



**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	
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	
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

## 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

#### **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 cycle  
 Cell 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 communication  
 The cytoskeleton  
 Microtubules  
 Intermediate filaments  
 Microfilaments

**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
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 currency
- ATP 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 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

**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

**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

**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
- 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, 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

**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

**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

**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

**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)

#### **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

**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

**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

**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

**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

**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 -0020E: 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

**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

**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, Lagiou 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 Fabricius, Peyer'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, 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

#### **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

**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

**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

**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

**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 assortment

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

**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 Counselling

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

**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

**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 gets 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.

**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

**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-Cambridge University Press
4. Cancer Causing substances-Faik Atroshi- IntechOpen Publisher
5. Text book of Cancer Epidemiology- Adami, Hunter, Lagiou 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

**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