Syllabus for

4 year under graduate course (B. Sc.) in Biochemistry

(2023 onwards)

FYUP CURRICULAR FRAMEWORK FOR BACHELORS PROGRAMME WITH BIOCHEMISTRYAS MAJOR SUBJECT(2023 onwards)

SEMESTER	COURSE CODE	TYPE OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY 4	PRACTICAL 2 or 0	TUTORIALS 0 or 2
I	BCH122J	MAJOR	BIOMOLECULES	4	2	0
II	BCH222J	MAJOR	CELL BIOLOGY	4	2	0
III	BCH322J	MAJOR	ENZYMOLOGY	4	2	0
IV	BCH422J1	COURSE TYPE-1	BASICS OF METABOLISM AND BIOENERGETICS	3	1	0
	BCH422J2	COURSE TYPE-2	IMMUNOLOGY	4	2	0
	BCH422J3	COURSE TYPE-3	TOOLS AND TECHNIQUES IN BIOCHEMISTRY	4	2	0
V	BCH522J1	COURSE TYPE-1	CARBOHYDRATE AND AMINOACID METABOLISM	3	1	0
	BCH522J2	COURSE TYPE-2	HUMAN PHYSIOLOGY	4	2	0
	BCH522J3	COURSE TYPE-3	GENETICS	4	2	0
VI	BCH622J1	COURSE TYPE-1	LIPID & NUCLEIC ACID METABOLISM	3	1	0
	BCH622J2	COURSE TYPE-2	MOLECULAR BIOLOGY	4	2	0
	BCH622J3	COURSE TYPE-3	BIOLOGY OF MICROBES	4	2	0
VII	BCH722J1	COURSE TYPE-1	PLANT BIOCHEMISTRY	3	1	0
	BCH722J2	COURSE TYPE-2	GENETIC ENGINEERING	4	2	0
	BCH722J3	COURSE TYPE-3	RESEARCH METHODOLOGY	4	2	0
VIII (Hons)	BCH822J1	COURSE TYPE-1	ENDOCRINOLOGY	3	1	0
	BCH822J2	COURSE TYPE-2	NUTRITIONAL BIOCHEMISTRY	4	2	0
	BCH822J3	COURSE TYPE-3	MEDICAL BIOCHEMISTRY	4	2	0
VIII (Hons with research)	BCH822J1	COURSE TYPE-1	ENDOCRINOLOGY	3	1	0
	BCH822JP	PROJECT	PROJECT WITH DISSERTATION	-	12	-

PROGRAMME LEARNING OUTCOMES OF THE MAJOR DECIPLINE FROM I st TO THE LAST SEMESTER:

SEMESTER	COURSE CODE	LEARNING OUTCOMES											
		A	B	C	D	E	F	G	H	I	J	K	L
		Capability to understand that nucleic acids are the genetic material of all living organisms. That the lipids together with other biomolecules are building blocks of living cell	Instill among the students ways in which complex interactions of components of the food system influence human health and nutrition and to demonstrate an understanding of public health.	Able to understand the various biochemical processes and metabolic pathways. Furthermore, the role of various plants growth regulators and their use in crop production.	Students will get knowledge of structure and function of monosaccharides, proteins and lipids	The students will be able to describe the structure, regulation, functions and the mechanism of action of enzymes.	Construct logical arguments using correct technical language related to a field of learning, work/vocation, or an area of professional practice. Ability to work independently in terms of organizing laboratory, and critically analyzing research literature	They should be well versed with molecular and cellular foundations of life. Apply the knowledge to understand the association of microbes and diseases and the beneficial uses of microorganisms. Acquire the knowledge to understand disease diagnosis, prognosis, therapeutic intervention, biochemical industry and/or medicinal industry	To inculcate in student knowledge about the chromatin structure and its location and methods to identify various genetic disorders.	Comprehensively provides insight in the energy necessary for biological processes such as growth, reproduction, and maintaining the structure of organism	Helps in study of energy relationships and energy transformations and transductions in living organisms	Able to comprehend about cell to cell communication. Role of hormones in cell signaling and body physiology regulations	To provide well information about DNA, RNA and their replication, mutations, DNA repair mechanism and with high level thinking skills that is necessary for scientists.
I	BCH122J				✔								
II	BCH222J											✔	
III	BCH322J					✔							
	BCH422J1										✔		
IV	BCH422J2							✔					
	BCH422J3						✔						
	BCH522J1				✔								
V	BCH522J2									✔			
	BCH522J3								✔				
	BCH622J1	✔											
VI	BCH622J2		✔										
	BCH622J3							✔					
	BCH722J1			✔									
VII	BCH722J2			✔					✔				
	BCH722J3							✔					✔
	BCH822J1											✔	
VIII	BCH822J2						✔						
	BCH822J3							✔					

BACHELORS WITH BIOCHEMISTRY AS MAJOR/MINOR

IST SEMESTER

BCH122J: BIOMOLECULES **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Course Objective:

The main objective of the course is to provide students with an understanding of biomolecules, the basic building blocks of living organisms, mainly focusing on their structural, biological roles and/or functions. The course will emphasise on structure and function of various biomolecules at molecular and cellular level. Further, the course will give students an opportunity to learn basic laboratory techniques.

Course Learning Outcome:

Upon completion of this course students will be:

- Well versed with molecular and cellular foundations of life
- Able to comprehend the structure, function and biochemical properties of monosaccharides, proteins and lipids
- Able to prepare various laboratory solutions and independently identify various biomolecules in the laboratory

Course Content (Theory):

Unit-1: Carbohydrates (15 HOURS)

Definition, classification and structure of monosaccharides. Open and Ring structure, anomeric and epimeric forms, mutarotation. Reaction of monosaccharides with special reference to glucose, Structure and functions of important oligosaccharides Polysaccharides- Homo and Heteropolysaccharides; Structure and functions of important polysaccharides-Glycogen, Starch and Cellulose. Structure and role of glycoconjugates - proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides).

Unit-2: Proteins (15 HOURS)

Amino acids: Structure & their classifications, stereoisomerism and RS system of designation, optical isomers. Zwitter ion, isoelectric point (pI) and its biological significance.
Proteins: classification, composition and functions. Structure of peptide bond, chemical synthesis of polypeptides. Levels of structure in protein architecture, forces stabilizing the tertiary structure and quaternary structure of proteins. Denaturation and renaturation of proteins, Structure and function of Hemoglobin and myoglobin

Unit-3: Lipids (15 HOURS)

Introduction, classification, nomenclature, structure and properties of Fatty acids. Saturated and unsaturated fatty acids. Essential fatty acids, chemical properties and characterization of fats – hydrolysis, Saponification value, Reichert – Meissel number, Iodine number, rancidity of fats, Triacylglycerols, Cholesterol and prostaglandins. Structure and functions of phospholipids and sphingolipids. Synthesis of steroid hormones.

Unit-4: Nucleic Acids (15 HOURS)

Structure and compositions Nucleic acids -RNA and DNA, Purines and Pyrimidines, Nucleoside, Nucleotide, Nucleic acid structure – Watson-Crick model of DNA, forms of DNA; Structure and function of major species of RNA - mRNA, tRNA and rRNA. Denaturation and renaturation of DNA, Cot curve.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Safety measures in laboratories
2. Preparation of a solution (molar, normal and percent)
3. Preparation of Standard buffers and determination of pH of a solution
4. Qualitative tests for Carbohydrate
5. Qualitative tests for Amino acids
6. Qualitative tests for Lipids
7. Quantitative estimation of proteins

Books Recommended

1. Principles of Biochemistry by Lehninger, Nelson & Cox
2. Biochemistry by Lubert Stryer
3. Biochemisrty by Dr Satyanarayan
4. Experimental Biochemistry by B A Ganai
5. Bio-analytical Chemistry by Eazaz Husain Rizvi.

BACHELORS WITH BIOCHEMISTRY AS MAJOR/MINOR

2ND SEMESTER

BCH222J: CELL BIOLOGY **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Course Objective:

The course aims to offer insights into the basic structure of eukaryotic and prokaryotic cells including cellular organelles and their function. The laboratory course is aiming to train the students regarding the techniques involved in study of cell structure, cell counting, blood group typing and observe various stages of mitosis.

Course outcome:

After successful completion of the course our students will be:

- Able to differentiate various cell types including prokaryotic and eukaryotic cells.
- Proficient in differentiating animal vs plant cells
- Well versed about the various cellular organelles and their function.
- Able to comprehend about cell-to-cell communication.
- Capable of comprehending the phases of the cell cycle

Unit-1: Cell wall and membranes (15 HOURS)

Structure of eukaryotic cells- Overview of plant and animal cells, Composition, structure and functions of cell wall and cell membrane, Membrane transport (active and passive), membrane channels, carriers, and transporters

Unit-2: Cell organelles (15 HOURS)

Structure and functions of Nucleus- nuclear envelope, nuclear pore complex, nucleolus, Concept of chromatin and chromosome. Endoplasmic Reticulum- RER - Brief overview of cotranslational and posttranslational transport of proteins; SER – Lipid synthesis, brief overview of export of proteins

from ER to Golgi, Mitochondria, Golgi apparatus- organization, brief overview of glycosylation of proteins within Golgi. Ribosomes, structure and functions of lysosomes, peroxisomes, cytoskeleton (microtubules- Structure, assembly and function of Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies)

Unit-3: Cell communication (15 HOURS)

Cell communication- basic concept of anchoring junctions, tight junctions and communication junctions (gap junctions and plasmodesmata); ECM components – proteins, polysaccharides and adhesion proteins Cell signaling- Types, signal molecules, signal amplification, receptor types and sensing.

Unit-4: Cell Cycle (15 HOURS)

An overview of cell cycle; Components of cell cycle control system,
Mitosis: Prophase, prometaphase, metaphase, anaphase, telophase, cytokinesis
Meiosis: Phases of meiosis I and meiosis II
Motor proteins: actin and myosin
Intracellular and extra-cellular control of cell division,
Types of cell death: Senescence, apoptosis and necrosis

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Compare and contrast the morphologies of different cells under microscope
2. Blood group typing
3. RBC cell count by Haemocytometer
4. Study of different stages of mitosis by temporary preparation/ permanent slides of onion root tips.

Books Recommended:

1. The Cell: A Molecular Approach (2013) 6th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN: 978-0- 87893-300-6.
2. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620- 8.
3. Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7
4. Essential Cell Biology (4^{th} Edition) by Alberts et al.
5. The Cell A Molecular Approach by Couper and Housman
6. Fundamentals of Cell Biology by S K Singh
7. Online source- https://nptel.ac.in/.

BACHELORS WITH BIOCHEMISTRY AS MAJOR/MINOR

3RD SEMESTER

BCH322J: ENZYMOLOGY **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Course Objectives:

The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function, enzyme kinetics, enzyme catalysis and enzyme inhibition.

Course Outcomes:

The students will be able to describe the structure, regulation, functions and the mechanism of action of enzymes.

Unit-1: Basic concepts of enzymes (15 HOURS)

Introduction of enzymes and historical developments in Enzymology (like contributions by Wilhelm Kühne, Berzelius, Lois Pasteur, James B. Sumner, Emil Fischer, Linus Pauling etc), Classification of enzymes: IUB enzyme classification, Nomenclature of enzymes, Isoenzymes and its physiological significance, Isoenzymes in health and disease (ALT, ALP, LDH, CK, GGT, amylase), Multi-enzyme complexes, Enzyme specificity, Active site, Features of active site, Enzyme assays, Units of measurement of enzyme assays.

Unit-2: Enzyme Catalysis (15 HOURS)

Role of co-factors and co-enzymes NAD/$NADP^+$, FMN/FAD, Co-enzyme A, Biotin, Cobalamine, Lipoamide, TPP, Pyridoxal phosphate, Tetrahydrofolate, Metal ions with special emphasis on coenzyme functions, Acid base and covalent catalysis.

Unit-3: Enzyme Kinetics (15 HOURS)

Basics of enzyme kinetics, Enzyme concentration, Substrate concentration, Effect of pH & Temperature on enzyme activity, Michaelis-Menton equation, Determination of Km and Vmax by line-weaver Burk plot, Significance of Km, Significance of Vmax, Importance of Km (hexokinase Vs glucokinase as example).

Unit-4: Enzyme Regulation (15 HOURS)

Reversible Inhibition (Competitive inhibition, Non-competitive inhibition, Un-competitive inhibition), Irreversible inhibition. Derivation of Michaelis-Menton equation for competitive inhibitors. Allosteric inhibition and regulation. Reversible and irreversible covalent modifications of enzymes.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Verification of Beer Lambert Law
2. Estimation of SGPT and SGOT in serum
3. Effect of pH on enzyme activity and determination of optimum pH.
4. Determination of Km of enzymes using Line-weaver Burk plot
5. Determination of Vmax of enzymes using Line-weaver Burk plot

Books recommended:

1. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, By T Palmer, P L Bonner · 2017
2. Enzymes: Catalysis, Kinetics and Mechanisms by N. S. Punekar, Springer.
3. Enzymes:by Malcolm Dixon & Edwin Clifford Webb
4. Biochemical Calculations- Segel IH-John Wiley and Sons, New York.

BACHELORS WITH BIOCHEMISTRY AS MAJOR/MINOR

4TH SEMESTER

BCH422J1: BASICS OF METABOLISM AND BIOENERGETICS CREDITS: THEORY-3, PRACTICAL-1

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Objectives/Expected Learning Outcomes:

This course aims to introduce the students to basics of metabolism and bioenergetics with an expectation to learn how the principles of bioenergetics and thermodynamics hold good in biological systems also and how are these central in understanding metabolism.

Unit-1: Biological thermodynamics (15 HOURS)

Thermodynamic states, Zeroth law of thermodynamics, First law of thermodynamics and its implications in biological system, Second law of thermodynamics and its significance in biological system, Concept of third law of thermodynamics, Isothermal and adiabatic processes, Concept of heat of a reaction, thermodynamic systems, Thermodynamic properties, Importance of thermodynamics in biological systems.

Unit-2: Bioenergetics (15 HOURS)

Concept of work and energy, Bioenergetics, Energy change during a biochemical reaction, Endergonic and Exergonic reactions, Energy transformation in biological systems, Total internal energy, Gibbs free energy concept, Significance of free energy, Entropy and its significance, Enthalpy, Relation between entropy, enthalpy and free energy, Spontaneity of a biochemical reaction.

Unit-3: Basics of Metabolism (15 HOURS)

Metabolism, Catabolism, Anabolism, Amphibolism, Types of metabolic reactions, Oxidation-reduction reactions, Redox potential, dehydrogenation reactions, Energy rich compounds in living organisms, classification of energy rich compounds, Phosphoryl transfer potential, Coupled reactions,

ATP as energy currency, ATP-ADP cycle, Concept of Biological oxidation, Methods used to study metabolism in living organisms.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 09

1. Determination of heat of neutralization by treating acids and bases
2. Calculation of viscosity of different percentage solutions of carbohydrate, protein and fats
3. Specific heat determination by calorimeter
4. Principle of autoclave

Books recommended:

1. Biological Thermodynamics by Donald Haynie.
2. Thermodynamics-Principles and Applications by NC Dey.
3. Text book of Biochemistry by Lubert Stryer.
4. Text book of Biochemistry by Voet and Voet

BACHELORS WITH BIOCHEMISTRY AS MAJOR/MINOR

4TH SEMESTER

BCH422J2: IMMUNOLOGY **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Objectives/Expected Outcomes:

The course aims to provide students with the basic knowledge about the functioning of the immune system, inflammation, the causes and pathogenesis of major alterations in the immune response, vaccines.

After going through this course student shall be able to:

- Trace the components of immune system and development of an immune response.
- Describe immunological barriers and their protective functions.
- Explain the structure, properties and functions of antibodies.
- Compare and contrast primary and secondary immune response.
- Explain the importance of phagocytosis and natural killer cells in innate body defense.
- Describe the roles of different types of T cells, B cells and APCs.
- Compare and contrast the origin, maturation process, and general function of B and T lymphocytes
- Describe the mechanisms of hypersensitivity reactions
- Discuss about role of MHC in immune system.
- Understand about how APC and other cell are involved in antigen processing.
- List the Immunodeficiency diseases and understand transplantation.
- Understand the vaccines, their development and their importance.
- Production of Monoclonal antibodies.

Unit-1: Introduction: Immune cells & organs, Antigen, Complement system (15 HOURS)

Introduction to Immune System. Hematopoiesis. Cells and molecules of immune system. Primary and Secondary lymphoid organs/Tissues (MALT). Humoral and cell mediated immune response. Innate and Adaptive immunity. Antigens and Haptens, Epitopes, Antigenicity and Immunogenicity. B and T cell receptors. Complement system. Cytokines & Chemokines.

Unit-2: Antibodies: Classification, Structure, Functions, and Diversity (15 HOURS)

Antibody structure and function. Structure and distribution of classes and sub classes of immunoglobulins. Isotypes, Allotypes and idiotypes. Organization of antibody genes. B-Cell Maturation/selection. Gene rearrangement. Class switching, clonal deletion, allelic exclusion. Generation of antibody diversity. Somatic hyper mutation.

Unit-3: MHC, Antigen Presentation, T cell response (15 HOURS)

General organization and inheritance of MHC. Structure, distribution and role of MHC class I and class II proteins. Expression of HLA genes. Antigen Processing & Presentation. Antigen-antibody interactions, Role of TLRs & Interferons. T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer (NKT) cells and antibody dependent cellular cytotoxicity (ADCC).

Unit-4: Immunological Tolerance, Disorders and Applications (15 HOURS)

Immunological tolerance. Regulation of immune response. Hypersensitivity and its types. Primary and secondary immune-deficiencies. Auto immune diseases. Transplantation immunology. Immunization & Vaccines. Antibody engineering (Hybridoma technology), ELISA. RIA.

Books recommended:

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617- 8590-0.
2. Fundamental immunology by William E.Paul. Lipincott Williams and Wilkins.
3. Basic Immunology: the functions of the immune System by Abul K. Abbas and Andrew H. Lichtman. Publisher: Saunders
4. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Bleeding time & Clotting Time
2. Blood cell counting
3. Blood Grouping -A, B, O & Rh Factor
4. Assays based on precipitation reactions- Passive agglutination
5. Isolation of Macrophages / lymphocytes from blood
6. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
7. Demonstration of ELISA.

Books recommended:

1. Plummer D. T., Introduction to Practical Biochemistry, Tata McGraw Hill. (Third Edn.)
2. Deb A. C., Viva & Practical Biochemistry, Central Book Agency
3. Boyer R., Modern Experimental Biochemistry, Pearson.

BACHELORS WITH BIOCHEMISTRY AS MAJOR/MINOR

4TH SEMESTER

BCH422J3: TOOLS AND TECHNIQUES IN BIOCHEMISTRY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives/Expected Learning Outcomes:

This course aims to equip students with appropriate laboratory tools and practices. It also helps in utilizing the theoretical, technical and analytical skills to tackle issues and problems in the field of biochemistry. It provides students with some work experience, for example a summer internship or a research projects in a research laboratory to further boost the career prospects.

Unit-1: Basic lab practices and preparation of solutions (15 HOURS)

Safety practices in the laboratory, Writing and maintaining lab reports, Introduction to various laboratory reagents: chemicals and liquid reagents, distilled/ RO water, Weighing of chemicals on an electronic balance, Preparation and storage of solutions, labelling of prepared solutions, dilutions of solutions. Introduction and handling of acids and bases, Buffers, preparation of buffers using Handerson-Hasselbach equation, Hands-on training at pH meter, Preparation of a buffer with given pH and molarity. Hands-on training for micropipette.

Unit-2: Spectrophotometric techniques (15 HOURS)

Principles and application of Colorimetry and Spectrophotometry, Beer-Lambert's law and its limitations, UV spectra, visible spectra, molar extinction coefficient, Principle and applications of fluorimetry. Introduction to UV-Vis Spectrophotometer, Determination of absorption maxima and molar extinction coefficient (use any relevant organic molecule). Determine the concentration of a protein (BSA) solution using the Lowry method. Determine the concentration of BSA solution using the direct spectrophotometric method. Determining the concentration of DNA solution (prepared from lyophilized powder).

Unit-3: Centrifugation (15 HOURS)

Basic principles of centrifugation, application of centrifugation in molecular biology research, Factors affecting sedimentation, Types of centrifugation: differential, density gradient and ultra, Analytical and preparative centrifugation.

Unit-4: Chromatography (15 HOURS)

Chromatography and its application in research, Basic principles of various chromatographic techniques-gel filtration, ion exchange, affinity chromatography, gas chromatography, and high-performance liquid chromatography.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Preparation of a buffer by Handerson-Hasselbach equation
2. Determination of concentrations of proteins Nucleic acids by Beer Lambert's Law, by using Colorimetry and Spectrophotometry.
3. Separation of biomolecules using centrifugation: differential, density gradient and ultra, Analytical and preparative centrifugation.
4. Separation of amino acids using paper chromatography, and thin layer chromatography.
5. A visit to instrumentation facility of Biochemistry Department (Kashmir University)

Books recommended:

1. Principles & Techniques of Practical Biochemistry 5th edition by: Keith Wilson and John Walker.
2. Modern Experimental Biochemistry- Rodney Boyer 4th edition Benjamin Cummings publishing company inc.
3. Techniques in Biochemistry by Punit Puri
4. Basic Techniques in Biochemistry and Molecular Biology by Lajja Das.
5. Analytical Techniques in Biochemistry and Molecular Biology by Rajan Katoch (Author).
6. Bioanalytics: Analytical Methods and Concepts in Biochemistry and Molecular Biology by Joachim W. Engels (Editor), Friedrich Lottspeich (Editor).

BACHELORS WITH BIOCHEMISTRY AS MAJOR

5TH SEMESTER

BCH522J1: CARBOHYDRATE AND AMINO ACID METABOLISM CREDITS: THEORY-3, PRACTICAL-1

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 18

Objectives/Expected Learning Outcomes:

Metabolism is central to biochemistry and thus this course aims to introduce the students to Biochemistry with an expectation to learn how biochemistry is central to disease diagnosis, prognosis, therapeutic intervention, biochemical industry and/or medicinal industry.

Unit-1: Metabolism of Carbohydrates (15 HOURS)

Reactions and energetics of glycolysis. Gluconeogenesis, Glycogenesis and Glycogenolysis, Reactions and physiological significance of Pentose Phosphate Pathway, Entry of pyruvate into mitochondria, TCA cycle and its significance, Sequence of electron carriers, Sites of ATP production, Inhibitors of electron transport chain, Mitochondrial oxidative phosphorylation.

Unit-2: Metabolism of Amino acids (15 HOURS)

Concept of amino acid pool, Metabolism of amino acids, Transamination, Deamination and decarboxylation reactions of amino acids, Metabolism of ammonia, Ammonia toxicity, Urea cycle and its importance, Relation between urea cycle and TCA Cycle, Metabolism of important amino acids.

Unit-3: Regulation and Metabolic Disorders (15 HOURS)

Regulation of glycolysis, Regulation of TCA Cycle, Disorders of carbohydrate metabolism, Glycogen storage diseases, Regulation of Urea Cycle, Disorders of urea cycle, Clinical significance of transaminases, Metabolic disorders of amino acids, Phenylketanuria, Albinism, Alkaptunuria, Hartnup's disease, Cystinuria.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 9

1. Separation and identification of amino acids/sugars by paper chromatography.
2. Estimation of glucose by Nelson-Somogyi method.

3. Estimation of protein by Lowry method.

Books recommended:

1. Text book of Biochemistry by Lubert Stryer
2. Text book of Biochemistry by Voet and Voet
3. Text book of Biochemistry Lehninger by Nelson & Cox
4. Understanding Carbohydrate Metabolism by Rabia Hamid

BACHELORS WITH BIOCHEMISTRY AS MAJOR

5TH SEMESTER

BCH522J2: HUMAN PHYSIOLOGY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives/Expected Outcome:

By the completion of this course, the students are expected to:

- Demonstrate knowledge of major organ systems function.
- To understand the physiology and basic regulatory concepts related to the Digestive, Hepatobiliary, Respiratory, Circulatory, Musculo-skeletal, Nervous, Excretory and Reproductive systems.
- Name the key physiology themes (homeostasis & regulation, structure/function relationships,
- Know the mechanistic (how) and teleologic (why) understanding of the levels of organization comprising the human organism.
- Demonstrate an understanding of the physiology and basic regulatory concepts of the organ systems associated with this course and the mechanisms that allow the body to carry out those functions, and predict how a perturbation (e.g., disease, experimental manipulation) will alter function.
- Demonstrate the ability to integrate physiology from the cellular and molecular level to the organ system and organismic level of organization.
- Demonstrate knowledge of current topics in physiology.
- Conduct and/or evaluate laboratory experiments in physiology.

Unit-1: Digestive & Hepatibiliary systems (15 HOURS)

Physiology of digestive system: Stomach; Structure and function. Gastric Secretion-mechanism and hormones secreted. Neoplastic diseases. Peptic ulcers. Assessment of gastric functions. Physiology of hepatobiliary system: brief anatomy and functions of liver. Bilirubin, Bile acids

Unit-2: Respiratory & Circulatory systems (15 HOURS)

Physiology of respiratory system: Exchange of gases in lungs and tissues. Lung volumes and capacities. Physiology of cardiac system. Physiology and anatomy of heart. Cardiac cycle (cardiac output, venous return and their regulation). Blood pressure and its regulation, introduction to electro cardiogram.

Unit-3: Musculo-skeletal and Nervous systems (15 HOURS)

Physiology of Musculo-skeletal system: introduction. Classification. Physiology of muscle. molecular mechanism of contraction. Sarcomere. Muscle potential.
Physiology of nervous system: Structure of neuron. Mechanism of Nerve impulse conduction. Role of neurotransmitters. Action potential. structure of nervous system-CNS and PNS.

Unit-4: Excretory & Reproductive systems (15 HOURS)

Renal physiology: Structure and functions of kidney. Structure of nephron. Physiology of urine formation and excretion. Homeostasis
Sex determination, differentiation, organs. Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Fertilization and implantation.

Books recommended:

1. Devlin: Textbook of Biochemistry (with clinical correlation) (John Wiley and Sons Publishers).
2. Guyton and Hall, A Text book of Medical Physiology, W. B. Saunders
3. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.
4. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Histology of connective tissue, liver and/ brain permanent slides.
2. Estimation of hemoglobin in blood sample.
3. Separation of plasma proteins.

4. Estimation of serum albumin
5. Estimation of serum cholesterol, HDL cholesterol, LDL cholesterol- kit based.
6. Estimation of Alkaline phosphatase, serum acid phosphatase, ALT and AST
7. Case studies (Renal clearance, GFR, ECG).
8. Kidney function tests.
9. Estimation of T3, T4 and TSH - kit based.
10. Microscopic and routine examination of blood, sputum and urine
11. Measurement of blood pressure.

Books recommended:

1. Plummer D. T., Introduction to Practical Biochemistry, Tata McGraw Hill. (Third Edn.)
2. Deb A. C., Viva & Practical Biochemistry, Central Book Agency
3. Boyer R., Modern Experimental Biochemistry, Pearson.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

5TH SEMESTER

BCH522J3: GENETICS **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Course objectives:

The course aims to teach the students following:

- Study historical overview and laws of Inheritance.
- Understand Mendel's laws.
- Gene interactions and their outcome.
- Chromosomal abnormalities in various genetic disorders.

Course Outcomes:

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

- Understand the Mendel's laws and its deviations.
- Know about the chromatin structure and its location.
- Know the methods to identify various genetic disorders

Unit 1: Laws of Genetic Inheritance (15 HOURS)

Biography of Mendel and his experiments: Law of Segregation: Monohybrid cross, back cross and Test cross. Law of Independent Assortment: Dihybrid cross, Back cross and Test cross. Gene Interactions: Deviations from Mendelism: Incomplete inheritance and co-dominance, Complementary gene interaction (9:7), Supplementary gene interaction (9:3:4), Recessive Epistasis, Non-Epistasis (with an example for each trait)

Unit 2: Gene Interaction (15 HOURS)

Linkage: Coupling and repulsion hypothesis, Morgan's view of linkage, kinds of linkage, chromosome theory of linkage. Crossing over: Somatic and germinal crossing over, kinds of crossing over, theories

of the mechanism of crossing over, significance. Sex linked inheritance: Inheritance of X-linked gene (Colour blindness and haemophilia in man), Sex linkage in Drosophila.

UNIT 3: Chemical Basis of Heredity (15 HOURS)

Eukaryotic chromosomes- Structure, chemical composition, classification and uninemic and multinemic concept of chromosome structure, repetitive DNA, Microsatellite markers. Multiple Alleles: Definition, ABO blood groups and Rh factor in Human. Mutation: Historical background, chromosomal mutation (Chromosomal aberrations), gene mutations and their interpretation.

Unit 4: Genetic Disorders (15 HOURS)

Clinical features and Karyotype of Syndromes: Cri-du-chats, Down's, Edward's, Patau's, Turner's, and Klinefelter's. Methods for identification of genetic disorders-Pedigree analysis, Karyotyping, GWAS studies-CGH analysis, Deep sequencing, Chromatogram. Autosomal and Sex-linked disorders with examples.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Blood typing in humans for multiple alleles and Rh factor
2. Histological study of Cancer types using permanent slides
3. Genetic Problems on Monohybrid cross,
4. Genetic Problems on Dihybrid cross
5. Genetic Problems non-Mendelian Interactions.
6. Study of Karyotypes –Normal Karyotypes in Humans

Books recommended:

1. Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan publication.
2. Snustad, D. P., & Simmons, M. J. (2015). Principles of genetics. John Wiley & Sons.
3. Concepts of Genetics: Klug W.S., et al.
4. Genetics from Genes to Genomes: Hartwell L.H. et al

BACHELORS WITH BIOCHEMISTRY AS MAJOR

6TH SEMESTER

BCH622J1: LIPID AND NUCLEIC ACID METABOLISM CREDITS: THEORY-3, PRACTICAL-1

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 25

Objectives/Expected Learning Outcomes:

Metabolism is central to biochemistry and thus this course aims to introduce the students to Biochemistry with an expectation to learn how biochemistry is central to disease diagnosis, prognosis, therapeutic intervention, biochemical industry and/or medicinal industry.

Unit-1: Metabolism of Lipids (15 HOURS)

Triacylglycerols and hydrolysis of Triacylglycerols, Mobilisation of fat, transport of fatty acids in to mitochondria, β-oxidation of saturated and unsaturated fatty acids, Energetics and ATP yield from fatty acid oxidation, Biosynthesis of saturated and unsaturated fatty acids, Ketone bodies and Ketogenesis, Concept of cholesterol metabolism.

Unit-2: Metabolism of Nucleic Acids (15 HOURS)

Biosynthesis of purines, salvage pathway for purines, Inhibitors of purine synthesis, Degradation of purine nucleotides, Biosynthesis of pyrimidines, Inhibition of pyrimidine synthesis, degradation of pyrimidines, salvage pathway for pyrimidine synthesis.

Unit-3: Regulation and Metabolic Disorders (15 HOURS)

Regulation of fatty acid oxidation and fatty acid synthesis, Sudden Infant Death Syndrome (SIDS), Regulation of ketogenesis, Ketonemia, Ketonuria, Metabolic disorders of lipids, Atherosclerosis and Coronary heart diseases, Metabolic disorders of nucleic acids, Gout, Lesch-Nyhan syndrome, Oroticaciduria.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 9

1. Estimation of cholesterol.
2. Estimation of Triglycerides.

3. Estimation of Uric acid.

Books recommended:

1. Text book of Biochemistry by Lubert Stryer
2. Text book of Biochemistry by Voet and Voet
3. Text book of Biochemistry Lehninger by Nelson & Cox.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

6TH SEMESTER

BCH622J2: MOLECULAR BIOLOGY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives /Expected Outcomes:

Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis etc. At the end of this course students should be able to demonstrate a clear understanding of the facts and basic concepts of molecular biology which are covered in lectures, including:

- To provide with the core principles of molecular biology.
- To gain higher level thinking skills that is necessary for scientists.
- This course should excite about basic science and its applications.

Unit-1: Structure and Functions of Nucleic Acids (15 HOURS)

The beginning of Molecular Biology: Chromatin arrangement, remodeling & nucleosome formation. C value paradox. Operons, pseudogene. Euchromatin & heterochromatin. Unique and repetitive DNA. SNPs & Their function.

DNA: A carrier of genetic information, Chemical structure of DNA and Base composition, biologically important nucleotides, Watson - Crick Model, Super coiled DNA, structure of different types of nucleic acids, hydrolysis of nucleic acids. Conformation of nucleic acids: A-, B-, Z-, DNA, Stability of nucleic acid structure

Unit-2: DNA replication, repair and recombination (15 HOURS)

DNA replication: Prokaryotic and Eukaryotic DNA replication; mechanism, Initiation, elongation, termination and regulation of replication, Different types of Polymerases. Uni and bi-directional replication. Maintaining the ends of Linear DNA molecule. Extra chromosomal replicons. DNA damage and repair mechanisms (Brief Discussion).

Unit-3: RNA synthesis and processing (15 HOURS)

Structure and function of RNA polymerases. Transportation in prokaryotes & eukaryotes (Transcription factors and machinery, formation of initiation complex, transcription activators and repressors), Capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA.

Unit-4: Protein synthesis and processing (15 HOURS)

Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination (Prokaryotes & Eukaryotes), Genetic code, Aminoacylation of tRNA, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, posttranslational modification of proteins.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Extraction of DNA from Blood.
2. Use of Primer calculator Software to design Primer for PCR.
3. Polymerase chain reaction (PCR Technique)
4. To learn the use of UCSC and NCBI data base.

Books recommended:

1. Lehninger Principles of Biochemistry by D. L. Nelson, M. M. Cox. 6th Edition. W. H. Freeman. 2012.
2. Molecular Biology by R.F. Weaver, 4thedition. McGraw Hill, USA. 2007.
3. Karp, G., Iwasa, J., & Marshall, W. (2020). Karp's Cell and Molecular Biology. John Wiley & Sons.
4. Gene IX by Benjamin Lewin. Jones and Bartlett Publishers. 2007.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

6TH SEMESTER

BCH622J3: BIOLOGY OF MICROBES CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives/Expected Learning Outcomes:

This Syllabus focuses on studying the unicellular and clusters of microscopic animals, viruses, and bacteria. The aim of course is to teach the effects of these organisms on the human body and the environment. This syllabus also contains the information on different types of viruses and bacteria, their structures and how they affect human cells and hence causing different diseases. At the end of this course students should be able to demonstrate the clear understanding of the facts and the basic concepts of microbiology and related disease and their prevention.

Unit-1: Introduction and Diversity of Microorganisms (15 HOURS)

Concept of binomial nomenclature and rules, whittaker's five kingdom and Carl Woese's three kingdom classification systems.

Characteristics of different groups: cellular microorganisms (protozoa, mycoplasma, bacteria, algae and fungi) and acellular microorganisms (viruses, viroids, virusoids, prions) and with emphasis on distribution and occurrence.

General account of morphology and ultra-structure of protozoa, bacteria and virus.

Unit-2: Microbial Nutrition and Growth (15 HOURS)

Nutritional requirements in microorganisms: Modes of nutrition-phototrophy, chemotrophy, methylotrphy, organotrophy, mixotrophy, and saprophytic, symbiotic and parasitic mode of nutrition.

Microbial growth: Different phases of microbial growth, Growth kinetics, Measurement of Microbial Growth, Factors affecting microbial growth. Sterilizations methods

Antimicrobial agents: Characteristics, classification and mode of action, Antimicrobial Resistance (AMR).

Unit-3: Host microbe interactions (15 HOURS)

Overview of host-microbe relationships, infection, colonization, pathogenicity, virulence and its determinants (adhesion, enzymes, toxins – exotoxins and endotoxins), transmission (direct and indirect) of infectious diseases, types of infections (acute, latent, chronic), opportunistic and nosocomial infections, reservoir and source of infection.

Microbial associations with plants and other microorganisms, normal resident microflora of human body and their role.

Symptoms and mode of transmission of infectious diseases- bacterial: tuberculosis, tetanus, anthrax; viral: COVID-19, AIDS, dengue; fungal: athlete's foot, candidiasis; protozoan: malaria, amoebiasis.

Unit-4: Methods for studying microorganisms (15 HOURS)

Inoculation, incubation, isolation, inspection and identification of microrganisms.

Staining: gram staining, negative staining and acid-fast staining (permanent mount), Endospore staining using malachite green.

Microscopy: concept of lens and light, magnification and resolution, preparation and staining of specimens, light microscopes: bright field and dark field microscopy- principle and functions, applications of microscopy.

PRACTICALS (2 CREDITS: 1 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Sterilization techniques and handling of laboratory equipments.
2. Methods of Bacterial culture.
3. Preparation of competent cells by calcium chloride method.
4. Gram Staining of bacteria and Microscopy.

Books recommended:

1. Wiley JM, Sherwood LM and Woolverton CJ. Prescott’s Microbiology. McGrawHill International.
2. Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction. Pearson Edition.
3. Modi H.A, Elementary Microbiology Vol I, Fundamentals of Microbiology.
4. Microbial Research: By Vinita Katiyar & Anubha Joshi
5. Principles of virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by SJ. Flint, L.W. Enquist, V.R. Racaniello, A.M Shalka.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

7TH SEMESTER

BCH722J1: PLANT BIOCHEMISTRY CREDITS: THEORY-3, PRACTICAL-1

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Objectives of course:

A key aspect of the course will be to develop an understanding of the chemical basis and "chemical logic" of metabolic processes in plants particularly photosynthesis, respiration, Electron transport chain and secondary metabolites.

Course outcomes:

On successful completion of the course, the student shall be able to:

- Understand the structure of plant cell wall and role of various plant growth regulators.
- Define the biochemical processes and metabolic pathways, including photosynthesis, photorespiration in plants.
- Describe the physiological and biochemical reaction, nitrogen fixation and assimilation.

Unit-1: Plant cell and plant hormones (15 HOURS)

Structure and functions of plant cell wall, plastids, and peroxisomes, Plant cell division and Cell cycle. Plant growth hormones: Structure and physiological functions of Auxin, Gibberellins, Cytokinins, Abscisic acid and Ethylene. Plant growth inhibitors and retardants

Unit-2: Photosynthesis (15 HOURS)

Photosynthetic pigments, Basic structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon reduction. Factors affecting photosynthesis. Photorespiration and its importance.

Unit-3: Nitrogen fixation and plant secondary metabolites (15 HOURS)

Biological nitrogen fixation by free living and in symbiotic association, Structure, and function of Nitrogenase. Nitrate assimilation; nitrate reductase and nitrite reductase.

Definition, examples, and biological function of alkaloids, phenolics, terpenoids. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 9

1. Separation of photosynthetic pigments by TLC
2. Estimation of Chlorophyll content by using spectrophotometer.
3. Field visit to IIIM Srinagar/ICAR-Central Institute of Temperate Horticulture or medicinal botanical garden

Books recommended:

1. Fundamentals of Plant Physiology by Lincoln Taiz, Angns Murphy
2. Plant Biochemistry, Caroline Bowsher, Martin steer, Alyson Tobin, Garland science
3. Plant Biochemistry: Hans-Walter Heldt & Heldt
4. Plant Biochemistry by P.M Dey and J.B. Harborne

BACHELORS WITH BIOCHEMISTRY AS MAJOR

7TH SEMESTER

BCH722J2: GENETIC ENGINEERING CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives /Expected Outcomes:

This course will provide students with the recent knowledge of recombinant DNA Technology and genetic engineering. At the end of the course, a successful student will be able to

- Understand and explain the concept of genetic engineering including the techniques, applications and limitations.
- Discuss the process of cloning and expression of gene and other techniques in genetic engineering & Biotechnology
- Perform DNA extraction from bacterial cell and estimation of purity.
- Perform PCR assays and DNA manipulations techniques.
- Understand fermentation processes as high thorough put biotechnological tool.
- Demonstrate the ability to design recombinant molecules and apply information extracted from a variety of sources including journal articles, technical bulletins, product manuals, and drug information sheet to solve problems.
- Apply learned knowledge to their future research.

Unit-1: Introduction to Recombinant DNA Technology (15 HOURS)

Recombinant DNA Technology Tools: Restriction endonucleases: Historical perspective. Nomenclature. Different types of restriction-modification systems and their characteristic features. Blunt end and cohesive end cutters with examples. Isochizomers and isocaudemers. Restriction modification enzymes and their importance in DNA recombinant technology DNA ligases: E. coli and T4 DNA ligases.

Unit-2: Vectors for Gene Cloning (15 HOURS)

Plasmids: General features of plasmid vectors. Molecular regulation of high and low copy number plasmids. Characteristics features of pBR322, pUC series of plasmid vectors. Bacteriophages as cloning

vectors. Phagemid vectors: General features and their importance. YACs & BACs: General characteristic features and scheme of cloning

Unit-3: Applications of gene cloning and DNA Recombinant Technology (15 HOURS)

Construction of Genomic DNA library and its applications; Construction of cDNA Library: Method, problems to be addressed, advantages and disadvantages compared to the genomic DNA library, uses; Screening of recombinants: Screening by complementation, southern hybridization, northern hybridization, colony lift.

Unit-4: Fermentation Technology

Fermentation technology: Primary and secondary metabolites in biotechnology, Continuous and batch type culture techniques, types of fermenters. Fermentation processes, Brewing Manufacture of penicillin, Production of single cell proteins.

Books recommended:

1. Molecular biotechnology, S.B Primrose, Panima Publishing Corporation, New Delhi
2. Biotechnology, B.D Singh Kalyan Publishers, New Delhi
3. Gene cloning and DNA analysis: An introduction, T.A Brown

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Agarose gel electrophoresis of DNA.
2. Ultraviolet absorption spectrum of DNA and RNA.
3. Demonstration of PCR. Amplification of a DNA fragment by PCR
4. Isolation of plasmid DNA from E. coli
5. Bacterial transformation- Demonstration.
6. Restriction digestion of DNA
7. cDNA construction & cloning
8. Identification of cloned gene by blue-white colony selection.
9. Virtual lab exercise on recombinant DNA techniques.

Books recommended:

1. Plummer D. T., Introduction to Practical Biochemistry, Tata McGraw Hill. (Third Edn.)

2. Deb A. C., Viva & Practical Biochemistry, Central Book Agency

3. Boyer R., Modern Experimental Biochemistry, Pearson.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

7TH SEMESTER

BCH722J3: RESEARCH METHODOLOGY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives / expected learning outcomes:

This course aims to make the students understand the formulation and design of research. It will also help them to know the methods for data collection and interpretation of their results. The students will also learn to write and publish their work. The students are expected to develop scientific aptitude for conducting the good research.

Unit-1: Research methods and formulation (15 HOURS)

Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem - Hypothesis - Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.

Unit-2: Literature review and research design (15 HOURS)

Literature review - Primary and Secondary sources, Importance of literature review, critical literature review, Identifying gap areas from literature and research database.

Research design: Meaning, Concept and Importance in Research - Features of Good Design, Exploratory and Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Unit-3: Data collection and analysis (15 HOURS)

Observation and collection of data, methods of data collection, Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample.

Data Analysis: Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chi square test.

Unit-4: Interpretation, report writing and research ethics (15 HOURS)

Writing Research Report: Interpretation of Data and Paper Writing- Format and style, Layout of a Research Paper, Journals in Biosciences, Impact factor of Journals, When and where to publish?
Ethics - Ethical issues, Ethical committees (human & animal), Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Learning the basic and advanced features of MS Word
2. Learning the basic and advanced features of MS Powerpoint
3. Learning the basic and advanced features of MS Excel
4. Learning the role of Computer in research, Use of statistical software SPSS, PRISM, etc in research.

Books recommended:

1. Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.
2. Fundamentals of modern statistical methods by Rand R.wilcox.
3. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole.
4. Robert A. Day and Barbara Gastel 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Arlene Fink 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. SC Sinha and AK Dhiman 2002. Research Methodology, Ess Ess Publications. 2 volumes.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

8TH SEMESTER

BCH822J1: ENDOCRINOLOGY CREDITS: THEORY-3, PRACTICAL-1

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Objective/ Course Outcomes:

This course gives insight to the students about how endocrine systems works and regulates the synthesis, secretion, transport, receptors, mechanisms of action, and metabolism/excretion in the body

At the end of the course the student should be able to:

- Describe the different classes and chemical structures of hormones.
- Identify the glands that synthesize and secrete hormones.
- Identify and discuss the integration of the endocrine system in general with focus on specific interactions.
- Explain the consequences of under and overproduction of hormones.

Unit-1: Introduction to endocrinology (15 HOURS)

Endocrine and exocrine glands, types of endocrine glands, concepts of paracrine, autocrine, intracrine and neuroendocrine mechanisms. Hormones: Properties, Classification and their transport. Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins. Secondary messengers: cAMP, cGMP, IP_3, DAG, Ca^{2+}, NO. Effector systems: adenyl cyclase, guanyl cyclase, PDE, PLC.

Unit-2: Hypothalamo-hypophysial axis (15 HOURS)

Hypothalamic-Pituitary axis. Structure, biosynthesis, mechanism of action and physiological role of hypothalamic and pituitary hormones: GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Structure and functions of hormones of pineal gland. Endocrine disorders - gigantism, acromegaly, dwarfism, pigmies and diabetes insipidus.

Unit-3: Hormones and their mechanism of action (15 HOURS)

Structure, biosynthesis, transport, mechanism of action and physiological role of thyroid, parathyroid, adrenal, pancreas, gonads, thymus, gastro-intestinal track and placenta. Disorders of thyroid gland, adrenal gland, and pancreas.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 18

1. Study of the permanent slides of the endocrine glands
2. Demonstration of estimation of plasma/serum level of any hormone using ELISA

Books recommended:

1. Harrison's Endocrinology by J. Larry Jameson
2. Endocrinology by Mac E. Hadley, Pearson Education
3. Textbook on Endocrinology by Gayatri Prakash

BACHELORS WITH BIOCHEMISTRY AS MAJOR

8TH SEMESTER

BCH822J2: NUTRITIONAL BIOCHEMISTRY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives/Expected Learning Outcomes:

This unit aims to:

- Present a case for the essentiality of nutrients and energy in the diet
- Introduce key themes of the sociology of health and illness
- Establish the basic principles of metabolism and its regulation
- Explore the biochemical, physiological and clinical impact of inadequate intakes of specific nutrients

By the end of the course, a candidate will be able to describe and critically discuss:

- The nutrients and their extent of metabolic demand for nutrients.
- How nutrients are used by the body and the consequences of nutrient deficiency
- Mechanisms for the integration of metabolism, at molecular, cellular and whole-body levels
- The scientific basis of the safety and health promoting properties of nutrients and non-nutrient components of foods, based on knowledge of the metabolic effects of:
    - nutrients
    - nutraceuticals
    - functional foods
    - and any other metabolically active constituents of foods and the diet
- Nutrient analysis (assessment of macronutrient and energy content of a meal against healthy eating recommendations)
- Effects of methods of food production, preparation, preservation, fortification and format on the chemical composition and nutritional quality of food

Unit-1: Basic concepts of nutrition (15 HOURS)

Defining Nutrition, role of nutrients. Food: Sources, classification and Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements. Specific dynamic action (SDA) of proteins.

Unit-2: Macronutrients (15 HOURS)

Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions. Malnutrition – Prevention of malnutrition, Protein-calorie malnutrition. Role of fiber.

Unit-3: Micronutrients (15 HOURS)

Minerals - Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E, & K vitamins.

Unit-4: Food Science & Technology (15 HOURS)

Principles of food preservation. Thermal resistance of microorganisms and enzyme. Food standards: International – Concept of Codex alimentarius, USFDA, ISO. National – Introduction of BIS/IS, Food Safety and standard regulation 2010. Food spoilage and pathogenic bacteria associated with foods & processed foods. Major food borne diseases (staphylococcal gastroenteritis, botulism, listeriosis, salmonellasis, shigellosis-in brief). Neutraceuticals.

Books recommended:

1. Brody T., Nutritional Biochemistry 2nd Edition., Elsevier
2. Davidson S & Passmore JR, Nutrition & Dietetics, Edinburgh Churchill Livingstone
3. Swaminathan MS, Ramakrishnan, VenkatRao, Nutrional Biochemistry, T R Publications.
4. Berg, J.M., Tymoczko, J.L. and Stryer L., Biochemistry (2012) 7th ed., W.H. Freeman and Company.

5. Nelson, D.L. and Cox, M.M Lehninger: Principles of Biochemistry (2013) 6th ed, W.H. Freeman and Company.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Calorific Value of various foods
2. Estimation/Detection of Lycopene from a given sample like Tomato etc.
3. To determine the calcium in the sample by titration method.
4. Determination of Acid Value & Peroxide value of fats.
5. Bioassay for vitamin B12/B1.
6. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
7. Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
8. Vitamin A/E estimation in serum.

Books recommended:

1. Plummer D. T., Introduction to Practical Biochemistry, Tata McGraw Hill. (Third Edn.)
2. Deb A. C., Viva & Practical Biochemistry, Central Book Agency
3. Boyer R., Modern Experimental Biochemistry, Pearson.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

8TH SEMESTER

BCH822J3: MEDICAL BIOCHEMISTRY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Objectives / expected learning outcomes:

This course aims to introduce the students to various health issues and the biochemistry involved in these diseases. This will increase the knowledge of the students regarding the challenging issues and is expected to arouse the interest of students towards these challenges.

Unit-1: Biochemistry of cancer (15 HOURS)

Introduction to cancer, Incidence, Etiology of cancer, Molecular basis of cancer, oncogenic viruses, Proto-oncogenes, activation of proto-oncogenes, tumor suppressor genes, Tumor markers, cancer prevention, cancer therapy, Anti-cancer drugs, concept of apoptosis.

Unit-2: Biochemistry of AIDS and HIV (15 HOURS)

Introduction to AIDS, Epidemiology of AIDS, Structure of HIV, Virology of HIV, Immunology of AIDS, Laboratory diagnosis of AIDS and HIV, Anti-HIV Drugs, Prevention of HIV and AIDS, Vaccines against AIDS.

Unit-3: Biochemistry of common Health diseases (15 HOURS)

Multiple sclerosis, Guillain- Barre Syndrome, Prions and Prion diseases, Alzheimer's disease, Parkinsonism, protein misfolding diseases, Ageing and biochemistry of ageing, Cataract, Duchenne Muscular Dystrophy, Ehlers-Danlos Syndrome.

Unit-4: Clinical Biochemistry and Organ function tests (15 HOURS)

The reference range, Common abnormalities and their biochemical profile, Common techniques used in laboratory, Collection of blood samples and urine samples for analysis, Haemolysis, Kidney function tests, Liver function tests, Thyroid function tests, Quality control, Concept of lab track system.

PRACTICALS (2 CREDITS: 60 HOURS). MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Polymerase chain reaction.
2. Restriction fragment length polymorphism.
3. ELISA.
4. Kidney Function test.
5. Thyroid function test.
6. Lipid profile test.
7. Liver function test

Books recommended:

1. Text book of Biochemistry for Medical Students b y DM Vasudevan.
2. Text book of Biochemistry by Lubert Stryer.
3. Text book of Biochemistry by Voet and Voet.
4. Text book of Biochemistry Lehninger by Nelson & Cox.
5. Medical Biochemistry by Dinesh Puri.

BACHELORS WITH BIOCHEMISTRY AS MAJOR

8TH SEMESTER

BCH822JP: PROJECT **CREDITS: 12**

MAXIMUM MARKS: 300, MINIMUM MARKS: 108

Project Dissertation

The research project is a mandatory part for FYUGP Honours with research. The project dissertation will be assessed in its various aspects; thesis, techniques learnt, quantum and importance of results, and this will be followed by a project related presentation by the students defending their dissertation.

FYUP CURRICULAR FRAMEWORK FOR BACHELORS PROGRAMME WITH **BIOCHEMISTRY**AS MINOR

SEMESTER	COURSE CODE	TYPE OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY 4	PRACTICAL 2 or 0	TUTORIALS 0 or 2
I	BCH122J	MINOR	BIOMOLECULES	4	2	0
II	BCH222J	MINOR	CELL BIOLOGY & MICROBIOLOGY	4	2	0
III	BCH322J	MINOR	ENZYMOLOGY	4	2	0
IV	BCH422J1	MINOR	BASICS OF METABOLISM & BIOENERGETICS	3	1	0
V	BCH522J1	MINOR	CARBOHYDRATE & AMINOACID METABOLISM	3	1	0
VI	BCH622J1	MINOR	LIPID & NUCLEIC ACID METABOLISM	3	1	0
VII	BCH722J1	MINOR	PLANT BIOCHEMISTRY	3	1	0
VIII	BCH822J1	MINOR	ENDOCRINOLOGY	3	1	0

PROGRAMME LEARNING OUTCOMES OF THE MINOR DECIPLINE FROM I st TO THE 8th SEMESTER:

SEMESTER	COURSE CODE	LEARNING OUTCOMES											
		A	B	C	D	E	F	G	H	I	J	K	L
		Capability to understand that nucleic acids are the genetic material of all living organisms. That the lipids together with other biomolecules are building blocks of living cell	To understand correlation of enodocrine system with other important physiological systems of body and regulation of healthy body.	Able to understand the various biochemical processes and metabolic pathways. Furthermore, the role of various plants growth regulators and their use in crop production.	Students will get knowledge of structure and function of monosaccharides, proteins and lipids	The students will be able to describe the structure, regulation, functions and the mechanism of action of enzymes.	Well versed about the various cellular organelles and their function.	They should be well versed with molecular and cellular foundations of life. Apply the knowledge to understand the association of microbes and diseases and the beneficial uses of microorganisms. Acquire the knowledge to understand disease diagnosis, prognosis, therapeutic intervention, biochemical industry and/or medicinal industry	To comprehend the techniques in genetic engineering & biotechnology necessary for increased food production and high yield of crops.	To be able to know fundamental biochemistry knowledge related to health and equipping the student regarding the challenging health issues in today's world	Helps in study of energy relationships and energy transformations and transductions in living organisms	Able to comprehend about cell to cell communication. Role of hormones in cell signaling and body physiology regulations	To provide well information about DNA, RNA and their replication, mutations, DNA repair mechanism and with high level thinking skills that is necessary for scientists.
I	**BCH122N**	✔			✔								
II	**BCH222N**						✔	✔		✔			✔
III	**BCH322N**					✔							
IV	**BCH422N1**										✔		
V	**BCH522N1**				✔								
VI	**BCH622N1**	✔											
VII	**BCH722N1**			✔					✔				
VIII	**BCH822N1**		✔									✔	

Syllabus for 1st to 8th Semester (Minor) (1st to 3rd Sem) in Biochemistry at the Undergraduate Level

BACHELORS WITH BIOCHEMISTRY AS MINOR

IST SEMESTER

BCH122J: BIOMOLECULES **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Course Objective:

The main objective of the course is to provide students with an understanding of biomolecules, the basic building blocks of living organisms, mainly focusing on their structural, biological roles and/or functions. The course will emphasise on structure and function of various biomolecules at molecular and cellular level. Further, the course will give students an opportunity to learn basic laboratory techniques.

Course Learning Outcome:

Upon completion of this course students will be:

- Well versed with molecular and cellular foundations of life
- Able to comprehend the structure, function and biochemical properties of monosaccharides, proteins and lipids
- Able to prepare various laboratory solutions and independently identify various biomolecules in the laboratory

Course Content (Theory):

Unit-1: Carbohydrates (15 HOURS)

Definition, classification and structure of monosaccharides. Open and Ring structure, anomeric and epimeric forms, mutarotation. Reaction of monosaccharides with special reference to glucose, Structure and functions of important oligosaccharides Polysaccharides- Homo and Heteropolysaccharides; Structure and functions of important polysaccharides-Glycogen, Starch and Cellulose. Structure and role of glycoconjugates - proteoglycans, glycoproteins and glycolipids (gangliosides and

lipopolysaccharides).

Unit-2: Proteins (15 HOURS)

Amino acids: Structure & their classifications, stereoisomerism and RS system of designation, optical isomers. Zwitter ion, isoelectric point (pI) and its biological significance.
Proteins: classification, composition and functions. Structure of peptide bond, chemical synthesis of polypeptides. Levels of structure in protein architecture, forces stabilizing the tertiary structure and quaternary structure of proteins. Denaturation and renaturation of proteins, Structure and function of Hemoglobin and myoglobin

Unit-3: Lipids (15 HOURS)

Introduction, classification, nomenclature, structure and properties of Fatty acids. Saturated and unsaturated fatty acids. Essential fatty acids, chemical properties and characterization of fats – hydrolysis, Saponification value, Reichert – Meissel number, Iodine number, rancidity of fats, Triacylglycerols, Cholesterol and prostaglandins. Structure and functions of phospholipids and sphingolipids. Synthesis of steroid hormones.

Unit-4: Nucleic Acids (15 HOURS)

Structure and compositions Nucleic acids -RNA and DNA, Purines and Pyrimidines, Nucleoside, Nucleotide, Nucleic acid structure – Watson-Crick model of DNA, forms of DNA; Structure and function of major species of RNA - mRNA, tRNA and rRNA. Denaturation and renaturation of DNA, Cot curve.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Safety measures in laboratories
2. Preparation of a solution (molar, normal and percent)
3. Preparation of Standard buffers and determination of pH of a solution
4. Qualitative tests for Carbohydrate
5. Qualitative tests for Amino acids
6. Qualitative tests for Lipids
7. Quantitative estimation of proteins

Books Recommended

1. Principles of Biochemistry by Lehninger, Nelson& Cox
2. Biochemistry by Lubert Stryer
3. Biochemisrty by Dr Satyanarayan
4. Experimental Biochemistry by B A Ganai.
5. Bio-analytical Chemsitry by Eazaz Husain Rizvi

BACHELORS WITH BIOCHEMISTRY AS MINOR

2ND SEMESTER

BCH222J: CELL BIOLOGY AND MICROBIOLOGY CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 100, MINIMUM MARKS: 36

Course Objective:

The course aims to offer insights into the basic structure of eukaryotic and prokaryotic cells including cellular organelles and their function. The laboratory course is aiming to train the students regarding the techniques involved in cell culture, study of cell structure and blood group typing.

Course outcome:

After successful completion of the course our students will be:

- Able to differentiate various cell types including prokaryotic and eukaryotic cells.
- Proficient in differentiating animal vs plant cells
- Well versed about the various cellular organelles and their function.
- Able to comprehend about cell-to-cell communication.
- Able to comprehend the drug sensitivity of gram-positive vs gram negative bacteria.

Unit-1: Cell wall and membranes (15 HOURS)

Structure of eukaryotic cells- Overview of plant and animal cells, Composition, structure and functions of cell wall and cell membranes. Membrane transport (Active and passive), Membrane channels, carriers, and transporters.

Unit-2: Cell organelles (15 HOURS)

Structure and functions of Nucleus- nuclear envelope, nuclear pore complex, nucleolus, Concept of chromatin and chromosome. Endoplasmic Reticulum- RER - Brief overview of cotranslational and posttranslational transport of proteins; SER – Lipid synthesis, brief overview of export of proteins from ER to Golgi, Mitochondria, Golgi apparatus- organization, brief overview of glycosylation of proteins within Golgi. Ribosomes, structure and functions of lysosomes, peroxisomes, cytoskeleton

(microtubules- Structure, assembly and function of Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies)

Unit-3: Cell communication (15 HOURS)

Cell communication- basic concept of anchoring junctions, tight junctions and communication junctions (gap junctions and plasmodesmata); ECM components – proteins, polysaccharides and adhesion proteins Cell signaling- Types, signal molecules, signal amplification, receptor types and sensing.

Unit-4: Microbiology (15 HOURS)

General organization of bacterial cell, Cell wall structure of gram (+ve) and gram (-ve) bacteria. Bacterial growth, culture of bacteria and types of culture media. Sterilization and disinfection. Introduction to viruses- HBV, HIV, SARS-2,

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Sterilization techniques
2. Preparation of bacterial culture media
3. Bacterial Staining
4. Observation of cellular Morphology-Eukaryotic and Prokaryotic.
5. Blood group typing

Books Recommended:

8. The Cell: A Molecular Approach (2013) 6th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN: 978-0- 87893-300-6.
9. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620- 8.
10. Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7
11. Essential Cell Biology (4th Edition) by Alberts et al.
12. The Cell A Molecular Approach by Couper and Housman

13. Fundamentals of Cell Biology by S K Singh

14. Online source- https://nptel.ac.in/.

BACHELORS WITH BIOCHEMISTRY AS MINOR

3RD SEMESTER

BCH322J: ENZYMOLOGY **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 100, MINIMUM MARKS: 36**

Course Objectives:

The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function, enzyme kinetics, enzyme catalysis and enzyme inhibition.

Course Outcomes:

The students will be able to describe the structure, regulation, functions and the mechanism of action of enzymes.

Unit-1: Basic concepts of enzymes

Introduction of enzymes and historical developments in Enzymology (like contributions by Wilhelm Kühne, Berzelius, Lois Pasteur, James B. Sumner, Emil Fischer, Linus Pauling etc), Classification of enzymes: IUB enzyme classification, Nomenclature of enzymes, Isoenzymes and its physiological significance, Isoenzymes in health and disease (ALT, ALP, LDH, CK, GGT, amylase), Multi-enzyme complexes, Enzyme specificity, Active site, Features of active site, Enzyme assays, Units of measurement of enzyme assays.

Unit-2: Enzyme Catalysis

Role of co-factors and co-enzymes NAD/$NADP^+$, FMN/FAD, Co-enzyme A, Biotin, Cobalamine, Lipoamide, TPP, Pyridoxal phosphate, Tetrahydrofolate, Metal ions with special emphasis on coenzyme functions, Acid base and covalent catalysis.

Unit-3: Enzyme Kinetics

Basics of enzyme kinetics, Enzyme concentration, Substrate concentration, Effect of pH & Temperature on enzyme activity, Michaelis-Menton equation, Determination of Km and Vmax by line-weaver Burk plot, Significance of Km, Significance of Vmax, Importance of Km (hexokinase Vs glucokinase as example).

Unit-4: Enzyme Regulation

Reversible Inhibition (Competitive inhibition, Non-competitive inhibition, Un-competitive inhibition), Irreversible inhibition, Derivation of Michaelis-Menton equation for competitive inhibitors, Allosteric inhibition and regulation, Reversible and irreversible covalent modifications of enzymes.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 50, MINIMUM MARKS: 18

1. Verification of Beer Lambert Law
2. Estimation of SGPT and SGOT in serum
3. Effect of pH on enzyme activity and determination of optimum pH.
4. Determination of Km of enzymes using Line-weaver Burk plot
5. Determination of Vmax of enzymes using Line-weaver Burk plot

Books recommended:

5. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, By T Palmer, P L Bonner · 2017
6. Enzymes: Catalysis, Kinetics and Mechanisms by N. S. Punekar, Springer
7. Enzymes: by Malcolm Dixon & Edwin Clifford Webb
8. Biochemical Calculations by Segel IH-John Wiley and Sons, New York

BACHELORS WITH BIOCHEMISTRY AS MINOR

4TH SEMESTER

BCH422J1: BASICS OF METABOLISM AND BIOENERGETICS CREDITS: THEORY-3, PRACTICAL-1

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Objectives/Expected Learning Outcomes:

This course aims to introduce the students to basics of metabolism and bioenergetics with an expectation to learn how the principles of bioenergetics and thermodynamics hold good in biological systems also and how are these central in understanding metabolism.

Unit-1: BIOLOGICAL THERMODYNAMICS (15 HOURS)

Thermodynamic states, Zeroth law of thermodynamics, First law of thermodynamics and its implications in biological system, Second law of thermodynamics and its significance in biological system, Concept of third law of thermodynamics, Isothermal and adiabatic processes, Concept of heat of a reaction, thermodynamic systems, Thermodynamic properties, Importance of thermodynamics in biological systems.

Unit-2: BIOENERGETICS (15 HOURS)

Concept of work and energy, Bioenergetics, Energy change during a biochemical reaction, Endergonic and Exergonic reactions, Energy transformation in biological systems, Total internal energy, Gibbs free energy concept, Significance of free energy, Entropy and its significance, Enthalpy, Relation between entropy, enthalpy and free energy, Spontaneity of a biochemical reaction.

Unit-3: BASICS OF METABOLISM (15 HOURS)

Metabolism, Catabolism, Anabolism, Amphibolism, Types of metabolic reactions, Oxidation-reduction reactions, Redox potential, dehydrogenation reactions, Energy rich compounds in living organisms, classification of energy rich compounds, Phosphoryl transfer potential, Coupled reactions, ATP as energy currency, ATP-ADP cycle, Concept of Biological oxidation, Methods used to study metabolism in living organisms.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 09

1. Determination of heat of neutralization by treating acids and bases.
2. Calculation of viscosity of different percentage solutions of carbohydrate, protein and fat.
3. Specific heat determination by calorimeter.
4. Principle of autoclave

Books recommended:

5. Biological Thermodynamics by Donald Haynie.
6. Thermodynamics-Principles and Applications by NC Dey
7. Text book of Biochemistry by Lubert Stryer
8. Text book of Biochemistry by Voet and Voet

BACHELORS WITH BIOCHEMISTRY AS MINOR

5TH SEMESTER

BCH522J1: CARBOHYDRATE AND AMINO ACID METABOLISM CREDITS: THEORY-3, PRACTICAL-1

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 18

Objectives/Expected Learning Outcomes:

Metabolism is central to biochemistry and thus this course aims to introduce the students to Biochemistry with an expectation to learn how biochemistry is central to disease diagnosis, prognosis, therapeutic intervention, biochemical industry and/or medicinal industry.

Unit-1: Metabolism of Carbohydrates (15 HOURS)

Reactions and energetics of glycolysis. Gluconeogenesis, Glycogenesis and Glycogenolysis, Reactions and physiological significance of Pentose Phosphate Pathway, Entry of pyruvate into mitochondria, TCA cycle and its significance, Sequence of electron carriers, Sites of ATP production, Inhibitors of electron transport chain, Mitochondrial oxidative phosphorylation.

Unit-2: Metabolism of Amino acids (15 HOURS)

Concept of amino acid pool, Metabolism of amino acids, Transamination, Deamination and decarboxylation reactions of amino acids, Metabolism of ammonia, Ammonia toxicity, Urea cycle and its importance, Relation between urea cycle and TCA Cycle, Metabolism of important amino acids.

Unit-3: Regulation and Metabolic Disorders (15 HOURS)

Regulation of glycolysis, Regulation of TCA Cycle, Disorders of carbohydrate metabolism, Glycogen storage diseases, Regulation of Urea Cycle, Disorders of urea cycle, Clinical significance of transaminases, Metabolic disorders of amino acids, Phenylketanuria, Albinism, Alkaptunuria, Hartnup's disease, Cystinuria.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 9

1. Separation and identification of amino acids/sugars by paper chromatography.
2. Estimation of glucose by Nelson-Somogyi method.
3. Estimation of protein by Lowry method.

Books recommended :

1. Text book of Biochemistry by Lubert Stryer
2. Text book of Biochemistry by Voet and Voet
3. Text book of Biochemistry Lehninger by Nelson & Cox
4. Understanding Carbohydrate Metabolism by Rabia Hamid

BACHELORS WITH BIOCHEMISTRY AS MINOR

6TH SEMESTER

BCH622J1: LIPID AND NUCLEIC ACID METABOLISM **CREDITS: THEORY-3, PRACTICAL-1**

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 75, MINIMUM MARKS: 25**

Objectives/Expected Learning Outcomes:

Metabolism is central to biochemistry and thus this course aims to introduce the students to Biochemistry with an expectation to learn how biochemistry is central to disease diagnosis, prognosis, therapeutic intervention, biochemical industry and/or medicinal industry.

Unit-1: Metabolism of Lipids (15 HOURS)

Triacylglycerols and hydrolysis of Triacylglycerols, Mobilisation of fat, transport of fatty acids in to mitochondria, β-oxidation of saturated and unsaturated fatty acids, Energetics and ATP yield from fatty acid oxidation, Biosynthesis of saturated and unsaturated fatty acids, Ketone bodies and Ketogenesis, Concept of cholesterol metabolism.

Unit-2: Metabolism of Nucleic Acids (15 HOURS)

Biosynthesis of purines, salvage pathway for purines, Inhibitors of purine synthesis, Degradation of purine nucleotides, Biosynthesis of pyrimidines, Inhibition of pyrimidine synthesis, degradation of pyrimidines, salvage pathway for pyrimidine synthesis.

Unit-3: Regulation and Metabolic Disorders (15 HOURS)

Regulation of fatty acid oxidation and fatty acid synthesis, Sudden Infant Death Syndrome (SIDS), Regulation of ketogenesis, Ketonemia, Ketonuria, Metabolic disorders of lipids, Atherosclerosis and Coronary heart diseases, Metabolic disorders of nucleic acids, Gout, Lesch-Nyhan syndrome, Oroticaciduria.

PRACTICALS (1 CREDITS: 30 HOURS) **MAXIMUM MARKS: 25, MINIMUM MARKS: 9**

1. Estimation of cholesterol.

2. Estimation of Triglycerides.
3. Estimation of Uric acid.

Books recommended:

4. Text book of Biochemistry by Lubert Stryer
5. Text book of Biochemistry by Voet and Voet
6. Text book of Biochemistry Lehninger by Nelson & Cox.

BACHELORS WITH BIOCHEMISTRY AS MINOR

7TH SEMESTER

BCH722J1: PLANT BIOCHEMISTRY CREDITS: THEORY-3, PRACTICAL-1

THEORY (4 CREDITS: 60 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Objectives of course:

A key aspect of the course will be to develop an understanding of the chemical basis and "chemical logic" of metabolic processes in plants particularly photosynthesis, respiration, Electron transport chain and secondary metabolites.

Course outcomes:

On successful completion of the course, the student shall be able to:

- Understand the structure of plant cell wall and role of various plant growth regulators.
- Define the biochemical processes and metabolic pathways, including photosynthesis, photorespiration in plants.
- Describe the physiological and biochemical reaction, nitrogen fixation and assimilation.

Unit-1: Plant cell and plant hormones (15 HOURS)

Structure and functions of plant cell wall, plastids, and peroxisomes, Plant cell division and Cell cycle. Plant growth hormones: Structure and physiological functions of Auxin, Gibberellins, Cytokinins, Abscisic acid and Ethylene. Plant growth inhibitors and retardants

Unit-2: Photosynthesis (15 hours)

Photosynthetic pigments, Basic structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon reduction. Factors affecting photosynthesis. Photorespiration and its importance.

Unit-3: Nitrogen fixation and plant secondary metabolites (15 hours)

Biological nitrogen fixation by free living and in symbiotic association, Structure, and function of Nitrogenase. Nitrate assimilation; nitrate reductase and nitrite reductase.

Definition, examples, and biological function of alkaloids, phenolics, terpenoids. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 9

1. Separation of photosynthetic pigments by TLC.
2. Estimation of Chlorophyll content by using spectrophotometer.
3. Field visit to IIIM Srinagar/ICAR-Central Institute of Temperate Horticulture or medicinal botanical garden

Books recommended:

1. Fundamentals of Plant Physiology by Lincoln Taiz, Angns Murphy
2. Plant Biochemistry, Caroline Bowsher, Martin steer, Alyson Tobin, Garland science
3. Plant Biochemistry: Hans-Walter Heldt & Heldt
4. Plant Biochemistry by P.M Dey and J.B. Harborne

BACHELORS WITH BIOCHEMISTRY AS MINOR

8TH SEMESTER

BCH822J1: ENDOCRINOLOGY CREDITS: THEORY-3, PRACTICAL-1

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Objective/ Course Outcomes:

This course gives insight to the students about how endocrine systems works and regulates the synthesis, secretion, transport, receptors, mechanisms of action, and metabolism/excretion in the body

At the end of the course the student should be able to:

- Describe the different classes and chemical structures of hormones.
- Identify the glands that synthesize and secrete hormones.
- Identify and discuss the integration of the endocrine system in general with focus on specific interactions.
- Explain the consequences of under and overproduction of hormones.

Unit-1: Introduction to endocrinology (15 HOURS)

Endocrine and exocrine glands, types of endocrine glands, concepts of paracrine, autocrine, intracrine and neuroendocrine mechanisms. Hormones: Properties, Classification and their transport. Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins. Secondary messengers: cAMP, cGMP, IP_3, DAG, Ca^{2+}, NO. Effector systems: adenyl cyclase, guanyl cyclase, PDE, PLC.

Unit-2: Hypothalamo-hypophysial axis (15 HOURS)

Hypothalamic-Pituitary axis: Structure, biosynthesis, mechanism of action and physiological role of hypothalamic and pituitary hormones: GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Structure and functions of hormones of pineal gland. Endocrine disorders - gigantism, acromegaly, dwarfism, pigmies and diabetes insipidus.

Unit-3: Hormones and their mechanism of action (15 HOURS)

Structure, biosynthesis, transport, mechanism of action and physiological role of thyroid, parathyroid, adrenal, pancreas, gonads, thymus, gastro-intestinal track and placenta. Disorders of thyroid gland, adrenal gland, and pancreas.

PRACTICALS (1 CREDITS: 30 HOURS) MAXIMUM MARKS: 25, MINIMUM MARKS: 18

1. Study of the permanent slides of the endocrine glands
2. Demonstration of estimation of plasma/serum level of any hormone using ELISA

Books recommended:

1. Harrison's Endocrinology by J. Larry Jameson
2. Endocrinology by Mac E. Hadley, Pearson Education
3. Textbook on Endocrinology by Gayatri Prakash

BACHELORS WITH BIOCHEMISTRY AS MULIDISCIPLINARY COURSE

IST TO 3RD SEMESTER

BCH?: INTRODUCTION TO BIOCHEMISTRY **CREDITS: THEORY-4, PRACTICAL-2**

THEORY (3 CREDITS: 45 HOURS) MAXIMUM MARKS: 75, MINIMUM MARKS: 27

Course Objective:

The objective of the course is to introduce the subject of Biochemistry including biomolecules and water as a universal solvent, to students.

Course Learning Outcomes:

At the end of the course students will have:

- Gained the knowledge regarding structure and function of carbohydrates, protein, RNA, DNA and lipids
- Known how structure of a biomolecule determines its biochemical properties
- Understood biochemical foundations of life
- Known biological significance of each biomolecule

Unit I

Definition, Scope &significance of Biochemistry. Cellular basis of life (eukaryotic and prokaryotic)
Carbohydrates: Definition, classification and functions; Monosaccharides, Disaccharides, Polysaccharides, Homo- and Heteropolysaccharides. Hyper- and hypoglycaemia

Unit II

Amino Acids and Proteins: Definition, structure and function of amino Acids. Classification of Amino Acids- Aliphatic, Aromatic, Acidic, Basic, Essential and Non-essential Amino Acids
Primary, secondary, tertiary and quaternary structure of Proteins, Protein energy malnutrition

Unit III

Lipids: Definition and classification- Fatty acids, Triglycerols and Phospholipids. Significance of lipids as energy stores of body. Cholesterol and its function.

Nucleic acids: Ribose and De-oxyribose sugars, Nucleosides, Nucleotides, Nucleic acids (DNA and RNA) as genetic material

Books recommended:

1. Biochemistry by Dr U Satyanarayan
2. Lehninger, Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).