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
			Total credits 26				**Total Marks 650**	

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
			Total Credits 26				**Total Marks 650**	

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
			Total Credits 24				**Total Marks 600**	

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
			Total Credits 24				**Total Marks 600**	

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

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

1. **Research:** The course content of the program is broad and relevant with the changing technology and research. The students with M.Sc. in Biochemistry serve as 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 evaluations that are inevitable for diagnostics or management of patients. They carryout laboratory management by ensuring quality control, minimizing pre and post analytical errors, in proper handling of biological specimens and pathogens and safe bio-waste disposal. Their knowledge in all the important subjects helps them to serve as confident/teachers in medical and paramedical colleges.

3. **Conceptualizing the Problem and Solution:** The local, national and international problems ranging from diseases, environmental issues or food availability are best understood by biochemists and have the potential and training to explore solution by appropriate research design. The biochemist has been playing important roles in confronting infections, addressing population, global warming, food scarcity, and many other unprecedented challenges.

4. **Biomedical engineering:** The development or application of the important biomedical equipment ranging from high end advanced imaging systems to basic analyzers; involve the exploitation of the basic understanding of the difference in the biochemical parameters in disease and normal tissues. Our manpower is playing important role in design or development of such equipment in collaboration with biomedical engineers.

5. **Agriculture:** The understanding of the basic biochemical mechanisms in agricultural plants has enabled us to overcome food scarcity in the world. The science behind the different revolutions in agriculture including developing high-yielding livestock breeds and crops and developing anti-infection agents, disease disease-resistant crop variants helped us improve a lot agricultural produce.

6. **Pharmaceutical industry:** The biochemists play an important role in understanding the pharmacokinetics and dynamics of any potential therapeutic agent. The novel drug targets are identified and their possible interventions are explored by biochemists. Further, the biochemists are the vaccine developers and use their skills in the development of immunological therapies.

7. **Forensic science:** Biochemistry has a major application in this field. The biochemists are well trained to analyze biochemical specimens in order to nab the culprit or to resolve paternity disputes.

8. **Next-generation researchers and scientists:** The six-month internship in different research laboratories across the country prepares and motivates the students to pursue a Ph.D. in the cutting-edge areas of Molecular and Cellular Biology. This eventually contributes to producing a cohort of next-generation researchers and scientists.

SEMESTER I

Course Title: BIOMOLECULES **Credits: 04**
Course Code: BCH21-101CR **Max. Marks: 100 (80+20)**

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

UNIT-I

Carbohydrates

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

Course Title: CELL BIOLOGY **Credits: 04**
Course Code: BCH21-102CR **Max. Marks: 100 (80+20)**

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.*

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, NewYork

Course Title: METABOLISM-I **Credits: 04**
Course Code: BCH21-103CR **Max. Marks: 100 (80+20)**

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.*

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- α, β, ω, 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

Course Title: LABORATORY COURSE-I **Credits: 04**
Course Code: BCH21-104CR **Max. Marks: 100 (80+20)**

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.*

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

Course Title: PLANT BIOCHEMISTRY **Credits: 04**
Course Code: BCH21-101DCE **Max. Marks: 100 (80+20)**

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

UNIT-I

Photosynthesis
- Photosynthesis in higher plants – general concepts
- Organization of the photosynthetic apparatus
- Mechanism of electron transport in photosynthesis
- Proton transport and ATP synthesis
- Calvin cycle and its
- regulationC4 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 developments 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, Greussem and Jones-AAPS

Course Title: BIOCHEMICAL TECHNIQUES **Credits: 04**
Course Code: BCH21-102DCE **Max. Marks: 100 (80+20)**

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.

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 arrayanalysis, 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

Course Title: FUNDAMENTALS OF BIOCHEMISTRY **Credits: 02**
Course Code: BCH21-001OE **Max. Marks: 50 (40+10)**

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

UNIT-I

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

UNIT-II

Cell as a basic unit of life
Cell components
- Functions of the various components

Cell 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 son

SEMESTER II

Course Title: METABOLISM-II **Credits: 04**
Course Code: BCH21-201CR **Max. Marks: 100 (80+20)**

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.*

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

Course Title: MOLECULAR BIOLOGY **Credits: 04**
Course Code: BCH21-202CR **Max. Marks: 100 (80+20)**

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.*

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

Course Title: LABORATORY COURSE-II **Credits: 04**
Course Code: BCH21-203CR **Max. Marks: 100 (80+20)**

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.*

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

Course Title: ENZYMOLOGY **Credits: 04**
Course Code: BCH21-201DCE **Max. Marks: 100 (80+20)**

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

UNIT-I

Enzyme classification and nomenclature
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

Course Title: MICROBIOLOGY **Credits: 04**
Course Code: BCH21-202DCE **Max. Marks: 100 (80+20)**

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

UNIT-I

A brief introduction to 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 negativeorganisms
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 toxigenecity

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, Hatziioannou T and Skalka AM- ASM Press

Course Title: ADVANCED TECHNIQUES **Credits: 02**
Course Code: BCH21-203DCE **Max. Marks: 50 (40+10)**

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

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

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, microRNA 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

Course Title: PROTEIN BIOCHEMISTRY **Credits: 02**
Course Code: BCH21-002OE **Max. Marks: 50 (40+10)**

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.*

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

Course Title: CHRONIC DISEASES-CANCER AND DIABETES **Credits: 02**
Course Code: BCH21-001GE **Max. Marks: 50 (40+10)**

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.*

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

Course Title: IMMUNOLOGY **Credits: 04**
Course Code: BCH21-301CR **Max. Marks: 100 (80+20)**

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.*

UNIT-I

Historical perspective, terms associated with immunology
Antigenicity, Features of antigeneticiy, 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

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

Course Title: BIOTECHNOLGY **Credits: 04**

Course Code: BCH21-302CR **Max. Marks: 100 (80+20)**

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.*

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_2, 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

Course Title: LABORATORY COURSE-III **Credits: 04**
Course Code: BCH21-303CR **Max. Marks: 100 (80+20)**

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.*

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:

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

Course Title: NUTRITIONAL BIOCHEMISTRY AND ENDOCRINOLOGY **Credits: 04**
Course Code: BCH21-301DCE **Max. Marks: 100 (80+20)**

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.

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 obesityRole 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

Course Title: PHYSIOLOGY AND CLINICAL BIOCHEMISTRY **Credits: 04**
Course Code: BCH21-302DCE **Max. Marks: 100 (80+20)**

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.*

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 itsregulation

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. Teitz Fundamentals of Clinical Biochemistry- Burtis CA, Ashwood ER and Bruns DE- Saunders, Elsevier
5. Clinical biochemistry, metabolic and clinical aspects- Marshall WJ, Stephan K - Elsevier science health
6. Clinical Biochemistry: An illustrated color text- Gaw A, Murphy M, Cowan R, Reilly DO, Stewart M and Shepherd J- Churchill Livingtons

Course Title: GENETICS **Credits: 02**
Course Code: BCH21-303DCE **Max. Marks: 50 (40+10)**

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.*

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

Course Title: METABOLIC DISORDERS **Credits: 02**
Course Code: BCH21-002GE **Max. Marks: 50 (40+10)**

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.*

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

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.*

Course Title: PROJECT DISSERTATION **Credits: 10**
Course Code: BCH21-401CR **Max. Marks: 250**

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 tase for research. The project can server 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.

Course Title: HOST INSTITUTE EVALUATION **Credits: 02**
Course Code: BCH21-402CR **Max. Marks: 50**

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.

Course Tile: PROJECT ASSESSMENT **Credits: 04**
Course Code: BCH21-403CR **Max. Marks: 100**

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.

Course Title: JOURNAL CLUB **Credits: 04**
Course Code: BCH21-401DCE **Max. Marks: 100**

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

Course Title: CANCER BIOLOGY **Credits: 02**
Course Code: BCH21-003OE **Max. Marks: 50 (40+10)**

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

Unit-I

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

Course Title: BIOCHEMICAL LAB. TESTS AND INTERPRETATION **Credits: 02**
Course Code: BCH21-003GE **Max. Marks: 50 (40+10)**

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.*

UNIT-I

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

UNIT-II

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