

Learning Outcome Based Curriculum of
2-Years Master of Science (M.Sc.) Courses in
Biochemistry



Department of Biochemistry

Faculty of Science

University of Allahabad, Prayagraj-211002

(Session 2025-26 onwards)

(Revised in the light of NEP-2020)

Learning Outcomes Descriptors and Program Outcomes (POs) for Master's degree:

The Master's degree qualifies students who can apply an advanced body of knowledge in a range of contexts for professional practice, research, and scholarship and as a pathway for further learning. Graduates at this level are expected to possess and demonstrate specialized knowledge and skills for research, and/or professional practice and/or for further learning. Master's degree holders are expected to demonstrate the ability to apply the established principles and theories to a body of knowledge or an area of professional practice

Descriptor	Knowledge and understanding: The graduates should be able to demonstrate the acquisition of:
P.O. 1.	advanced knowledge about a specialized field of enquiry with a critical understanding of the emerging developments and issues relating to one or more fields of learning,
P.O. 2.	advanced knowledge and understanding of the research principles, methods, and techniques applicable to the chosen field(s) of learning or professional practice,
P.O. 3.	procedural knowledge required for performing and accomplishing complex and specialized and professional tasks relating to teaching, and research and development.
Descriptor	General, technical and professional skills required to perform and accomplish tasks: The graduates should be able to demonstrate the acquisition of:
P.O. 4.	advanced cognitive and technical skills required for performing and accomplishing complex tasks related to the chosen fields of learning.
P.O. 5.	advanced cognitive and technical skills required for evaluating research findings and designing and conducting relevant research that contributes to the generation of new knowledge.
P.O. 6.	specialized cognitive and technical skills relating to a body of knowledge and practice to analyze and synthesize complex information and problems.
Descriptor	Application of knowledge and skills: The graduates should be able to demonstrate the ability to:
P.O. 7.	apply the acquired advanced theoretical and/or technical knowledge about a specialized field of enquiry or professional practice and a range of cognitive and practical skills to identify and analyze problems and issues, including real-life problems, associated with the chosen fields of learning.
P.O. 8.	apply advanced knowledge relating to research methods to carry out research and investigations to formulate evidence-based solutions to complex and unpredictable problems.
Descriptor	Generic learning outcomes: The graduates should be able to demonstrate the ability to:
P.O. 9.	listen carefully, read texts and research papers analytically and present complex information in a clear and concise manner to different groups/audiences,

P.O. 10.	communicate, in a well-structured manner, technical information and explanations, and the findings/results of the research studies undertaken in the chosen field of study,
P.O. 11.	present in a concise manner view on the relevance and applications of the findings of recent research and evaluation studies in the context of emerging developments and issues.
P.O. 12.	evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
P.O. 13.	meet one's own learning needs relating to the chosen fields of learning, work/vocation, and an area of professional practice,
P.O. 14.	pursue self-paced and self-directed learning to upgrade knowledge and skills, including research-related skills, required to pursue a higher level of education and research.
P.O. 15.	problematize, synthesize, and articulate issues and design research proposals,
P.O. 16.	define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships,
P.O. 17.	develop appropriate tools for data collection for research,
P.O. 18.	the ability to use appropriate statistical and other analytical tools and techniques for the analysis of data collected for research and evaluation studies,
P.O. 19.	plan, execute, and report the results of an investigation,
P.O. 20.	follow basic research ethics and skills in practicing/doing ethics in the field/ in one's own research work.
P.O. 21.	make judgements and take decisions regarding the adoption of approaches to solving problems, including real-life problems, based on the analysis and evaluation of information and empirical evidence collected.

P.O. 22.	make judgement across a range of functions requiring the exercise of full responsibility and accountability for personal and/or group actions to generate solutions to specific problems associated with the chosen fields/subfields of study, work, or professional practice.
Descriptor	Constitutional, humanistic, ethical, and moral values: The graduates should be able to demonstrate the willingness and ability to:
P.O. 23.	embrace and practice constitutional, humanistic, ethical, and moral values in one's life,
P.O. 24.	adopt objective and unbiased actions in all aspects of work related to the chosen fields/subfields of study and professional practice,
P.O. 25.	participate in actions to address environmental protection and sustainable development issues,
P.O. 26.	support relevant ethical and moral issues by formulating and presenting coherent arguments,

P.O. 27.	follow ethical principles and practices in all aspects of research and development, including inducements for enrolling participants, avoiding unethical practices such as fabrication, falsification or misrepresentation of data or committing plagiarism.
Descriptor	Employability and job-ready skills, and entrepreneurship skills and capabilities/ qualities and mindset: The graduates should be able to demonstrate the acquisition of knowledge and skill sets required for:
P.O. 28.	adapting to the future of work and responding to the demands of the fast pace of technological developments and innovations that drive the shift in employers' demands for skills, particularly with respect to the transition towards more technology-assisted work involving the creation of new forms of work and rapidly changing work and production processes.
P.O. 29.	exercising full personal responsibility for the output of own work as well as for group/team outputs and for managing work that is complex and unpredictable requiring new strategic approaches.

PSO No.	Program Specific Outcome
PSO1	Develop an in-depth understanding of advanced concepts in biochemistry, including metabolism, enzymology, molecular biology, immunology, and cell signaling.
PSO2	Acquire proficiency in modern biochemical, biophysical, and molecular techniques for experimentation and analysis.
PSO3	Critically analyze, interpret, and evaluate experimental and literature-based data to generate new scientific insights.
PSO4	Apply biochemical knowledge to interdisciplinary areas such as biotechnology, molecular medicine, and bioinformatics to solve real-world biological problems.
PSO5	Demonstrate research competence, ethical responsibility, effective communication, and professional skills necessary for academic, industrial, and clinical careers.

Evaluation Pattern: The assessment and evaluation of students shall adhere to the Choice Based Credit System (CBCS) regulations of the University of Allahabad. Students' performance in all courses shall be evaluated through two components: continuous assessment and end-term examination. Continuous assessment, which constitutes 40% of the overall marks assigned to a particular course, may include tests, assignments and practical, depending on the course requirements. The end-term examination shall account for the remaining 60% of the marks, in line with university norms. This evaluation pattern also applies to dissertation course in 4th semester. However, for these courses the end-term examination will involve seminar presentations, viva-voce, and other modalities as determined by the external/internal Board of Examiners appointed by the Board of Studies (BoS) of the department. This comprehensive assessment

approach ensures a balanced evaluation of students' academic performance, integrating both theoretical understanding and practical application.

Continuous Assessment of 40% weightage: For the theory courses, the continuous assessment shall be done in 40 marks, which include:

(I) Unit Test (T1/T2)- 20 Marks

(II) Mid-Term examination (T2)- 20 Marks

The best of (T1) and (T2) shall be counted for semester grade sheet.

The continuous assessment of courses of Dissertation shall also be done in 40 marks as per the modalities describe in the respective courses.

End-term Examination of 60% weightage: The end-term examination of all courses shall be done in 60 marks. The question paper of all the ***theory courses shall be of 60 marks consisting 5 questions with internal choices as per university norm. The duration of the examination shall be of 3 hours.***

The End-term assessment of Dissertation courses shall also be done in 60 marks by the internal board of examiners appointed by the Board of Studies (BoS) of the department.

Any changes in assessment pattern shall be subjected to changes in Choice Based Credit System (CBCS) regulation of the university.

**DEPARTMENT OF BIOCHEMISTRY
FACULTY OF SCIENCE
UNIVERSITY OF ALLAHABAD, PRAYGARAJ
(w.e.f. 2025-26 onwards)**

(Revised in the light of NEP-2020)

PROGRAMME STRUCTURE FOR M.Sc.

M. Sc Program

M. Sc Biochemistry Semester I	
Theory Papers	Credits
BCH 501: Biophysical and analytical principles	4
BCH 502: Chemistry of Biomolecules	4
BCH 503: Human Physiology	4
BCH 504: Cell Biology	4
Practical	
BCH 531: Practical Biochemistry – Lab practical, Viva voce, Seminars	
M. Sc. Biochemistry Semester II	

Theory Papers	
BCH 505: Tools and Techniques in Biochemistry	4
BCH 506: Enzymology	4
BCH 507: Endocrinology and Clinical Biochemistry	4
One Elective Paper (BCH 551 or BCH 552)	4
BCH 551: Microbiology	
BCH 552: Research Methodology and Biostatistics	
Practical	
BCH 532: Practical Biochemistry - Lab practical, Viva voce, Seminars	
M. Sc. Biochemistry Semester III	
Theory Papers	
BCH 508: Intermediary Metabolism	4
BCH 509: Molecular Biology	4
BCH 510: Immunology	4
One Elective Paper (BCH 553 or BCH 554)	4
BCH 553: Nutritional Biochemistry & Toxicology	
BCH 554: Human Health and Disease	
Practical	
BCH 533: Practical Biochemistry - Lab practical, Viva voce, Seminars	
M. Sc. Biochemistry Semester IV	
BCH 511: Dissertation -Research Methodology	3
BCH 512: Dissertation -Thesis Writing	7
BCH 513: Dissertation - Experimental Performance Appraisal	4
BCH 514: Dissertation Work PowerPoint Presentation	3
BCH 515: Biochemistry Course Viva voce	3
Ph. D. Program	

Semester 1

BCH 501	Biophysical and analytical principles
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Course Objectives:

To introduce the fundamental principles of electrochemistry and their relevance in biochemical systems, including pH, buffers, enzyme electrodes, and biosensors.

To explain the laws of thermodynamics and their application to biological energetics, energy compounds, and coupled reactions.

To develop an understanding of photometric and spectrophotometric techniques for analyzing biomolecules.

To familiarize students with various spectroscopic techniques and their use in studying the structure and function of biological molecules.

To expose students to advanced analytical and biophysical methods such as mass spectrometry, circular dichroism, and X-ray diffraction for molecular characterization.

Course learning outcome

CO 1: Explain the basic principles of electrochemistry, including pH, buffers, enzyme electrodes, and biosensors.

CO 2: Interpret the laws of thermodynamics and apply them to analyze biological energy transformations and coupled reactions.

CO 3: Describe the principles, instrumentation, and applications of photometric and spectrophotometric techniques (colorimetry, UV-Vis, IR, fluorescence).

CO 4: Differentiate and analyze the principles and applications of atomic absorption, emission, NMR, ESR, and EPR spectroscopy.

CO 5: Evaluate advanced analytical tools such as mass spectrometry, MALDI-TOF, circular dichroism, and X-ray diffraction in structural biology.

CO 6: Integrate knowledge of biophysical and analytical techniques to design experimental strategies for studying biomolecular properties.

Mapping of Course outcomes:

Course Learning Outcomes (COs)	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO7	PO8
CO1	✓	✓				✓		
CO2	✓		✓			✓		
CO3		✓	✓			✓		
CO4	✓	✓	✓			✓		
CO5	✓	✓	✓	✓			✓	✓
CO6		✓	✓	✓	✓		✓	✓

Course content:

Unit-1: Electrochemistry: pH, Buffers, Enzyme Electrode, Biosensors.

Unit-2: Energetics and Thermodynamic considerations: Laws of Thermodynamics, Gibbs Free Energy, Biological Order. Coupled Reactions, Ion-Electrochemical potentials. Entropy, Energy Compounds, Energy Interconversions.

Unit-3: Photometry: Principle and Instrumentation of a simple and double beam spectrophotometer, applications of Colorimetry, Spectrophotometry (Visible, UV and IR), Fluorometry.

Unit-4: Spectroscopy 1: Principles and Applications to Biological Problems

Atomic Absorption and Emission Spectroscopy, NMR, EPR Spectroscopy, ESR Spectroscopy.

Unit-5: Spectroscopy 2: Mass Spectroscopy, X-Ray Diffraction, Circular Dichroism, MALDI-TOF.

Suggestive Readings:

Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). New York: W. H. Freeman and Company.

Wilson, K., & Walker, J. (Eds.). (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge: Cambridge University Press.

West, E. S., Todd, W. R., Mason, H. S., & Van Bruggen, J. T. (1974). *Textbook of Biochemistry* (4th ed.). New Delhi: Oxford & IBH Publishing Co.

BCH 502	Chemistry of Biomolecules
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Course content:**Unit-1:**

Biomolecules: Molecular logic of life: Meaning and importance in the functional organization of the cell. Informational and non-informational biomolecules.

Unit-2:

Carbohydrates: Structure, properties, classification, function and biological importance. Mono-, di-oligo- and polysaccharides. Chain and ring structures. Optical isomerism. Homopolysaccharides, glycolipids, proteoglycans, mucopolysaccharides, peptidoglycans, hemicelluloses, lignins. Bioactive carbohydrates.

Unit-3:

Lipids: Structure, properties, classification, function and biological importance. Storage lipids. Structural lipids in membranes. Phosphoglycerides, Plasmalogens, (Lecithins, PE, PS, Phosphatidyl Inositols), Sphingomyelins, Ceramides, Glycolipids, Prostaglandins. Lipids as signals, cofactors and pigments. Phosphatidylinositol-based lipids in cell signaling. Isoprenoids and sterols.

Unit-4

Proteins: Classification and functional diversity of proteins. Amino acids: classification and properties. Overview of Protein structure: Primary, Secondary, Tertiary and Quaternary structures. Protein denaturation. Sequencing, Protein folding. Role of Heat shock proteins. Structure-function relationship: Hair. Silk. Prions.

Nucleic acids: Structure of nucleotides and formation of polynucleotide chain. Structure and function of DNA and RNA. Watson Crick model of DNA. Various forms of DNA. Nucleic acid chemistry. Cofactor functions of nucleotides.

Unit-5:

Plant-based polyphenols: -Classification, structure and biological activity.

Vitamins and Hormones: Chemical nature, active form, and analogues.

BCH 503	Human Physiology
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Course content:**Unit-1**

Functional organization of the human body and homeostasis: Intracellular and extracellular division of body fluids, the concept of homeostasis and feedback control systems. Major transport mechanisms through the cell membrane.

Digestion and absorption in the gastrointestinal tract: Digestion and absorption of carbohydrates, fats, proteins, vitamins and minerals. Endocrine control of digestive and absorptive processes.

Unit 2

Nerve-impulse transmission system: Sensory and motor nerves, major levels of nervous system function, Central and autonomic nervous systems. Generation of nerve impulse: Membrane potentials, action potentials, transmission of nerve impulse, synapse, neurotransmitters.

Vision: Receptor and neural functions of the retina. The visual cycle. Light and Dark adaptation. Color vision.

Blood: Composition of blood. Erythrocytes: Properties. Functions Hemopoiesis. Hemoglobin: structure and function. Anemias.

Hemostasis and blood coagulation: Events, Mechanism. Thromboembolic conditions.

Blood group substances, transfusion. Tissue transplant: Role of HLA typing.

Unit-3

Resistance of the body to infection: Innate and acquired immunity. Leucocytes in immunity. Elements of the immune response. B- and T- lymphocytes. Humoral and cell mediated immunity. Clonal Selection theory. Immunoglobulins: structure and functions. Principles of vaccination.

Unit-4

The Cardiac cycle and ECG: The heart as a pump. The normal ECG. Applications in diagnostics.

Regulation of acid-base balance: Role of buffers in blood, respiratory control, renal controls. Transport and exchange of respiratory gases. Carbon Dioxide dissociation curve. Bohr's effect. Haldane effect.

Unit-5

Principles of urine formation: Glomerular and tubular function. Mechanisms for control of urine composition.

Regulation of Extracellular Fluid Osmolarity and Sodium Concentration: osmotic balance in the extracellular fluid. Role of the kidney in water balance. The antidiuretic hormone.

BCH 504	Cell Biology
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Course content:

Unit-1:

Ultra structure of cell: Study of cells, organization of cellular components.

Unit-2:

Biomembrane and cell architecture: Lipid bilayer and membrane assembly, membrane carbohydrates, phospholipids and asymmetric organization. GPI-anchored protein and their dynamism, membrane transport of small molecules. Membrane transport of macromolecules, exocytosis, endocytosis (Fluid phase, receptor mediated) and transcytosis, ATP

Unit-3:

Membrane Traffic and sorting events: Compartmentalization of higher cells, nuclear export and import of proteins, mitochondrial export and import of proteins, signal hypothesis, secretory-Endocytic vesicular path-ER-Golgi Lysosome and secretory vesicles, co-translational and post translational modifications (of proteins and sorting events, Anterograde and Retrograde hypotheses)

Unit-4:

Cell cycle and programmed cell death: Cell cycle. Yeast as a model system, Yeast odc. Genes for social control of cells, mechanism of cell division (cyclins). Apoptosis.

Unit-5:

Organization of genetic material in prokaryotes and eukaryotes: Concept of gene, Satellite DNA, Cot value, Reassociation kinetics, C value paradox, nucleosome structure

Semester 2

BCH 505: Tools and Techniques in Biochemistry

Course Objectives

The course aims to:

1. Introduce the fundamental principles and applications of modern biochemical techniques used for separation, analysis, and characterization of biomolecules.
2. Provide understanding of centrifugation, chromatography, and electrophoresis methods in biochemical research.

3. Familiarize students with immunological and radiolabeling techniques for detection and quantification of biological molecules.
4. Develop conceptual knowledge and operational understanding of microscopic and isotopic tracer techniques.
5. Enable students to select appropriate tools and techniques for solving biochemical problems in research and diagnostics.

Course Learning Outcomes

After successful completion of this course, the student will be able to:

CO 1: Explain the principles and applications of centrifugation techniques for separation of cellular components.

CO 2: Describe different chromatographic methods and their role in purification and analysis of biomolecules.

CO 3: Demonstrate understanding of electrophoretic and immunological techniques used for detection and characterization of proteins and nucleic acids.

CO 4: Interpret the principles, instrumentation, and applications of microscopic techniques in studying biological structures.

CO 5: Discuss radioisotope tracer techniques and their applications in biochemical and molecular biology research.

Mapping of Course outcomes:

Course Outcomes (COs)	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2
CO 1	✓	✓		✓		✓	✓
CO 2	✓	✓	✓	✓		✓	✓
CO 3	✓	✓	✓	✓	✓	✓	✓
CO 4	✓	✓		✓		✓	✓

CO 5	✓	✓	✓	✓	✓	✓	✓
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Course content

Unit -1:

Centrifugation Techniques: Differential, Zonal, Density-gradient and Ultracentrifugation.

Unit-2:

Chromatography: Adsorption, Partition, Ion-Exchange, Chromatofocussing, Reverse- Phase, Covalent, Gel Filtration. Affinity Chromatography, GPLC, FPLC.

Unit-3:

Electrophoretic Techniques: Paper and Gel Electrophoresis (Agarose, and SDS) 2-D Gel Electrophoresis, Pulsed-Field Gel Electrophoresis, Isoelectric Focussing.

Immunological Techniques Gel Diffusion, Immuno-electrophoresis, Ouchterlony. Radioimmunoassay, ELISA, Immunoblotting. Fluorescent Immunoassays.

Unit-4 :

Microscopy: Principles and applications of Light, Phase-contrast and Electron- Microscopy (SEM, TEM and Immune electron microscopy [IEM]).

Unit-5:

Radioisotopic Tracer Techniques: Detection and measurement of isotopes, GM and Scintillation Counters, Autoradiography, Fluorography, Applications in biology.

Suggested reading

Wilson, K., & Walker, J. (Eds.). (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge: Cambridge University Press.

BCH 507	Enzymology
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Course content:

Unit-1:

Enzyme Classification : Recommendation and Systemic Nomenclature.

Enzyme Chemistry: Subcellular Distribution of Enzymes. Isolation and Purification of Enzymes, Criteria for Enzyme homogeneity, General Properties, Enzyme Activity , Specific Activity and Turnover Number, Marker Enzymes.

Unit-2:

Enzyme Kinetics: Enzyme-Substrate Interaction, ES Complex, Binding Site, Active Site. Specificity, Steady-State, Pre-Steady State and Equilibrium-State Kinetics, Michael- Menten Equation and its derivation, Graphical Methods for determination of K_m , V_{max} . Significance.

Factors affecting Initial rate of Enzyme-catalysed Reaction: Enzyme, Substrate, pH, temperature. Collision and transitional state theories, Significance of Activation, Energy, Mechanism of bisubstrate and multisubstrate reaction, Methods for identifying mechanism.

Unit-3:

Enzyme Inhibition and Activation: types of inhibition, and activation, Competitive non-competitive and Uncompetitive inhibitors, Determination of K_i , Suicide Inhibitors.

Mechanism of Enzyme action: enzyme-substrate complementarity, Stereochemistry of enzyme substrate action, factors associated with catalytic efficiency.

Unit-4:

Enzyme regulation: Allosteric and Hysteric Enzymes, Proenzymes-Zymogens and activation.

Structure and Function of Selected Enzymes: Chemical modification of active-site group. Chymotrypsin. Glyceraldehyde-3P- Dehydrogenase, Serine and Cysteine Proteases.

Unit-5:

Multi Enzyme Complexes: Significance. Examples.

Immobilized Enzymes: Immobilization methods, Kinetics, Industrial applications

Enzyme engineering and Co-Factor Engineering: Ribozymes, Abzymes.

BCH 508	Endocrinology and Clinical Biochemistry
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Course content:

Unit-1:

Endocrinology: Introduction to endocrinology. Mechanism of hormone action, signaling pathways, G proteins, second messengers, lipids as signaling molecules.

Unit-2:

Chemistry, functions, deficiency conditions and feedback controls of hormones produced by: Pituitary. Thyroid. Parathyroid. Pancreas. Gonads: Ovary, Testis. Pineal gland. Other hormone producing structures. Autocrine and paracrine compounds. Prostaglandins.

Unit-3:

Meaning and scope of Health vs. Disease. Importance of Clinical Biochemistry. Factors affecting results in a clinical setting. Reference ranges: computation and significance. Clinical utility. True and false positives and negatives in disease diagnosis.

Unit-4:

Biochemical Assessment of health: Analytes in blood, urine, tissues. Complete Blood Count: Hemoglobin, hematocrit, total and differential leukocyte count, microscopy of erythrocytes. Plasma proteins. Glucose tolerance test,

Unit-5:

Tests for organ functions: Renal function tests, Liver function tests.

Other enzymes in disease diagnosis: acid phosphatase, alkaline phosphatase, amylase, angiotensin converting enzyme, cholinesterase, creatine phosphokinase, gamma glutamyltransferase, lactate dehydrogenase, rennin,

Free radicals and the link between diet and disease: Generation, stability and quenching of free radicals. ROS and RNS. Role in intracellular signaling. Concept of oxidative stress and resulting damage to biomolecules. Antioxidant defense systems. Dietary antioxidants.

BCH 551	Microbiology
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Unit-1:

Isolation and identification of microbes: Sterilization, Types of media, plating techniques, Staining techniques

Unit-2:

Biology of Microbes: Classification of bacteria, Bacterial cell wall biosynthesis and action of antibiotics, Nutrition, physiology and growth characteristics of bacteria. Special features of bacterial metabolism. Protozoa. Host-parasite interaction. Food-borne infections.

Unit-3:

Microbial Genetics: Gene transfers in bacteria.

Unit-4:

Microbial fermentation: Antibiotics, organic acids, and vitamins, Microbial transformations.

Microbes in Decomposition and Recycling Processes: Symbiotic and non-symbiotic, Nitrogen Fixation, Microbiology of water, air, soil, and sewage. Microbial leaching of minerals

Unit-5:

Applications of microbes: in medicine, industry, agriculture and environment.

Viruses: General Properties and Classification, Replication, Retroviruses and Reverse Transcriptase, Interferons, Bacteriophages.

BCH 552	Research Methodology and Biostatistics
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Unit-1:

Methodology of Scientific Research: Nature of scientific method. The research process. Research designs in Biochemistry: exploratory, case-control, cohort, observational, cross-sectional, longitudinal, experimental, in vitro, in vivo, in situ. Clinical trials. Advantages and limitations. Identifying variables. Independent and dependent variables. Hypothesis formulation and testing. Internet resources for literature.

Unit-2:

Statistical procedures in Biochemistry: Sources of variation. In a Lab setting and in a clinical setting. Analytical, Physiological errors. Sampling techniques. Randomization.

Unit-3:

Measures of Central Tendency: Class intervals. Frequency distribution. Mean, Median, Mode. The Gaussian Probability Distribution. Standard deviation. Variation. Standard error. Confidence intervals. Significance testing. Reference Ranges.

Unit-4:

Correlation. Correlation coefficient. Uses.

Other measures in data analysis: Chi square. Odds ratio. One-way and two-way ANOVA

Unit-5

Use of computers for statistical analysis. Statistical packages. Multiple Linear regression. MANOVA.

Introduction to Bioinformatics: Biological Databases, Search and analysis.

Semester 3

BCH 508: Intermediary Metabolism

Course Objectives:

The course aims to:

1. Provide a comprehensive understanding of the organization, principles, and regulation of metabolic pathways.
2. Explain the mechanisms of energy production and utilization in carbohydrate, lipid, protein, and nucleic acid metabolism.
3. Describe the integration and interconnection of metabolic pathways in maintaining cellular and organismal homeostasis.
4. Discuss the biochemical basis of inborn errors and metabolic disorders.
5. Relate metabolic processes to physiological, nutritional, and clinical contexts.

Course Learning Outcomes (CLOs):

After successful completion of this course, the student will be able to:

CO 1: Explain the fundamental design and principles of metabolism, including high-energy compounds and energy transduction.

CO 2: Describe the pathways of carbohydrate metabolism, their regulation, and their interconnections with energy-yielding processes.

CO 3: Interpret the mechanisms of oxidative phosphorylation, electron transport chain, and photosynthetic energy conversion.

CO 4: Discuss the catabolic and anabolic pathways of lipid and nucleic acid metabolism, including their regulation and interrelationships.

CO 5: Illustrate the metabolic fate of amino acids, nitrogen metabolism, and the biochemical basis of inborn errors of metabolism.

Mapping of Course outcomes:

Course Outcomes (COs)	PSO1	PSO2	PSO3	PSO4	PSO5	PO1-PO3
CO 1	✓			✓		✓
CO 2	✓		✓	✓		✓
CO 3	✓		✓	✓		✓
CO 4	✓		✓	✓		✓
CO 5	✓		✓	✓	✓	✓

Course content

Unit-1:

Introduction to metabolism: Basic concepts and design. High energy compounds.

Unit-2:

Carbohydrate metabolism: An overview of aerobic and anaerobic carbohydrate metabolism. Glycolysis and the catabolism of hexoses. Feeder pathways. Regulation. Pentose phosphate pathway. Utilization of glycogen. The Citric Acid cycle. Anaplerosis. Regulation. The glyoxylate cycle. Carbohydrate biosynthesis. Gluconeogenesis. Glycogen synthesis. Glycogen storage diseases. Glucuronic acid pathway.

Unit-3:

Oxidative phosphorylation: Electron transport chain and formation of ATP. Regulation. Inhibitors and uncouplers of ETC.

Photosynthesis. Light and dark reactions. Electron flow. ATP synthesis by photophosphorylation. Biosynthesis of starch and oligosaccharides.

Unit-4:

Lipid metabolism: Introduction to Lipids as energy sources. β oxidation. Oxidation of unsaturated and odd chain fatty acids. Ketone bodies. Biosynthesis of: Fatty acids. Triacyl glycerols. Membrane phospholipids. Cholesterol, steroids and isoprenoids. Membrane Phosphoinositides, Ceramides.

Nucleic acid metabolism: Biosynthesis and degradation of purines and pyrimidine nucleotides. Regulation of purine and pyrimidine biosynthesis. Other functions of nucleotides.

Unit-5:

Protein Metabolism: Metabolic fate of amino groups. Transamination, deamination and decarboxylation. Essential and non-essential amino acids. Nitrogen excretion and the urea cycle. Pathways of amino acid degradation. One carbon transfer, role of tetrahydrofolate and S- adenosyl methionine. Biosynthesis of amino acids and compounds derived from amino acids. Inborn errors of metabolism.

Suggested reading

Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). New York: W. H. Freeman and Company.

Stryer, Lubert, et al. *Biochemistry*. 9th ed., W. H. Freeman, 2019.

Lieberman, Michael, et al. *Marks' Basic Medical Biochemistry: A Clinical Approach*. 6th ed., Wolters Kluwer, 2023.

BCH 511 Molecular Biology

Course content:

Unit-1:

Gene transfer mechanisms in Bacteria: Transformation, Conjugation, Transduction, Transfection.

Unit-2:

DNA replication mechanism: DNA ligase, DNA gyrase, Nuclease, Okazaki fragments, different types of DNA replications: Rolling circle, bidirectional theta replication, Difference between Prokaryotic and Eukaryotic replication. DNA damage and repair mechanisms

Replication of viruses: Replicase and Reverse transcriptase

Unit-3:

Transcription mechanism: Process of transcription in prokaryotes and eukaryotes, post transcriptional modifications (capping, poly A tailing, splicing, intron exon splicing) Splicosome, Ribonucleoparticles, structure of mRNA, tRNA transcription in vitro. RNA polymerase and factors, Ribozyme.

Translation: Mechanism and regulation of translation in Pro and eukaryotes, structure of ribosome, translation factors: initiation, elongation and termination of polypeptide

Unit-4:

Regulation of gene expression: Regulation of gene expression mechanisms in Prokaryotes and Eukaryote, differences in regulation of gene expression in Pro and Eukaryotes. Housekeeping and Master Regulatory Genes.

Mutation and cancer: Molecular basis of mutation: Insertional mutation, Frame shift mutation, suppressor mutation. Cancer molecular genetics: Classification of cancer, cancer development, genetic basis of cancer, c DNA microarrays, analysis of cancer cells, Retroviruses in cancer, protooncogenes and oncogenes.

Unit-5:

Recombinant DNA Technology: Basic experimental techniques, cloning vectors, plasmids, Bacteriophages, cosmids, phagemids, BACs, YACs and HACs as cloning vectors, genome and C DNA libraries.

Mapping of bacterial chromosome: Site directed mutagenesis, PCR Technology, DNA – Footprinting.

BCH 512 Immunology

Unit-1:

Introduction to immune system: Specific and Non-Specific immune responses. Cells of the immune system. Humoral versus Cell-mediated immunity. Immunological memory. T and B lymphocytes. Antigens. Immunogen, Haptens, Adjuvants.

Unit-2:

Immunoglobulins: Structure, Classes, properties and functional significance of Immunoglobulins. Isotypic, allotypic and idiotypic variations. Clonal selection theory. Generation of Antibody Diversity. Monoclonal antibodies, Hybridoma technology.

Unit-3:

Antigen-Antibody Interaction Agglutination, Opsonization, precipitation, neutralization. T and B-cell interactions. Lymphokines. Perforins, Interleukins. Alternate versus Classical pathway of complement activation, Natural Killer cells.

Unit-4:

Major histocompatibility complex (MHCs): HLA typing. Role in antigen processing and presentation. Transplantation antigens. T cell Receptor Biology. Autoimmunity.

Unit-5:

Hypersensitivity Reaction: Overview.

Vaccines: Active and passive immunization, Types of vaccines.

BCH 553 Nutritional Biochemistry and Toxicology

Course content:

Unit-1

Nutrients in maintenance of Health: Dietary components: Fuels: Carbohydrates and dietary fibre. Proteins and amino acids. Lipids, sterols and Fat. Energy requirements. Accessory nutrients: Requirements and sources of fat soluble(Vitamins A, D, E, K) and water soluble (Thiamine, Riboflavin, Niacin, pyridoxamine, folic acid, cobalamine, ascorbic acid) vitamins. Minerals (Calcium, iron, magnesium, iodine, fluorine, trace elements).

Unit 2:

Nutritional needs and assessments during the life cycle. Recommended Dietary allowances: FAO, ICMR. Methodological issues and statistical basis. Problems. Measurement of nutrient intakes. Sub-clinical and clinical deficiencies. Anthropometrical, clinical and biochemical assessment. Biochemical basis of dietary modulations.

Unit-3:

Nutrigenomics. Nutrient-disease interactions. Brief overview of Genomics, Transcriptomics. Proteomics. Metabolomics. Interplay between diet and gene expression: Role of SNPs, HapMaps. Role of folate in polymorphism MTHFR677→ T. Role of nutrients as transcription

factors (fatty acids, retinoids). Nutrient-gene-environment interactions on the metabolome. Role of epigenetics in nutrigenomics. Systems Biology and the dietary signature. Concept, interpretation and limitations.

B. Toxicology:

Unit-4:

Principles of toxicology: Toxicants, therapeutic dose, dose-response curve, multiple toxicants response, serum enzymes behavior, hepatic and non-hepatic enzyme change during toxicity.

Xenobiotic metabolism: Toxicants entry and fate in living system, absorption, distribution, excretion and detoxification, phase I and phase II reactions and their interrelationships.

Unit-5:

Toxicity testing: Basic principles and test protocols.

Food Toxicology: Toxicology of food additives, animal and plant toxins, heavy metals.

BCH 554	Human Health and Disease
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Course content:

Unit-1:

Biochemical role of vitamins and minerals as coenzymes and cofactors. Structures and functions of coenzymes and cofactors. Mechanisms of action at the molecular level. Potential roles in genetic expression of selected vitamins.

Unit-2:

Integration and hormonal regulation of metabolism. Hormonal regulation and integration of metabolism. Integration of fuel metabolism. Biochemistry of starvation: Alternate methods of energy generation, organ interrelationships during starvation.

Unit-3:

Aging: Theories of aging. Changes during the aging process: Caloric restriction. Anti-aging strategies.

Obesity. Assessment. Biochemical aspects of body fat distribution. Adipocyte number vs. size. Etiology. Genetic contributions. Hormones of the adipose tissue: Leptin, adiponectin etc. Ghrelin. Metabolic changes in obesity. Treatment. Strategies. Problems.

Unit-4:

Disorders of carbohydrate metabolism: Diabetes: Classification, diagnostic parameters, biochemical alterations. Inborn errors of metabolism.

Alterations in lipid metabolism: Lipoprotein metabolism: chylomicrons, VLDL and IDL, HDL, LDL. Implications in disease. Formation of atherosclerotic plaque. Effects of dietary and other factors.

Unit-5:

Disorders of amino acid metabolism: phenylketonuria, homocysteinuria, tyrosinemia and related disorders.

Disorders of Nucleic acid metabolism: Diseases associated with purine degradation. Gout.

Cancer: Etiology, diagnosis, treatment strategies. Neoplastic drugs. Carcinogens.

Semester IV

BCH 511: Dissertation -Research Methodology

Course Objectives:

To develop a comprehensive understanding of scientific research principles, experimental design, and ethical practices in biochemistry.

To train students in planning, executing, and analyzing biochemical research projects using appropriate methodologies and data interpretation tools.

To enhance students' ability to critically review scientific literature, write research proposals, and effectively communicate research findings.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

CO1: Design and formulate a research problem, develop hypotheses, and select appropriate biochemical methodologies for investigation.

CO2: Collect, analyze, and interpret experimental data using relevant statistical and analytical tools.

CO3: Prepare a well-structured dissertation or research report, demonstrating scientific writing, referencing, and presentation skills.

CO4: Exhibit awareness of research ethics, intellectual property rights, and plagiarism issues in scientific research.

BCH 512: Dissertation -Thesis Writing

Course Objectives:

1. To guide students in organizing, compiling, and presenting their research findings effectively.

2. To develop scientific writing and data presentation skills for thesis preparation and publication.

Course Learning Outcomes:

After completion of this course, students will be able to:

CO1: Structure and write a scientific thesis following standard formats and ethical guidelines.

CO2: Analyze and present research data with clarity and logical coherence.

CO3: Defend their research outcomes through oral presentation and discussion.

BCH 513: Dissertation - Experimental Performance Appraisal

BCH 514: Dissertation Work PowerPoint Presentation

BCH 515: Biochemistry Course Viva voce

Ph. D. Program