



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

**Choice Based Credit System Syllabus for  
M.Sc. Biochemistry  
(2021 onwards)**

PAPERS, CREDITS, HOURS AND MARKS DETAILS								
SEMESTER I								
Paper			Hrs./Week			Credits	Max Marks	
Code	Name	Category	L	T	P		Ext	Int
BCH21-101CR	Biomolecules	Core	4	0	0	4	80	20
BCH21-102CR	Cell Biology	Core	4	0	0	4	80	20
BCH21-103CR	Metabolism - I	Core	4	0	0	4	80	20
BCH21-104CR	Lab Course - I	Core	0	0	8	4	80	20
BCH21-101DCE	Plant Biochemistry	DCE	3	2	0	3+1=4	80	20
BCH21-102DCE	Biochemical Techniques	DCE	3	2	0	3+1=4	80	20
BCH21-001OE	Fundamentals of Biochemistry	OE	1	2	0	1+1=2	40	10
<b>Total credits 26</b>							<b>Total Marks 650</b>	
SEMESTER II								
BCH21-201CR	Metabolism II	Core	4	0	0	4	80	20
BCH21-202CR	Mol Biology	Core	4	0	0	4	80	20
BCH21-203CR	Lab course – II	Core	0	0	8	4	80	20
BCH21-204DCE	Enzymology	DCE	3	2	0	3+1=4	80	20
BCH21-201DCE	Microbiology	DCE	3	2	0	3+1=4	80	20
BCH21-202DCE	Adv. Techniques	DCE	2	0	0	2	40	10
BCH21-002OE	Protein Biochemistry	OE	1	2	0	1+1=2	40	10
BCH21-001GE	Chronic diseases	GE	1	2	0	1+1=2	40	10
<b>Total Credits 26</b>							<b>Total Marks 650</b>	
SEMESTER III								
BCH-21-301CR	Immunology	Core	4	0	0	4	80	20
BCH-21-302CR	Biotechnology	Core	4	0	0	4	80	20
BCH-21-303CR	Lab course - III	Core	0	0	8	4	80	20
BCH-21-304DCE	Nutritional Biochemistry & Endocrinology	DCE	3	2	0	3+1=4	80	20
BCH-21-301DCE	Physiology and Cl Biochemistry	DCE	3	2	0	3+1=4	80	20
BCH-21-302DCE	Genetics	DCE	2	0	0	2	40	10
BCH-21-002GE	Metabolic Disorders	GE	1	2	0	1+1=2	40	10
<b>Total Credits 24</b>							<b>Total Marks 600</b>	
SEMESTER IV								
BCH-21-401CR	Project Dissertation	Core	0	0	24	10	250	0
BCH-21-402CR	Host-institute evaluation	Core	0	0	4	2	50	0
BCH-21-403CR	Project Assessment	Core	0	8	0	4	100	0
BCH-21401DCE	Journal Club	DCE	-	8		4	100	0
BCH-21-003OE	Cancer Biology	OE	2	0	0	1+1=2	40	10
BCH-21-003GE	Biochemical tests & Interp.	GE	2	0	0	1+1=2	40	10
<b>Total Credits 24</b>							<b>Total Marks 600</b>	

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

**Abbreviations:**

CR - Core

DCE - Discipline Centric

GE - General Elective

OE - Open elective

L, T, P - Lectures, Tutorials and Practical, respectively

### **Program Outcome**

*Master in Biochemistry program has a vast scope and enumerable career options due to the ever increasing demand of the subject trained manpower. There indicators of success of the program can be drawn from the Noble Prize award data. Out of 225 noble laureates (in 113 times noble prize awards in Physiology or Medicine) 192 are biochemists. In addition to overwhelming acceptance and highly sought out program in areas where no special and specific qualification are needed, the students with this program have distinction of befitting into diverse areas and fields. It is a challenge to cover all the incredible outcomes with which students of M. Sc biochemistry have been proving their metal in the ventures of huge importance. 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 unparallel 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 evaluation 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 biowaste disposal. Their knowledge in all the important subjects help them to serve as confident /teachers in medical and paramedical colleges.*
3. **Conceptualizing the Problem and Solution:** *The local, national and international problems ranging form 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 have 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 analysers, 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 antiinfection 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 analyse 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.*

## SEMESTER

### I

#### **BCH 21-101CR: Biomolecules**

##### **UNIT-I**

###### Carbohydrates

- Definition, classification, characterization and biological importance of mono- and disaccharides
- Structure and conformation of sugars
- Stereo- and optical isomerism
- Structure and function of homo- and heteropolysaccharides
- Mucopolysaccharides and proteoglycans
- Chemical reactions of functional groups present in carbohydrates

##### **UNIT-II**

###### Lipids

- Classification of lipids
- Chemical composition and properties of triglycerides
- Nomenclature and properties of saturated and unsaturated fatty acids
- Properties and functions of phosphoglycerides and sphingolipids
- Structure and functions of steroids (cholesterol and bile acids)
- Prostanoids

##### **UNIT-III**

###### Amino acids

- Structure, classification and physiochemical properties
- Essential and non-essential amino acids
- Characteristics of a peptide bond
- Oligo-peptides and polypeptides
- Chemical synthesis of a peptide

###### Proteins

- Levels of protein structure
- Elucidation of primary structure
- Forces stabilizing the tertiary structure
- Protein denaturation and renaturation

##### **UNIT-IV**

###### Nucleic Acids

- Primary, secondary and tertiary structure of DNA
- Various forms of DNA
- Properties of DNA
- Denaturation and annealing of DNA, Cot
- Curve DNA as a genetic material
- Primary, secondary and tertiary structure of RNA
- Functions of various types of RNA

**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.*

#### **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: 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

**BCH 21-102CR: Cell Biology****UNIT-I**

Cell membrane  
 Chemical composition  
 Structure and function of membrane proteins  
 Membrane lipids and membrane fluidity  
 Membrane potential  
 Mitochondria - structure and function  
 Golgi complex- structure and function  
 Introduction to vesicle transport  
 Lysosomes and plant vacuoles, Peroxisomes

**UNIT-II**

Introduction to endomembrane system  
 Approaches to study endomembrane  
 Endoplasmic reticulum, structure and function  
 Structure and function of Nucleus and nucleolus  
 Chromosome and chromatin structure Structure  
 and composition of a gene

**UNIT-III**

Cell cycle and its stages  
 Regulation of cell  
 cycleCell cycle and  
 cancer  
 Mitosis  
 Prophase, prometaphase, metaphase, anaphase, telophase, cytokinesis  
 Motor proteins and their role in cell division  
 Meiosis  
 The stages of meiosis  
 Genetic recombination during meiosis

**UNIT-IV**

Extracellular matrix and cell interaction  
 Extracellular space  
 Interaction of cells with extracellular material  
 Tight Junction- sealing the extracellular space  
 Cell -cell adhesion  
 Cell -cell  
 communicationThe  
 cytoskeleton  
 Microtubules  
 Intermediate filaments  
 Microfilaments

**Course outcome:** *After completing this course, the student will have understood the basic and advanced concepts in Cell Biology. The students will develop the fear idea of the functioning of the cell and its organelles in detail. The concept in role of role cell organelles in cellular metabolism and other functions will be developed by students. Further, the students will essentially build the concepts of cell cycle regulation, cell division and intracellular communication. The student's understanding of the subject will be tested by interacting with them in class, asking questions, discussing advanced concepts and holding class tests and end-of-the-semester examinations.*

**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. Freemanand company, New York
5. Principles of Cell and Molecular Biology- Kleinsmith LJ and Kish VM-Harpercollins Publishers, New York

**BCH21-103CR: Metabolism - I****UNIT-I**

Bioenergetics  
 Energy transformation by biological systems  
 Concept and significance of free energy  
 Phosphoryl transfer potential  
 Coupled reactions  
 ATP as energy  
 currencyATP Cycle  
 Nernst equation and redox potential

**UNIT-II**

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

**UNIT-III**

Lipid metabolism and its regulation  
 Fatty acid oxidation-  $\alpha$ ,  $\beta$ ,  $\omega$ , oxidation and lipo-oxidation.  
 Fatty acid biosynthesis- Acetyl CoA carboxylase, Desaturase and  
 elongaseBiosynthesis 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

**UNIT-IV**

Metabolite transport across mitochondrial membrane  
 Structural organization of respiratory chain  
 Electron flow in respiratory chain  
 Inhibitors 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

**Course outcome:** The course will help students to: 1. Know the reactions of the major catabolic and anabolic pathways of carbohydrate and lipid metabolism, as well as the generation of energy in mitochondria 2. Rationalize the transfer of energy in living systems on the molecular level. 3. Understand the signalling pathways of epinephrine, glucagon, and insulin. 4. Understand the regulation of metabolic pathways. **Outcome:** On completing the course, the students are able to explain/describe the synthesis of lipids, and carbohydrates and their role in metabolic pathways. 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. At the end of the programme, the student is able to apply and integrate molecular and metabolic knowledge of conditions and disease states for clinical problem solving (e.g., diabetes, carcinogenesis, mental illness, etc.) and also develop a critical level of observational, analytical and problem-solving skills to work on unknown mechanisms and suggest new hypotheses.

**Books Recommended:**

1. Fundamentals of Biochemistry: Life at the Molecular- Voet D, Voet JG and Pratt CW- John Wiley & Sons, Inc
2. Lehninger Principles of Biochemistry- Nelson DL and Cox MM-WH Freeman and Company
3. Biochemistry-Garrett RH and Grisham CM- Belmont, CA:Brooks/Cole, Cengage Learning
4. Bioenergetics: A Practical Approach- Brown GC and Cooper CE -Oxford University Press
5. Harper's Biochemistry-Botham, Bender and Rodwell-McGraw Hill

**BCH21-104CR: Laboratory Course – I**

Expression of concentrations of solutions and calculations  
Concept of pH and buffers  
Qualitative estimations of carbohydrates and amino acids  
Quantitative estimation of proteins by  
    Lowry's method  
    Bradford's method  
    Spectrophotometric method  
Quantitative estimation of cholesterol by Zlatki's method  
Quantitative estimation of glucose  
    Nelson Somogy's method  
Titrimetric estimation of vitamin C  
Paper/thin layer chromatography of amino acids

**Course outcome:** *After completing this practical course, the students will be ready to plan and carry out experiments like the qualitative and quantitative estimation of various carbohydrates, amino acids, Cholesterol and vitamin C. The students can impart the knowledge of this practical training in diagnostic setups.*

**Employability potential:** *This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.*

**Books Recommended:**

1. An Introduction to Practical Biochemistry-Plummer DT -Tata McGraw Hill
2. Biochemical Calculations- Segel IH- John Wiley and Sons Inc
3. Practical Biochemistry, Wilson K and Walker JM-Cambridge University Press

**BCH21-101DCE: Plant Biochemistry****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
- C<sub>4</sub> 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, tannins, lignins, lignans, alkaloids and surface waxes – their biosynthesis and physiological role
- Plant defence against pathogens
- 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

**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.*

**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, Greussem and Jones-AAPS



**BCH21-102DCE: Biochemical Techniques****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
- Multiplex, Gradient and Nested PCR, RT-PCR

## Principles of - RFLP, RAPD and AFLP techniques

## Single strand conformation polymorphism and heteroduplex analysis, Mutagenesis Preparation and analysis of RNA and DNA probes and tags

**UNIT-IV**

## Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH Methods for analysis of gene expression at RNA level and protein level

## qPCR

## Large-scale expression analysis using micro array analysis Flow-cytometry

## Microscopy

- Light, electron (scanning and transmission), phase contrast and fluorescence microscopy
- Freeze- fracture techniques
- Confocal Microscopy

**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.

**Employability potential:** This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.

**Books Recommended:**

1. Principles and Techniques of Biochemistry and Molecular biology - Wilson K and Walker J- Cambridge University Press

2. Modern Experimental Biochemistry-Rodney F Boyer- Benjamin Cummings publishing company Inc
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder-W.H. freeman and Company
4. Physical Biochemistry: Principles and Applications-David Sheehan-John Wiley
5. Principles of Physical Biochemistry- Holde KEV, Jhonson WC and ShingHo P-Prentice Hall Inc
6. Biophysical Chemistry- Cantor CR and Schimmel PR-W.H. Freeman and Company

**BCH21-001OE: Fundamentals of Biochemistry****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 death and its causes  
Cell division as the means of propagation  
Concept of mitosis and meiosis

**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.*

**Book 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

### **BCH21-201CR: Metabolism-II**

#### **UNIT-I**

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 of amino acid metabolism

#### **UNIT-II**

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

#### **UNIT-III**

Disorders of carbohydrate metabolism  
 Hereditary fructose intolerance, Lactose intolerance, Glycogen storage diseases  
 Disorders of lipid metabolism  
 Lipid storage diseases, Hypercholesterolemia, Atherosclerosis  
 Inherited disorders of amino acid metabolism  
 Phenylketonuria, Alkaptonuria, Maple Syrup Urine Disease, Nonketotic hyperglycinemia  
 Urea cycle disorders  
 Disorders of nucleic acid metabolism  
 Purine and Pyrimidine metabolism related diseases  
 Hypo and Hyperuricemia, Gout, Lesch Nyhan Syndrome, Severe Combined Immunodeficiency Disease  
 Xeroderma pigmentosum

#### **UNIT-IV**

Metabolism of  
 Calcium  
 Phosphorus  
 Vitamin D  
 Calcitonin  
 Parathyroid hormone  
 Metabolism of Iron  
 Metabolism of trace elements (Zn, Cu, Mn, Co, Ni, Mo, Cr, Se, Cd, Sr, F, As)

**Course outcome:** *On completing this course, the students are able to explain/describe the synthesis and degradation of amino acids, and nucleic acids. The students will be knowledgeable about the various metabolic disorders and diseases associated with amino acid and nucleic acid metabolism. The students will be in apposition to impart or decipher knowledge about various metabolic diseases e.g. Phenylketonuria, Alkaptonuria, Maple Syrup Urine Disease, Nonketotic hyperglycaemia Urea cycle disorders, Hypo and Hyperuricemia, Gout, Lesch Nyhan Syndrome, Severe Combined Immunodeficiency Disease Xeroderma pigmentosum in various clinical and healthcare settings.*

#### **Book 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

**BCH 21–202CR: Molecular Biology****UNIT-I**

Replication  
 Unit of replication  
 Replication Origin and Replication  
 Fork Enzymes involved in replication  
 Initiation, Elongation and Termination of Replication  
 Fidelity of Replication  
 Recombination and 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  
 Eukaryotes  
 Viruses  
 Transcriptional activators and repressors  
 Role of chromatin in regulating gene expression and gene silencing  
 Epigenetics and its importance in regulation of gene expression

**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

**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 chromatin organization, DNA replication, transcription and its regulation in prokaryotes, eukaryotes and viruses.*

**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

**BCH21-203CR: Laboratory Course - II**

Extraction and assay of enzymes

Effect of temperature, pH, and time on enzyme activity

Isolation and purification of proteins gel filtration columns

Polyacrylamide gel electrophoresis of purified proteins

Electrophoretic separation of serum proteins

Molecular weight determination by gel filtration chromatography and SDS-PAGE

Isolation of DNA: Different Methods, Different sources

Quantification of DNA by

Spectroscopy Electrophoresis of

Isolated DNA

**Course outcome:** *After completing this practical course, the students will be ready to plan and carry out experiments, like isolation, purification and identification of proteins, perform PAGE and SDS-PAGE protein electrophoresis, and enzyme assays (animal and plant sources). They can generate and test hypotheses, analyse data using statistical methods where appropriate, and appreciate the limitations of conclusions drawn from experimental data. The students would be able to troubleshoot the experimental challenges they face while doing Ph.D. or while using the skills in diagnostic setups.*

**Employability potential:** *This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.*

**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

**BCH21 - 201DCE: Enzymology****UNIT-I**

Enzyme classification and nomenclature  
 Methods of examining enzyme – substrate complexes  
 Enzyme kinetics  
 An introduction, factors influencing enzyme reaction velocity  
 Henri and Michaelis Menten equation, Briggs-Haldane modification  
 Determination and significance of kinetic constants  
 Bisubstrate Reactions  
 Ping Pong and ordered Bi Bi reaction mechanism

**UNIT-II**

Enzyme inhibition  
 Reversible inhibition, its types  
 Determination of inhibitor constants  
 Irreversible inhibition  
 Enzyme assays  
 Mechanism of catalysis of  
 Serine proteases  
 Triose phosphate isomerases

**UNIT-III**

Enzyme regulation  
 General mechanism of enzyme regulation  
 Allosteric enzymes  
 Sigmoidal kinetics and their physiological significance  
 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

**UNIT-IV**

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

**Course outcome:** This students after completing this will be ready to opt for applied biology or medical laboratory sciences as their career.

**Books Recommended:**

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

**BCH21-202DCE: Microbiology****UNIT-I**

A brief introduction to major groups of microorganisms  
 Bacteria, Viruses, Fungi, Protozoa, Mycoplasma and Algae  
 Ultrastructure of bacteria 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  
 Cell surface appendages  
 Pilli, Capsule, Flagella (Locomotion by flagella, chemotactic movement)  
 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 PTS  
 Transport and Iron Uptake  
 Microbial media  
 Complex medium, Defined medium, Selective medium and Differential medium  
 Isolation, culture, identification and preservation of bacteria  
 Microbial genetics  
 Modes of genetic exchange in microbes- Conjugation, Transformation and Transduction

**UNIT-III**

Antimicrobial agents-their classification  
 Mechanisms of action of antimicrobial agents  
 Classification of antibiotics  
 Selective toxicity and therapeutic index  
 Mechanisms of antibiotic resistance  
 Superbugs, Multidrug resistance  
 Plasmids and genetic mutation in resistance  
 Normal 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  
 Immune response to viruses  
 Viroids, Virusoids  
 Emerging and re-emerging viral diseases  
 SARS, Influenza, Dengue, AIDS, Nipah virus disease and Zika virus disease

**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.

**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

**BCH21-203DCE: Advanced Techniques****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, FREP  
 Analysis of interacting proteins with SPR spectroscopy, 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)  
 Microplate capture and detection 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  
 Ion Torrent/semiconductor sequencing  
 Pyrosequencing  
 Genome wide sequencing (GWS) and Whole genome gene sequencing (WGS)  
 Genome-wide association studies (GWAS)  
 Transcriptome and Exome 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 have enough knowledge about the various molecular and cell biology methodologies e.g. protein-protein interactions, protein-DNA interactions, gene silencing and genome sequencing.*

**Employability potential:** *This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.*

**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

**BCH21 -002OE: Protein Biochemistry****UNIT-I**

Amino acids, the building blocks of proteins  
Protein – a molecule with myriad of functions  
Primary structure of the protein and its determination  
Secondary structure, types  
Tertiary structure, forces stabilizing tertiary structures  
Quaternary structures

**UNIT-II**

Quantitative estimation of proteins by  
Lowry's method  
Bradford's method  
Spectrophotometric method  
Polyacrylamide gel electrophoresis of purified proteins  
Molecular weight determination by gel filtration chromatography and SDS-PAGE

**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. Further, the students will impart the knowledge in various methods used in protein estimation.*

**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

**BCH 21– 001GE: Chronic Diseases–Cancer and Diabetes****UNIT-I**

Cancer - an Introduction  
Various known causes of cancer  
Cancers in Kashmir  
Signs and symptoms  
Cancer diagnosis  
Management of cancer patients  
Cancer prognosis  
Responsibility of patients and attendants  
Facilities of cancer care in developing world

**UNIT-II**

Glucose Metabolism  
Organs and enzymes  
Diabetes  
Causes of diabetes  
Diagnosis of diabetes  
Incidence of diabetes in Kashmir  
Treatment of diabetic patients  
Diet control and physical exercise  
Impact of diabetes on society  
Preventive measures

**Course Outcome:** *The students will be well-versed with the knowledge of chronic diseases such as cancer and diabetes. The students will gain knowledge pertaining to mechanisms and possible preventive measures for these diseases.*

**Books Recommended:**

1. The Biology of Cancer- Weinberg R-Garland Science, NY
2. Textbook of medical physiology- Hall E and Guyton AC-PA: Saunders/Elsevier
3. Teitz Fundamentals of Clinical Biochemistry- Burtis CA, Ashwood ER and Bruns DE- Saunders, Elsevier Text book of Cancer Epidemiology- Adami, Hunter, Laggiou and Mucci, Oxford University Press
4. Cancer Epidemiology: Principles and Methods Isabel Dos Santos Silva, IARC/WHO

## SEMESTER III

### **BCH21 – 301CR: Immunology**

#### **UNIT-I**

Historical perspective, terms associated with immunology  
 Antigenicity, Features of antigenicity, super antigens, adjuvants  
 Cells of immune system: Myeloid, Mononuclear cells, T-Lymphocytes, B-Lymphocytes, NK-Cells  
 Primary and secondary lymphoid organs: Thymus, Bursa of fabricus, Peyers 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, T cell development and activation, TCR  
 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**

Immunoblotting and diagnosis of various important diseases, only infectious and few cancerous types  
 Techniques – ELISA, RIA, fluorescent IA, agglutination of pathogenic bacteria, Haemagglutination and its inhibition  
 Affinity, avidity  
 Immunoelectron microscopy  
 Enumeration of total T-cell numbers by sRBC, resetting technique  
 Determination of total number of B-lymphocytes by staining for surface IgG  
 Antigen – antibody interaction and its applications  
 Total hemolytic assay

**Course Outcome:** *On completion of this course, the students will develop critical thinking for various immunological processes. The students will explain the functioning of the immune system. They will be able to clearly state the role of innate and adaptive immune systems, and innate recognition receptors (i.e. Toll-Like Receptors) in immune responses. The students will be able to compare humoral versus cell-mediated immune responses, be able to distinguish various cell types involved in immune responses and associated functions, be able to distinguish and characterize CD4+ T helper cell lineages and distinguish and characterize antibody isotypes, development, and functions; 11) understand the role of cytokines in immunity and immune cell activation; and be able to 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.*

#### **Books Recommended:**

1. Immunology- Kuby J, Kindt T J, Osborne BA and Goldsby RA- WH Freeman and Co. Ltd
2. Fundamental Immunology- Paul WE- Lippincott Williams and Wilkins
3. Essential Immunology- Roitt IM, Brostoff J and Male D - Wiley-Blackwell

4. Immunology: An introduction- Tizard IR - Saunders College Publishing
5. Introduction to Medical Immunology-Gabriel Virella- Marcel Dekker Inc
6. Basic Immunology: The Functions of the Immune System-Abbas AK and Lichtman AH- Publisher Saunders

**BCH21 –302CR: 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

**UNIT-III**

Animal Cell Culture  
 Primary and established cell lines  
 Types of various cell lines  
 Biology and characterization of the cultured cells  
 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  
 Immortalization and methods used to immortalize cells  
 Viability and cytotoxicity assays: Trypan blue, MTT, TUNEL and ELISA based assays  
 Concept of Plant Cell culture

**UNIT-IV**

Immunobiotechnology  
 Development of Monoclonal Antibodies by Hybridoma Technology  
 Applications of MCA and Antibody Fragments  
 Vaccination: Conventional and genetically engineered vaccines  
 Lymphokines – production and applications

**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, production of monoclonal antibodies using hybridoma technology, antibody fragments and vaccines.*

**Employability potential:** *This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.*

**Books Recommended:**

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

**BCH21-303CR: Laboratory Course - III**

Amplification of a DNA segment by PCR  
 Purification of PCR product  
 Restriction digestion of PCR product  
 Isolation of RNA from leukocytes  
 cDNA synthesis from mRNA  
 Bacterial culture methods  
 Preparation of plasmid DNA - Manual/Kit  
 Plasmid Transformation and cloning  
 Western blotting

**Course outcome:** *After completing this practical course, the students will be ready to plan and carry out experiments, like gene cloning, cDNA synthesis, preparation of plasmids and western blotting. They can generate and test hypotheses, and analyse 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.*

**Employability potential:** *This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.*

**Books Recommended:**

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



**BCH21-301DCE: Nutritional Biochemistry and Endocrinology****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 and factors affecting energy requirements, Recommended allowances, Balanced diet  
 Protein nutrition  
 Proteins reserves of human body  
 Nitrogen balance studies and factors influencing nitrogen balance Determination of nitrogen, amino acids, PER, NPR, NPU, BV, Chemical score  
 Protein energy malnutrition (PEM)  
 Etiology, clinical features, metabolic disorders and management of marasmus and kwashiorkor  
 Basic concept of high protein low caloric weight reduction diets  
 Carbohydrate nutrition  
 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 (Definition and classification)  
 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 specific deficiency diseases associated with fat and water soluble vitamins  
 Hypervitaminosis symptoms of fat- soluble vitamins

**UNIT-III**

Introduction to endocrinology  
 Basic concepts of Signal Transduction  
 Mechanism of action of hormones - hormone receptors  
 Second messenger mechanisms for mediating intracellular hormone functions  
 Components and general mechanism of Signal Transduction  
 Signaling motifs: SH2, SH3, PH and PDZ domains  
 Role of protein kinases in cell signaling: Serine/Threonine and Tyrosine kinases  
 Structure, biosynthesis, secretion, transport, mechanism of action and physiological role of Pancreatic and Thyroid hormones

**UNIT-IV**

Hypothalamic-Pituitary axis  
 Pituitary hormones and their control by hypothalamus  
 Structure, biosynthesis, secretion, transport, mechanism of action and physiological role of Adrenal, Gastrointestinal, Sex hormones

**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. This includes a basic understanding of metabolism, physiology, molecular genetics and epidemiology. The students can develop research proposals for the study of human nutrition with concepts in nutritional sciences related to diet and disease.*

*The students who opt for the endocrinology section of this course will be able to explain the integration of developmental events, proliferation, growth, and differentiation, and the psychological or behavioural activities, metabolism, growth and development, tissue function, sleep, digestion, respiration, excretion, mood, stress, lactation, movement, reproduction and sensory perception caused by 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

**BCH 21– 302DCE: Physiology and Clinical Biochemistry****UNIT-I**

Haematology

Composition of blood

Mechanism and regulation of blood coagulation, fibrinolysis

Neuro-muscular system

Mechanism of conduction of nerve impulse along axon, neurotransmitters

Ultra structure and molecular mechanism of contraction of skeletal and smooth muscles and its regulation

Biochemistry of vision

**UNIT-II**

Gastrointestinal physiology

Secretion, Digestion and absorption

Gastrointestinal disorders

Excretory system

Formation of urine

Normal and abnormal constituents of urine

**UNIT– III**

Introduction to clinical biochemistry

Water and electrolyte balance

Regulation of water and electrolyte balance, role of kidney and hormones

Acid base balance regulation by human body, concept of metabolic and respiratory acidosis and alkalosis

**UNIT– IV**

Principles of diagnostic enzymology

Evaluation of organ function tests

Clinical presentation and diagnosis of renal, hepatic and pancreatic diseases

Cardiac function tests and Thyroid function tests

Diagnostic significance and interpretation of glucose tolerance test

Diagnostic tests for Apo lipoproteins, HDL cholesterol, LDL cholesterol and triglyceride disorders

**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.

**Employability potential:** This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.

**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. Tetz 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
6. Clinical Biochemistry: An illustrated color text- Gaw A, Murphy M, Cowan R, Reilly DO, Stewart M and Shepherd J- Churchill Livingtons

**BCH 21– 303 DCE: Genetics****UNIT-I**

Introduction to Mendelian Genetics

Mendel's Laws of inheritance

Dominance

Segregation

Independent assortmentGene

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

**UNIT-II**

Human Genetics

Normal Human Karyotype

Autosomal inheritance-dominant and recessive

X-linked linked inheritance

Y-linked linked

inheritanceGenetic Diseases

Pedigree analysis for the inheritance pattern of genetic diseases

Genetic Counselling

Chromosomal Changes

Number variation – Euploidy (auto and allopolyploidy),

aneuploidyStructural variations – duplications, Inversions,

translocations

Population genetics - gene pool, gene frequency

Hardy-Weinberg law

Non-random mating-factors influencing, heritability

Genetic polymorphism-transient and stable

**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) design, execute, and analyze the results of genetic experimentation in animal and plant model systems.

**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, NY
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

**BCH21 – 002GE: Metabolic Disorders****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  
 Urea cycle disorders  
   Hyperammonemia, Argininemia  
 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

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

**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**

### **BCH 21– 401CR: Project Dissertation**

The research project is an inevitable part of M. Sc Biochemistry. It trains students at a higher level after getting the academic and laboratory teachings. The project is not only important in passing the course but also serves as the final test of students' capability to work independently and think critically. Students explore a different world and get time to test their choice and taste for research. The project can serve a strong bridge between master's program to research including PhD program. The project dissertation will be carried out in any laboratory and will be assessed in its various aspects- Thesis, techniques learnt, quantum and importance of results, and presentation of comprehensive project.

### **BCH21-402CR: Host Institute Evaluation**

During the project, the students will be critically evaluated by the host supervisors 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.

### **BCH21-403CR: Project Assessment**

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

### **BCH 21– 401 DCE: Journal Club**

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 outcome:*** On completing this six months dissertation, the students will develop and defend their thesis. The thesis will be developed by the students in their respective research laboratories on novel research problems. The students will know how to implement the theoretical knowledge to execute the experiments. Eventually, this course will prepare these students to take up the research assignments in their Ph.D. programs.

***Employability potential:*** This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.

**BCH21 – 003OE: Cancer biology****Unit-I**

Aetiology of  
 cancer  
 Tobacco  
 Physical factors  
 Chemical factors  
 Dietary factors  
 Viruses  
 Root cause of cancer  
 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

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

**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 Pierrce GB- CambridgeUniversity Press
4. Cancer Causing substances-Faik Atroshi- IntechOpen Publisher
5. Text book of Cancer Epidemiology- Adami, Hunter, Laggiou and Mucci, Oxford University Press
6. Cancer Epidemiology: Principles and Methods Isabel Dos Santos Silva, IARC/WHO

**BCH21 – 003GE: Biochemical Laboratory Tests and Interpretation****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  
Tumour markers – PSA, carbohydrate markers

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

***Employability potential:** This course has a potential for employability in research laboratories, diagnostic setups and biotechnology industry.*

**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



**List of MOOCs courses available on SWAYAM platform recommended by Department of Biochemistry for the Session - 2021**

- Research methodology and statistical analysis
- Analytical techniques
- Biomolecules: structure function in health and disease
- Biostatistics and mathematical biology
- Cancer fundamentals
- Cell biology: cellular organization, division and processes
- Cell designer - modelling tool for gene-regulatory and biochemical networks
- Diet management in health & disease
- Fundamentals of bioinformatics
- Functional foods and nutraceuticals
- Introduction to research
- Introductory mathematical methods for biologists
- Introduction to process modelling in the membrane separation process
- Medical biomaterials
- Metabolic engineering
- Plant biochemistry and plant biotechnology
- Principles of genetics
- Functional genomics

**Note:** Students are advised to opt for above mentioned MOOCs course, if available, as per the policy of the University of Kashmir