

**Department of Biochemistry
Faculty of Life Sciences
AMU, Aligarh**

B.Sc. (Hons) Syllabus
(Effective from 2018-19)
Passed in BOS held on 07.04.2018

**B.Sc. (Hons) Biochemistry
Semester I
Core Course
BIOMOLECULES
(BCB151)**

**Credit: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: WATER AND PROTEINS (12 Lectures)

Water: Physical properties and hydrogen bonding of water; structure of liquid water and its solvent properties; hydrophobic interactions. Ionization of H₂O and ion product of water; the pH scale; relationship between pH and pK_a (Henderson-Hasselbalch equation); buffers

Proteins: Definition, biological functions of proteins; structure of twenty alpha-amino acids commonly found in proteins; abbreviations and classification of 20 amino acids; zwitterion nature of amino acid in aqueous solutions; essential amino acids; peptide bond formation; backbone structure of proteins/polypeptides; N-terminal and C-terminal amino acids; properties of amino acids/proteins arising from their dipolar nature; basic understanding of primary, secondary, tertiary, and quaternary structure of proteins/peptides; fibrous and globular proteins; elementary ideas on protein denaturation and renaturation.

UNIT II: CARBOHYDRATES (12 Lectures)

Definition, biological functions; classification into monosaccharides (aldoses and ketoses), oligosaccharides and polysaccharides; optical isomerism, open chain and ring structures of carbohydrates; mutarotation; structure of biologically important carbohydrates (D-glucose, D-galactose, D-mannose, D-fructose, D-ribose, D-2-deoxyribose, D-maltose, D-lactose, D-sucrose); polysaccharides- starch, cellulose, glycogen and mucopolysaccharides; suitability of polysaccharides as storage material.

UNIT III: LIPIDS

(12 Lectures)

Definition; biological functions; general formulae, nomenclature and properties of fatty acids; essential and non-essential fatty acids; classification of lipids; general structure and function of major lipid subclasses: acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins; saponifiable and non-saponifiable lipids; suitability of triglycerides as storage lipids; saponification number and iodine number; biomembranes

UNIT IV: NUCLEIC ACIDS

(12 Lectures)

Nucleosides and nucleotides; generalized structural plan of nucleic acids. Evidence that DNA is the genetic material; Watson-Crick model of DNA; size of DNA in prokaryotic and eukaryotic cells. Central dogma of molecular biology; gene, genome and chromosome. Basic ideas of DNA replication, transcription and protein biosynthesis; genetic code and codons. Mutations- definition and types.

Suggested Reading:

- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition. WH Freeman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition. WH Freeman and Co.
- Introducing Biochemistry (1982) by Wood and Pickering. ELBS/John Muray.
- Outlines of Biochemistry by Conn and Stumpf (5th Edition, 1987) Wiley, New Delhi.

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B.Sc. (Hons) Syllabus
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**B.Sc. (Hons) Biochemistry
Semester II
Core Course
MICROBIOLOGY & VIROLOGY
(BCB251)**

**Credit: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: CRITERIA FOR CLASSIFICATION, MORPHOLOGY, NUTRITION & PHYSIOLOGY OF BACTERIA (12 Lectures)

Brief introduction to microorganisms, criteria used in the classification of bacteria- morphology, cytology, genetics, host specialization, serology, physiology etc. Numerical taxonomy, a brief account of Bergey's manual. General organization of bacterial cells - gram positive and gram negative organisms; structure and function of peptidoglycan in gram positive and gram negative organisms; functions of polymeric components in outer membrane and acidic polymers in gram negative organisms. Bacterial growth; phases of growth, physical factors affecting bacterial growth (pH, temperature and oxygen requirements).

UNIT II: BACTERIAL GENETICS (12 Lectures)

Adaptation and mutation: types of mutations and their effects. Significance of gene transfer in bacteria. Methods of lateral gene transfer: transformation, transduction and conjugation; their discovery and mechanism. Generalised and specialised transduction; Temperate and virulent phages, lysogenic and lytic cycles, Characteristics of plasmids, Transposable elements: insertion sequences and transposons.

UNIT III: MORPHOLOGY & REPLICATION OF VIRUSES (12 Lectures)

Definitions of virus, viroids, virusoids and prion; general properties of viruses. Virus structure; variations in size and shape/symmetry. Cultivation and detection of viruses; Plaque formation and haemagglutination inhibition test. Replication of bacteriophages, animal viruses and retroviruses.

UNIT IV: VIRAL INFECTIONS

(12 Lectures)

Acute viral infections - Influenza, dengue and yellow fever viruses; persistent viral infections-herpes/hepatitis and AIDS; transformation and cancer. Role of vaccines in prevention of viral infections, types of polio vaccines.

Suggested Reading:

- Microbiology: Principles and Explorations (2014) by JG Black and LJ Black. Ninth edition. Wiley & Sons, Inc.
- Alcamo's Fundamentals of Microbiology (2013) by JC Pomerville. Tenth edition, Jones and Bartlett.
- Microbiology (2001) by Chan, Pelczar and Krieg. Fifth edition. McGraw Hill India.
- Microbiology: An Introduction (2014) by Tortora, Funke and Case. Twelfth edition. Pearson Education, Inc.

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B.Sc. (Hons) Syllabus

(Effective from 2018-19)

Passed in BOS held on 07.04.2018

**B.Sc. (Hons) Biochemistry
Semester III
Core Course
ENZYMOLOGY
(BCB351)**

Credits: 4

Total Lectures: 48

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: INTRODUCTION

(12 Lectures)

Definition, historical perspective, IUB enzyme classification (rationale, overview and specific examples). Nature of non-enzymatic and enzymatic catalysis. Measurement and expression of enzyme activity, enzyme assays. Definition of IU, enzyme turn over number and specific activity. Role of non-protein organic molecules and inorganic ions, co-factors, coenzymes, prosthetic groups. Role of vitamins as coenzyme precursors (general treatment), details of coenzyme functions of NAD and pyridoxal phosphate.

UNIT II: MECHANISM OF ENZYME ACTION

(12 Lectures)

Concept of enzyme-substrate complex, evidences for the formation of enzyme-substrate complex. Nature of substrate binding sites, active sites of enzymes. Collision and transition state theory. Michaelis-Menten equation, determination and significance of V_{max} and K_m . Lock and key and induced fit model of enzyme-substrate interactions. Stereo-specificity of enzyme for substrates. Enzyme catalytic efficiency, proximity, orientation, distortion or strain, acid-base and nucleophilic catalysis.

UNIT III: ENZYME KINETICS & ALLOSTERIC ENZYMES

(14 Lectures)

Kinetics of zero and first order reactions, effect of enzyme concentration, substrate concentration, temperature and pH on enzyme activity; enzyme inhibition (reversible and irreversible inhibition). Evaluation of K_m , K_i and V_{max} in the presence of inhibitors. Significance and evaluation of energy of activation and free energy. Allosteric enzymes- definition, behavior and physiological significance.

UNIT III: INDUSTRIAL AND CLINICAL APPLICATION OF ENZYMES

(10 Lectures)

Industrial uses of enzymes; production of glucose from maltose, starch, cellulose and dextran; use of lactase in dairy industry; production of glyco-fructose syrup from sucrose. Use of proteases in food, detergent and leather industries. Medical applications of enzymes; use of glucose oxidase in enzyme electrodes.

Suggested Reading:

- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition.
- Biochemistry (1998) by GL Zubay. Fourth edition. W.C. Brown Publishers, USA
- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition.
- Biochemical Calculations by Irwin H. Segel
- Fundamentals of Enzymology (2000) by N. Price and L. Stevens.
- Understanding Enzymes by Trevor Palmer

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B.Sc. (Hons) Syllabus
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**B.Sc. (Hons) Biochemistry
Semester III
Ability Enhancement Discipline Centric Course
TOOLS AND TECHNIQUES IN BIOCHEMISTRY
(BCB352)**

**Credits: 2
Total Lectures: 24**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: BIOCHEMICAL REAGENTS AND SOLUTIONS (6 Lectures)

Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions.

UNIT II: CONCEPT OF BUFFER (6 Lectures)

Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter. Quantitative transfer of liquids.

UNIT III: SPECTROPHOTOMETRIC TECHNIQUES (6 Lectures)

Principle and instrumentation of UV-visible and fluorescence spectroscopy. Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule). Determination of concentration of a protein solution by Lowry/BCA method.

UNIT IV: CHROMATOGRAPHY TECHNIQUES (6 Lectures)

Chromatography: general principles, types and techniques; partition, size exclusion, ion exchange, and affinity chromatography.

Suggested Reading:

- Physical Biochemistry: Principles and Applications (2010) by D. Sheehan. Second edition, Wiley Blackwell (West Sussex)
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) by David Freifelder. Second Edition, W.H. Freeman and Company (New York)
- An Introduction to Practical Biochemistry (1998) by DT Plummer. Third Edition, Tata McGraw Hill Education Pvt. Ltd. (New Delhi)

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**B.Sc. (Hons) Biochemistry
Semester III
Ability Enhancement Discipline Centric Course
BIostatistics AND DATA ANALYSIS
(BCB353)**

**Credits: 2
Total Lectures: 24**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: DATA IN BIOLOGY (4 lectures)

Data in Biology: development in biostatistics; samples and populations: sampling techniques (random and stratified); sampling and non-sampling errors; accuracy and precision; frequency distributions and their graphical representations.

UNIT II: MEASURES OF CENTRAL TENDENCY AND DISPERSION (8 Lectures)

Measures of central tendency: mean, median and mode. Partition values: Quartiles, deciles and percentiles. Measures of dispersion: Range, standard deviation and coefficient of variance. Distribution patterns: normal, Binomial and Poisson distribution patterns. Skewness and Kurtosis.

UNIT III: PROBABILITY, CORRELATION AND REGRESSION (6 Lectures)

Probability: Basic concepts, addition and multiplication rules of probability, conditional probability, Bayes' theorem and its applications in biostatistics. Correlation analysis: Scatter diagrams, Pearson's and Spearman's coefficients of correlation. Regression analysis: Method of least squares, equations of lines of regression and their applications in biostatistics.

UNIT IV: HYPOTHESIS TESTING AND ANALYSIS OF VARIANCE (6 Lectures)

Hypothesis testing: concept of null hypothesis, type I and type II errors, P-value of the statistic. Student's 't' test: paired and unpaired. Chi-square test. F-test. Analysis of variance: one-way and two-way classifications.

Suggested Reading:

- Primer of Biostatistics (2011) by Stanton Glantz. Seventh edition, McGraw-Hill Medical.
- Biostatistics: A Foundation for Analysis in the Health Sciences (2013) by Wayne Daniel and Chad Cross. Tenth edition, Wiley.
- Principles of Biostatistics (2000), Marcello Pagano and Kimberlee Gauvreau. Second edition, Thompson learning.
- Biostatistical Analysis, 5th edition (2009) by Jerrold Zar. Fifth edition, Pearson.

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B.Sc. (Hons) Syllabus
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**B.Sc. (Hons) Biochemistry
Semester IV
Core Course
METABOLISM
(BCB451)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: ANAEROBIC CARBOHYDRATE METABOLISM (12 Lectures)

Definition, reactions of glycolysis; entry of galactose, fructose and mannose in glycolysis; utilization of sucrose and lactose; production of ATP and its utilization during muscle contraction; oxygen debt; alcoholic fermentation; glycogenolysis, gluconeogenesis, glycogenesis; hexose monophosphate shunt pathway and its significance; regulation of glycolysis; what happens in diabetes? galactosemia, glucose intolerance.

UNIT II: AEROBIC CARBOHYDRATE METABOLISM (12 Lectures)

History and background of the tricarboxylic acid (TCA) cycle; oxidation of pyruvate to acetyl CoA; individual reactions of the TCA cycle; energetics of the cycle; anabolic nature of TCA cycle; regulation of TCA cycle; glyoxalate cycle and its significance; electron transport and oxidative phosphorylation; energy coupling hypothesis.

UNIT III: LIPID METABOLISM (12 Lectures)

Historical development and individual reactions of beta-oxidation pathway; oxidation of unsaturated fatty acids and odd chain fatty acids; metabolism of triacylglycerols; formation and break down of ketone bodies; biosynthesis of fatty acids and cholesterol; role of serum lipoproteins (LDL, HDL) in the development of coronary heart disease.

UNIT IV: NITROGEN METABOLISM (12 Lectures)

Nitrogen balance studies in man (normal, negative and positive nitrogen balance). Urea cycle (preliminary account); transamination and deamination reactions; comparative biochemistry of nitrogen excretion; metabolism of purines and pyrimidines including regulation (preliminary account). Synthesis of biologically active amines e.g. epinephrine, non-epinephrine, dopamine, serotonin, γ -aminobutyric acid & histamine. Glutathione as cofactor.

Suggested Reading:

- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition. WH Freeman.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition. WH Freeman.
- Outlines of Biochemistry (1987) by Conn and Stumpf. Fifth edition, Wiley, New Delhi.

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**B.Sc. (Hons) Biochemistry
Semester IV
Ability Enhancement Discipline Centric Course
CLINICAL BIOCHEMISTRY
(BCB452)**

**Credits: 2
Total Lectures: 24**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT 1: INTRODUCTION (6 Lectures)

Organization of clinical laboratory. Introduction to instrumentation and automation in clinical biochemistry laboratories, safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

UNIT 2: BIOCHEMICAL CHANGES IN LIVER AND RENAL DISEASES (6 Lectures)

Hepatic and renal diseases: associated symptoms and their evaluation. Diagnostic strategies (liver and renal function tests).

UNIT 3: BIOCHEMICAL CHANGES IN CARDIAC DISEASES AND LIPID PROFILE

(6 Lectures)

Cardiac diseases: associated symptoms and their evaluation. Cardiac markers. Lipid profile: components and implications in cardiovascular disease. Clinical significance of variations in lipoproteins. Estimation of triglycerides.

UNIT 4: ASSESSMENT OF BLOOD GLUCOSE

(6 Lectures)

Clinical significance of variations in blood glucose. Estimation of blood glucose by glucose oxidase peroxidase method. Various blood glucose laboratory tests: fasting blood sugar test, post-prandial blood sugar test, glucose tolerance test, glycated haemoglobin (HbA1c).

Suggested Reading:

1. Tietz Fundamentals of Clinical Chemistry (2001), 5th ed., Burtis, C. A., Ashwood, E., R., W. B. Saunders Company, ISBN: 0-7216-8634-6
2. Harper's Illustrated Biochemistry (2015) by Rodwell, Weil, Botham, Bender, Connolly. Thirtieth edition, McGraw Hill Education.

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**B.Sc. (Hons) Biochemistry
Semester IV
Ability Enhancement Discipline Centric Course
PROTEIN PURIFICATION AND CHARACTERIZATION TECHNIQUES
(BCB453)**

**Credits: 2
Total Lectures: 24**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: PROTEIN PURIFICATION (6 Lectures)

Basic concept about purification of proteins, different techniques of protein purification: ion-exchange chromatography, gel filtration chromatography, affinity chromatography.

UNIT II: SEQUENCING, FOLDING AND DENATURATION OF PROTEINS (6 Lectures)

Protein sequencing; sequenators; quaternary structure of proteins; characteristics of molten globule state; in vivo folding; models of protein folding.

UNIT III: PROTEIN GEL ELECTROPHORESIS AND MS (6 Lectures)

Two-dimensional polyacrylamide gel electrophoresis; mass spectrometry: matrix assisted laser desorption ionization MS.

UNIT IV: PROTEIN FOLDING (6 Lectures)

Folding and denaturation of proteins. Functional proteomics; applications of proteome analysis.

Suggested Reading:

- Physical Biochemistry: Principles and Applications (2010) by D. Sheehan. Second edition, Wiley Blackwell (West Sussex)
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) by David Freifelder. Second Edition, W.H. Freeman and Company (New York)
- An Introduction to Practical Biochemistry (1998) by DT Plummer. Third Edition, Tata McGraw Hill Education Pvt. Ltd. (New Delhi)

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B.Sc. (Hons) Biochemistry

Semester IV

Open Elective Course

OUTLINES OF BIOCHEMISTRY

(BCB491)

Credits: 2

Total Lectures: 24

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: WATER

(6 Lectures)

Water and its hydrogen bonding property. pH, pKa and Henderson-Hasselbalch equation, hydrophobic and hydrophilic interactions, buffers.

UNIT II: PROTEIN CHEMISTRY

(6 Lectures)

Definition, structure of amino acids; peptide bond formation; backbone structure of proteins/polypeptides; N-terminal and C-terminal amino acids; disulphide bonds. Basic understanding of primary, secondary, tertiary and quaternary structure of proteins/peptides; elementary ideas on protein denaturation and renaturation.

UNIT III: ENZYMES

(6 Lectures)

Basics of enzymology: classification of enzymes, characteristics of enzymes, concept of holoenzyme, apoenzyme, coenzyme and cofactor; mechanism of enzyme action. Enzyme kinetics; Michaelis-Menten equation; determination and significance of V_{max} and K_M . Basic idea of enzyme inhibition.

UNIT IV: MOLECULAR BIOLOGY

(6 Lectures)

Genome, Gene and Organization: Chromatin structure. Primary and secondary structure of DNA. Watson-Crick model of DNA; supercoiling. Denaturation and renaturation of DNA.

Suggested Reading:

- Biochemistry (1998) by Geoffrey Zubay. Fourth edition, WC Brown Publishers, USA.
- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition.

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**B.Sc. (Hons) Biochemistry
Semester V
Core Course
CONCEPTS OF CELL BIOLOGY
(BCB551)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: SUBCELLULAR ORGANELLES (12 Lectures)

a) Structural organization of eukaryotic and prokaryotic cells. Ultrastructure, organization and functions of mitochondria, nucleus, endoplasmic reticulum, golgi apparatus, lysosomes and microbodies, peroxisome.

b) Structure of a typical plant cell. Cell wall – composition, structure and functions. Ultrastructure of chloroplasts. Preliminary idea of light and dark reactions of photosynthesis; photophosphorylations. Functions of vacuoles in plants.

UNIT II: MEMBRANE STRUCTURE AND FUNCTION (12 Lectures)

Functions of biological membranes. Composition - nature of lipids, proteins, carbohydrates and other molecules. Model membranes - monolayer, bilayer, liposomes. Singer and Nicholson model (fluid-mosaic model). Factors affecting membrane fluidity and asymmetry. Transport function of membranes, active and passive transport of various substances; transport via vesicle formation. Electrical properties of membrane.

UNIT III: CYTOSKELETAL PROTEINS AND TECHNIQUES IN CELL BIOLOGY (12 lectures)

a) Structure and organization of cytoskeletal filaments-microfilaments, microtubule and intermediate filaments. Assembly and movement of cilia and flagella.

b) Visualization of cells and sub-cellular components by light microscopy, different fixation and staining techniques for EM, freeze etch and freeze fracture methods for EM.

UNIT IV: CELL CYCLE, CELL DEATH AND CELL RENEWAL (12 Lectures)

Cell division-mitosis and meiosis; eukaryotic cell cycle- steps and control of cell cycle. Restriction points and check points. Brief outline of apoptosis and necrosis. Salient features of a transformed cell.

Suggested Reading:

- Cell Biology (2012) by G. Karp. Seventh edition, Wiley.
- Molecular Biology of the Cell (2014) by Alberts, Johnson, Lewis, Raff, Roberts, Walter. Sixth edition, Garland Publishing Inc. New York, USA.
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth Edition. W.H.Freeman & Co Ltd
- Molecular Cell Biology (1986) by CJ Avers. Third edition, Addison Wesley, USA.
- Cell Biology (2005) by SC Rastogi. Third edition, Tata McGraw Hill Publishing Co, New Delhi.

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B.Sc. (Hons) Syllabus
(Effective from 2018-19)
Passed in BOS held on 07.04.2018

**B.Sc. (Hons) Biochemistry
Semester V
Core Course
CONCEPTS OF IMMUNOLOGY
(BCB552)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: BASIC ASPECTS OF IMMUNITY (12 Lectures)

- (a) Innate and adaptive immunity; cellular and humoral immunity.
- (b) Definition of antigen, antibody, hapten, antigenic and haptenic determents; structure of antibody molecules, classes of antibodies; polyclonal and monoclonal antibodies.
- (c) Primary and secondary immune response; idea of vaccination, adjuvant.

UNIT II: HOST PARASITE INTERACTIONS AND ORGANS OF IMMUNE SYSTEM (12 Lectures)

- (a) Host-parasite relationship: normal flora, pathogenicity, disease progress, transmission and types of diseases, disease establishment.
- (b) Primary and secondary lymphatic organs, spleen, thymus, lymph nodes.

UNIT III: CELLS OF IMMUNE SYSTEM (12 Lectures)

General properties of effector cells, B cells and T cells (T_c), natural killer cells; NKT cells. B and T cell receptors; introduction to B and T cell receptor genes.

UNIT IV: IMMUNOLOGICAL TECHNIQUES (12 Lectures)

Introduction to various immunological techniques: ELISA, RIA, immunodiffusion, immunoelectrophoresis, immunoblotting, immunofluorescence.

Suggested Reading:

- The Elements of Immunology. (2012) by Fahim H. Khan. -2nd Imp, Pearson Education Inc.
- Kuby's Immunology (2013) by –Richard A. Goldsby, Thomas J. Kindt and Barbera A. Osborne. 7th edition, Freeman Press, New York.
- Microbiology- B.D. Davis, R. Dalbacco H.S. Ginsberg, W.B. Wood & M. Mclanty (Harper & Row Publishers) 3rd Edition.
- Immunology (2015) by I. Roit J. Bros Taft and Male. 13th edition Mosby Publishers.

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**B.Sc. (Hons) Biochemistry
Semester V
Discipline Centric Elective Course
HUMAN PHYSIOLOGY
(BCB553)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: BLOOD AND CIRCULATORY SYSTEM (12 Lectures)

Blood components and their functions; genesis of erythrocytes and leukocytes; granular and agranular systems and inflammation; phagocytosis by neutrophils and macrophages. Functions of T and B lymphocytes. Mechanism of blood clotting by intrinsic and extrinsic pathways. Structure of heart, the origin and propagation of heart beat, cardiac cycle and electrocardiogram.

UNIT II: RENAL PHYSIOLOGY AND RESPIRATORY SYSTEM (12 Lectures)

- a) Anatomy of the nephron and its organization; functions of glomerular membrane, glomerular filtration rate (GRF), structural and functional characteristics of tubules selective reabsorption and secretion by active and passive transports of various substances (sugars, amino acids, urea & creatinine), concentration of urine, role of aldosterone and antidiuretic hormone.
- b) Organization of respiratory system. Exchange of gases, transport of oxygen: role of haemoglobin, oxyhaemoglobin; dissociation curve and its significance. Transport of CO₂: Bohr's effect, isohydric transport of CO₂ and chloride shift. Acid-base balance: acidosis and alkalosis, role of lung and kidney in regulation of acid-base balance.

UNIT III: ENDOCRINE AND DIGESTIVE SYSTEM (12 Lectures)

- a) Endocrine System: A brief outline of various endocrine glands, endocrine hormones and their physiological functions; hormone receptors and their activation; general mechanism of extracellular and intracellular hormone action.
- b) Digestive System: Structure and functions of different components of digestive system; digestion and absorption of carbohydrates, lipids and proteins; role of various enzymes and hormones involved in these processes. Mechanism of HCl formation in stomach; role of bile salts in lipid digestion and absorption.

UNIT V: NERVOUS AND MUSCULO SKELETAL SYSTEM

(12 Lectures)

- a) Nervous System: Organization of nervous system, nerve cells, nerve fibers, nerve impulses, neurotransmission, synapses: chemical & electrical synapses, functional properties of nerve fibers, action potential.
- b) Physiology and Biochemistry of vision. Sensory transduction. Physiology of muscle contraction in striated and non striated muscle.

Suggested Reading:

- A Text Bok of Animal Physiology (2008) by AK Berry. Eleventh edition, Emkay Publications, New Delhi
- Guyton and Hall Textbook of Medical Physiology (2015) by JE Hall. Thirteenth edition, WB Saunders Co., USA
- Principles of Biochemistry: Mammalian Biochemistry (1985) by EL Smith, RL Hill, IR Lehman, RJ Lefkowitz, P Handler, AWhite. Seventh edition, Tata McGraw Hill International Book Co.
- Ganong's Review of Medical Physiology (2013) by Barrett, Barman, Boitano and Brooks. Twenty fourth edition, McGraw Hill.
- The department may provide write-up for some units which shall be available in the seminar library for reprography

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**B.Sc. (Hons) Biochemistry
Semester V
Discipline Centric Elective Course
BIOSAFETY AND BIOETHICS
(BCB554)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: INTRODUCTION (12 Lectures)

Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals.

UNIT II: BIOSAFETY GUIDELINES (12 Lectures)

Definition of genetically modified organisms (GMOs) and living modified organisms (LMOs) by government of India. Roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMOs. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

UNIT III: FOUNDATION OF BIOETHICS (12 Lectures)

Definition, historic evolution, codes and guidelines, universal principles. Key to the environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. Ethical use of animals in laboratory.

UNIT IV: CODES, COVENANTS, DECLARATIONS AND GUIDELINES (12 Lectures)

Bioethics in relation to profession, society, and biomedicine. Gradation of moral and ethical norms from simpler to higher levels for initiating right actions Guidelines and codes having relevance to bioethics.

Suggested Reading:

- Bioethics and Biosafety (2008) by M. K Sateesh. First edition, IK International Pvt Ltd. ISBN-13: 978-8190675703.
- The Cambridge Textbook of Bioethics (2008), Peter A. Singer and A. M. Viens. First edition, Cambridge University Press, ISBN-13: 978-0511545566.
- Foundation of Bioethics (1996) by EH Tristram. Second edition, Oxford University Press, ISBN-13: 9780195057362.
- Social Science: An Introduction to the Study of Society (2010) by EF Hunt and DC Colander. Fourteenth edition, Pearson/Allyn and Bacon, Boston, ISBN-13: 978-020570271.
- Principles of Biomedical Ethics (2011) by T Beauchamp and JF Childress. Sixth edition, Oxford University Press, 2001. ISBN-13: 978-0195143317.
- A Companion to Bioethics (2012) Helga Kuhse and Peter Singer. Second edition, John Wiley and Sons, ISBN-13: 978-1444350845.
- Bioethics: An Introduction to the History, Methods and Practice (1997) by NS Jecker, AR Jonsen, RA Pearlman. First edition, Jones and Bartlett Learning, ISBN-13: 978-0763702281.
- Genetically Modified Organisms and Biosafety (2004) by Tomme Young. First edition. ISBN-13: 978-2831707983.
- Environmental Safety of Genetically Engineered Crops (2011) by R Grumet, JF Hancock, KM Mareida, C Weebadde. First edition, Michigan State University Press ISBN-13: 978-1611860085.
- Biosafety and Bioethics (2006) by Rajmohan Joshi. First edition, Isha Books ISBN-13: 978-8182053779.
- Bioethics and Biosafety in Biotechnology (2007) by V. Sreekrishna. First edition, New Age International (P) Ltd., ISBN-13: 978-8122420852.

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B.Sc. (Hons) Syllabus
(Effective from 2018-19)
Passed in BOS held on 07.04.2018

**B.Sc. (Hons) Biochemistry
Semester V
Discipline Centric Elective Course
MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES
(BCB555)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: NUTRITIONAL DISORDERS (12 Lectures)

Overview of major and minor nutrient components in the diet. Balanced diet and the concept of RDA. Nutrient deficiencies; Kwashiorkor and Marasmus, scurvy, beri beri, pellagra and vitamin B12 deficiency, Xerophthalmia and night blindness, vitamin D deficiency, vitamin K deficiency; their symptoms.

UNIT II: METABOLIC AND LIFESTYLE DISORDERS (12 Lectures)

Obesity and eating disorders like anorexia nervosa and bulimia. Diabetes mellitus as metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress. Cardiovascular disorders and atherosclerosis-defining the ailments that fall in this category, understanding the factors that contribute to the syndrome. Irritable bowel syndrome- influence of diet, stress and environment on the condition.

Unit III: MULTIFACTORIAL COMPLEX DISORDERS AND CANCER (12 Lectures)

Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases.

Cancer: characteristics of a transformed cell, stages of cancer, proto-oncogenes and tumor suppressor genes; Disorders of mood: Schizophrenia, dementia and anxiety disorders. Polycystic ovarian syndrome, Parkinson's disease, ALS.

UNIT IV: MONOGENIC DISEASES AND DISEASES DUE TO MISFOLDED PROTEINS **(12 Lectures)**

In born errors of metabolism: PKU, alkaptonuria, maple syrup urine disease. Receptor and transport defects: cystic fibrosis, long QT syndrome, familial hypercholesterolemia, Achondroplasia. Hemoglobinopathies and clotting disorders. Etiology and molecular basis for Alzheimer's and prion diseases, Huntington's chorea, sickle cell anemia, thalassemia.

Suggested Reading:

- Textbook of Biochemistry with Clinical Correlations (2011) by TM Devlin. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
- Introduction to Human Physiology (2013) Lauralee Sherwood. Eighth edition, Brooks/Cole, Cengage Learning.
- The World of the Cell (2009) by Becker, Klionsmith, Hardin, Bertoni. Seventh edition, Pearson.
- Genetics (2012) by Snustad and Simmons. Sixth edition, John Wiley.
- The Cell: A Molecular Approach (2015) by Cooper and Hausman. Seventh edition, Sinauer Associates, MA.

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**B.Sc. (Hons) Biochemistry
Semester VI
Core Course VII
MOLECULAR BIOLOGY
(BCB651)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: DNA REPLICATION AND TRANSCRIPTION (12 Lectures)

Replication: Possible modes of replication, Meselson-Stahl experiment, origin of replication in *E. coli*, major proteins and enzymes involved in replication process; DNA replication in nut shell, rolling circle model of replication.

Transcription: Mechanism of transcription, DNA dependent RNA polymerase(s), recognition, binding and initiation sites, TATA/Pribnow box, transcription termination. Post-transcriptional modifications; inhibitors of transcription.

UNIT II: GENETIC CODE AND TRANSLATION (12 Lectures)

Genetic Code: Basic features of genetic code, biological significance of degeneracy, Wobble hypothesis, gene within genes, overlapping genes, split genes and pseudogenes, Universality of genetic code and its exceptions, single coding system between nucleic acids and amino acids.

Mechanism of Translation: Ribosome structure, A and P sites; charged tRNA, f-met tRNA, initiation codon and non-sense codons, Shine-Dalgarno consensus sequence, formation of 70S initiation complex, role of EF-Tu, EFTs, EF-G, GTP and release factors (RF1 and RF2). Post-translational modifications and inhibitors of protein synthesis.

UNIT III: REGULATION OF GENE EXPRESSION IN PROKARYOTES (12 Lectures)

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, regulation of lac operon and trp operon, attenuation, transcriptional regulation in λ -bacteriophage.

UNIT IV: REGULATION OF GENE EXPRESSION IN EUKARYOTES (12 Lectures)

Heterochromatin, euchromatin, chromatin remodeling, regulation of galactose metabolism in yeast, regulation by phosphorylation of nuclear transcription factors, role of chromatin structure in gene expression.

Suggested Reading:

- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition.
- Molecular Biology of the Gene (2017) by Watson, Hopkin, Roberts, Stertz, Weiner, Freeman Pub., San Francisco.
- Principles of Genetics (2006) by Gardner, Simmons and Snustad. Eighth edition, John Wiley & Sons, New York, USA.
- Molecular Biology: Principles of Genome Function (2010) by Nancy Craig, Orna Cohen-Fix, Rachel Green, Carol Greider, Gisela Storz and Cynthia Wolberger. Second edition, Oxford.
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth Edition. W.H.Freeman & Co Ltd

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**B.Sc. (Hons) Biochemistry
Semester VI
Core Course
CONCEPTS IN GENETICS
(BCB652)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: INTRODUCTION TO MODEL ORGANISMS AND MENDELISM

(12 Lectures)

Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, T-even bacteriophages and *Arabidopsis thaliana*. Basic principles of heredity. Chromosomal basis of Mendelism - Sutton and Boveri hypothesis.

UNIT II: EXTENSIONS OF MENDELISM

(12 Lectures)

Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles, pseudoalleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic. Penetrance and expressivity. Basic aspects of Hardy-Weinberg principle.

UNIT III: BACTERIAL AND BACTERIOPHAGE GENETICS

(14 Lectures)

Complementation test, limitations of *cis-trans* test, intragenic complementation, rII locus of T4 phage and concept of cistron. Mechanism of genetic exchange in bacteria- conjugation, transformation and transduction. Types of recombinations and their mechanism.

UNIT IV: DNA REPAIR AND MUTATIONS

(10 Lectures)

Types of mutations, molecular bases of mutations. DNA repair and its mechanisms.

Suggested Reading:

- Genetics (2012) by Gardner, Simons and Snustad. Sixth edition, John Wiley.
- Genetics - A Conceptual Approach (2016) by BA Pierce. Sixth edition, WH Freeman & Co. (New York).
- An Introduction to Genetic Analysis (2011) Griffiths, Wessler, Carroll and Doebley. Tenth edition, WH Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

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**B.Sc. (Hons) Biochemistry
Semester VI
Elective Discipline Centric Course
NUTRITIONAL BIOCHEMISTRY
(BCB653)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: INTRODUCTION TO NUTRITION AND ENERGY METABOLISM

(12 Lectures)

Definition, historical perspective; types and functions of nutrients. Definition and unit of energy. Positive and negative energy balance. Measurement of energy content of food and physiological energy value of foods. Direct and indirect calorimetry and Respiratory Quotient. Estimation of energy requirement and energy expenditure with reference to man. Basal and resting metabolism- determination of BMR and factors affecting BMR. Specific dynamic action of food. Balanced diet and factors considered in planning it. Recommended nutrient intakes (RNI) and recommended dietary allowances (RDA) for different age groups.

UNIT II: DIETARY CARBOHYDRATES AND LIPIDS

(12 Lectures)

- a) Review of the functions of carbohydrates. Digestion, absorption, utilization and storage. Hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates. Dietary fiber- sources and their role in health.
- b) Review of classification, sources, functions, digestion, absorption, utilization and storage of lipids. Role of dietary fiber in lipid metabolism. Essential fatty acids. Functions of EFA, RDA – excess and deficiency of EFA. Lipotropic factors, role of saturated fats, cholesterol, lipoproteins and triglycerides. Importance of the following in the body: Omega – fatty acids; ratio of Omega3 and Omega6 fatty acids; Phospholipids; Cholesterol; mono and poly-unsaturated fatty acids and saturated fatty acids.

UNIT III: DIETARY PROTEINS

(12 Lectures)

Review of functions of proteins in the body. Digestion and absorption. Essential and non-essential amino acids. Amino acid availability, antagonism, toxicity and imbalance. Amino acid supplementation; effects of deficiency. Food source and RDA for different age groups. Amino acid pool. NPU, biological value, nitrogen balance. PEM and Kwashiorkor. Integration of metabolism of proteins, fats and carbohydrates.

UNIT IV: VITAMINS AND MINERALS

(12 Lectures)

Vitamins A, C, E, K, B complex and D-their dietary sources, RDA, Absorption, distribution, metabolism, excretion (ADME) and deficiency. Calcium, phosphorus and iron - distribution in the body, digestion, absorption, utilization, transport, excretion, balance, deficiency, toxicity, sources and RDA. Role of iron in prevention of anemia, Calcium: Phosphorus ratio. Iodine, fluoride, Mg, Cu, Zn, Se, Mn, Cr, Mo- distribution in the human body, physiology, functions, deficiency, toxicity and sources. Iodine cycle.

Suggested Reading:

- Textbook of Biochemistry with Clinical Correlations (2011) by TM Devlin. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
- Essentials of Clinical Nutrition (1988) by EB Feldman. Davis Company ISBN-0-8036-3431-
- Nutrition for Health, Fitness and Sport (2013); Williams.M.H, Anderson, D.E, Rawson, E.S. McGraw Hill international edition. ISBN-978-0-07-131816-7.
- Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings,S.E, Raymond,J. Elsevier's Publications. ISBN- 978-1-4377-2233-8.
- The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
- Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press

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B.Sc. (Hons) Syllabus
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**B.Sc. (Hons) Biochemistry
Semester VI
Elective Discipline Centric Course
RECOMBINANT DNA TECHNOLOGY
(BCB654)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: Sessional for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: (12 Lectures)

Tools of recombinant DNA technology: Enzymes used in genetic engineering e.g. Restriction endonucleases, SI nucleases, DNA ligases, Alkaline phosphatase, Reverse transcriptase, DNA polymerase, poly nucleotide kinase, terminal transferase. Cloning vectors: General properties of ideal cloning vectors.

UNIT II: (12 Lectures)

Construction of chimeric DNA molecules. Isolation of plasmid DNA, genomic DNA. Sequencing methods; Sanger's dideoxy chain termination method, Maxam Gilbert chemical degradation method.

UNIT III: (12 Lectures)

Amplification of genomic DNA and cDNA by PCR. Cloning of PCR products. Applications of PCR. Expression vectors, Expression construct. Different types of expression system.

UNIT IV: (12 Lectures)

Transgenic organisms. regulation of GM organisms, Molecular diagnostics; high throughput methods of DNA analysis, DNA microarrays, DNA fingerprinting and its applications, Gene therapy, DNA vaccines.

Suggested Reading:

- Molecular cloning: A Laboratory Manual: volumes 1-3 (2012) by Green and Sambrook. Fourth edition, Cold Spring Harbor Laboratory Pub.
- Principles of Gene Manipulation and Genomics (2016) by Primrose and Twyman. Eighth edition, Wiley.

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**B.Sc. (Hons) Biochemistry
Semester VI
Elective Discipline Centric Course
MOLECULAR BASIS OF INFECTIOUS DISEASES
(BCB655)**

**Credits: 4
Total Lectures: 48**

NOTE: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

UNIT I: CLASSIFICATION OF INFECTIOUS AGENTS (12 Lectures)

Past and present, emerging and re-emerging infectious diseases and pathogens. Concept of infection and evasion. Source, reservoir and transmission of pathogens. Antigenic shift and antigenic drift. Overview of viral and bacterial pathogenesis. Infection and evasion.

UNIT II: OVERVIEW OF DISEASES CAUSED BY BACTERIA (12 Lectures)

Study of important bacterial diseases- Tuberculosis, typhoid, diphtheria, pertussis, tetanus, and pneumonia. Causative agent, molecular basis of infection and pathogenicity. Therapeutics, and vaccines. Drug resistance and implications for public health.

UNIT III: OVERVIEW OF DISEASES CAUSED BY VIRUSES (12 Lectures)

Study of AIDS, history, causative agent, pathogenesis, diagnostics, drugs. Brief idea of hepatitis, influenza, rabies, chikungunya and polio.

UNIT IV: OVERVIEW OF DISEASES CAUSED BY PROTOZOA AND OTHER PARASITES (12 Lectures)

Study of malaria- vectors, life cycle, diagnostics, drugs. Brief study of trypanosomiasis, leishmaniasis, amoebiasis

Suggested Reading:

- Prescott, Harley, Klein's Microbiology (2008) by JM Willey, L Sherwood, CJ Woolverton. Seventh edition, Graw Hill International Edition (New York).
- Mandell, Douglas and Bennett.S, Principles and Practices of Infectious diseases,7th edition, Volume, 2. Churchill Livingstone Elsevier.
- Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
- Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences.