SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

(Formerly University of Pune)

Master of Science in Biochemistry

(Faculty of Science and Technology)

New syllabi as per NEP 2020

For affiliated colleges

To be implemented from Academic Year 2023-24

Framework for MSc Biochemistry as per NEP Guidelines 2020

Semester I		
Sub. Code	**Subject Title**	**Number of Credits**
Core courses		
Major Core- 10 (T) + 4 (P)		
CHB-501 MJ	Biomolecules (T)	**4**
CHB-502 MJ	Enzymology and Biophysical Techniques (T)	**4**
CHB-503 MJ	Cell Biology (T)	**2**
CHB-504 MJP	Analytical Biochemistry (P)	**4**
Major Elective 2 (T) + 2 (T/P)		
CHB-505 MJ	Microbiology (T)	**2**
CHB-506 MJ	Nutrition Science (T)	**2**
CHB-507 MJP	Microbiology (P)	**2**
CHB-508 MJ	**Research Methodology**	**4**
Semester II		
Core courses		
Major Core- 10 (T) + 4 (P)		
CHB-551 MJ	Bioenergetics and Metabolism (T)	**4**
CHB-552 MJ	Membrane Biochemistry and Genetics (T)	**4**
CHB-553 MJ	Techniques in Characterization of Biomolecules (T)	**2**
CHB-554 MJP	Enzymology and Biophysical Techniques (P)	**4**
Major Elective 2 (T) + 2 (T/P) (Theory anyone)		
CHB-555 MJ	Bioinformatics (T)	**2**
CHB-556 MJ	Bio-entrepreneurship development program (T)	**2**
CHB-557 MJP	Bioinformatics (P)	**2**
Internship/ On job Training (OJT)		
CHB-558 OJT	OJT- After completion of Sem II exam (One month: Full Time)	**4**
Exit option: Award PG Diploma in Biochemistry on completion of 44 credits after Three Year UG degree **OR** continue with PG second		

Semester III		
Core courses		
Major Core- 10 (T) + 4 (P)		
CHB-601 MJ	Molecular Biology (T)	**4**
CHB-602 MJ	Immunology and Biochemistry of specialized tissues (T)	**4**
CHB-603 MJ	Medical Biochemistry (T)	**2**
CHB-604 MJP	Molecular Biology and Clinical Biochemistry (P)	**4**
Major Elective 2 (T) + 2 (T/P) Any two courses		
CHB-605 MJ	Toxicology (T)	**2**
CHB-606 MJ	Developmental Biology (T)	**2**
CHB- 607 MJ	Plant Biochemistry (T)	**2**
CHB-608 MJ	Neurochemistry (T)	**2**
CHB-609 RP	**Research Project- I (P)**	**4**
Semester IV		
Core courses		
Major Core- 8 (T) + 4 (P)		
CHB-651 MJ	Genetic Engineering (T)	**4**
CHB-652 MJ	Endocrinology and Tissue Culture (T)	**4**
CHB- 653 MJP	Special Experiments (P)	**4**
Major Elective 2 (T) + 2 (T/P) Any two courses		
CHB-654 MJ	Fermentation technology (2T)	**2**
CHB-655 MJ	Food Technology (T)	**2**
CHB-656 MJ	Drug discovery and development (2T)	**2**
CHB-657 MJP	Proteomics and genomics (T)	**2**
CHB-658 RP	**Research Project- II (P)**	**6**

Total 4 Semesters	Major Core	Major Elective	Research Methodology (RM)	Internship on Job Training (OJT)	Research Project (RP)	Total Credits
	54	**16**	**4**	**4**	**10**	**88**

2 Years- 4 SEM. Award PG Degree in Biochemistry on completion of 88 credits after Three years UG Degree or 1 Year -2 SEM PG Degree (44 Credits) after Four-year UG Degree

Notes: Abbreviations: T- Theory, P- Practical.

1. Wherever require the BOS can choose theory or practical course as per the need and

within the given structure.

2. Each course should be designed with the minimum 2 or maximum 4 credits.

M. SC. BIOCHEMISTRY PART-I SEMESTER – I

Course Code: **CHB-501 MJ**	Course Title: **BIOMOLECULES**	

Course objectives: To make students understand the basics of biomolecules like carbohydrates, proteins, lipids, vitamins, DNA, RNA etc. To make student understand via study of their classifications, types, properties etc. and their importance for life because they help organisms to grow, stay alive, and have more offspring. By interacting with each other, they help build organisms from single cells to complex living things like human beings.

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Biomolecules I: Carbohydrates, Lipids and Vitamins	**30 Hrs**
1 The molecular logic of life: The chemical unity of diverse living organisms, composition of living matter. Macromolecules and their monomeric subunits. 2 Properties of water: With interactions in aqueous systems. Ionization of water, weak acid weak bases. 3 Carbohydrates: Classification, basic chemical structure, general reactions and properties, biological significance, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids. 4 Lipids: Classification, structure and function of major lipid sub Classes- acylglycerols, Lipoproteins, chylomicrons, LDL, HDL and VLDL, rancidity. Formation of micelles, monolayers, bilayer, liposomes. 5 Vitamins and Co-enzymes: Classification, water soluble and fat-soluble vitamins. Structure, dietary requirements, deficiency conditions, coenzyme forms and their mechanism.	
Biomolecules II: Amino acids, Proteins and Nucleic acids	**30 Hrs**
1 Amino acids: Classification, Properties, reactions, rare amino acids. 2 Protein classification: Reactions, functions, properties and Solid phase synthesis, 3 Structural levels of protein: Primary, Secondary, Tertiary and Quaternary Structure, Structure of Hemoglobin and Keratin 4 End group analysis, sequencing and peptide synthesis 5 Nucleic Acids: Types and structure of nucleosides, nucleotides. Types of DNA and RNA. Watson and Crick Model	

Suggested readings

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M.Cox.
2. Biochemistry by Lubert Stryer.
3. Biochemistry by Zubay.
4. Biochemistry by Garrett and Grisham.
5. Biochemistry by Voet and Voet.

Course outcomes
After studying this course students should be able to get the knowledge about structure and function of biomolecules and how they work, interact, and their importance in all living systems. Several of the functions of these biological molecules are still a mystery, and scientists are using cutting-edge techniques to find more molecules and figure out what role they play in keeping life going.

Course Code: **CHB-502 MJ**	Course Title: **ENZYMOLOGY AND BIOPHYSICAL TECHNIQUES**	
Course objectives: To acquire fundamental knowledge on enzymes and their importance in biological reactions. To understand the kinetics and mechanisms of action of enzymes. To help students to understand methods used in the laboratory to study biochemical processes. These techniques can be used to identify the biomolecules involved in a biochemical reaction, separation of biomolecules based on their size and other properties, or separate and determine molecular weight of a protein.		
Course Credit: **4**	Total contact hours: **60 Hrs**	
Course Contents (Topics & subtopics)		**Reqd. Hours**
Enzymology		**30 Hrs**
1. Basic aspects: Remarkable properties, cofactors, nomenclature, classification, isoenzymes and multienzymes. 2. Enzymes kinetics: One-substrate reactions, effect of pH, temperature, inhibitions, two substrate reactions: theory, order analysis, pre-steady state kinetics, stopped flow relaxation methods 3. Mechanism of enzymes action: Theoretical background, factors leading to rate enhancement of enzyme catalyzed reactions, acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment. Experimental approaches of determination of enzymes mechanism: Kinetics studies, detection of intermediates, X-ray crystallographic studies, chemical modification of amino acid side chain and affinity labeling. Examples of chymotrypsin, triose phosphate isomerases, Lysozymes and Ribonuclease 4. Regulation of Enzyme activity: Control of activities of single enzyme: Inhibitor molecules, availability of substrate or cofactor and changes in covalent structure of enzymes. Zymogen activation and phosphorylation, dephosphorylation, ligand binding and induced changes, allosteric enzymes, theoretical models, Hill equation, Adair equation, M.W.C. and K.N.F. Models, usefulness of the models. Significance of allosteric and cooperative behavior in enzymes 5. Enzyme turnover: Kinetics of enzyme turnover, measurement of enzyme turnover, Ks and Kd, correlation between the rates of enzyme turnover and structure and function of enzymes, mechanism of enzyme degradation, significance of enzyme turnover.		
Biophysical Techniques		**30 Hrs**
1. UV and visible Spectrophotometry 2. Membrane filtration and dialysis: Nitrocellulose, fibre glass, Polycarbonate filters,		

dialysis and Concentration, reverse dialysis, freeze drying and lyophilization. 3. Chromatography techniques: Partition and adsorption Chromatography- paper, TLC, GLC, gel filtration, ion exchange chromatography: properties of ion exchangers, choice, HPLC, HPTLC, affinity chromatography, hydrophobic interaction chromatography, metal chelate chromatography, covalent chromatography. Special chromatographic techniques for nucleic acids: DNA cellulose chromatography, MAK hydroxyl-apatite chromatography, separation of DNA fragments according to their base composition. 4. Electrophoretic techniques: Types of electrophoresis: moving boundary electrophoresis and zone electrophoresis (paper, cellulose-acetate electrophoresis, gel Electrophoresis (starch gel, native PAGE, disc PAGE, gradient PAGE, SDS-PAGE, agarose gel electrophoresis, Isoelectric focusing, 2D gel electrophoresis) 5. Isolation, purification of proteins and enzymes & other biomolecules.	

Suggested readings

1 Fundamentals of Enzymology by Price and Stevens, 3rd edition (1999).
2 Enzymology by Dixon and Webb, 2nd edition (1964).
3 Enzymes by Palmer
4 Physical biochemistry by D. Freifelder IInd edition (1982)
5 Biochemical techniques by Wilson and Walker, Seventh edition, Cambridge University Press 2010.
6 Biophysical techniques by Upadhye and Upadhye, Himalaya Pub. House, (2009).

Course outcomes

After studying this course, the student should understand that enzymes are essential for life and are one of the most important types of protein in the human body. Acquired theoretical and experimental knowledge in enzymology and biophysical techniques will enable students to find appropriate employment in different development, scientific-research laboratories, or to continue their further studies in biochemistry or related disciplines.

Course Code: **CHB-503 MJ**	Course Title: **CELL BIOLOGY**	
Course objectives: To impart the knowledge of structure and functioning of basic unit of life, cell organelles and their detail functions, cell cycle and cell division, cytoskeleton and the cell-cell interactions in eukaryotic cells. Also, to make students familiar with how cell division plays an important role in all living organisms, and its functional significance.		
Course Credit: **2**	Total contact hours: **30 Hrs**	
Course Contents (Topics & subtopics)		**Reqd. Hours**
Cell Biology		**30 Hrs**
1 Cell classification, cell variability, size, shape and complexity, function 2 Animal cells: Structure, sub cellular components: Nucleus, chromosomes, plasma membrane, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus, mitochondria, cytoskeleton, sub-cellular fractionation: Differential and density gradient centrifugation, specific staining of organelles and marker enzymes		

3	Cell division: mitosis, meiosis and cell cycle	
4	Plant cells: Cell wall and its function, chloroplast, xylem, phloem and epidermal cells. The interaction and communication between the cells, cell-cell reorganization in plants.	
5	Fungi: Cell structure, classification and biological importance.	
6	Cell-cell adhesion and the extracellular matrix, intercellular recognition, specific cell aggregation in sponges, cell junctions, extracellular matrix and role of collagen, elastin and fibronectin.	
7	Germ cells and fertilization, stem cells, cell differentiation, organogenesis, functional and biochemical maturation of tissues.	

Suggested readings

1. Molecular Biology of the cell– Bruce Alberts – J.D. Watson et al Garland publishing Inc., N.Y., 4th edition (2002) and recent edition.
2. Cell and Molecular Biology – DeRobertis and Saunders, 8th edition (2017).
3. The cell – C.P. Swanson, Prentice Hall (1989)
4. Cell Biology – C.J. Avers, Addision Wesley Co. (1986).
5. Molecular biology by Lodish and Baltimore, 4th edition (2000). Cell Structure and Function by Loewy and Gallant.

Course outcomes

After studying this course, the student should understand How cells work by examining the machinery inside of them, investigating how they communicate and determining how they form larger structures.

Course Code: **CHB-505 MJ**	Course Title: **MICROBIOLOGY**	

Course objectives: Students will study the growth and control of microbes such as bacteria, viruses, etc. They try to understand how these organisms live, grow, and interact with their environments. Also study different bacteriological techniques involved in microbiology.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)		**Reqd. Hours**
Microbiology		**30 Hrs**
1	Cell structure and components, characterization and classification of microorganisms.	
2	Microscopy: Theory, phase contrast microscopy, fluorescence microscopy and electron microscopy: Theory, specimen preparation, freeze etching, freeze fracture, shadow casting, electron microscopy of nucleic acids, TEM, SEM.	
3	Cultivation of Bacteria, nutrition, physiology and growth of microbial cells, reproduction and growth, synchronous growth, continuous culture of microorganisms.	

4 Pure cultures and their characteristics. 5 Fundamentals of control of microbial growth control by physical agents and chemical agents. 6 Production of mutants by chemical and physical agents and their characterizations. 7 Host microbe interactions, endotoxins, exotoxins, enzymatic and other factors, tissue affinity, resistance and immunity. 8 Viruses of bacteria, plant and animal cells: Structure, classification and life cycle, mycoplasma and viriods, diseases. 9 Industrial microbiology: production of lysine, glutamic acid, alcohol, vinegar, citric acid 10 Nitrogen fixation: Historical background, nitrogen cycle in nature, symbiotic nitrogen fixation, nitrogenase system, nitrate reductase.	

Suggested readings

1. Microbiology, M.S. Pelczar, R.D. Reid, E.C.S. Chan, Mc Graw Hill, New York, 5th edition (2001).
2. General Microbiology (Vth Edition), R.Y. Stanier, Prentice Hall (1986)
3. Biology of Microorganisms by Brocks, 12th edition (2009)
4. Introductory Microbiology, F.C. Ross, Charles Merril Publication (1983).

Course outcomes

After studying this course, the student should understand the General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae. Demonstrate theory and practical skills in microscopy and their handling cultural techniques, various physical and chemical means of sterilization and staining procedures. To know various Culture media and their applications and effectively comprehend the various methods for identification of unknown microorganisms and get equipped with various methods of bacterial growth measurement.

Course Code: **CHB-506 MJ**	Course Title: **NUTRITION SCIENCE**	

Course objectives: To enable students to

1. Explain nutrients in foods and the specific functions in maintaining health
2. Familiarize nutritional assessment, RDA and Recommendations & Guidelines.
3. Apply knowledge of the role of nutrition and healthy eating for disease prevention and wellness.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Nutrition Science	**30 Hrs**
1. Basic Concepts: Nutritional value and functions of food, 2. Food in relation to health, Balanced diet, ICMR. Food groups, My Pyramid 3. Energy content and its measurement in foods, Thermic effect of food, BMR, RDA 4. Role of Macro and micronutrients 5. Protein nutritional quality determination and Scoring system	

6. Sensory evaluation of food 7. Major nutrition related community health problems – PEM, starvation, obesity, anemia, iodine deficiency, vitamin A deficiency, scurvy, Beri Beri, Pellagra, fluorosis etc. 8. Functional foods and Nutraceuticals, Dietary fiber- chemical composition and importance.	

Suggested readings

Reference books:

1. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974), Ganesh Pub, Madras
2. Human biochemistry – James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
3. Human nutrition and dietetics-Davidson and Passmore
4. Nutrition science by B. Srilakshmi

Course outcomes

After studying this course, the student should understand –

1. To develop skill and confidence to make informed decisions about healthy diet in health and disease.
2. To learn composition and chemistry of different foods and study the fundamentals of the science of nutrition in relation to macro and micro nutrients.
3. To understand the working and management of the dietary departments of the various organizations.

Course Code: **CHB-508 MJ**	Course Title: **RESEARCH METHODOLOGY**	

Course objectives:

1. To help students to understand methods used in the laboratory to study good laboratory practices and lab safety.
2. To introduce the concepts of research objectives, methodology, research data analysis and significance of the research.
3. To impart skills of statistical treatment & statistical analysis of biological data.

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Research Methodology	
1. Fundamental Laboratory Techniques: (1 credit) a. Basic laboratory procedures, Basic principles, working with liquids b. Making and recording measurements, SI units and their use.	**15 Hrs**
2. Chemical safety and Disaster Management: (1 credit) a. General safety: General safety and operational rules, safety equipment, personal protective equipment, safety practices for disposal of broken glass wares, centrifuge safety, treated biomedical wastes and scientific ethics. How to extract the safety information from MSDS. b. Emergency response: chemical spills, radiation spills, biohazard spills, leaking	**15 Hrs**

compressed gas cylinders, fires, medical emergency accident reporting	
3. Research Analysis, Presentation of data and Statistics: (1 credit) a. Using graphs, presenting data in tables, drawing chemical structures, Hints for solving numerical problems. b. Descriptive statistics, choosing and using statistical tests.	**15 Hrs**
4. Information technology and Library resources and Intellectual Property right: (1 credit) a. Internet resources for chemistry/biochemistry, spread sheets, word processors, databases and other packages, Search engines, Scifinder b. IPR: Introduction to IPR, Types of IPR, Criteria for patentability and novelty, patent filling.	**15 Hrs**

Suggested readings

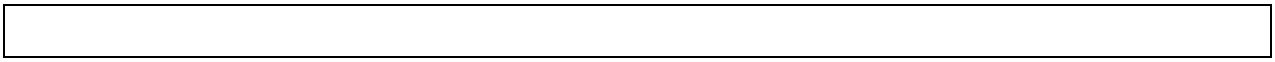
Reference books:

1. Laboratory Safety for Chemistry Students Robert H. Hill, Jr., David C. Finster A John Wiley & Sons, Inc., Publication
2. Vogel′s Textbook of Practical Organic Chemistry, 5th Ed., A. Vogel, et al., ed., Prentice Hall
3. Chemical Laboratory Safety and Security A Guide to Developing Standard Operating Procedures, By National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies, Committee on Chemical Management Toolkit Expansion: Standard Operating Procedures, Board on Chemical Sciences and Technology, 2016
4. Chemical Safety in the Laboratory, By Stephen K. Hall 1994 CRC-Press
5. School Chemistry Laboratory Safety Guide, By Centers for and Prevention, Department of Human Services, National Institute Health and Safety 2014, Publisher: Create Space Independent Publishing Platform
6. Research Methodology in Chemical Sciences Experimental and Theoretical Approach Edited By Tanmoy Chakraborty, Lalita Ledwani, 1st Edition, eBook Published10 March 2017, New York, Apple Academic Press. DOI https://doi.org/10.1201/9781315366616
7. Statistical Methods in Analytical Chemistry, Author(s): Peter C. Meier, Richard E. Zünd, 2000, DOI:10.1002/0471728411, 2000 John Wiley & Sons,
8. Fundamentals of Intellectual Property Rights For Students, Industrialist and Patent Lawyers By B. Ramakrishna, H. S. Anil Kumar, 2017
9. Intellectual Property Law by Avtar Singh Publisher: Eastern Book Company ISBN: 9789350289853

Course outcomes

At the end of the course student should be able to formulate research objectives using literature review, conduct research with good lab practices and safety, use data analysis tools and interpret results.
Students will understand the significance of statistical treatment of biological data and understand the data from the statistical point of view.
Also, on successful completion of this course the student should be able to:

1. Distinguish and Explain various forms of IPRs.
2. Identify criteria to fit one's own intellectual work in particular form of IPRs.
3. Apply statutory provisions to protect particular form of IPRs.



Course Code: **CHB-504 MJP**	**ANALYTICAL BIOCHEMISTRY PRACTICALS**	

Course objectives: This course will enable to understand and get accustomed with the basic laboratory analytical estimation methods which will be used routinely in the Biochemistry laboratories.

Course Credit: **4**	Total contact hours:

Course Contents (Topics & subtopics)	**Reqd. Hours**
ANALYTICAL BIOCHEMISTRY PRACTICALS	
1. Separation of amino acid mixture by Paper chromatography 2. Estimation of amino acid by Ninhydrin method 3. Estimation of protein by Biuret method 4. Estimation of protein by Lowry method. 5. Estimation of protein by Bradford method 6. Specific reactions for Amino acids 7. Estimation of sugar by Folin-wu method 8. Estimation of sugar by Ferricyanide method 9. Estimation of sugar by DNSA method 10. Identification of carbohydrate mixture with suitable tests. 11. Isolation of amino acid cystine from hair hydrolysate. 12. Isolation of Egg albumin and globulin. 13. Isolation of milk casein by isoelectric pH precipitation. 14. Isolation of Starch and characterization. 15. Alpha and Beta amylolysis. 16. Isolation of Cholesterol and lecithin from egg. 17. Estimation of Vitamin C from lemon fruits. 18. Determination of alpha amino nitrogen of amino acid. 19. Estimation of inorganic phosphorus by Fiske-Subbarow method. 20. Determination of saponification value of fat 21. Determination of acid value of fat 22. Determination of iodine number of fat	

Suggested readings

Reference books:

1 Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker. (2006) 5th Edition
2 Practical Biochemistry by David Plummer (2015) 3rd Edition
3 Introductory Practical Biochemistry by S.K. Sawhney and R.Singh.
4 Practical Biochemistry by J. Jayaraman
5 Biochemical methods by S. Sadasivam and A. Manickam (2010) New Age International. New Delhi

Course outcomes

After studying this course, the student will acquire the laboratory skills in handling different biochemical equipment's needed for various estimations and preparations. The students will be able to plan the experiments which will help them in their research projects

Course Code: **CHB-507 MJP**	**MICROBIOLOGY PRACTICALS**	

Course objectives: Students will study the growth and control of bacteria. They will learn the techniques needed for cultivation of microbes. They will try to understand how these organisms live and grow under different conditions.

Course Credit: **2**	Total contact hours:

Course Contents (Topics & subtopics)	**Reqd. Hours**
MICROBIOLOGY PRACTICALS	
1. Media preparation, pour plate and streak plate techniques, 2. Microscopic examination (motility, monochrome staining and gram staining). 3. Sterilization: Steam, Dry heat and filter. 4. Detection of amylase, caseinase, catalase activity 5. Preservations of bacterial cultures. 6. Phosphatase test for the quality of milk 7. Methylene blue reduction test (MBRT) for quality of milk 8. Growth curve of *E. coli*. 9. Total viable count determination (pour plate and spread plate). 10. Ultraviolet irradiation and survival curve. 11. Isolation of auxotrophic mutants. 12. Plaque assay for phage. 13. Immobilization of yeast cells 14. Microbial assay of vitamin and antibiotic. 15. Transformation 16. Lac operon by studying β-galactosidase	

Suggested readings

Reference books:

1. Microbiology, M.S. Pelczar, R.D. Reid, E.C.S. Chan, Mc Graw Hill, New York, 5th edition (2001).
2. Microbial methods – J. Collins and lynes – 8th edition.
3. Medical Microbiology, Vol. II – Cruickschank, 12th edition (1980)
4. Textbook of Practical Microbiology by S.C. Parija, Ahuja Publishers, New Delhi (2006)

Course outcomes

After studying this course, the student will acquire the laboratory skills in handling microorganisms. This training will help the students to plan and execute various experiments related to microorganisms.

M. SC. BIOCHEMISTRY PART-I, SEMESTER II

Course Code: **CHB-551 MJ**	Course Title: **BIOENERGETICS AND METABOLISM**	

Course objectives: The primary objective of this course is for the student to gain an understanding of the metabolic pathways involving catabolism and anabolism in carbohydrates, lipids, proteins, nucleic acids and how errors in metabolic processes lead to diseases. Also, to understand how the sum of all chemical reactions required to support cellular function.

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Bioenergetics and Metabolism - I	**30 Hrs**
1. Introduction of metabolism and overview. 2. Bioenergetics: Basic low of thermodynamic, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, redox potentials, high energy compounds, structure and significance of ATP 3. Glycolysis: Detailed study, energetics, regulation and significance. 4. Citric acid cycle: Detailed study, energetics, regulation and significance. 5. Electron transport and oxidative phosphorylation, AIP synthase and mechanism 6. Alternate pathways of carbohydrate metabolism: Pentose phosphate pathway, glyoxalate cycle, glucuronic acid pathway, inter conversion of hexoses, Pasteur effect. 7. Polysaccharide metabolism: Biosynthesis, degradation and regulation of glycogen, metabolism starch and cellulose, inborn error of carbohydrate metabolism. 8. Gluconeogenesis 9. Lipid metabolism: Beta oxidation of even and odd number carbon atoms fatty acids, energetics and regulation. Formation of ketone bodies, other types of fatty acid oxidation. 10. Biosynthesis of lipids: Requirements of carbon dioxide and citrate for biosynthesis, fatty acid synthase complex, regulation of biosynthesis. Biosynthesis of triglycerides, cholesterol and phospholipids	
Bioenergetics and Metabolism -II	**30 Hrs**
1. Oxidative degradation of amino acids: Proteolysis, transamination, oxidative deamination, acetyl CoA, alpha ketoglutarate, acetoacetyl CoA, succinate, fumarate and oxaloacetate pathway. Decarboxylation, urea cycle, ammonia excretion. 2. Biosynthesis of amino acids: Amino acid biosynthesis, precursor functions of amino acids, biosynthesis of aromatic amino acids, Histidine, one carbon atom transfer by folic acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine.)	

3. Inborn errors of amino acid metabolism 4. Peptides, polyamines, porphyrins, gamma glutamyl cycle, glutathione biosynthesis, nonribosomal protein biosynthesis. 5. Purine and pyrimidine degradation. 6. Biosynthesis of purine and pyrimidine nucleotides, regulation and biosynthesis of nucleotide coenzymes	

Suggested readings

Reference Books

1. Biochemistry – Lehninger, 7th edition (2017)
2. Metabolic Pathways – Greenberg, 3rd edition (1970).
3. Biochemistry – G. Zubay, Addision Wesley Publ. (1983).
4. Biochemistry – Stryer (2002) 5th Edition W.H. Freeman and Co.
5. Harper's Biochemistry- 30th edition, (2015)

Course outcomes

After studying this course, the student should understand the basic concepts of bioenergetics and how they influence biochemical processes. How metabolism transforms the matter of macronutrients into substances a cell can use to grow and reproduce and also into waste products.

Course Code: **CHB-552 MJ**	Course Title: **MEMBRANE BIOCHEMISTRY AND GENETICS**	

Course objectives: To enable students to

1. Get a deeper insight into the diverse biological functions that take place at different cellular membranes.
2. Understand how biophysical forces control the membrane structures and the arising biological functions.
3. To understand Mendelian inheritance and to learn the concepts of Linkage. To know the significance of organellar inheritance and to know the concept of sex-linked inheritance as well as basis of genetic disorders.

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Membrane Biochemistry	**30 Hrs**
1 Biological membrane, structure, and assembly: Constituents, asymmetry, flip flop, protein lipid interaction, factors affecting physical properties of membranes. Membrane models: biological and physical model, membrane associated diseases	
2 Membrane transport: Diffusion, passive, active and facilitated, transport role of proteins in the process, receptor mediated endocytosis, osmoregulation and ATP-ADP exchanger.	
3 Na, H dependent processes and phosphotransferase synthesis, specialized mechanism for transport of macromolecules, gap junctions, nuclear pores, toxins, control of transport processes and binding proteins.	

4 Role of Na^+, K^+ ATPase and passive permeability of the plasma membrane to Na^+, K^+ and Cl^-, voltage and ligand gated ion channels, and propagation of nerve impulse, action potential, Na^+ and K^+ channels 5 Molecular mechanisms, ionophores, ion translocating antibiotics, valinomycin, gramicidin, group translocation.	
Genetics	**30 Hrs**
1 DNA as genetic material, double helix, semi conservative mechanism of replication, nearest neighbor analysis, denaturation and renaturation. 2 Laws of Heredity: Genotype, Phenotype and Mendelian Laws of inheritance. 3 Basis of Biochemical genetics: Concept of gene by Benzer, One gene one cistron, complementation tests and Co-linearity. 4 Auxotroph, prototroph, conditional mutants, mutant isolation and selection. Transformation, conjugation and transduction. 5 Sex factors and Plasmids: Fertility factor, Hfr, mapping of *E. coli* chromosome, Cloning vectors: Plasmids, phages, cosmids. Introduction to Operon. 6 Genetic Code: Biochemical and genetic analysis of the genetic code. 7 Genetic disorders: Chromosomal origin, gene origin mutation, human teratogenesis.	

Suggested readings

Reference books:

1 Biochemistry-G Zubay, Addison Wesley, 1983
2 Biochemistry, L Stryer, 3rd/4th/5th ed, 1989, Freeman and Co. NY
3 Principles of Biochemistry –Lehninger, 7th edition (2017)
4 Membranes and their cellular functions- IB Filnean, R. Coleman and RH Michell, 1984, Blackwell scientific publishers, Oxford, 3rd ed.
5 Genetics – Strickberger M.W., Macmillan Pub;. Inc., 3rd edition (1995).
6 Molecular Biology of the Gene- Watson Benjamin / Cummings Publ. Company 6th Edition (2008).
7 Genetics Analysis and Principles: R.J. Brooker Addison-Wesley, 4th edition (2012).

Course outcomes

After studying this course, the students

1. Acquire a deeper knowledge on how the structures and properties of membranes are defined and regulated by their lipid, protein and carbohydrate constituents.
2. Acquire a deeper knowledge on how parents pass some of their characteristics to their children. It is an important part of biology, and gives the basic rules on which evolution acts. Genes that do not work correctly can cause problems. A group of rare diseases are caused when a single gene stops working normally

Course Code: **CHB-553 MJ**	Course Title: **TECHNIQUES IN CHARACTERIZATION OF BIOMOLECULES**	
Course objectives: To enable students to familiarize with the basic concepts and applications of modern techniques used in Biochemistry, Biophysics, Cell and Molecular Biology		
Course Credit: **2**	Total contact hours: **30 Hrs**	

Course Contents (Topics & subtopics)		Reqd. Hours
		30 Hrs
1 Sedimentation: Differential and density gradient centrifugation, Theory, Preparatory and analytical ultracentrifuges, factors affecting sedimentation velocity, sedimentation coefficient, measurement of S, Zonal centrifugation, DNA analysis, Determination of molecular weight by sedimentation, diffusion and sedimentation equilibrium methods. Specific examples of application. 2 Partial specific volume and the diffusion coefficient, Measurement of partial specific volume and diffusion coefficients. 3 Viscosity: Theory, effect of macromolecules on the viscosity of a solution, measurement, molecular weight determination. 4 Radioactivity, Measurement and autoradiography 5 X-ray diffraction, Ramachandran Plot 6 Spectroscopic methods: NMR, IR, Fluorescence, and CD 7 Mass Spectrometry: LCMS, GCMS, MALDI-MS, MALDI-TOF-MS		

Suggested readings

Reference books:

1 Physical Biochemistry by D. Freifelder IInd Edition Freeman publication (1982)
2 Biochemical techniques by Wilson and Walker, Seventh edition, Cambridge University press (2010)
3 Biophysical techniques by Upadhye and Upadhye, Himalaya Pub. House, (2009).
4 Biochemistry by L. Stryer 4th edition (1995).
5 Molecular biology of gene by J. D. Watson, 5th edition (2004).
6 Fundamentals of biochemistry by D. Voet, J. Voet and C.W. Prott, 5th edition, 2016.
7 7. Molecular cell biology 4th ed. Lodish B., Zipursky Matsudaira, Ball, 4th edition (2000).

Course outcomes

After studying this course, the student will acquire a deeper knowledge on working on molecular level of biomolecules and their interactions and its application in biochemical fundamentals and translational research.

Course Code: **CHB-555 MJ**	Course Title: **BIOINFORMATICS**	

Course objectives:

1. To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge
2. To develop and implement computational logic, learning programming languages, algorithms and software for progressive life science solutions.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	Reqd. Hours
Bioinformatics	**30 Hrs**
1. Introduction	

2. Scientific literature search: Pubmed, Scopus, google scholar. Measures of scientific impact assessment: impact factor, h-index, i10-index etc. 3. Computational biology resources: EBI, ExPASY, NCBI 4. DNA sequence databases: GenBank, EMBL, DDBJ, dbEST, RefSeq, dbSTS, Probe Database 5. RNA sequence databases: Relevant microRNA, long non-coding RNA, siRNA, tRNA and UTR databases 6. Protein sequence database- GenPept, UniProtKB, UniRef, UniParc, Proteomes, NextProt 7. Sequence alignment: Pair-wise and Multiple Sequence Alignment (MSA) and analysis, Global and Local alignment. Alignment based tools: BLAST, BLAT, CLUSTALW 8. Phylogenetic analysis 9. Protein structure database: PDB 10. Structure visualization	

Suggested readings

Reference books:

1 Essential Bioinformatics – **Jin Xiong** Cambridge University Press; 1st edition, Cambridge.
2 A text book of bioinformatics (2008) **Sharma, Munjal and Shankar**. Rastogi Publications, Meerut.
3 Introduction to Bioinformatics (2008) **Arthur M. Lesk** OUP, Oxford.

Course outcomes

A student completing a major in Bioinformatics shall be able to apply: knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics. existing software effectively to extract information from large databases and to use this information in computer modeling.

Course Code: **CHB-556 MJ**	Course Title: **BIO-ENTERPREUNERSHIP DEVELOPMENT PROGRAM**	
Course objectives: The program is designed to provide students with a broad coverage of key areas of modern biotechnology and a basic understanding of business and finance issues. Suitable for students who are interested in early stage technology companies and/or aspire to start industry.		
Course Credit: **2**	Total contact hours: **30 Hrs**	
Course Contents (Topics & subtopics)		**Reqd. Hours**
1. Introduction to bio-business, from the Indian context, SWOT analysis of bio-business, Development of Entrepreneurship. 2. Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centers. Etc.,), operational biotech parks in India. 3. Scope-with case study: Herbal bulk drug production, Nutraceuticals, value added herbal products. Pollution monitoring and Bioremediation for Industrial pollutants.		**30 Hrs**

Pesticides, Herbicides etc. Fermented products-probiotic and prebiotics. Bioethanol production using Agri waste, Algal source. 4. Regulatory affairs in Bio business-regulatory bodies and their regulations (eg. FDA, EU, DSIR, AYUSH, FSSAI etc.) 5. Ethical concerns of biotechnology research and innovation-Interference with nature fear of unknown, unequal distribution of risks. 6. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.	

Suggested readings

1. Principles of Management P. C. Tripathi, P.N. Reddy Tata McGraw Hill Fifth Edition, 2012
2. Entrepreneurship Development S.S. Khanka S. Chand & Co 2006
3. Practical Approach to IPR Rachana Singh Puri IK Intl. Ltd 2009
4. Bioethics & Biosafety R Rallapalli & Geetha Bali APH Publication 2007

Course outcomes

After studying this course, the student should be able to demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology, Pharma and Agri industry, Regulatory Agencies, and Academia.

Course Code: **CHB-554 MJP**	**ENZYMOLOGY AND BIOPHYSICAL TECHNIQUES PRACTICALS**	
Course objectives: To enable students to familiarize with the basic concepts and applications of modern techniques used in Biochemistry, Biophysics, Cell and Molecular Biology		
Course Credit: **4**	Total contact hours:	
Course Contents (Topics & subtopics)		**Reqd. Hours**
ENZYMOLOGY PRACTICALS (2 credit)		
1. Detection of some common enzymes. Extraction and enzyme activities of the enzymes invertase/amylase/peroxidase/catalase/ alkaline phosphatase. 2. Study of specific activity and progress curve. 3. To assess effect of substrate conc. (Vmax and Km) on enzyme activity. 4. To assess the effect of pH on enzyme activity. 5. To assess effect of enzyme conc. 6. To assess temperature stability of the enzyme. 7. To assess effect of activator on enzyme activity. 8. To assess effect of inhibitor on enzyme activity. 9. Effect of enzyme immobilization and determination of its activity. 10. Statistical analysis of data		
BIOPHYSICAL TECHNIQUES PRACTICALS (2 credit)		
1. Concept of pH, preparation of buffer of desired pH and molarity and measurement of pH. 2. pH metry: Acid base titration curves. Measurement of pKa of amino acids. 3. Ion exchange chromatography: Nature of ion exchanger, capacity of column,		

Separation of amino acids. 4. Gel filtration: Determination of void volume, Determination of partition coefficient, and Separation of two components in a sample. 5. Viscosity: Viscosity of hydrolyzed, partially hydrolyzed and unhydrolyzed starch. Determination of relative viscosity, Specific viscosity and intrinsic viscosity. 6. Electrophoresis: Separation of serum proteins by paper or agarose gel electrophoresis/Polyacrylamide Gel electrophoresis (PAGE). 7. UV and Visible Spectrophotometry: Absorption spectra, Varification of Lamberts- Beer's Law, absorption spectrum of proteins and amino acids, Absorption spectra of hemoglobin derivatives – oxyhemoglobin, carboxyhemoglobin and methemoglobin. 8. Dialysis, reverse dialysis and membrane filtration. 9. RBC membrane fragility	

Suggested readings

Reference books:

1. Biochemical Techniques Theory and Practice: J.R. Robyt and B.J. White (1987).
2. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker, 5th edition (2006).
3. Practical Biochemistry by David Plummer, 3rd edition (2015).
4. Introductory Practical Biochemistry by S.K. Sawhney and R.Singh, (1990).
5.

Course outcomes

After studying this course, the student will acquire a deeper knowledge on working on molecular level of biomolecules and their interactions and its application in biochemical fundamentals and translational research.

Course Code: **CHB-557 MJP**	**BIOINFORMATICS PRACTICALS**	

Course objectives:

1. To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge
2. To develop and implement computational logic, learning programming languages, algorithms and software for progressive life science solutions.

Course Credit: **2**	Total contact hours:

Course Contents (Topics & subtopics)	**Reqd. Hours**
BIOINFORMATICS PRACTICALS (2 credit)	
1. To explore the NCBI resource and to query PUBMED, GenBank, dbEST, RefSeq, dbSTS and Probe databases using the various search strategies. To know and use ENTREZ search engine 2. To explore EMBL-EBI resource and to know various computational tools available at ExPASY 3. To explore and query microRNA, long non-coding RNA, siRNA, tRNA and UTR	

databases 4. To explore, query PDB and to perform structural visualization 5. To explore UniProtKB protein sequence databases 6. To know sequence file formats 7. To perform pair-wise and multiple sequence alignments. To construct and analyze phylogenetic tree. To perform alignment-based searches in various databases	

Suggested readings

Reference books:

1 Essential Bioinformatics – Jin Xiong Cambridge University Press; 1st edition, Cambridge.
2 A text book of bioinformatics (2008) Sharma, Munjal and Shankar. Rastogi Publications, Meerut.
3 Introduction to Bioinformatics (2008) Arthur M. Lesk OUP, Oxford.

Course outcomes

A student completing a major in Bioinformatics shall be able to apply: knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics. existing software effectively to extract information from large databases and to use this information in computer modeling.

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