WEST BENGAL STATE UNIVERSITY

M.Sc. in Biochemistry

Syllabus for 2 years

Syllabus under NEP (Semester System)

Effective from the Academic Session -2026-27

Department of Biochemistry

West Bengal State University

The Postgraduate NEP Syllabus of 2years M.Sc. Biochemistry Program

Semester	Paper	Title of the paper	Theory/ Practical/ Mixed	Credit	Full marks	Semester Full Marks	Semester credit
Semester I	BCH2P COR01T	Chemistry of Biomolecules & vitamins and minerals	Theory	4	50		
	BCH2P COR02T	Metabolism &Bioenergetics	Theory	4	50		
	BCH2P COR03T	Microbiology	Theory	4	50		
	BCH2P COR04T	Advanced Enzymology	Theory	4	50		
	BCH2P COR05P	Lab Course	Practical	4	50		
	BCH2P AEC01T	Biophysical Principle&Biosafety Measurements	AEC	2	50		
Total						**300**	**22**
Semester II	BCH2P COR06T	Plant Biochemistry	Theory	4	50		
	BCH2P COR07T	Molecular Biology	Theory	4	50		
	BCH2P COR08T	Cell Biology	Theory	4	50		
	BCH2P COR09T	Immunology	Theory	4	50		
	BCH2P COR10P	Lab course	Practical	4	50		
Total						**250**	**20**
Semester III	BCH2P COR11 M	Bioanalytical Techniques & Immuno techniques	Mixed (Theory & Practical)	4	50		

	BCH2PCOR12M	Clinical Biochemistry & Microbial Pathology (infectious diseases)	Mixed (Theory & Practical)	4	50		
	BCH2PCOR13T	Research methodology, Biostatistics & IPR	Theory	4	50		
	BCH2PCOR14M	In house project	Mixed (Theory & Practical)	4	50		
	BCH2PDSE01M	Food Chemistry Or Environmental Biotechnology	Mixed (Theory & Practical)	4	50		
	BCH2PSEC01M	Bioinformatics &Computer aided Drug design	Mixed (Theory & Practical)	2	50		
Total						**300**	**22**
Semester IV	BCH2PCOR15T	Advanced Biotechnology	Theory	4	50		
	BCH2PDSE02T	Genetics & epigenetics Or Ecology	Theory	4	50		
	BCH2PDSE03T	Introduction to System Biology Or Developmental Biology	Theory	4	50		
	BCH2PCOR16T	Review writing, Presentation and Industrial visit	Theory	4	50		
	BCH2PCOR17M	Dissertation (out house)	Mixed (Theory & Practical)	4	50		

	BCH2P COR18T	Grand Viva	Theory	4	50		
Total						**300**	**24**
						1150	**88**

Departmental course: Total 21 courses. Minimum requirement: Department must offer at least 11 Core courses and at least 2 DSEs.

Abbreviation of course code:

T - Theory
P - Practical
M - Mixed (Theory & Practical)

Number of Classes

For Theory:

A 4 credit course generally requires 4 hours of classes per week over a 15-weeks of semester. This translates to a total of 60 direct contact hours (typically 45–60 hours) of teaching. Accordingly 60 hours for theory classes given.

For Practical:

1 practical credit equates to 30 hours of actual laboratory work. Therefore, 4 credit course generally requires 30 Hours * 4 credits = 120 Hours.

For Mixed paper:
CreditRatio 3 Theory: 1 Practical.
Theory: 3 credits = 45 hours (approx. 3 lectures/week), Practical: 1 credit = 30 hours (approx. 2 hours of lab/week), Total Class Time:75 Hours.

* Probable number of classes are given in the bracket in the syllabus.

Postgraduate NEP Syllabus of M.Sc. Biochemistry program, WBSU

Program outcome

M.Sc. in Biochemistry program of WBSU is a laboratory-based science subject course exposing the students in the modern areas of interdisciplinary biological and biochemical sciences. This course introduces the post-graduate students to the state-of-the-art methodologies of biochemical, biotechnological and molecular biological sciences. This course is extremely important from the view point of applied field of interdisciplinary biological sciences. The concept of interdisciplinary sciences is gaining momentum these days and the course of M.Sc. Biochemistry aims at establishing such interdisciplinary orientation in biological sciences removing the subject-wise barriers among Physics, Chemistry, Botany, Zoology, Physiology and other life science-oriented subjects. This course also opens the door to a variety of careers.

The students can get an idea and concept of subjects like Cell Biology, Metabolism, Molecular Biology, Microbiology, Genetics, Biochemical Techniques, Plant Biochemistry, Immunology, Enzymology, Human Physiology, Advanced Biotechnology, Environmental Biochemistry and Environmental Microbiology, clinical Biochemistry, Food Chemistry, Toxicology etc. They also can enhance their skill by studying computer aided drug design as skill enhanced course. They also can enrich their knowledge by studying subjects like Bioinformatics, Introduction to Tissue engineering and Introduction to System Biology. Students also get an opportunity to select their preferred subjects from elective papers. The students can enhance their skill by doing various types of practical. In fourth semester, they can increase their research aptitude by doing dissertation.

After studying M.Sc. in Biochemistry, students can proceed for a research career in the field of interdisciplinary biological and biochemical sciences by doing Ph.D., doing post-doctoral studies and possess high chances of being appointed as a faculty in an academic institute. After pursuing M.Sc. in Biochemistry, students have also ample scope to get employment as a biochemist/ analytical chemist/toxicologist in several sectors such as employment in government and industrial laboratories, in forensic science laboratories, opportunities in clinical diagnostic medicine in hospitals and in the numerous companies now providing diagnostic procedures, the pharmaceutical, brewing and food processing industries, monitoring and control of pollution, in the biotechnology industry etc. Biochemistry will continue to have very good prospect for the professions of medicine and pharmacy. Opportunities exist in universities and research institutes for biochemists with higher research degrees.

Semester –I

Course code BCH2PCOR01T

Chemistry of Biomolecules &vitamins and minerals Credit 4 Marks 50

Course outcome:

This course will familiarize the students with the major basic biomolecules and other components of the living systems. This course is very much essential for the beginner learners in biochemistry. As the students are coming from various fields at this initial semester, they all must be made introduced to the basic concepts of biochemistry that covers the study of major biomolecules.

Course content:

1.**Carbohydrates**- Importance, Nomenclature, Classification, Asymmetry, Optical Isomerism, Mutarotation, General structure and functions of monosaccharide, disaccharide, oligosaccharides, polysaccharides (10)

2.**Amino Acids**- Importance, Structure, Distribution in Proteins, Location in proteins, Physical properties, Electrochemical properties, Classification, Amino acid titration, pI of peptides, chemical synthesis of amino acids and peptides, Nonprotein Amino Acids, Toxic analogues, misincorporation of amino acids analogues. (6)

3.**Proteins-** importance, Peptide bonds, Chemical Bonds involved in Protein structure. Protein Configuration: Primary Structure, Secondary Structure, Tertiary Structure, Quaternary Structure, Hemoglobin and Myoglobin, Denaturation, Anfinsen Experiment, Protein folding, unfolding, misfolding, protein folding related conformational diseases, prions. (12)

4.**Lipids**: Biological roles of lipids, Classification: Simple, Compound and Derived Lipids, Properties of Fats and oils, Chemical Properties, Rancidity. (8)

5.**Nucleic acid-** Discovery of DNA. Historical events related to genetic material. Structure of DNA and RNA. Chemical and physical properties of nucleic acids,Nucleosides, Nucleotides, Various bonds in DNA, Watson-Crick model and Double helical structure, Variants of Double helical DNA, DNAs with unusual bonds, DNA topology, Denaturation and renaturation (kinetics), Cot analysis, The C-value paradox, and repetitive DNA (12)

6.**Vitamins & Minerals –** Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins. Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. (12)

Reference books:

1. Lehninger's Principles of Biochemistry, David L. Nelson, Michael M. Cox. Publisher:W.H.Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher:WHFreeman
3. Biochemistry, 4thEdition-DonaldVoet, Judith G.Voet.–Publisher: JohnWiley& Sons.
4. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
5. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.

Course code BCH2PCOR02T

Metabolism &Bioenergetics Credit 4 Marks 50

Course outcome:

This course will familiarize the students with the major thermodynamic principles in biology and basic metabolic pathways of the living systems. This course is very much essential for the beginner learners in biochemistry. As the students are coming from various fields at this initial semester, they all must be made introduced to the basic concepts of metabolism and bioenergetics.

1. **Bioenergetics** -Energy transformation by biological systems Laws of thermodynamics, Concept of enthalpy, entropy, free energy and standard free energy change Standard reduction potential and its relationship with free energy change High energy compounds: ATP, ATP/ADP cycle, Coupled reactions. (3)

2. **Approaches for studying metabolism-** metabolic inhibitors, growth studies and biochemical genetics; Isotopes in Biochemistry; Isolated organs, cells and subcellular organelles. (4)

3.**Carbohydrate metabolism and its regulation**-Major pathways of glucose and other sugar utilization, discovery of EMP pathways.Glycolysis and regulation,fates of glycolysis end products in different organs, Citric acid cycle, its function in energy generation,and its anaplerotic roles, regulation, Pentose phosphate pathway and its regulation. Gluconeogenesis and regulation, Glycogenolysis and regulation, Biosynthesis of glycogen and starch, Disorders of carbohydrate metabolism. (12)

4.**Lipid metabolism and its regulation**-Lipid (triglycerides and phospholipids) digestion, absorption and transport. Fatty acid β oxidation, Minor pathways of fatty acid oxidation, Biosynthesis of Fatty acid, triacylglycerols and phospholipids. Ketone bodies- synthesis and functions. Formation of prostaglandins, prostacyclins and thromboxane, Cholesterol (utilization and synthesis).Lipoproteins (structure, classification, functions). Regulation and metabolic disorders of lipid metabolism.(12)

5. **Amino acid metabolism and its regulation-** Source and utilization of amino acids in human body. Catabolism of amino acids,Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Carbon skeleton: glucogenic, ketogenic. Urea cycle and its regulation. Regulation and disorders of amino acid metabolism .(8)

6. **Nucleic acid metabolism**- Biosynthesis of purines and pyrimidines, deoxyribonucleotides and ribonucleotides, Denovo and salvage pathways. Degradation of purines and pyrimidines.Regulation and disorders of nucleotide metabolism. Structure and regulation of ribonucleotide reductase.Inhibitors of nucleic acid biosynthesis. (7)

7.**Oxidative phosphorylation**. Electron transport mechanism and its carriers -Complex I, II, III, IV; Respirasome concept. How electron transports are coupled with proton pumping. Mitchell's Hypothesis—experimental verification, ATP synthesis by F1-FO ATP synthase, E. Racker's experiment. Relation of proton movement and ATP synthesis. Experimental demonstration of the movement of ATP synthase. Methods used in bioenergetics. Principle of Clark electrode for measuring respiration. Uncouplers and inhibitors of energy transfer.(10)

7.**Vitamins & Porphyrins** – Biosynthesis of ascorbic acid, thiamine, pantothenic acid,folic acid and porphyrins. Degradation of porphyrins. Production of bile pigments.(4)

Reference books:

1. Lehninger's Principles of Biochemistry, David L. Nelson, Michael M. Cox. Publisher:W.H.Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher:WHFreeman
3. Biochemistry -DonaldVoet, Judith G.Voet.–Publisher: JohnWiley& Sons.
4. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
5. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.

Course code BCH2PCOR03T

Microbiology Credit 4 Marks 50

Course outcome:

This course will familiarize the students with the biochemistry of microbes. Knowledge of microbial biochemistry will open up the door for the students for the job positions of microbiologists in pharmacy, medicine and diagnostic laboratory. The course is designed in such a way so that it introduces students to the basic knowledge of microbiology.

1.**Microbial Life & History of Microbiology**-.Introduction to Microbiology, Microbes include Eukaryotes and Prokaryotes, application of microbes. Three Domain Classification, Carl Woese and the three domains of life. (2)

2.**Staining-**Stains and Staining, dyes, chromophoric and auxo-chromic groups, classification of biological stains, basic dyes, acid dyes, principle of staining: physical and chemical, mordants, simple staining, Differential staining, Resolution of objects by our eyes,Different kinds of stain, Simple staining, Gram staining, Negative staining, Acid fast staining. Endospore staining (2)

3.**Bacterial Cell Structure and function and signaling-** Microbial size and shape, structure and functions of cell membrane, The cell wall and outer layers of Gram positive and Gram negative bacteria, Glycocalyx, Slime layers, Capsules, S layer, Pili, Fimbriae, ribosomes, inclusion bodies, Bacterial flagella: Structure-Function, Chemotaxis: Mechanism. Bacterial Endospores: Formation, Germination of endospores,two component signaling system in bacteria, stringent response and quorum sensing. (5)

4.**Growth of bacteria-** Effect of different environmental factors on bacterial growth, , classification of bacteria based upon the environmental factors, different types of media,growth of bacteria in liquid solid medium, methods of measurement of growth, growth kinetics, relation of growth to substrate concentration, growth curve, the chemostat, turbiostat, synchronized growth, techniques of pure cultures, Bacterial Cell division (5)

5.**Control of microorganisms by physical agents, chemical agents and chemotherapeutic agents-**The rate of death of bacteria, condition influencing antimicrobial action, high temperature, Thermal death time (TDT), decimal reduction time (D value), F value, 12-D Process, different types of physical, chemical and their mode of actions on bacteria, classes of antibiotics and their properties, structure and mode of action of antibiotics, genetics and , biochemical mechanisms of drug resistance, characteristics of an ideal antimicrobial chemical agent and its selection for practical application, Evaluation of antimicrobial chemical agents, tube dilutions and agar diffusion techniques, phenol coefficient methods. (5)

6.**Bacterial nutrition**, Autotroph, heterotroph, phototroph, chemotroph, oxidation of nitrogenous and sulphur compounds, oxidation of iron, hydrogen, oxygen, nitrate, sulphate, methanogenesis (3)

7.**Transformation-**Discovery of Transformation, Competence, Regulation of competence in B. subtilis, Experimental evidence for models of natural transformation, Plasmid transformation and phage transfection of naturally competent bacteria, Role of natural transformation, Importance of natural transformation for forward and reverse genetics, artificially induced competence. (8)

8.**Conjugation**- Classification of self-transmissible plasmids, Mechanism of DNA transfer during conjugation in Gram negative bacteria, Chromosome transfer by plasmids, Formation of Hfr strains, Transfer of chromosomal DNA by integrated plasmids, Chromosome mobilization, Prime factors, mapping genes by interrupted mating, fine structure analysis of genes, Transfer system of Gram-positive bacteria, Plasmid attracting pheromones. (8)

9.**Horizontal gene transfer mediated by bacteriophages**. Specialized and generalized transduction. (6)

10.**Evolution of host immune responses against bacteriophages**- Innate immunity and the role of altruism in host defensive mechanism. Acquired immunity against bacteriophages – CRISPR-Cas based immunity. (2)

11. **Identification and classification of Prokaryotes**-Principles of taxonomy, using phenotypic and genotypic characteristics to identify prokaryotes and classify prokaryotes, characterizing strain difference, difficulties in classifying prokaryotes. (2)

12. **Virology**-General features, morphology of viruses -ultra structure, capsid and its arrangements, types of envelops and its composition; nomenclature and classification of viruses, Viral genomes, its type and structure; Viroids, virusoids, -brief details. cultivation of virus, Bacteriophages – Structural organization, multiplication cycle; eclipse phase, phage production, bacteriophage therapy, genetics of lytic and lysogenic cycle, bacteriophage typing, Animal viruses – pathogenicity,diagnosis, prevention and treatment of viruses including RNA viruses-Corona virus, influenza virus, polio virus, measles virus, Rotaviruses, Rhino virus, HIV, DNA viruses – Pox viruses, Herpesviruses, Hepatitis viruses; oncogenic viruses (12)

Reference Books:

1.Microbiology by Prescott LM, harley JP & Klein DA(2005). McGraw Hill International Edition, USA.

2.Microbiology by Gerard J. Tortora, Berdell Ra. Funke and Christine L. Case. Publ: Pearson Education Inc.

3. Brock Biology of Microorganisms. Michael T Madigan, Johnn M. Martinko, Paul V. Dunlap, David P Clark. Pearson International edition.

4.Principle of Microbiology. Ronald M. Atlas.

5. Molecular Genetics of Bacteria. Larry Snyder, Joseph E Peters, Tina M Henkin, Wendy Champness. ASM Press.

Course code BCH2PCOR04T

Advanced Enzymology **Credit 4** **Marks 50**

Course outcome:

This course will familiarize the students with the enzyme biochemistry of the living systems. This course is very much essential for the beginner learners in biochemistry. As the students are coming from various fields at this initial semester, they all must be made introduced to the preliminary ideas of enzyme chemistry. This knowledge of enzyme kinetics, mechanism and regulation covers a vast and very important area of biochemistry. Without this knowledge of enzyme chemistry the students cannot pursue other courses of biochemistry.

1.Introduction– Historical perspective, general characteristics, nomenclature; IUBMB system, Enzyme classification (specific examples).Definition& properties of enzymes. Enzyme turnover number, IU and specific activity. Concept of holoenzyme and roles of inorganic ions, non-protein organic molecules, coenzymes and prosthetic groups. Vitamins as coenzyme precursors. (5)

2.**Kinetics of enzyme action** – Concept of ES complex, active site, substrate specificity, derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of Km & Vmax and their physiological significances. Importance of Kcat/Km. Kinetics of zero & first order reactions. Significance and evaluation of energy of activation. Michaelis pH and temperature functions and their significance.Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, Transition state analogue, catalytic antibodies, suicide inactivation. (15)

3. **Mechanism of Enzyme Action** – Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain and distortion theory. Chemical modification of active site groups. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase. (14)

4. **Enzyme Regulation** – General mechanisms of enzyme regulation, product inhibition. Feed back inhibition and feed forward stimulation, Covalent modification of enzymes,examples ;PTMs and proteolytic activation of enzymes, Blood clotting cascade, Zymogens, isozymes and their significance (LDH). Multisubstrate systems and their kinetics; Multienzyme complexes. Allosteric enzymes, Sigmoidal kinetics; Aspartate transcarbamoyase (ATCase), T & R states (quaternary structures), positive and negative modulators; PKA and role of cAMP . (12)

6.**Enzyme Technology -** Large scale production of enzymes, immobilization of enzymes by chemical and physical methods. Synzymes, enzyme electrodes and biosensors.(8)

7.**Enzyme isolation & Purification**: Methods for isolation, purification and characterization of enzymes, Enzyme assays. (6)

Reference Books:

1. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher:WHFreeman

2. Fundamentals of Enzymology (1999) by Price & Stevens.

3. Structure and Mechanism in Protein Science; Guide to Enzyme Catalysis (1999) by A. Fersht. Freeman Press.

4. Enzymes; Biochemistry, Biotechnology, Clinical Chemistry (2001) by T. Palmer. Horwood Ltd.

5. Molecular Enzymology (1981) by CW Wharton and R Eisenthal. Wiley

6. Biochemical Calculations (1976) by I.H. Segal. John Wiley & Sons.

Course code BCH2PCOR05P

Laboratory course **Credit 4** **Marks 50**

Course outcome:

This course will familiarize the students with the laboratory techniques of biochemistry. This course is very much essential for providing the students hands on training for carrying out experiments in biochemistry. It opens up the scope of further research in biochemistry. Without this knowledge of practical training the students cannot pursue other courses of biochemistry.

Biochemistry

1. Qualitative and quantitative of carbohydrate estimation
2. Qualitative and quantitative of protein estimation
3. Assay of enzyme activity
4. Determination of Km & V_{max} values
5. Time course of enzymatic reaction.
6. Influence of substrate concentration on the rate of enzymatic reaction.
7. Effect of pH and temperature on the rate of enzyme reaction.
8. Inhibition of enzyme activity.
9. Paper chromatography
10. Formol titration
11. Estimation of vitamin C

Microbiology

1. Preparation of various culture media and broth and slants
2. Sterilization of culture media by autoclave method
3. Pure culture technique
4. Isolation and propagation of bacteria
5. Staining of bacteria – Simple staining, differential staining, staining of spores and capsules
6. Determination of catalase activity
7. Antibiotic assay

Course code BCH2PAEC01T

Biophysical Principle &Biosafety Measurements Credit 4 Marks 50

Course outcome:

This course will familiarize the students with the biophysical chemistry. This course is very much essential for providing the concept to the students. It opens up the scope of further research in biochemistry. Without this knowledge of practical training the students cannot pursue other courses of biochemistry

1. **Properties of solutions**- solutions, water as solvent, solubility product, ionization of solutes, common ion effect (2)
2. **Types of bonds/interactions**-covalent and non-covalent interactions (2)
3. **Acids, base &Buffers:**- pH and buffers: Bronsted-Lowry Concept of Acids and Bases, Measurement of pH by indicators, electrometric determination, HendersonHasselbalch equation (4)
4. **Diffusion and Osmosis**-Kinetic approach to diffusion methods of determination of diffusion coefficient, significance of diffusion coefficient, measurement of osmotic pressure, theories of osmotic pressure, Van't hoff's law of osmotic pressure, significance of diffusion and osmosis in biology (4)
5. **Viscosity and Surface tension**– factors affecting, measurement application and significance in biology (3)
6. **Adsorption-** characteristics, kinds of interaction, importance of adsorption phenomena (3)
7. **Biosafety-Regulatory Framework in India & International Level Biosafety**: The legal and socioeconomic impact of biotechnology, public education of the process of biotechnology involved in generating new forms of life for informed decision making, biosafety regulation and national & international guidelines, r-DNA guidelines, experimental protocol approvals, levels of containment, levels of safety. Regulations on ethical principles in biomedical/ biotechnological practice: The Nuremberg code, declaration of Helsinki; the Belmont report, cooperational guidelines – WHO, guidelines of DBT (India), ICMR guidelines, Guidelines for an informed consent. (12)

Reference Books:

1. Debajyoti Das. Biophysics and Biophysical Chemistry. Academic publishers
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry. Himalaya Publishing House

Semester –II

Course code BCH2PCOR06T

Plant Biochemistry Credit 4 Marks 50

Course outcome:

This course will familiarize the students with the major biochemical pathways existing specifically in plant system. This course is very interesting and will introduce students to some

unique biochemical system hitherto they have not studied. Knowledge about plant biochemistry is very essential for understanding the basic physiology of plants. This course is lucrative in job market as many agricultural institutes offer the position of plant biochemists. This course will also prepare students for later on higher studies in research in the arena of plant biochemistry

1.**Photosynthesis**- Chromophores. Light Harvesting complexes, Linear and cyclic electron transport NADPH/ATP ratio, Chemiosmosis Photophosphorylation,Photoprotection and state transition. RUBISCO Calvin cycle and photosynthetic CO_2 fixation. Photorespiration. C_4 and CAM plants. Sucrose Phosphate Synthase and Cellulose Synthase, Sugar translocation (14)

2.**Nitrate assimilation** - Structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation. (8)

3.**Sensory photobiology**- different photoreceptors, phytochrome, cryptochrome, photropin, structure and function, photoreversibility, roles of phytochorome in photoperiodism, germination, signaling, blue light signaling and cryptochrome mediated flowering induction, phototropin mediated stomatal opening, chloroplast movement, Induction of flowering, different stages, circadian rhythym, photoperiodism with examples, signaling mechanism of short day and long day flowering. (10)

4.**Phytohormones:** Auxin, GA, cytokinin, ethylene, ABA, salicyclic acid, jasmonic acid, brassinosteroid- biosynthesis, physiological responses and signalling (10)

5. Special features of secondary plant metabolism - Classification, biosynthesis of terpenes,lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components. (10)
6.**Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature, salt) stresses. (8)

Reference Book

1.Plant Physiology and Development, Lincoln Taiz, Eduardo Zeiger, Ian Max Møller, Angus Murphy

2. Biochemistry & Molecular Biology Of Plants, Bob 8. Buchanan, Wilhelm Gruissem, and Russell L. Jones

Course code BCH2PCOR07T

Molecular Biology **Credit 4** **Marks 50**

Course outcome:

This course will familiarize the students with the all the molecular biology background which has not yet been covered in the syllabus. These areas are very important. Without studying this course the M.Sc. program in biochemistry will remain ever incomplete. This course will impart knowledge about all the aspects of emergent areas of molecular biology and its latest status. This is mainly a research oriented course and increase the visibility of studying biochemistry as a research oriented subject.

1.**Molecular Concept of a Gene**- The fine structure of genes, split genes, pseudogenes, non-coding genes, overlapping genes, and multi-gene families. (2)

2.**Chromosome**-Histones and DNA in the formation of nucleosomes, the morphology, higher-order organization. Holocentric chromosomes, the distinction between heterochromatin and euchromatin. Chromosome Conformation Capture Technologies (4)

3.**DNA Replication** - The chemistry of DNA synthesis, experiments on Replication, Enzymes in DNA synthesis; mechanisms of action and properties; prokaryotic and eukaryotic DNA Replication; polymerases and Accessory Proteins. The replicons, origin of replication, replication fork, primosome, replisomes and Sliding Clamp. Mechanism of Replication: Assembly of the pre-replication complex, Leading and lagging strand synthesis, Termination. Telomeres and Telomerase**,** Regulation and Fidelity. Mitochondrial Replication. Inhibitors of replication. (12)

4. **Molecular Basis of Recombination**: Homologous Recombination: Models of recombination, Key Enzymes, structure and function. Site-Specific Recombination: Mechanism of action of Recombinases, transposition and their biological role. (5)

5.**Mutation, DNA damage and repair mechanisms**- Types of mutations, causes, mechanism, detection, mutant types, mutagenic agents. Introduction to DNA damage, types of DNA repair and their mechanisms. DNA repair defects in Human diseases. (5)

6.**Mechanism of Transcription & Post transcriptional Processing**– Prokaryotic and eukaryotic transcription, reverse transcription. inhibitors of transcription. non-coding RNA maturation of rRNA, mRNA and tRNA, RNA splicing, alternative splicing, RNA editing, ,mRNA quality control and different degradative pathways (12)

7. **Regulation of Transcription in prokaryotes & eukaryotes**- Prokaryotic transcription regulation, concept of operon, lac-, ara-, trp-operons, eukaryotic gene expression regulation, lytic cycle of bacteriophage. DNA binding motifs in pro- & eukaryotes, (5)

8.**Translation in Pro- and Eukaryotes** – Discovery and Deciphering of the genetic code.Ribosomes, structure, functional domain and subunit assembly, cell free protein synthesis, direction of protein synthesis (Dintzis experiment), adaptor role of tRNA, formation of initiation complex, chain elongation, translocation & termination. Inhibitors of protein biosynthesis. Post Translational processing. Brief idea of protein sorting – Co- and post-translational protein translocation (15)

Reference Book

1. Molecular Biology of the Genes-Watson JD, Hopkins NH, Roberts JW and Weiner AM Benjamin/Cummings Publishing Company Inc.
2. Molecular Biology- Weaver Robert - McRraw-Hill, New York
3. iGenetics-A Molecular Approach. Peter J Russell. Pearson.
4. Principles of Genetics. International Student Version. D.Peter Snustad. Michael J. Simmons.
5. Molecular Biology Understanding the Genetic revolutions. David P. Clark
6. Genes IX. Benjamin Lewin. Jones & Bartlett Publishers
7. Molecular Genetics of Bacteria. Larry Snyder, Joseph E Peters, Tina M Henkin, Wendy Champness. ASM Press.

Course code BCH2PCOR08T

Cell Biology **Credit 4** **Marks 50**

Course outcome:

This course will familiarize the students with the all the cellular components, cell division, cellular communication. These areas are very important. Without studying this course the M.Sc. program in biochemistry will remain ever incomplete. This course will impart knowledge about all the aspects of emergent areas of molecular biology and its latest status. This is mainly a research oriented course and increase the visibility of studying biochemistry as a research oriented subject.

1.**Plasma membrane**-A brief history of studies on Plasma Membrane structure: The chemical composition of membranes. Liposome. Cell fusion experiment. Membrane fluidity, Lipid Rafts. Movement of substances across cell membrane (5)

2**. Membrane and non-membrane bound cellular components**- The ultra-structure and function of nucleus, mitochondria, endoplasmic reticulum (rough and smooth), Golgi apparatus, lysosomes, peroxisomes, ribosome and their functions, liquid-liquid phase separation. Structure and function of cytoskeleton, Extracellular Matrix- composition and functions, Cell junctions, (12)

3.**Cellular Communication**- Introduction to cell signalling, components of cell signalling pathway, Role of PTMs in signalling; Subcellular localisation and signalling molecules; The evolution of signalling proteins; Methods for studying signalling networks. Cell surface and intracellular receptors, Heterotrimeric and monomeric and G protein signalling, signalling pathways that involve in regulation of gene expression, light mediated, regulated protein degradation mediated, redox signalling and other major signalling pathways, Cross-talk between signalling pathways (12)

4**.Cell Cycle**- Brief idea of cell division, Introduction to the cell cycle, Introduction to Cyclins and CDKs, their discovery, Principles of regulation of CDK activity. Molecular basis of START/Restriction point, Regulation of checkpoints. Restriction of replication to once per cell cycle, Flow cytometry and cell sorting, cell cycle analysis (14)

5.**Cancer and apoptosis**-Causes and types of cancer, growth and spread of cancer, metastasis, interaction of cancer cells with normal cells, Genetic rearrangements in progenitor cells, oncogenes, tumor suppressors genes, virus induced cancer, molecular basis of cancer therapy, molecular markers.Programmed cell death and its regulation in normal physiology, regulation and execution of mammalian apoptosis, and role of apoptosis in tumor genesis. single cell analysis. Assays of cell death (12)

6. **Physiology of aging-** Aging at cellular level, aging at the molecular level, aging of connective tissues, aging and immunological survelliance, mental aspects aspects of aging, theories of aging, aging related disorder (5)

Reference Books-

1. Molecular biology of the cells-Albert B, Bray D and Lewis J- Garland Publications, New York.
2. Molecular cell Biology-Lodish H, Arnold B, Zipursky SL, Matsudaira P and Baltimore D- WH. Freeman and company, New York.

3. Karps Cell And Molecular Biology Concepts And Experiments Asian Edition 9Ed (Pb 2020)Karps Cell And Molecular Biology Concepts And Experiments Asian Edition 9Ed (Pb 2020)
4. The Cell: A Molecular Approach by Geoffrey M. Cooper Rert E. Hausman

Course code BCH2PCOR09T

Immunology Credit 4 Marks 50

Course outcome:

This course will familiarize the students with the basic immunological concepts which are very fundamental to biochemistry. Without the knowledge of diverse immune responses, mechanisms and antigen-antibody interactions, students will lag behind in medical biochemistry. This course on basic immunology is very essential to expose the students in the field of cancer biology and immuno-deficiency diseases, the primary research area of modern day biochemistry.

1.**Introduction to immune system** – Innate and acquired immunity. Structure and functions of primary and secondary lymphoid organs. (4)

2. **Cells involved in immune responses** – Lymphoid cells (B-lymphocytes, T-lymphocytes and Null cells), mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cell.(3)

3. **Antigens**- chemical nature, antigenicity and immunogenicity, hapten, epitopes, mitogens (definition, properties, examples); Adjuvant (definition, examples, function). (3)

4 Immunoglobulins - structure and function, Immunoglobin genes, generation of diversity, affinity maturation, Isotype switching, Allelic exclusion, Ig receptor of B-cells. Monoclonal and polyclonal antibody generation and applications (8)

4. **Generation of Diversity in Immune system** – Clonal selection theory - concept of antigen specific receptor. Organization of immunoglobulin genes: generation of antibody diversity, T cell receptor diversity. (6)

5. **Antigen processing and presentation**-pathways of antigen processing and presentation of intracellular and extracellular antigens.Cytokines. (5)

6. **B-cell Development**-B-cell maturation, activation and differentiation, T dependent and independent antigen, Idiotype network. (6)

7. **T cell Development** -MHC restriction, T cell receptor complex and genes, T-cell differentiation, thymic selection, super antigens, T-cell cytotoxicity. (6)

8. **Complement**- The complement components, function, complement activation- (i) Classical, (ii) Alternate and (iii) lectin pathways. Regulation. (5)

9. **Hypersensitivity reactions**- Types I, II, III, IV (5)

10. **Vaccines-** Different types of Vaccines and its significance.(4)

11. **Disorders of immune system and immunotherapy –** Autoimmunity, congenital immunodeficiencies, acquired immunodeficiencies.Cancer Immunotherapy. (5)

Reference Books-

1. Kuby IMMUNOLOGY Eighth Edition Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A. Owe
2. Janeway's Immunology, Kenneth Murphy and Casey Weaver
3. Abul K Abbas, Cellular and Molecular Immunology
4. Roitt's Essential Immunology

Course code BCH2PCOR10P

Lab course Credit 4 Marks 50

Course outcome

This course will familiarize the students with the laboratory techniques of biochemistry. This course is very much essential for providing the students hands on training for carrying out experiments in biochemistry. It opens up the scope of further research in biochemistry. Without this knowledge of practical training the students cannot pursue other courses of biochemistry.

Molecular biology

1. Isolation of genomic DNA
2. Isolation of plasmid DNA,
3. Restriction digestion,
4. Agarose gel electrophoresis
5. Preparation of competent cells, transformation
6. Polymerase Chain Reaction

Plant Biochemistry

1.Estimation of phenol, flavonoids, tannic acid, chlorophyll, antioxidant from plant extract
2. Separation of plant pigments by chromatography
3. Isolation of chloroplast from leaf extract

Semester III

Course code BCH2PCOR11M

Bioanalytical Techniques & Immunotechniques Credit 4 Marks 50

Course outcome

This course will familiarize the students with the techniques. This course is complementary to the laboratory courses. While in laboratory courses the students will be introduced to practical knowledge of the analytical techniques to some extent, this course will provide them theoretical knowledge to understand the rationale behind each analytical methodology.

1.**Spectroscopy and spectrometry** - Concepts of spectroscopy, Beer-Lambert's law, Principles and applications of colorimetry. UV-Vis spectroscopy, Fluorescence spectroscopy, Raman spectroscopy, IR spectroscopy,ORD, CD, Mass spectrometry (8)

High resolution spectroscopy- X-ray diffraction and NMR, Cryo-EM (3)

Biocalorimetry- ITC (Isothermal Titration Calorimetry) and DSC (Differential Scanning Calorimetry) (3)

2.Chromatographic techniques-Principles and applications of paper, chromatographic performance parameters, thin layer, ion exchange, affinity, gel filtration, HPLC and FPLC, gas chromatography, (8)

2. **Centrifugation**-principle of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, sub-cellular fractionation. (4)

4. **Electrophoretic techniques** – Principles of electrophoresis. DNA, RNA and Protein electrophoretic gels. Pulse field gel electrophoresis. (4)

5. **Bio-imaging techniques**– Principle and techniques of Transmission and Scanning electron microscopy, Phase contrast, Fluorescence and Confocal microscopy, Different staining procedures in tissue sections. (6)

6**. Immunological techniques –** (9)

a. Immunoprecipitation- and Agglutination-Based Techniques - Immunoprecipitation in and in gel matrices, isolation of specific molecules from cell and tissue extracts hemagglutination reactions, hemagglutination inhibition reactions

b. Antibody Assays Based on Molecules Bound to Solid- Phase Supports, Radioimmunoassays, ELISAs, ELISPOT Western Blotting.

c. Methods to Determine the Affinity of Antigen-Antibody interactions equilibrium dialysis and surface plasmon resonance for measurements of antibody affinity

d. Antibody-Mediated Microscopic Visualization of Cells and Subcellular Structures- Immunocytochemistry and Immunohistochemistry, Use of enzyme-conjugated antibodies to create images of fixed tissues, immunoelectron microscopy, use of gold beads

Reference Book-

1. Kuby IMMUNOLOGY Eighth Edition Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A. Owe.
2. Physical biochemistry: principles and applications, David Sheehan
3. Introduction to Practical Biochemistry György Hegyi József Kardos Mihály Kovács András Málnási-Csizmadia László Nyitray Gábor Pál László Radnai Attila Reményi István Veneke
4. Principles and Techniques of Biochemistry and Molecular Biology, Edited By Keith Wilson And John Walker

Lab course - (30 classes)

1 SDS PAGE
2 SRID
3 Ouchterlony double diffusion
4 Immunoelectrophoresis
5 Thin layer chromatography
6 Column chromatography

Course code BCH2PCOR12M

Clinical Biochemistry & Microbial Pathology (infectious diseases) Credit4 Marks 50

Course outcome

This course will familiarize the students with clinical biochemistry. This course is complementary to the laboratory courses. While in laboratory courses the students will be introduced to practical knowledge of the analytical techniques to some extent, this course will provide them theoretical knowledge to understand the rationale behind each analytical methodology.

1. **Electrolytes , acid-base balance and Redox Biology** – Regulation of electrolyte content of body fluids and maintenance of pH, reabsorption of electrolytes. Buffer system present in human body. chemistry of free radicals and reactive oxygen species-, Detection of free radicals, Lipid peroxidation, protein&, DNA damage by ROS/RNS. Anti-oxidant defense enzymes, Free radical scavengers, Origin of oxidative stress, consequences, Implications of free radicals in diseases (5)

3. **Hormone action and its dysfunction related diseases** - Endocrine glands, basic mechanism of hormone action, hormones and diseases (4)

4. **Digestion**- An outline of digestion of carbohydrates, proteins, fat in human system, regulation of digestion (nervous system and hormonal), disorder of digestion, (2)

5. **Liver, kidney and pancreas**- Normal and abnormal functions of liver and kidney, renin-angiotensin system, disorders of liver and kidney, liver function test, Kidney function test physical examination of urine, chemistry of normal urine, Elements of Clinical Enzymology: Isoenzymes in health and disease, pancreatic function test (5)

6. **Cardiovascular and Respiratory disorder**- Cardiac cycle, cardiac function test in health and disease, blood pressure, electrocardiography, Mechanism of respiration and its disorder (4)

7. **Hematology**- Composition of blood, Hemostasis: Vascular spasm, formation of a platelet plug and blood clotting, Clotting factors, Blood Agranulocytosis, Thrombocytopenia, β Thalassemias, anemias, haemoglobinopathies, disorders of blood clotting mechanism, laboratory test to measure coagulation and thrombolysis (4)

8.**Reproduction** -Reproductive processes, gametogenesis, ovulation, neuroendocrine regulation, disorder and treatment (3)

9. **Neuromuscular interaction**-Physics of membrane potential, generation of action potential, mechanical properties of muscles (contraction, role of calcium ion), (3)

10**. Tissue analysis**-Clinical tissue analysis, FNAC, biopsy, liquid biopsy, circulating RNA and DNA as molecular diagnosis of different diseases. (3)

11. **Stress and Obesity**- Molecular mechanism of stress and its effect. Gut-Brain Neuroendocrine Signalling Under Conditions of Stress. Genetic and environmental factors leading to obesity, obesity related diseases and management of obesity (4)

12. **Host pathogen interaction**- Normal flora, principles of infectious diseases, cause and establishment of infection, mechanism of pathogenicity of microbes- epidemiology, reasons for spreading and awareness for prevention. Life Cycle and General Morphology, Pathogenesis, Control and treatment, Drug target, Action and Drug Resistance of Malaria, Tuberculosis, Cholera and dengue. (8)

Lab Course (30 classes)

1. Detection of serum glucose,
2. Estimation of serum cholesterol, TG,
3. Detection of serum SGOT,
4. Detection of serum SGPT,
5. Detection of serum Ca^{++},
6. Detection of serum ALP

Reference Book

1.Textbook of medical physiology- Hall E and Guyton AC-PA: Saunders/Elsevier.
2. Principles of Human Physiology- Stanfield Cindy L-Pearson Education.
3. Microbiology a human perspective. Eugene W Nester, Denise G Anderson, C Evans Roberts jr, Nancy N Pearsall, Martha T Nester. Mc Graw Hill
4. Alcamo's Fundamentals of Microbiology.

Course code BCH2PCOR13T

Research methodology, Biostatistics & Intellectual Property Rights Credit 4 Marks 50

Course outcome

The students will have a basic knowledge of the research projects. They will have a basic idea of how to conduct research, how to collect data and how to interpret, importance of statistics on research project, how to file a patent.

1. **Research Methodology and tools for research**- Introduction to research methodology: definition, objectives and characteristics of research, Types of research, role of theory, hypothesis and its types, sampling, variables, randomness, identification and sources of research problems; criteria for selection of problem, purpose of research, significance of research, criteria of good research, research reporting, research design, Experimental research, Early experimentation, experimental groups, method of controlling variables, designing and validation of experiments, Descriptive data analysis, Inferential data analysis, Computer data analysis,- Analysis of quantitative data and effective presentation with tables, graphs, etc. (12)

2.**Biostatistics**- Measures of central tendency, measures of variability, correlation and regression, inferential statistics, probability theory and hypothesis testing (12)

3. **Scientific Writing and Presentation** -Scientific writing. Importance of abbreviations and acronyms. Types of scientific publications- magazines, journals, reviews, news-letters, structure of scientific paper. Various reference styles. Report Writing, Impact Factor, H-Index, Citation Index, references/bibliography, structuring the thesis, use of software in thesis writing. Presentation tools: Oral and Poster, Microsoft Power Point and PDF slides. (12)

4. **Bioethics**- Introduction to ethics and bioethics, the responsible conduct of biotechnological research; research with human subjects; social commitment of a biotechnologist; Ethical legal and social issues (ELSI) in biotechnology: environmental ethics (protecting public health and environment; genetically modified foods – the ethical and social issues. ELSI in genetic engineering/biomedical science, Eugenics, Use and Misuse of genetic information, ethical

issues related genetic engineering, Ethical issues related to publishing, Plagiarism and Copyrights Impact Factor, structuring of thesis and manuscript. (12)

5.**Intellectual Property Rights**- IPR, Patents and protection IPR: Jurisprudential definition and concept of property rights, duties and their correlations, history and evaluation of IPR – like patent design and copyright. Rights/ protection, infringement or violation, remedies against infringement, civil and criminal, Indian patent act 1970 (2000) international convention in IPR, major changes in Indian patent system as post TRIPS-GATT-International conventions effects. Contents of patent specification and procedure for patents: Detailed information on patenting biological products (12)

Reference Books

1 Research Methodology methods and techniques- C.R. Kothari & Gaurav Garg

Course code BCH2PCOR14M

In house project Credit 4 Marks 50

Course outcome

It will enhance their knowledge and clear the theoretical concept through conducting research. They will have a practical knowledge about the problems associated with surroundings and how to solve it through research to some extent.

Course code BCH2PDSE01M

Food Chemistry Credit 4 Marks 50

Course outcome

This course will familiarize the students with food biochemistry. This course is complementary to the laboratory courses. While in laboratory courses the students will be introduced to practical knowledge of the analytical techniques to some extent, this course will provide them theoretical knowledge to understand the rationale behind each analytical methodology.

1.**Basic Concept**- Energy content of foods. Measurements of energy expenditure: Direct & Indirect calorimetry. Definition of BMR and SDA and factors affecting these. Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements. (8)

2. Dietary fibre, proteins and Phytonutrients - Definition, fibre components. Hydration, viscosity, gelation, texturation, emulsifying and foaming properties of proteins. physiochemical changes in food, colloidal properties, gelatinization, gel formation, emulsion, foam, browning reaction : enzymatic and non-enzymatic, crystallization. polyphenols, flavonoids, lignans, stilbenes, phytosterols, plant metabolites and non-nutrient effect of specific nutrients (10)

3.**Functional Food and Food additives**- Definition and history, types of functional foods, prebiotics, probiotics, synbiotic, food colour, preservatives, antioxidants, food toxins. (11)

4. Nutraceuticals and their importance- Classification of Nutraceuticals, Scope and Future Prospects, properties, structure and functions. latest trends in Nutraceutical Formulations in

India, Nutraceuticals in Medicine, Nutraceutical Supplements from Plant Sources and Animal Sources. Nutrigenomics (8)

5.**Nutritional Disorders**: Protein Energy Malnutrition (PEM): Aetiology, Clinical features, Metabolic disorders and Management of Marasmus and Kwashiorkor diseases. Disorders of Mineral Metabolism: Hypercalecemia, Hypocalcaemia, Hyperphosphatemia. (8)

Reference Book:

1. Nutrition Science- B. Srilakshmi
2. Advanced Nutrition & human Metabolism- Groff & Gropper.

Course code BCH2PDSE01M

Environmental Biotechnology **Credit 4** **Marks 50**

Course outcome

This course will familiarize the students with environmental biotechnology. This course is complementary to the laboratory courses. While in laboratory courses the students will be introduced to practical knowledge of the analytical techniques to some extent, this course will provide them theoretical knowledge to understand the rationale behind each analytical methodology.

1, **Environment-** Concept and definition of environment, Microbial ecology, biogeochemical cycling, environmental pollution, pollution due to plastics, microplastics, E-waste, effects of pollution on health,biomonitoring of environmental pollution, climate change, concept of sustainable development goal (SDG) (8)

2.**Sustainability Development**: *Renewable energy*- Definition, significance of alternative sources of energy, ; *agriculture*- biofertilizers, biopesticides (8)

3**. Water microbiology-** Characteristics of pollution indicator microorganisms, Definitions for indicator and index microorganisms of public health concern, Microbiological characteristics of pollution indicator microorganism, Growth pattern of fecal and non-fecal coliforms on differential media, IMViC test, Waste water treatment (physical, chemical, biological) (8)

4. **Solid waste management**- Integrated solid waste management, solid waste characteristics, collection, processing of municipal solid waste, material separation, biochemical processing, current issues in solid waste management (5)

5.**Xenobiotic metabolism** –Bioremediation by microbes and plants, biodegradation of hydrocarbons, pesticides, surfactants, polyaromatic hydrocarbons, dyes (6)

6.**General principles of Toxicology**-

Concepts of toxicology, toxicity tests, outlines of toxicological testing methods, dose-response relationship, food adulteration and natural toxicant in food, mode of action of toxicants, modifying factors of toxicity of xenobiotic chemicals, selective toxicity, Biotransformation-Phase I and II reactions, Bioaccumulation of xenobiotics, antidotal therapy, environmental impact and risk assessment (10)

Reference Books:

1.Biotechnology. B.D.Singh

2.Envoronmental Microbiology- Raina m maier, Ian L Pepper, Charles P Gerba. Academic press.
3. Renewable energy & energy harvesting – Abani Mohan rudra, Apala Bhattacharya,Atanu Dan
4. Fundamentals of Toxicology- Kamleshwar Pandey, J.P.Shukla, S.P. Trivedi. New Central BookAgency (P) Ltd.

Lab Course (30 classes)

1. Food analysis
2. Food adulterants assay
3. Water Microbiology (plate count, MPN)
4. Water quality analysis (TDS, DO, pH)
5. Bioremediation assay

Course code BCH2PSEC01M

Bioinformatics &Computer aided drug design Credit 4 Marks 50

Course outcome

The aim of this course is to develop student interdisciplinary research skills. It focuses on computational methods that can improve and promote the drug discovery process. Students will be expert and they acquire skill from this course by identification of the molecular target, analyzing the data, utilizing molecular docking and other tools. Definitely, it will be very helpful to students for seeking their job in the future.

1.**Biological tools and databases** - Introduction to Bioinformatics, Sequence and molecular file formats, Sequence conversion tools, Databases in bioinformatics, Sequence analysis tools. Sequence alignments, Concept of alignment, Scoring Matrices, Multiple sequence Alignment, Gene prediction methods, Molecular Evolution and Phylogenetics – homologs, orthologues and paralogs, Molecular clocks, Statistical Evaluation of reliability of molecular phylogenetic prediction. (12)

2. **Protein structure prediction and evaluation**: Use of Chou Fasman and GOR algorithms, Comparative modelling – Homology, *Ab-initio* and threading methods, use of artificial intelligence in protein modelling (Alpha fold); Model evaluation and refinement. Hands on session on protein modelling and structural analyses of proteins. (12)

3. **Molecular Docking**: Molecular docking algorithms, shape complementarity based methods, rigid and flexible docking, evaluation of docking complexes, Hands on session on Docking using suitable software / server, Molecular dynamics simulations of proteins (12)

4. **Computer Aided Drug Discovery**: Concept of drug discovery, Differences between high throughput and computational methods. Structure Based and Ligand based Virtual screening, Evaluation of drug likeliness and LADMET properties of compounds, QSAR, QSPR and QSTR methods and their applications. Use of machine learning methods in drug design. Case studies to evaluate efficacy of methods. (12)

5. **Basic programming using R** – Understanding functions in R – basic statistical testing and image generation (12)

References:

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Campbell, M &Heyer, L. J. (2006), Discovering Genomics, Proteomics and Bioinformatics, Pearson Education.
3. An Introduction to Chemoinformatics- Andrew R. Leach and Valerie J. Gillet (Springer)
4. Molecular Modeling-Principles and Applications- Andrew R. Leach.
5. Bioinformatics-from Genomes to drugs- Thomas lengauer.
6. Fundamentals of Medicinal Chemistry by Gareth Thomas.
7. Bioinformatics: a Textbook, Wiley Online Library
8. Bourne, P. E., &Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
9. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
10. Oprea, T. (2005). Chemoinformatics in Drug Discovery, Volume 23. Wiley Online Library.
11. Gasteiger, J. &Engel,T. (2003), Chemoinformatics: a Textbook, Wiley Online Library
12. Relevant Research and Review Articles

Semester –IV

Course code BCH2PCOR15T

Advanced B**iotechnology** **Credit 4** **Marks 50**

Course outcome

This course will familiarize the students with latest biotechnological background which has not yet been covered in the syllabus. These areas are very important. Without studying this course the M.Sc. program in biochemistry will remain ever incomplete. This course will impart knowledge about all the aspects of emergent areas of biotechnology and its latest status. This is mainly an application-oriented course and opens up the opportunity of the students to choose career in biotechnology in industries and academic institutes. The students also get an idea of entrepreneurship development

1.**Recombinant DNA methods** – Features of commonly used vectors, strategies for cloning in various vectors and Identification of bacterial colonies containing recombinant plasmids, and bacteriophage vectors. Restriction enzymes. Protocols and strategies for cDNA and genomic DNA library preparation, analysis, amplification of DNA by the polymerase chain reaction (PCR), different types of PCR (qPCR, droplet PCR), DNA Markers**,** preparation of radio-labeled DNA and RNA probes, synthetic oligonucleotide probes, expression of cloned genes in cultured cells, screening expression with antibodies and oligonucleotides. Site directed mutagenesis, applications of RDT, Inbred strains, congenic strains, adoptive transfer experiments, transgenic animals, knock-in and knockout technologies, Cre/ lox System, Chromosome Walking and jumping. DNA fingerprinting (12)

3. **DNA sequencing** – Rapid DNA sequencing methods; Maxam-Gilbert technique, Sanger's Dideoxynucleotide sequencing, second generation sequencing: Pyrosequencing ,Illumina,SOLiD and ion Torrent platforms, Third generation DNA sequencing, foot printing, RNA sequencing. (10)

4.**Animal cell culture and Plant tissue culture techniques** -Animal and plant cell culture, basic equipment, cell culture media components, Primary cell culture, clonal cell lines, subculturing disaggregation, method for quantitation of cells in culture, counting chamber, counters, cell viability determination, 3 D cultures. Prospects of improving crop productivity, gene isolation, gene transfer systems, gene expression, regeneration and application. Advances in producing transgenics, transgenic animals and plants. Its application in various fields.(12)

7. **Nanobiotechnology**- Basics and chronological development of Nanoscience and Nanotechnology. Different types of nanomaterials, synthesis of nanoparticles by physical, chemical and biological methods. Properties of nanomaterials mechanical, electrical and optical. Spectral and structural characterization. Applications of Nanoscience and Nanotechnology (10)

8.**Fermentation technology –**General design of fermentors, fermentation processes (batch, fed-batch, continuous) production of alcohols, antibiotics, and enzymes; biotransformation, biomass & production of single cell protein. (5)

9.**CRISPR-Cas9 technology and application-** Mechanism of CRISPR-Cas9 technology, applications (3)

10**. Biotechnology entrepreneurship**- Introduction and scope in Bio-entrepreneurship, Types of bio-industries, Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in Biotechnology. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), Quality control & transfer of technologies, Knowledge centers and Technology transfer agencies, (4)

11. **Stem cells and regenerative medicine**- Introduction and basic biology of stem cells, Pluripotent stem cell and molecular mechanism, introduction to regenerative medicine (4)

Reference Books:

1.Gene Cloning and DNA Analysis: An Introduction- T.A. Brown
2. Principles of Gene Manipulation and Genomics, S.B. Primrose and R.M. Twyman
3. Biotechnology. B.D.Singh
4. Introduction to nanoscience and nanotechnology. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore
5. Basic principles of nanotechnology. Wesley C. Sanders
6. Nano Materials Synthesis and Characterisation. V. Rajendran
7. Nanoparticles: Building Blocks for Nanotechnology. Vincent Rotello
8. Transmission Electron Microscopy: A Textbook for Materials Science. C. Barry Carter and David B. Williams
9. Elements of X-ray diffraction.B. D. Cullity
10. Scanning Electron Microscopy: Physics of Image Formation and Microanalysis. Ludwig Reimer
11. Principles of Three Dimensional Imaging in Confocal Microscopes. Min Gu
12. Confocal Raman Microscopy. Thomas Dieing, Jan Toporski, Olaf Hollricher
13. Industrial Microbiology- L.E. Casida

Course code BCH2PDSE02T

Genetics and Epigenetics Credit 4: Marks 50

Course outcome

This course will familiarize the students with the latest knowledge about Mendelian genetics, human genetics, bacterial and viral genetics and epigenetics. This knowledge is complementary to the earlier molecular biology courses covered in the syllabus. This course is an important component of M.Sc. Biochemistry program. This course will impart knowledge about all the aspects of emergent areas of genetics and its latest status. This is mainly research oriented course and pursuing this course will make the students more apt towards taking decisions about research career.

1. **Mendelian principles**: Dominance, segregation, independent assortment Allele, multiple alleles, pseudoallele, complementation tests. (11)

2. **Extensions of Mendelian principles** : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. (6)

3. **Gene mapping methods**: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. (6)

4. **Extra chromosomal inheritance**: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. (5)

5.**Bacteriophage genetics**: Basics concepts of bacteriophage growth and assay methods. Classical concepts of gene structure and function derived from bacteriophage genetics. (5)

6.**Host-phage interaction mechanisms**. Understanding gene regulatory circuits using bacteriophages as model systems, decision making modules that control fate of lysogenic bacteriophages such as.Re-appropriation of host metabolism by bacteriophages using T4 as the model system. (5)

7. **Human genetics**: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. (6)

8. **Quantitative genetics**: Polygenic inheritance, heritability and its measurements, QTL mapping. (5)

9. **Structural and numerical alterations of chromosomes**: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. (3)

10. **Epigenetics**: DNA methylation, histone modifications, chromatin modifications, epigenetic regulation of gene expression, gene silencing in fungi, yeast and plant system, non-coding RNAs in epigenetic regulation, epigenetics and imprinting, X inactivation, epigenetics and human disease (cancer), epigenetic inheritance, differences between Mendelian and epigenetic inheritance, phenotypic plasticity: epigenetics and environment, epigenetic biomarkers. (8)

Reference Books:

1.iGenetics-A Molecular Approach. Peter J Russell. Pearson.

2.Principles of Genetics. International Student Version. D.Peter Snustad. Michael J. Simmons

3. Concepts of Genetics. International Edition.William S Klug, Michael R Cummings.

Course code BCH2PDSE02T

Ecological Principles Credit 4: Marks 50

Course outcome

This course will familiarize the students with the basic principles of ecology. This preliminary knowledge of ecology is very much essential for the students to qualify in CSIR-UGC NET examinations as questions are very frequently made from this part of the syllabus. Ecology is an integrated interdisciplinary science and students from all background must be exposed to a very preliminary level to build up basic concepts in this arena. Study of ecology is very closely related to environmental protection and conservation which are very contemporary study areas in the field of environmental sciences.

1.**Habitat and Niche**: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. (6)

2.**Population Ecology**: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. (8)

3.**Species Interactions**: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. (8)

4.**Community Ecology**: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. (6)

5.**Ecological Succession**: Types; mechanisms; changes involved in succession; concept of climax. (7)

6.**Ecosystem Ecology**: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). (8)

7.**Applied Ecology**:Biodiversity: status, monitoring and documentation; biodiversity indices; major drivers of biodiversity change; biodiversity management approaches. (8)

8.**Conservation Biology**: Principles of conservation, key stone, umbrella, flagship, indicator species concept, IUCN categories of threatened species and its characteristics, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). (9)

Reference Books:

1. Ecology-P. D. Sharma

2. Fundamentals of Ecology. Eugene P. Odum and Gary W. Barett

3. Elements of Ecology. Thomas. M. Smith & Robert Leo Smith

Course Code BCH2PDSE03T

Systems Biology Credit 4: Marks 50

Course outcome

This course will familiarize the students with the introduction to the system biology . This preliminary knowledge of the tissue engineering is very much essential for the students to develop knowledge in the field of biomedical engineering.

1.**Introduction to Systems Biology:** Historical development of Systems Biology, Biological complexity and emergent properties, Hierarchical organization of biological systems, Biological information flow, Introduction to biological networks , Systems thinking in biology - Feedback loops, Robustness, Adaptability, Self-organization, Nonlinearity, Network dynamics; The IUPS Physiome project (12)

2.**Biological Networks and analyses**: Network theory fundamentals , Graph representations of biological systems, Protein-protein interaction networks, Gene regulatory networks, Metabolic networks ,Signaling pathways, Network topology: Nodes and edges, Degree distribution, Hubs, Clustering coefficient, Scale-free networks, Small-world networks, Network visualization tools; Metabolic Flux Analysis, Biochemical reaction networks and stoichiometry, Regulatory cascades. (12)

3.**Omics technologies and Data integration**: Genome organization and Analyses, Sequencing technologies (Sanger, Pair End and Long read methods), Structural and functional genomics, Comparative genomics, Genome Annotation, Transcriptome Analyses – (RNA Seq), Concept of Differentially expressed genes, detecting non coding RNAs; Spatial transcriptomics; Proteomics - Protein identification quantification, interaction mapping and applications of mass spectrometry methods; Metabolomics: Metabolite profiling, Metabolic fingerprints, Biomarker discovery, Use of NMR; Lipidomics, Epigenomics – use of CHIP – seq and ATAC – seq, ENCODE database and UCSE Genome browser for detecting epigenomic signatures, Single cell sequencing, Metagenomics – Amplicon and shotgun based approaches, functional microbiome analyses, (12)

4.**Mathematical and Computational Modeling:** Mathematical models in biology, Dynamic modeling, Parameter Estimation, Simulation; Deterministic versus Stochastic approaches; Gillespie algorithm (12)

5: **Systems Biology for One Health Approach:** Synthetic Biology and Genetic circuits, modeling of host microbiome interactions – the gut brain and gut lung axis, Digital twins in healthcare, Virtual Patient Models, Ecosystem resilience, Cytomics - From cell states to predictive medicine, Ethics of use of AI in systems medicine (12)

Reference:

1. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Lehrach, H., & Herwig, R. (2016). Systems biology: A textbook (2nd ed.). Wiley-Blackwell.
2. Alon, U. (2019). An introduction to systems biology: Design principles of biological circuits (2nd ed.). Chapman & Hall/CRC Press.
3. Ingalls, B. P. (2013). Mathematical modeling in systems biology: An introduction. MIT Press.
4. Pevsner, J. (2015). Bioinformatics and functional genomics (3rd ed.). Wiley-Blackwell.
5. Barabási, A.-L. (2016). Network science. Cambridge University Press.
6. Primrose, S. B., & Twyman, R. M. (2023). Principles of gene manipulation and genomics (8th ed.). Wiley-Blackwell.
7. Hood, L., Price, N. D., & Ginsburg, G. S. (Eds.). (2017). Systems medicine: Integrative, qualitative and computational approaches. Academic Press.

Course code BCH2PDSE03T

Developmental Biology Credit 4: Marks 50

Course outcome

This course will familiarize the students with the advanced aspects of developmental biology in plants and animals. This preliminary knowledge of developmental biology is very much essential for the students to qualify in CSIR-UGC NET examinations as questions are very frequently made from this part of the syllabus. Developmental biology is an emergent subject and this course will introduce students to a very preliminary level to build up basic concepts in this arena.

1.**Basic concepts of development** : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development (10)

2.**Gametogenesis,** fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. (10)

3.**Morphogenesis and organogenesis in animals** : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditiselegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination. (10)

4.**Morphogenesis and organogenesis in plants**: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum (10)

5.**Programmed cell death, aging and senescence**:Basic concepts, types of cell death, PCD in life cycles of plants and animals, metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence. (10)

6.**Developmental processes**: Embryonic development, Morphogen gradient, asymmetric cell division; Maternal effect genes, Polarity development (dorsoventral and anterior-posterior): Dorsal (ventral), Dpp (dorsal), Bicoid (anterior), Hunchback (anterior), Nanos (posterior);Pattern formation: Notch-Delta (lateral inhibition), Hedgehog, Wnt. (10)

Reference Books

1.Gilbert, S. F., & Barresi, M. J. F. (2022). Developmental Biology (13th Ed.) Sinauer Associates.
2. Lewis Wolpert et al. (2019). Principles of Development (6th Ed.) Oxford University Press.

Course code BCH2PCOR16T

Review writing, Presentation and Industrial visit Credit 4: Marks 50

Course outcome

To cultivate the critical skills necessary to comprehend, evaluate, effectively communicate and present cutting-edge research and advanced concepts in Biochemistry. This course aims to bridge the gap between theoretical knowledge and practical application by immersing students in the dynamic world of scientific discovery through peer-reviewed literature.

Course Code BCH2PCOR17M

Dissertation Credit 4: Marks 50

Course outcome

This course will familiarize the students with the laboratory techniques of biochemistry. This course is very much essential for providing the students hands on training for carrying out experiments in biochemistry. It opens up the scope of further research in biochemistry. Without this knowledge of practical training the students cannot pursue other courses of biochemistry.

Course content: Students will have to carry out a 2-month duration project work supervised by any faculty of any recognized institute in the field of biochemistry and prepare a dissertation project for submission and evaluation. Students will also deliver a power-point presentation to face the critical evaluation.

Course Code BCH2PCOR18T

Grand Viva Credit 4: Marks 50

Course outcome

The overall knowledge during this Biochemistry course of the students will be checked by the external expert.