanced diet  
Protein energy malnutrition (PEM),  
Etiology, clinical features, metabolic disorders and management of marasmus and kwashiorkor  
Dietary requirement and sources of carbohydrates, Glycemic index, Protein sparing action  
Simple and complex carbohydrates, Physiological actions of dietary fibers

#### UNIT-II

Lipid nutrition  
Major classes of dietary lipids, Dietary needs of lipids,  
Essential fatty acids and their physiological functions  
Obesity  
Genetic and environment factors leading to obesity, Obesity related diseases and management of obesity  
Role of leptin in regulation of body mass  
Mineral nutrients  
Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper  
Vitamins  
Dietary sources of vitamins  
Biochemical functions and deficiency diseases associated with fat and water-soluble vitamins  
Hypervitaminosis

#### UNIT-III

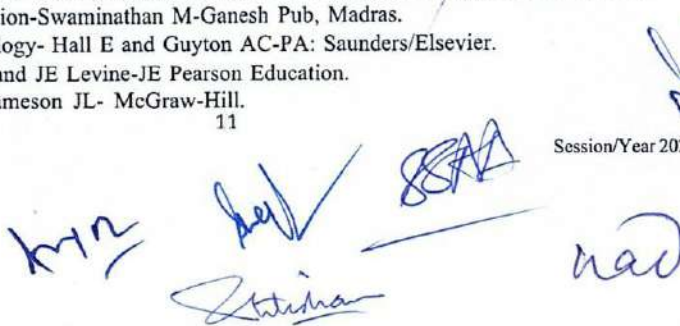
Introduction to endocrinology  
Overview of endocrine glands  
Classification of hormones  
Mechanism of action of hormones  
Hormone receptors, Second messengers  
Structure, biosynthesis, secretion, transport, mechanism of action, physiological role and pathophysiology of pancreatic and thyroid hormones

#### UNIT-IV

Hypothalamic-Pituitary system  
Characteristics and regulation of hypothalamic and pituitary hormones  
Diseases of hypothalamic and pituitary gland  
Structure, biosynthesis, secretion, transport, mechanism of action, physiological role and pathophysiology of adrenal, gastrointestinal, sex hormones

#### Books Recommended:

1. Introduction to Human Nutrition- Gibney MJ, Lanham SA- Aedin Cassidy, Hester H. Vorster, Wiley- Blackwell.
2. Human Nutrition and Dietetics- Garrow JS and James WPT -Churchill Livingstone Publications.
3. Essentials of food and nutrition-Swaminathan M-Ganesh Pub, Madras.
4. Textbook of medical physiology- Hall E and Guyton AC-PA: Saunders/Elsevier.
5. Endocrinology-MC Hadley and JE Levine-JE Pearson Education.
6. Harrison's Endocrinology-Jameson JL- McGraw-Hill.



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**Course Objective:** The course is aimed to acquaint the students with the functioning of digestive, renal, neuromuscular muscular system and associated diseases. In addition, students will also be introduced to basics of clinical biochemistry, water, electrolyte and acid/base balance, and various aspects of diagnostic enzymology that rely on the measurement and profiling of the activity of various enzymes.

**Course Outcome:** By the completion of this course, the Masters students are expected to: 1) Demonstrate knowledge of organ systems function. 2) Demonstrate knowledge of cellular function. 3) Demonstrate the ability to integrate physiology from the cellular and molecular level to the organ system and organismic level of organization. 4) Conduct and/or evaluate laboratory experiments in physiology.

#### UNIT-I

##### Hematology

Composition of blood

Hemostasis: Vascular spasm, Formation of a platelet plug and Blood clotting

Clotting factors, extrinsic and intrinsic pathways of blood clotting, Fibrinolysis

Prevention of blood clotting in the normal vascular system, Anticoagulants: heparin and warfarin

##### Neuro-muscular system

Mechanism of conduction of nerve impulse along axon, neurotransmitters

Muscle tissue: skeletal muscle, cardiac muscle, and smooth muscle

Ultra structure skeletal muscles, Neuromuscular Junction (NMJ), Generation of action potential

Excitation-contraction coupling (ECC) and Mechanism of skeletal muscle contraction

#### UNIT-II

##### Gastrointestinal physiology

Anatomy of Gastro-Intestinal Tract (GIT), Gastro-Intestinal (GI) motility: types and regulation Gastro-

Intestinal (GI) Secretion, Digestion and absorption of food (carbohydrates, proteins and fats)

Gastrointestinal disorders: achalasia, vomiting, peptic ulcer, diarrhea

##### Renal physiology

Anatomy of the Kidney and Nephron

Mechanism of Urine formation: Glomerular filtration, Tubular reabsorption, Tubular secretion

Production and maintenance of hyperosmolar renal medullary interstitium

Mechanisms for excreting diluted and concentrated urine

#### UNIT- III

##### Introduction to clinical biochemistry

##### Water and electrolyte balance

Body fluid compartments, Regulation of fluid exchange

Regulation of electrolyte balance, role of kidney and hormones

Disorders of water and electrolyte balance

Edema-Intracellular and Extracellular

##### Acid base balance

Defenses against change in  $H^+$  concentration

Buffering of  $H^+$  ions in the body fluids

Respiratory and renal control of acid base balance

Acid base disorders: Clinical causes, measurement and Analysis

#### UNIT- IV

##### Principles of diagnostic enzymology

Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, lactate dehydrogenase, alkaline phosphatase, acid phosphatase

Liver function test (LFT): Estimation of ALT, AST, ALP, AP

Kidney function test (KFT): Estimation of Creatinine, Bilirubin, Na, K,

Ca Lipid Profile: Estimation of Cholesterol, Triglyceride, HDL, LDL

Cardiac function tests and Thyroid function tests

Diagnostic significance and interpretation of glucose tolerance test

##### Books Recommended:

1. Textbook of medical physiology- Hall E and Guyton AC-PA: Saunders/Elsevier.
2. Principles of Human Physiology- Stanfield Cindy L-Pearson Education.
3. Introduction to Physiology by Davidson H and Segal MB- Academic Press.
4. Teitz Fundamentals of Clinical Biochemistry- Burtis CA, Ashwood ER and Bruns DE- Saunders, Elsevier
5. Clinical biochemistry, metabolic and clinical aspects- Marshall WJ, Stephan K - Elsevier science health

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**Course Objective:** To familiarize the students with chromatin and its impact on the epigenetic regulation, and the signal transduction pathways associated with the cellular processes of the cells.

**Course Outcome:** After completion of this specialized course, the students will have knowledge of hierarchical organization of chromatin and its impact on the epigenetic regulation of biological processes such as DNA replication, gene regulation and DNA repair. Further, the students will be well versed with knowledge of complex mechanism and pathways by which different molecular pathways communicate with each other and respond to extracellular environment.

#### UNIT-I

Chromatin structure - basic organization of a eukaryotic genome in nucleus  
Histones, nucleosome structure  
Higher-order chromatin structure  
Epigenetics  
Regulation of chromatin by: acetylation, methylation, phosphorylation and ubiquitination  
Chromatin remodeling: a brief overview with emphasis on the role of various histone chaperones  
CAF1, ASF1, FACT  
ATP-dependent chromatin remodeling complexes  
Euchromatin and Heterochromatin  
Maintenance of chromatin structure during DNA replication and repair

#### UNIT-II

General principles of cell signaling- extra-cellular signaling molecules and their receptors  
Autocrine, paracrine and endocrine signaling  
Intra-cellular signaling molecular aspects  
Signaling through G-protein coupled receptors (GPCR)  
Second messengers, cAMP, Inositol-1,4,5-triphosphate, Ca<sup>2+</sup>-calmodulin  
Signaling through enzyme-linked receptors  
Activation of receptor tyrosine kinase and downstream cascade  
MAP kinase signaling pathway, PI3-Kinase/Akt pathway, Jak-STAT signaling pathway  
Wnt/  $\beta$ -catenin signaling pathway  
Cross-talk between signaling pathways

#### Books Recommended:

1. Molecular biology of the cells-Albert B, Bray D and Lewis J- Garland Publications, New York.
2. Cell and Molecular Biology: Concepts and experiments- Karp G, John HD-Wiley & sons, New York.
3. The Cell: A Molecular Approach- Cooper GM- Sunderland: Sinauer Associates, Inc.
4. Molecular cell Biology-Lodish H, Arnold B, Zipursky SL, Matsudaira P and Baltimore D- WH. Freeman and company, New York.

**Course Title: METABOLIC DISORDERS**  
**Course Code: BCH24-002GE**

**Credits: 02**  
**Max. Marks: 50 (40+10)**

**Course Objective:** The objective of this course is to provide basic knowledge about the metabolism of carbohydrates, amino acids, lipids, and nucleic acids and their associated metabolic disorders to students with diverse backgrounds in life sciences.

**Course Outcome:** On completing this open elective course, the students are able to explain/describe metabolic disorders related to carbohydrate, amino acids, lipids and nucleic acids. The students will be in apposition to impart or decipher knowledge about various metabolic diseases e.g. Diabetes, Lactose/Fructose intolerance, Glycogen storage diseases, Phenylketonuria, Alkaptonuria, Maple Syrup Urine Disease, Nonketotic hyperglycinemia, Urea cycle disorders, Hypo and Hyperuricemia, Gout, Lesch Nyhan Syndrome, Severe Combined Immunodeficiency Disease Xeroderma pigmentosum in various clinical and healthcare settings.

#### UNIT-I

Introduction to carbohydrates, lipids and their metabolism  
Disorders of carbohydrate metabolism  
Diabetes  
Hereditary fructose intolerance  
Lactose intolerance  
Glycogen storage diseases  
Disorders of Lipid Metabolism  
Hypercholesterolemia  
Atherosclerosis

#### UNIT-II

Introduction to amino acids, proteins and nucleic acids  
Inherited disorders of amino acid metabolism  
Phenylketonuria  
Alkaptonuria  
Maple Syrup Urine Disease  
Nonketotic hyperglycinemia  
Disorders of nucleic acid metabolism  
Purine and Pyrimidine metabolism related diseases,  
Hypo and Hyperuricemia,  
Gout  
Lesch Nyhan Syndrome  
Severe Combined Immunodeficiency Disease (SCID)  
Xeroderma pigmentosum

#### Books Recommended:

1. Textbook of medical physiology- Hall E and Guyton AC-PA: Saunders/Elsevier.
2. Harrison's Manual of medicine- Longo DL, Fauci AS, Kasper DL, Hauser SL and Jameson JL- McGraw-Hill Companies, Inc.
3. Lehninger Principles of Biochemistry- Nelson DL and Cox MM- WH Freeman and Company.

## SEMESTER IV

Course Title: PROJECT DISSERTATION  
Course Code: BCH24-401CR

Credits: 10  
Max. Marks: 250

The research project is an inevitable part of M.Sc. Biochemistry. The project can serve as a strong bridge between master's program and the research. The students get the opportunity to work in a research laboratory under the supervision of a principal investigator.

The project dissertation will be based upon short-term research work assigned by principle investigators. The dissertation will be submitted in the Department at the end of semester and evaluated. The dissertation will be assessed in its various aspects like techniques learnt, quantum and importance of results, and presentation of comprehensive project.

Course Title: PROJECT ASSESSMENT  
Course Code: BCH24-402CR

Credits: 04  
Max. Marks: 100

This will include an open presentation by the students, defending their project work that will be evaluated by an external examiner (to be nominated by Head of the Department) and faculty members. The presentation will be followed by the viva voce of the students, to be carried out by the external examiner.

Course Title: HOST INSTITUTE EVALUATION  
Course Code: BCH24-401DCE

Credits: 02  
Max. Marks: 50

During the project, the students will be critically evaluated by the host supervisor and will be graded by them based on their attendance in the lab, daily experimental work, writing and communications skills and other criteria related to routine lab work.

Course Title: JOURNAL CLUB  
Course Code: BCH24-402DCE

Credits: 04  
Max. Marks: 100

The recent and advanced scientific papers in high profile journals will be chosen by the students in consultation with mentor teachers and then presented by the student. The presenter is supposed to have all the relevant knowledge of the article. The audience will include faculty, research scholars and PG students.

**Course Objective:** The objective of this elective course is to provide knowledge about the nature, etiology and epidemiology of cancer as a disease, and to familiarize them to different hallmarks of cancer.

**Course Outcome:** On completing this open elective course, the students will have advanced concepts of the environmental and genetic causes that promote cancer.

#### UNIT-I

Etiology of cancer  
Tobacco  
Physical factors  
Chemical factors  
Dietary factors  
Viruses  
Cancer epidemiology

#### UNIT-II

Cancer Biology  
Basic concepts of cancer biology  
Properties of cancer cell  
Hallmarks of cancer  
Self-sufficiency in growth signals  
Insensitivity to antigrowth signals  
Evading apoptosis  
Sustained angiogenesis  
Limitless replicative potential  
Tissue invasion and metastasis

#### Books Recommended:

1. Cell and Molecular Biology- DeRobertis EDP and DeRobertis EMF-Lippincott Williams & Wilkins, Philadelphia, USA.
2. The Biology of Cancer- Weinberg R-Garland Science, NY.
3. Cancer Biology-Ruddon RW -Oxford University Press, NY.
4. The Biological Basis of Cancer- Mckinnell RG, Parchment RE, Perantoni AO and Pierce GB- Cambridge University Press.
5. Cancer Causing substances-Faik Atroshi- IntechOpen Publisher
6. Textbook of Cancer Epidemiology- Adami, Hunter, Lagiou and Mucci, Oxford University Press.
7. Cancer Epidemiology: Principles and Methods Isabel Dos Santos Silva, IARC/WHO.

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K112, SAA, MS/20, and others.

Course Title: **BIOCHEMICAL LAB. TESTS AND INTERPRETATION**  
Course Code: **BCH24-003GE**

Credits: **02**  
Max. Marks: **50 (40+10)**

**Course Objective:** The objective of this elective course is to familiarize students to reference values and lab errors, and advanced concepts of various clinical biochemistry tests used in diagnosis.

**Course Outcome:** On completing this open elective course, the students will have advanced concepts of various clinical biochemistry tests used in diagnosis.

#### UNIT-I

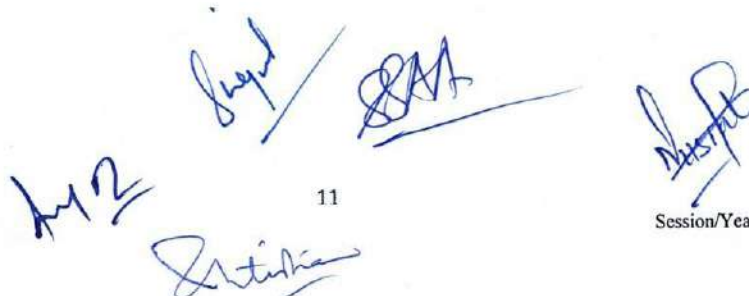
Concept of reference values  
Observed values  
Blood biochemistry  
Electrolytes estimation and clinical significance  
Blood gas analysis  
Blood sugar and its clinical importance

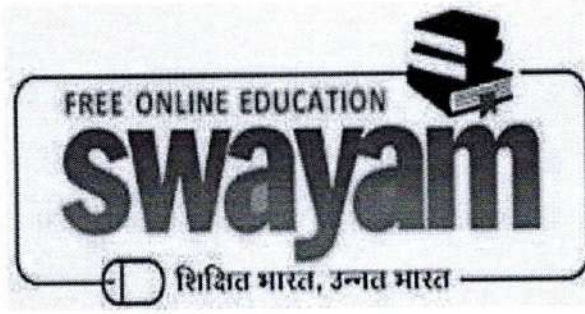
#### UNIT-II

Cardiac function tests and clinical uses  
Liver function tests: diagnostic importance  
Kidney function test importance  
Tumor markers

#### Books Recommended:

1. Introduction to Clinical Biochemistry: Interpreting Blood results- Basten G - Graham Basten and Ventus Publishing ApS.
2. Learning Guide Clinical Chemistry- Roberta Reed-Abbott Laboratories.
3. Teitz Fundamentals of Clinical Biochemistry- Burtis CA, Ashwood ER and Bruns DE- Saunders, Elsevier.





**MOOC courses available on SWAYAM platform (see the link below)**

<https://swayam.gov.in/explorer>

**Note: Students are advised to choose a relevant MOOC course as per the policy of the University of Kashmir.**

*[Handwritten signatures and marks]*