

**Master of Science  
Biochemistry**

**PROGRAMME STRUCTURE AND SYLLABUS  
2019-20 ADMISSIONSONWARDS**

**(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)**



**EXPERT COMMITTEE IN BIOCHEMISTRY (PG)  
MAHATMA GANDHI UNIVERSITY**

**2019**

## **ACKNOWLEDGEMENT**

We place on record our sincere gratitude to the honourable Vice Chancellor, Mahatma Gandhi University for the guidance and support extended to us during the process of restructuring of the Curriculum and Syllabus of the P G Biochemistry programme.

We gratefully acknowledge the support and cooperation of the members of the Syndicate of Mahatma Gandhi University, especially Dr K Jayachandran, Dr V S Praveenkumar and Dr K Krishnadas.

We thank the staff of the Academic section of Mahatma Gandhi University for their timely assistance.

The members of the Faculty of Biochemistry of the various colleges of Mahatma Gandhi University participated in the workshop and wholeheartedly extended their support during the various stages of this process. Their genuine endeavours deserve special mention. It was their constructive criticism suggestions and proposals that lead to the creation of this unique syllabus.

We acknowledge the cooperation extended to us by the faculty members (UG and PG) and research scholars of the Department of Microbiology of Sree Sankara College, Kalady.

We also thank the faculty members of the Department of Biosciences of Mahatma Gandhi University for their support.

We extend our sincere gratitude to the Management, Principal and Staff of Sree Sankara College, Kalady for the support rendered to us for the successful completion of the workshop.

## **EXPERT COMMITTEE**

## **THE EXPERT COMMITTEE IN BIOCHEMISTRY (PG)**

### **Chairperson:**

Dr Valsa A K, Associate Professor, Department of Microbiology, Sree Sankara College, Kalady

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2. Dr Sandhya C, Assistant Professor, Department of Biochemistry, K E College, Mannanam.
3. Dr Tessy Iype, Senior Scientist, Maggenome Technologies, Pvt Ltd.,SEZ, InfoPark, Kochi.
4. Ms. Neelima T K, Assistant Professor, Department of Biochemistry, MES College, Marampilly.
5. Ms Geena Jose, Assistant Professor, Department of Biochemistry, Presentation College of Applied Sciences, Puthenvelikara.
6. Ms Anju S Kumar, Assistant Professor, Department of Biochemistry, Sree Sankara College, Kalady.

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## M.Sc. Degree Programme

### (Mahatma Gandhi University Regulations PGCSS2019 from 2019-20 Academic Year)

#### Aim of the Programme:

Biochemistry deals with the study of chemical processes of living systems. The M.Sc. Degree programme aims at providing an in-depth understanding of the core principles of Biochemistry and their experimental aspects. This programme also aims at a study on some of the emerging areas of Bioscience. The students get an overview of the recent trends, and will be able to annex an updated information to their knowledge base. The major areas dealt with are:

- Structure function relationships, interaction between macromolecules and cellular processes at the molecular level.
- Tools and techniques used in biological analysis.
- Metabolic pathways, Clinical aspects, Energetics and Catalysis.
- Genetic engineering and Tissue culture.
- Pharmacology, Toxicology and Nanobiology.
- Research methodology, Legal rights of intellectual activity, problems and ethical issues related to Bioscience research.

#### **1. Eligibility for Admissions**

A candidate seeking admission to M.Sc. Biochemistry must have at least 50% marks in biological sciences (Zoology, Botany, Biochemistry, Biotechnology, Microbiology) or Chemistry at the graduate level.

The admission to M.Sc Biochemistry PG Programme shall be as per the rules and regulations of the university.

#### **2. Medium of Instruction and Assessment**

The medium of instruction and assessment will be English.

#### **Faculty under which the Degree is Awarded**

Faculty of Science.

#### **Specializations offered, if any**

NIL

#### **3. Note on compliance with the UGC Minimum Standards for the conduct and award of Post Graduate Degrees**

The programme structure and syllabus of M.Sc Biochemistry complies with the minimum standards prescribed by the University Grants Commission. The M. Sc Biochemistry programme is under the Credit Semester Scheme, consisting of four semesters spread over a period of two years.

- Total credits is 80.
- Number of courses: Core courses - 12, Elective courses - 3, Laboratory courses – 4
- Evaluation: Internal assessment and external evaluation - 1:3 ratio.
- Grading: Direct grading system on a 7 point scale.

## THE PROGRAMME STRUCTURE

Course Code	Title of the Course	Type of the Course	Hours per week	Credits
<b>FIRST SEMESTER</b>				
BC010101	Biomolecules and structural Biology	Core course	04	04
BC010102	Analytical Biochemistry and Bioinformatics	Core course	04	04
BC010103	Cell Biology and Genetics	Core course	04	04
BC010104	Human Physiology and Biostatistics	Core course	03	03
BC010105	Laboratory course I	Core course	<b>10</b>	04
<b>SECOND SEMESTER</b>				
BC010201	Metabolism and Bioenergetics	Core course	04	04
BC010202	Molecular Biology and Genetic engineering	Core course	04	04
BC010203	Immunology	Core course	04	04
BC010204	General Microbiology	Core course	03	03
BC010205	Laboratory course II	Core course	10	04
<b>THIRD SEMESTER</b>				
BC010301	Enzymology	Core course	04	04
BC010302	Plant Biochemistry	Core course	04	04
BC010303	Molecular Endocrinology	Core course	04	04
BC800301	Neurobiochemistry	Elective -1	03	03
BC810301	Biochemical Toxicology	Elective -1		
BC820301	Pharmacological Biochemistry	Elective -1		

BC010304	Laboratory course III	Core course	10	04
<b>FOURTH SEMESTER</b>				
BC010401	Clinical Biochemistry	Core course	05	04
BC800402	Nutritional Biochemistry	Elective -2	05	03
BC810402	Research Methodology, IPR and Bioethics	Elective -2		
BC820402	Genomics and Proteomics	Elective -2		
BC800403	Plant and Animal Cell Culture	Elective -3	05	03
BC810403	Nanobiology	Elective -3		
BC820403	Ecology and Environmental Biochemistry	Elective -3		
BC010402	Laboratory course IV	Core course	10	05
BC010403	Project			05
BC010404	Viva Voce			03
<b>Total Credits</b>				<b>80</b>

### GROUPS OF ELECTIVES

<b>GROUP A</b>	<b>GROUP B</b>	<b>GROUP C</b>
BC800301 Neurobiochemistry	BC810301 Biochemical Toxicology	BC820301 Pharmacological Biochemistry
BC800402 Nutritional Biochemistry	BC810402 Research Methodology, IPR and Bioethics	BC820402 Genomics and Proteomics
BC800403 Plant and Animal Cell Culture	BC810403 Nanobiology	BC820403 Ecology and Environmental Biochemistry



**SEMESTER I**

<b>NAME OF THE COURSE</b>	<b>COURSE CODE</b>	<b>CREDITS</b>
Biomolecules and structural Biology	BC010101	04
Analytical Biochemistry and Bioinformatics	BC010102	04
Cell Biology and Genetics	BC010103	04
Human Physiology and Biostatistics	BC010104	03
Laboratory course I	BC010105	04
	Total Credits	19

## Course code BC010101

### BIOMOLECULES AND STRUCTURAL BIOLOGY

Hours/week 04

Credits 04

#### **Course Outcome**

- Understand the basic concepts of biomolecules.
- Analyse the structure- function relationship of biomolecules.
- Know about the interactions between macromolecules.

#### **Module I**

**Carbohydrates:** Composition, structural classification and functions.

**Oligosaccharides:** Glycosidic bonds; Classification: glycoproteins (O-linked and N-linked); glycolipids; nature of carbohydrate moiety attached; function- as cell recognition factors, in intracellular targeting.

**Polysaccharides:** Classification: Homopolysaccharides(Cellulose,Starch, Chitin and Glycogen), Heteropolysaccharides (bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and heparin); Structural characteristics and functions. Synthetic polysaccharides and their uses. Characterization of Polysaccharides from biological systems.

#### **Module II**

**Lipids:** Composition, structural classification and functions.

**Glycerophospholipids:** Structure and function of Phosphatidic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, PhosphatidylGlycerol, Phosphatidylcholine, Phosphatidyl inositol, plasmalogens, CDP-diacylglycerol, lung surfactants.

**Glycosphingolipids:** Structure and functions of Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides

**Eicosanoids:** Prostaglandins, Leukotrienes and Thromboxanes: Chemistry and physiological functions.

**Steroids:** Classification, structure and functions.

### **Module III**

**Protein structure and function:** Amino acids - structure, reactions. Peptides. Primary, Secondary, Tertiary and Quaternary structure of Proteins - Fibrous proteins (Keratins and collagen) and Globular proteins (myoglobin and haemoglobin), Membrane protein (ATP synthase); Structural implication of the peptide bond-rigid planar peptide unit-cis and trans configuration-conformations of a pair of linked peptide units- torsion angles: phi and psi- steric hindrance- allowed and disallowed conformation – Ramachandran diagram –conformational map of glycine. Protein folding and dynamics– Molten globule state– Molecular chaperones– HSPs. Denaturation (pH, temperature, chaotropic agents).

### **Module IV**

**Nucleic acid structure and function:** Purines, pyrimidines, nucleosides, nucleotides, A, B and Z DNA. Super coiling of the DNA molecule; topoisomers and superhelices; Higher orders of DNA Structure: Chromatin structure: Histones and Nucleosomes; Conformation of Chromatin fibers; Organization of the DNA Sequence: Genes, pseudo genes, extragenic regions (beta globin gene and gene family) duplicated genes; denaturation and reassociation kinetics, repetitive DNA sequences.

RNA Structure: Types of RNA; structure of mRNA, tRNA, and rRNA.

### **MODULE V**

**Macromolecular interactions:** Protein - DNA interaction-helix turn helix, helix loop helix, zinc fingers, homeo box.

Protein RNA interaction-RNA recognition motif.

Protein-protein interaction-leucine zippers, bHLH, bZip motifs, PTB SH2, SH3 domains.

Protein lipid interaction – PH domain.

## REFERENCES

1. Introduction to Biophysics by Pranab Kumar Banerjee S.Chand & Company Ltd
2. Lehninger, Principles of Biochemistry, Fourth Edition by David L.Nelson Michael. M Cox  
Publisher: W.H.Freeman;
3. Biochemistry Donald Voet, Judith G Voet , JohnWiley & Sons Inc
4. Principles of Biochemistry, Robert Horton H,Laurence A Moran, Gray Scrimgeour K,  
Pearson.
5. Biochemistry Jeremy M. Berg John L.tymoczko LubertStryer B.I Publications Pvt.Ltd
6. Biochemistry – The chemical reactions of living cells. David E Metzler, Academic press  
Newyork.

## Course code: BC010102

### ANALYTICAL BIOCHEMISTRY AND BIOINFORMATICS

Hours/week 04

Credits 04

#### Course outcome

- Understand the biochemical techniques used in research and industry.
- Handle various instruments used in laboratories.
- Demonstrate the insilico tools for biological data analysis.
- Understand the significance and precautions to be taken during radioactivity experiments.

#### **MODULE I**

**Spectroscopic techniques:** Principle, instrumentation, and applications of UV-Visible, Infra-red and Fluorescence spectroscopy. Instrumental setup and applications of flow cytometry.

Methods for studying the structure of macromolecules- X - Ray crystallography, Nuclear magnetic resonance spectroscopy(NMR), Electron Spin Resonance (ESR) and Matrix Assisted Laser Desorption/Ionization- Time Of Flight-mass spectroscopy (MALDI-TOF MS).

#### **MODULE II**

**Hydrodynamic techniques:** Principle, instrumentation, methods and application of adsorption and partition chromatography-Paper chromatography, Thin layer chromatography, HPTLC. Gel filtration chromatography, Affinity chromatography, Ion-exchange chromatography, HPLC and GC-MS, and LC MS.

**Centrifugation-** Principle, methods and applications of Ultra-centrifugation,differential and density gradient centrifugation.

#### **MODULE III**

**Electrophoretic and blotting techniques :** Principle, instrumentation, methods and applications of electrophoresis; Gel electrophoresis- agarose gel electrophoresis,Polyacrylamide gel electrophoresis, SDS - PAGE, isoelectric focusing, and pulse field gel electrophoresis.

Principle, instrumentation, methods and applications of Western- Southern & Northern blotting techniques

#### **MODULE IV**

**Analytical methods based on Radioactivity:** Radioactivity, types of radiation, Detection and measurement of radiation: GM counter, Scintillation counter and pulse height Analyzer. Applications of radioisotopes in biology: Radioimmunoassay and tracer studies. Radiation hazard & laboratory handling methods.

#### **MODULE V**

**Bioinformatics :** Introduction to Bioinformatics, Scope, History and development, major biological data bases and its classification –nucleotide sequence databases, protein sequence databases, structural data bases, derived and specialized data bases, DNA and RNA sequence databases, genomic databases, mutation and polymorphism databases, Creating databases, Data organisation, Searching data bases, sequence and structure file formats.

Basic idea of sequence comparison- Pair wise and multiple sequence alignment. Applications of multiple sequence alignment. Sequence analysis softwares- BLAST, FASTA, CLUSTAL.

Applications of bioinformatics- Pharmaceutical industry, Drug designing, Immunology, Agriculture and Forestry.

#### **REFERENCES**

1. Practical Biochemistry-Principles and techniques, Keith Wilson and John walker, University press, Cambridge, UK.
2. Modern Experimental Biochemistry. Rodney F Boyer. N Benjamin/ Cummings publishing company Inc. Redwood city, California.
3. Chromatographic methods. A Braithwaite and FJ Smith. Chapman and Hall, New York.
4. Gel Electrophoresis of Nucleic acids-A Practical approach. Rickwood D and BD Hames. IRL Press, New York
5. Spectrophotometry and Spectrofluorimetry: A Practical Approach. Harris DA and CL Bashford (Ed.) IRL Press, Oxford.

6. Introduction to Spectroscopy. Donald L. Pavia Gary M. Lipman, George S. Kriz. Harcourt Brace College Publishers, Orlando, Florida
7. Introduction to Biophysics-Sokal R.R. & Rohlf F.J
8. Introduction to Bioinformatics; Attwood T K and Parry-Smith D J Pearson Education Ltd.
9. An Introduction to Computational Biochemistry; C. Stan Tsai, Wiley India Pvt. Ltd
10. Basic bioinformatics, S. Ignachimuthu, SJ Narosa Publishing House
11. Introduction to Bioinformatics, Arthur M Lesk, Oxford.
12. Introduction to Bioinformatics; V Kothekur DHRUV Publications.

## **Course code: BC010103**

### **CELL BIOLOGY AND GENETICS**

Hours/week 04

Credits 04

#### **Course outcome**

- Understand the various organelles of a cell and its functions.
- Know about the different cellular receptors and signal transduction pathways.
- Understand the etiology of cancer.
- Aware of the genetic aspects of inheritance.

#### **MODULE I**

**Cell and cell cycle :** Plant, animal and microbial cells. Structure and functions of Plasma membrane, Nucleus, Cytoskeleton and cell organelles. Different phases of cell cycle - G1, S, G2 and M phases. checkpoints, regulations of cell cycle. Maturation Promoting factor, cyclins, ubiquitin, protein kinases, inhibitors of CdK. Cell division - mitosis and meiosis.

Extra cellular matrix components; Cell –Cell interaction and cell matrix interaction.

#### **MODULE II**

**Biological membranes :** Types of membranes, Chemical composition; Fluid Mosaic model, membrane rafts; Gap and tight junctions; Physical and biochemical methods to study the structure and function of membrane; Specialized forms of membranes: brush border, flagella, red cell membranes and microsomal membrane.

**Membrane functions:** Membrane Transport - Endocytosis and exocytosis. Transport across membranes - Porins facilitated diffusion, Porter molecules: facilitated transport - symport, antiport, uniport. Anion porter, glucose porter; Active transport: proton pumps; Na<sup>+</sup> K<sup>+</sup> pumps, Ca<sup>+</sup> pumps; Ion channels: Types and characteristics of ion channels.

#### **MODULE III**

**Signal transduction:** Membrane receptors - Types, Structure and functions of receptors; Mechanism of signal transduction – signals, second messengers. Signalling pathways: GPCR,



Ion channel-linked receptors, Enzyme-linked receptors- receptor and non-receptor tyrosine kinases, serine/threonine kinase coupled receptors, mitogen activated protein kinases, phospholipid mediated signalling. Nuclear receptors. Kinases and Phosphatases.

#### **MODULE IV**

**Cell Death and Cancer:** Necrosis and apoptosis, stages of apoptosis, Role of mitochondria, DNA ladders, transglutaminase activity, programmed cell death in *Ceanorhabdtis elegans* and *Xenopus*. Proteins involved in apoptosis - Bcl2 family, caspases and death proteins - their role in apoptosis, Autophagy.

**Cancer-** Stages in cancer development, causes, properties of cancer cells, tumour viruses, Proto-oncogenes, functions of proto-oncogene products. Proto-oncogene and signal transduction, proto-oncogene and G proteins, proto-oncogene and cell survival. Cancer Pathways: MAPK, P13K, TP53 network, NF $\kappa$ B pathways; Signalling by TGF  $\beta$  factor, Tumour Suppressor gene, functions of tumour suppressor gene products. Cancer treatment strategies.

#### **MODULE V**

**Chromosomes and Mendelism:** Characteristics of Mendelian pattern of inheritance. Dominance, segregation, independent assortment, deviation from mendelian inheritance: codominance, incomplete dominance, multiple alleles, pedigree patterns, chromosomal abberations .

#### **REFERENCES**

1. Cell Biology, Smith and Wood
2. Cell and Molecular Biology by Gerald Karp, Academic Press
3. Cell and Molecular Biology by Cooper, Oxford University press
4. Biology of Cancer by Robert Weinberg, Garland Science.
5. Principles of Genetics, Sunstad, Simmons and Jenkins, John Wiley And Sons Inc
6. Genetics, Robert Weaver and Philip Hendricks, W.H.C Brown Publishers, Iowa
7. Basic human Genetics, E J Mange and A P Mange, Rastogi Publishers, India.
8. Fundamentals of Genetics BD Singh, Kalyani Publishers.

9. Introduction to Genetic Analysis, Griffiths, Wessler, Lewontin, Gelbert , Suzuki and Miller, Freeman's and Co, New York.
10. Modern Genetic Analysis, Griffiths, Lewontin, Gelbert, and Miller, Freeman's and Co, New York.

**Course code: BC010104**

**HUMAN PHYSIOLOGY AND BIOSTATISTICS**

Hours/week 03

Credits 03

**Course Outcome**

- Understand the tissues and organs of the human body.
- Demonstrate the ability to differentiate physiology from the cellular and molecular level to the organ system.
- Evaluate laboratory experiments in physiology.
- Appraise the role of statistics in research.

**MODULE -1**

**Introduction to physiology**

Introduction to physiology, scope of human physiology, Elementary tissues- epithelial tissue, connective tissue, muscle tissue, nervous tissue. Homeostasis - blood buffers, acid-base balance. Digestion- digestive processes at various regions of digestive system.

**MODULE –II**

**Muscle and cardiovascular physiology**

Muscle classification - skeletal muscle, smooth muscle and cardiac muscle. Muscle contraction, membrane excitation, neuromuscular junction, rigor mortis.

Heart: Action potential in cardiac muscle, cardiac cycle, heart sounds, conducting mechanism, heart beat and regulation, cardiac output, ECG, blood pressure.

Formed elements of blood - erythrocytes, leukocytes, thrombocytes. Hematopoiesis, Blood groups, blood transfusion, blood coagulation, lymph– origin, circulation and functions.

### **MODULE -III**

**Renal physiology :** Kidney, Structure and functions of nephron, renal circulation, glomerular filtration, tubular reabsorption, tubular secretion, renal regulation of water and electrolyte balance, composition of urine.

### **MODULE –IV**

**Respiratory Physiology:** Organization of respiratory system, respiratory membrane, pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation, surfactants, exchange of gases, transport of gases, regulation of respiration, hypoxia, cyanosis, hypercapnia, dyspnea, apnea, periodic breathing, artificial respiration.

### **MODULE –V**

**Biostatistics:** Introduction, scope, probability and probability distribution analysis, variables in biology, collection, classification and tabulation of data, graphical and diagrammatic representations-scatter diagrams, histograms, frequency polygon, frequency curve, logarithmic curves, Descriptive statistics, measures of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic means. Measures of dispersion, Standard deviation, standard error, Variance, coefficient of variation, correlation and regression, Principle component analysis. Tests of significance, Basic idea of Significance test, hypothesis testing, levels of significance, student's t-test, ANOVA, Chi-square test and goodness of fit, comparison of means of two samples, three or more samples, statistical packages, use of statistical softwares, Excel, SPSS, Prism, Graphpad softwares.

### **REFERENCES**

- 1.Vander's Human Physiology-The mechanism of Body function, Widmaier, Raff, strang. McGraw Hill Newyork.
- 2.Text book of Medical Physiology.Arthur.C.Guyton & John.E.Hall Elsevier Saunders, Pennsylvania.
3. Review of Medical Physiology-William F.Ganong

4. Essentials of Medical Physiology K.Sembulingam&PremaSembulingam, Jaypee Brothers medical publishers, New Delhi.
5. Statistical methods in Biology-Norman T J Bailey Cambridge University Press.
6. Introductory Practical Biochemistry, S.K.Sawhney&Randhir Singh (eds), Narosa Publishing House, New Delhi.
7. Standard Methods of Biochemical Analysis, S.K.Thimmaiah (ed), Kalyani Publishers, Ludhiana.
8. Experimental Biochemistry, A Student companion, BeeduSasidhar Rao and Vijay Deshpande(ed), I.K.InternationalPvt.Ltd, NewDelhi
8. Practical Biochemistry, R.C.GuptaS.Bhargava(eds) CBS Publishers and Distribuors, New Delhi.

**Course code:BC010105**  
**LABORATORY COURSE –I**

**Hours/Week:10**

**Credits 04**

**1. Preparation of Solutions:**

- Percentage solutions.
- Molar solutions.
- Normal solutions.
- Dilution of Stock solutions

**2. Preparation of buffers using the Henderson - Hasselbalchequation**

**3. Spectrophotometric experiments:**

- Determination of UV-Visible spectrum of compounds
- Determination of Concentration of molecules from Molar Extinction coefficient values.

**4. Qualitative analysis of Carbohydrate mixtures** following systematic analysis(a combination of polysaccharide, disaccharide and monosaccharide). General reactions of amino acids, proteins and lipids.

**5. Quantitative Analysis-Any five**

- Estimation of reducing sugars by Dinitrosalicylic acid method
- Estimation of glucose by Nelsons Somogyi method
- Estimation of glucose by orthotoluidine method
- Estimation of fructose by Roe and Papadopaulose method
- Estimation xylose by orcinol method
- Estimation of tyrosine by Folin Ciocalteumethod
- Estimation of Cholesterol by Zak's method
- Estimation of protein by Biuret method.
- Estimation of protein by Lowry's method
- Estimation of albumin by BCG method
- Estimation of Methionine by Nitroprusside method
- Estimation of total aminoacids by Ninhydrin method

- Determination of Saponification value, acid value, iodine number of oils or fats.

## **6. Chromatographic techniques**

- Separation of amino acids by Paper chromatography (Descending or Ascending)
- Separation of Plant pigments/lipids/sugars by Thin layer chromatography
- Separation of any biomolecule by column chromatography

## **7. Demonstration of stages of mitosis, meiosis and counting chromosome numbers**

## **8. Physiology experiments**

- Determination of haemoglobin concentration.
- Determination of haematocrit.
- Enumeration of blood cells - Erythrocytes by haemocytometry, Total leukocyte by haemocytometry.
- Preparation of Blood smears for differential count and cell morphology.
- Determination of Erythrocyte sedimentation rate.

## **9. Bioinformatics**

- Familiarizing with the different data bank mentioned in the syllabus.
- Retrieve a document reporting recent work on a genomic analysis of human disease.
- Retrieve one sequence both DNA and protein from database retrieval systems.
- Retrieve nucleotide sequences and construct a distance tree.

## **10. Biostatistics**

Problems on Bar diagrams, Pie diagrams, Histogram, Arithmetic mean, Standard deviation, correlation, regression, Student's t test, Chi square test.

## **REFERENCES**

1. Introductory Practical Biochemistry, S .K. Sawhney & Randhir Singh ( eds) Narosa Publishing House, New Delhi.
2. Standard Methods of Biochemical Analysis, S.K. Thimmaiah (ed), Kalyani Publishers, Ludhiana
3. Hawk's Physiological Chemistry, Bernard L.Oser(ed) TATA McGraw Hill Publishing Company LTD, New Delhi.
4. Statistical methods in Biology-Norman T J Bailey Cambridge University Press.

## SEMESTER II

<b>NAME OF THE COURSE</b>	<b>COURSE CODE</b>	<b>CREDITS</b>
Metabolism and Bioenergetics	BC010201	04
Molecular Biology and Genetic engineering	BC010202	04
Immunology	BC010203	04
General Microbiology	BC010204	03
Laboratory course II	BC010205	04
	Total Credits	19



## Course code: BC010201

### METABOLISM AND BIOENERGETICS

#### Course outcome

- Define the major pathways of intermediary metabolism and discuss their energetics, physiological adaptation, regulation, localization and cellular compartmentalization.
- Correlate the metabolic activity of tissues and organs with their function.
- Discuss how derangements in metabolism leads to diseases.

#### MODULE- 1

**Metabolism of carbohydrates :** Glycolysis- Reactions, Energetics and Regulation.

Metabolism of sugars other than glucose- fructose, galactose and mannose.

Citric acid cycle- Reactions, Amphibolic nature of the cycle, Anaplerotic reactions. Regulation.

Gluconeogenesis- Reactions, Energetics and Regulation, Cori Cycle, Glyoxylate pathway, Pentose Phosphate Pathway. Alternative oxidative pathway of glucose- Uronic acid pathway, Phosphoketolase pathway.

Metabolism of Glycogen- Glycogen breakdown and Glycogen synthesis. Regulation.

Hormonal regulation of Carbohydrate metabolism- Role of insulin, glucagon, epinephrine.

#### MODULE II

**Lipid metabolism :** Fatty acid oxidation - alpha, beta, omega oxidation. Catabolism of unsaturated fatty acids, formation and utilisation of ketone bodies.

Fatty acid biosynthesis- Regulation.

Synthesis and breakdown of triacylglycerols- Regulation.

Phospholipids and Glycolipid metabolism- Glycerophospholipids, Sphingolipids, Sphingoglycolipids.

Cholesterol metabolism- Cholesterol biosynthesis and Regulation, Transport of cholesterol- LDL receptor pathway, Cholesterol catabolism- synthesis of bile acid.

Lipoprotein metabolism- chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL.

Arachidonic acid metabolism- leukotrienes and prostaglandins, thromboxanes

#### MODULE III

**Metabolism of proteins and amino acids :** Catabolism and anabolism of individual aminoacids- Regulation. Conversion of aminoacids to histamine, polyamines, serotonin, nor epinephrine and gamma amino butyrate.

Biosynthesis of Urea.

#### MODULE IV

**Metabolism of purine and pyrimidine nucleotides**

Metabolism of purines and regulation, metabolism of pyrimidines and regulation.  
Heme synthesis and degradation.

## MODULE V

**Bioenergetics** : Introduction to thermodynamics, concept of enthalpy and entropy and free energy. High energy molecules.

Functional significance of mitochondrial respiratory chain and oxidative phosphorylation. Electron transport chain- structural components of the chain, complexes, free elements, structural and functional properties of cytochrome, ferrosulphated proteins and CoQ.

Generation of electrochemical proton gradient, chemiosmotic ATP synthesis, Structural and functional properties of ATP synthase, inhibitor agents and decoupling agents of the respiratory chain and ATP synthesis, Transport process across the inner mitochondrial membrane.

**Metabolomics** : Introduction to the origin of metabolomics, definition of metabolite and metabolome. Applications of metabolomics in toxicity assessment, toxicology. Metagenomics.

## REFERENCES

1. Lehninger, Principles of Biochemistry Fourth Edition by David L.Nelson Michael M.Cox Publisher: W.H. Freeman.
2. Biochemistry Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
3. Principles of Biochemistry, Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-hill Book Company.
4. Principles of Biochemistry. Robert Horton H, Laurence A Moran, Gray Scrimgeour, Pearson
5. Biochemistry Jeremy M Berg, John Tymoczko Lubert Stryer. B.I publications Pvt.Ltd ‘
6. Biochemistry – The chemical reactions of living cells. David E Metzler, Academic press, Newyork.

## Course code: BC010202

### MOLECULAR BIOLOGY & GENETIC ENGINEERING

#### Course Outcome

- Understand the molecular mechanisms underlying the transmission of genetic information.
- Realise the different molecular tools and strategies in practice in genetic engineering.
- Appreciate the applications of rDNA technology in various fields.

#### MODULE -1

**DNA Replication-** Chromosomes, Process of DNA replication, Semiconservative, discontinuous unidirectional and bidirectional, Okazaki fragments, Enzymes and other proteins in eukaryotes and prokaryotes, Klenow fragment. Modes of replication - theta, rolling circle, D-loop replication, Primosome, SSB, Helicase, Ligase, methylation and control, repetitive DNA sequences, minisatellite, microsatellite, DNA protein interaction, DNA Linking number and topoisomerase, Inhibition of replication.

#### MODULE -2

**Transcription-**Process of transcription, stages in transcription, RNA polymerases in prokaryotes and eukaryotes, sigma factor in prokaryotes, Rho dependent and Rho independent termination. Enhancers, Transcription factors in Eukaryotes, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications - Polyadenylation, capping. r-RNA processing, Splicing- Spliceosome, lariat structure, Group I,II and III Introns, Ribozyme - Importance of ribozyme, properties, application, RNaseP, RNase III, RNaseII, monocistronic and polycistronic m-RNA, Joint transcript of r-RNA and tRNA in prokaryotes and their processing. Transplicing, alternate splicing, inhibitors of Transcription.

Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system, +ve&-ve regulation; Operon concept - structure of operon, Lac, Trp, Ara operon, Catabolic repression, attenuation. Role of Hormones in gene regulation. RNA World, RNA based technology-Molecular mechanism of Ribozyme, Antisense

RNA, siRNA, MicroRNA, Ribozymes and their applications; Telomerase structure and function. Nucleic acid as therapeutic agent.

### **MODULE III**

**Translation :** Process of translation. Stages in translation, genetic code, properties, wobble hypothesis, eukaryotes and prokaryotes ribosomes, mRNAs, tRNAs, aminoacyl t-RNA synthetases, protein factors initiation complex, peptidyltransferases, releasing factors, differences between prokaryotic and eukaryotic systems, inhibition of translation. Post translation modification by cleavage, self assembly, assisted self assembly chaperones, acylation, phosphorylation, acetylation and glycosylation. Histone acetylation and deacetylases, chromosome remodelling complex. Intein splicing. Protein targeting, cotranslational import, post translational import, SRP-structure and function, Blobel's concept, Lysosome targeting, M6P address Glycosylation, core glycosylation terminal glycosylation, Dolichol phosphate. Targeting to Nucleus, Peroxisomes, Chloroplast and Mitochondria.

### **MODULE IV**

**Tools and techniques for genetic Engineering:** Introduction: History of rDNA Technology, Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymer tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes

E. coli based vectors: development, features, and selection procedures of plasmid vectors - pSC101, pBR322 direct selection plasmid vectors. Bacteriophages - M13 vector, in vitro packaging mechanisms, cosmids and cosmid cloning schemes. Phagemids pBluescript, Construction of genomic and cDNA libraries, procedures for recombinant selection and library screening

PCR and its variants, DNA sequencing - Plus and minus sequencing, Sanger's dideoxy sequencing Maxam and Gilbert method. Advanced sequencing procedures; Pyrosequencing, Illumina, ABI / SOLID and their applications.

## MODULE V

**Applications of Genetic Engineering :** Applications of transgenic Technology Improving quality and storage life of fruits and vegetables. Plants with novel features, Engineering metabolic pathways, Pharming. Animal cloning, Ethics of cloning. Applications of Molecular Biology in forensic sciences, medical science, archeology and paleontology.

### REFERENCES

1. Modern Genetic Analysis, Griffiths, Lewontin, Gelbart, and Miller, Freeman and Co, New York
2. Cell Biology, Smith and Wood, Garland Science.
3. Cell and Molecular Biology by Gerald Karp, Academic Press
4. Cell and Molecular Biology by Cooper, Oxford University press.
5. Molecular Biotechnology-Glick and Pasternak, American Society for Microbiology.
6. Principles of gene manipulation- Old, Twyman and Primrose, Blackwell.
7. Gene cloning and DNA analysis-T.A Brown, Wiley, Black well.
8. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter Publisher: Garland Science.
9. Genes IX by Benjamin Lewin Jones and Bartlett publishers, Inc.
10. Molecular Biology of the Gene James D Watson, Tania A Baker, Stephen P Bell  
Publisher: Dorling Kindersley (India) Pvt Ltd.
11. Genetics - A Molecular Approach – Peter A Russel, Pearson
12. , India.

## **Course code:BC010203**

### **IMMUNOLOGY**

#### **Course Outcome**

- Conceptualize cellular and molecular basis of the immune system.
- Understand how the innate and adaptive immune responses coordinate to fight against invading pathogens.
- Appreciate the structure and functions of MHC molecules and Immunoglobulins.
- Understand the complement system, its activation and biological consequences of complement activation.
- Differentiate between the types of antigen-antibody interaction and the different immunological assays based on the interaction.
- Understand about the vaccines in use and the strategies to develop vaccines of the future.
- Understand and identify the genetic defects that lead to immunodeficiency diseases and their treatment as well as the current status of gene therapy.

#### **MODULE I**

**Overview of immune system:** Infection, Source of infection, Methods of transmission. Types of immunity. Mechanisms of innate immunity-barriers, inflammation, phagocytosis-mechanisms, Pattern recognition receptors-Scavenger receptors and the Toll-like receptors etc. Organs and cells with immune functions. Lymphocytes and lymphocyte maturation.

#### **MODULE II**

**Antigens and Antibodies and interactions:** Antigens, Antigenicity, Epitopes, Antibodies, Immunoglobulin- structure, classes and functions Fc receptors. Monoclonal antibodies- production and application, Antibody engineering. Antigenic determinants on Ig-Isotype, Allotype, Idiotype. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, V(D)J rearrangements, somatic hypermutation and affinity maturation, Class-switching, Antigen- antibody reactions, Agglutination, Precipitation, Complement fixation, Radioimmuno assay, Immunofluorescence, ELISA, Western blotting, Flow cytometry etc.

### MODULE III

**Generation of immune responses:** MHC, Antigen processing and presentation, Complement system, Complement activation, regulation, Biological effects of complements, B cell generation, activation, differentiation, Humoral Immune response, Primary and secondary immune response, Clonal selection theory. T-cell maturation, activation and differentiation, Cell mediated Immune response, Properties of Cytokines.

### MODULE IV

**Immune system in health and disease:** Immunology of transplantation- Immunologic basis and clinical manifestation of graft rejection, Allograft reaction and GVH reaction, Immune tolerance to allograft, Immunology of malignancy-Tumour antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohematology- ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born.

### MODULE V

**Immune effector mechanisms:** Immunological Tolerance, Autoimmunity- Mechanisms of autoimmunity, Autoimmune diseases. Hypersensitivity-immediate and delayed reactions, Clinical types of hypersensitivity, Immunodeficiency diseases, Immunoprophylaxis-Vaccines-types of vaccines, DNA vaccine and recent trends in vaccine development.

### REFERENCES

1. Roitt IM & Delves PJ *Roitt's essential Immunology* Blackwell Science Oxford. 10<sup>th</sup> ed.
2. Kindt TJ, Goldsby RA, Osborne BA & Kuby J *Kuby Immunology*. W.H Freeman, New York.
3. Murphy K, Travers P, Walport M, & Janeway C *Janeway's Immunobiology*. Garland Science, New York 7<sup>th</sup> ed.
4. Chapel H *Essentials of clinical Immunology*. Blackwell, Malden, mass; Oxford. 5<sup>th</sup> ed.
5. Kimball J *Introduction to Immunology*. Macmillan, London 2<sup>nd</sup> ed.
6. Paniker CKJ, Ananthanarayanan & Panicker's *Textbook of microbiology*. Orient Longman 7<sup>th</sup> ed.

**Course code: BC010204**  
**GENERAL MICROBIOLOGY**

**Course outcome**

- Understand the diversity of microbial world and their interactions with the environment.
- Know about the genetic materials and different genetic mechanisms in bacteria and their role in the transmission of characters.
- Emphasize the importance of sterilization and disinfection and the methods used in a microbiology laboratory and premises
- Categorise microorganisms based on their characteristics.

**MODULE I**

**Overview of microbiology:** The historical foundations and development of microbiology. An overview of microbial world. Beneficial and Harmful microbes. Bacterial diversity- The bacteria and the archaea. Principles of bacterial taxonomy Molecular methods in taxonomy. Morphology and structure of bacteria. Surface structures and inclusions of bacteria.

**MODULE II**

**Microbial nutrition, Growth and locomotion:** Factors influencing microbial growth and nutritional factors. Nutritional types of bacteria. Microbial locomotion-flagellar motility, gliding motility and amoeboid motion. Chemotaxis and Phototaxis Cultivation of bacteria-culture media and methods. Measurement of bacterial growth. Bacterial growth curve. Binary fission, Microbial growth at different temperature, pH and oxygen level. Maintenance and transport of cultures.

**MODULE III**

**Identification and methods of microbial control:** Identification of bacteria. Staining reactions. Cultural, physiological biochemical properties and molecular methods. Sterilization-Principles and methods, physical and chemical methods. Disinfectants-modes



ofaction. Testing of disinfectants. Antibiotics- mechanism of action. Drug resistance in bacteria. Antibiotic sensitivity tests.

#### **MODULE IV**

**Bacterial genetics:** Genetic materials in bacteria. Bacterial chromosome. Extra chromosomal genetic elements. Plasmid, Transposons. Mutation, Site Directed Mutagenesis, DNA repair,. Mechanism of gene transfer-transformation, transduction and conjugation.

#### **MODULE V**

**Viruses and Fungi:** Viruses-unique properties, morphology and structure. Virion, Viroids and Prions. Viral replication. Viral diversity-bacterial, plant and animal viruses . General properties of Fungi, Economic Importance of fungi.

#### **REFERENCES**

1. Russel AD, Hugo WB & Ayliffe GAJ *Principles and practice of disinfection, preservation, and sterilisation*, Blackwell Science, Oxford
2. Bryan LE *Antimicrobial Drug Resistance* Academic Press, Orlando.
3. Topley WWC, Wilson GS Parker T & Collier LH *Topley and Wilson's Principles of Bacteriology, Virology and Immunology*. Edward Arnold, London. 8<sup>th</sup>ed.
4. Davis BD *Microbiology*, Lippincott, Philadelphia.
5. Zinsser H & Joklik WK *Zinsser Microbiology* Appleton & Lange, Norwal, CT.
6. Gerhardt P (1994) *Methods for General and Molecular Bacteriology*. American Society for Microbiology, Washington, D.C
7. Pelezar MJ, Chan ECS, & Krieg NR *Microbiology : concepts and applications* McGraw-Hill.
8. Prescott LM, Harely JP, & Klein DA *Microbiology*, McGraw-Hill, Boston; London.

**Course code: BC010205**  
**LABORATORY COURSE-II**

**(Microbiology, Immunology, Molecular Biology and Genetic Engineering)**

**MICROBIOLOGY AND IMMUNOLOGY**

- Microscopic examination of bacteria in living conditions
- Testing of motility
- Staining procedures-Gram's, Volutin, Spore, Capsule, Negative, Fungal staining etc.
- Cultivation of bacteria and fungi
- Sterilization methods
- Study of cultural characteristics and biochemical reaction of bacteria
- Testing of disinfectants
- Bacterial growth curve
- Antibiotic sensitivity tests-disc diffusion
- Serological tests for the diagnosis of microbial infections
- Agglutination and precipitation tests
- Immunodiffusion in gel
- ELISA

**MOLECULAR BIOLOGY AND GENETIC ENGINEERING**

- PAGE-Protein separation
- DNA and RNA isolation
- Agarose gel electrophoresis of nucleic acids
- Estimation of DNA and RNA
- Polymerase Chain Reaction
- Restriction enzyme digestion
- Blue white screening

**References:**

1. Cheesbrough M District Laboratory Practice in Tropical Countries. Cambridge University Press

2. Collee JG & Mackie TJ Mackie and McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.14<sup>th</sup>ed.
3. Gradwohl R B H, Sonnenwirth A C, & Jarett L Gradwohl's Clinical Laboratory Methods and Diagnosis. Mosby, St Louis, Mo.;London 8<sup>th</sup> ed.
4. Dubey R C & Maheshwari DK Practical Microbiology(S.Chand& Company Limited.
5. Aneja K R Experiments In Microbiology,Plant Pathology And Biotechnology. New Age International.
6. Sambrook J and Russell D. Molecular Cloning: A Laboratory Manual, 3<sup>rd</sup> edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
7. Sambrook J, Fritsch E.F, and Maniatis T. Molecular Cloning: A Laboratory Manual, 2<sup>nd</sup> edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York

### SEMESTER-III

NAME OF THE COURSE	COURSE CODE	CREDITS
Enzymology	BC010301	04
Plant Biochemistry	BC010302	04
Molecular Endocrinology	BC010303	04
<b>Group A Electives</b> (Select 1 from 3)		03
Neurobiochemistry	BC800301	
Biochemical Toxicology	BC810301	
Pharmacological Biochemistry	BC820301	
Laboratory course III	BC010304	04
	Total credits	19

## Course code: BC010301

### ENZYMOLGY

Hours/ Week : 4

Credits:4

#### Course Outcome

- Describe structure, functions and mechanism of action of enzymes
- Classify enzymes based on the reactions catalysed.
- Understand kinetics, inhibition and regulation of enzyme catalysed reactions.

#### MODULE I:

**Introduction to enzymes:** Holoenzyme, apoenzyme, and prosthetic group; Interaction between enzyme and substrate- lock and key model, induced fit model. Features of active site, activation energy, Rate enhancement through transition state stabilization, Chemical mechanism for transition state stabilization. Enzyme specificity and types. Enzyme Commission system of classification and nomenclature of enzymes (Class subclass and subclass with one example). Ribozymes, Abzymes. Coenzymes and their functions-  $\text{NAD}^+$ ,  $\text{NADP}^+$ , FAD, FMN, lipoic acid, TPP, Pyridoxal phosphate, biotin and cyanocobalamin.

Measurement and expression of enzyme activity, enzyme assays. Definition of IU, katal, enzyme turnover number and specific activity, Isolation, purification and characterisation of enzymes and criteria of purity.

#### MODULE II:

**Enzyme kinetics:** Importance, order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction-enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators (explanation with graphical representation). Derivation of Michaelis Menten equation and  $K_m$  value and its significance, Definition of  $V_{\max}$  value of enzyme and its significance, Lineweaver-Burk plot; King and Altman Method to determine velocity Equations. Bi- substrate reactions: Classification. Reaction mechanisms - The Serine Proteases: An Illustrative Example. Allosteric enzymes: Examples of Cooperativity and Allostery in Proteins, Models of Allosteric Behaviour, Effects of Cooperativity on Velocity Curves.

### **MODULE III:**

**Enzyme inhibition:** Reversible and irreversible-examples. Reversible-competitive, non-competitive and uncompetitive inhibition; Graphic determination of inhibitor type, Dose-response curves of Enzyme inhibition. Mutually Exclusive Binding of Two inhibitors; Structure-Activity Relationships and Inhibitor Design.

### **MODULE IV:**

**Regulation of Enzyme activity:** Covalently modulated enzymes with examples of adenylation and phosphorylation; Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; Allosteric regulation -Aspartate transcarbamoylase. Isoenzymes- Lactate dehydrogenase and creatine phosphokinase.

### **MODULE V:**

**Application of enzymes:** Industrial uses of enzymes: production of glucose from starch, cellulose and dextrans, use of lactase in dairy industry, production of glucose fructose syrup from sucrose, use of proteases in food, leather and detergent industry. Diagnostic and therapeutic enzymes; Enzyme engineering.

### **REFERENCES**

1. Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis stevens, Oxford University Press, USA
2. Enzyme Kinetics: A modern Approach, Alejandro G. Marangoni, Wiley-Interscience
3. Enzyme Mechanism by P.K Sivaraj Kumar, RBSA Publishers
4. Enzymes in Industry: Production And Applications by Aehle W (2007) John Wiley & Sons Inc
5. Enzymes: Biotechnology, Clinical Chemistry (second Edition)by Trevor Palmer, Philip Bonner Horwood Publishing Limited
6. Lehninger, Principles of Biochemistry David L.Nelson Michael M.Cox, W.H.Freeman.
7. Biochemistry Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
8. Enzymology Dixon and Webb, Academic Inc publishers, Newyork.

**Course code: BC010302**

**PLANT BIOCHEMISTRY**

**Hours/week: 4**

**Credits:4**

Course Outcome

- Evaluate the phytoconstituents and their application in drug development.
- Know about phytohormones and its applications in agriculture.
- Understand the applications of plant lectins in the purification of glycans.
- Know how plants survive stress conditions and climate change.

**MODULE I**

**Photosynthesis:** Ultra Structure and organization of chloroplast membranes, electron transport chain. Thylakoid membrane, protein complexes, Calvin cycle: Biochemistry of RuBP Carboxylase/Oxygenase, activation of Rubisco, Hatch and slack pathway, CAM plants; productivity of C<sub>4</sub> plants, Photorespiration and compensation point.

**MODULE II**

**Nitrogen Metabolism:** Nitrogen fixation, nitrogenase complex, electron transport chain and mechanism of action of nitrogenase. Structure of 'NIF' genes and its regulation, Hydrogen uptake and bacterial hydrogenases. Nitrate Metabolism: Enzymes of nitrate metabolism, regulation of their synthesis and activity. Ammonium assimilation enzymes: glutamine synthetase, glutamate synthase and Glutamate dehydrogenase. Water and mineral balance in plants.

**MODULE III**

**Plant growth regulators:** Auxins, Gibberellins, Cytokines, Abscisic acid and Ethylene - biosynthesis and their metabolic functions, synthetic growth hormones, inhibitors. Stress response in Plants.

**MODULE IV**

**Secondary metabolites:** Major chemical classes of secondary metabolites, brief account of the following classes- Alkaloids, Terpenoids, Flavonoids, Phenolics and Phenolic acids, Steroids, Coumarins, Quinines, Acetylenes, Cyanogenic glycosides, Amines and nonprotein amino acids,

gums, mucilages and resins(Structures not necessary). General biosynthetic pathways of the following classes of secondary metabolites (structures of intermediates not necessary) - Terpenoids, Phenols, and alkaloids.

## **MODULE V**

**Importance of secondary metabolites:** Protection of the producer plant from predators and insects, its functions in plants and uses. Uses of secondary metabolites to man: as drugs, precursors of drugs in pharmaceutical industry, as natural pesticides/insecticides and other uses of secondary metabolites. Application of plant lectins in purification of glycans.

## **REFERENCES**

1. Plant Metabolism by H.D Kumar and H.N Singh Macmillan
2. Biotechnology: Secondary Metabolites by K.G Ramawat, Science Publishers, U.S.
3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) Academic Press
4. Plant Metabolism by Prof David T. Dennis, Prof David H. Turpin, Dr Daniel D. Lefebvre and Dr David B. Layzell(Editors), Longman.
5. Plant Biochemistry by Hans-Walter Heldt Professor Em, Academic Press



**MOLECULAR ENDOCRINOLOGY**

**Hours/Week-4**

**Credits-4**

Course Outcome

- Understand the different cellular signals and regulation of metabolic activities.
- Understand the mechanism of action of hormones and different types of receptors.
- Analyze cellular mechanism of hormonal control in diseased condition.

**MODULE I**

**Introduction to endocrinology:** Classification of hormones. hormone receptors- general features, and regulation. Mechanism of hormone action. Signal transduction. Plasma membrane receptors. Second messengers - cAMP, Ca<sup>2+</sup>ions, & IP3. Role of adenylate kinase, G Proteins, protein kinases, tyrosine kinases, calcium and calmodulin. Steroid hormone receptors: cytoplasmic and nuclear receptors.

**MODULE II**

**Hypothalamus and Pituitary hormones:** Biochemistry and mechanism of action. Regulation of synthesis and secretion. Hypo and hyper activity of pituitary hormones-gigantism, dwarfism, acromegaly, diabetes insipidus, syndrome of inappropriate ADH secretion.

**MODULE III**

**Thyroid hormones:**Synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions. Antithyroid agents. Thyroid diseases: -thyrotoxicosis, goiter, hypothyroidism, Graves' disease, Hashimoto's disease.

**Parathyroid Hormone and Calcitonin:** Biological actions, regulation of calcium and phosphorus metabolism.Calcitriol.Pathophysiology.

**MODULE IV**

**Adrenal hormones:**Adrenal cortex- glucocorticoids and mineralocorticoids-synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions. Adrenal androgens- metabolic effect and functions. Adrenal medulla- catecholamines- synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions. Abnormal secretion of adrenal hormones- Addison's disease, Cushing's syndrome, Congenital adrenal hyperplasia, pheochromocytoma.

**Gonadal hormones:** Androgens and estrogens-synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions. Ovarian cycle.

## **MODULE V**

**Pancreatic hormones:** Islets of Langerhans and hormone secretion. Biosynthesis, secretion and mechanism of action. Receptors, intracellular mediators and signaling pathways of insulin and glucagon. Somatostatin, Pancreatic polypeptide and insulin like growth factors.

**Gastrointestinal hormones:** Hormone producing cells, synthesis, structure, secretion and functions, GIP, VIP, gastrin, CCK and other peptides.

**Hormones secreted from other organs and tissues:** Liver, kidney, heart, thymus and pineal gland

## **REFERENCES**

1. Williams Textbook of Endocrinology Larsen et al, Elsevier
2. Harpers Biochemistry-Murray et al Mc Graw Hill.
3. Lehninger, Principles of Biochemistry David L. Nelson Michael M. Cox, W.H. Freeman.
4. Principles of Biochemistry-Donald J Voet and Judith Voet, John Wiley & Sons Inc
5. Endocrinology-Mac E Hadley and Jon E Levine, Pearson
6. Vander's Human Physiology-The mechanism of Body function, Widmaier, Raff, strang. McGraw Hill Newyork.
7. Text book of Medical Physiology. Arthur.C. Guyton & John.E. Hall Elsevier Saunders, Pennsylvania
8. Review of Medical Physiology-William F. Ganong, Mc Graw Hill.
9. Essentials of Medical Physiology K. Sembulingam & Prema Sembulingam, Jaypee Brothers medical publishers, New Delhi.

**Course code: BC800301**  
**NEUROBIOCHEMISTRY**  
(Elective 1)

**Hours/Week-03**

**Credits-03**

**Course Outcome**

- Understand neurons and their functions .
- Understand the role of neurotransmitters in health and disease.
- Create an in-depth knowledge of neurodegenerative diseases.

**MODULE I**

**Neuron:** Neurocellular anatomy, neural membrane, classification of neuron, nerve fibers, axonal transport, neural growth, neuroglia, nervous system, blood brain barrier, cerebrospinal fluid

**MODULE II**

**Neuronal signaling:** Membrane potentials, ion channels, recording neuronal signals, ionic basis of resting potential and action potential, propagation of action potential.

**MODULE III-**

**Synaptic transmission:** Synapse, Electrical synapse transmission, chemical synaptic transmission, Synaptic transmitter release, synaptic potentials, synaptic delay, synaptic plasticity, molecular mechanism of synaptic transmission, myoneural junction

**MODULE IV**

**Neurotransmitters:** Chemistry, synthesis, storage, release, receptors and function- acetyl choline, catecholamines, serotonin, histamine, glutamate, aspartate, GABA, glycine, neuropeptides, nitric oxide

**MODULE V**

**Neural processing and neurodegenerative disorders:** Introduction to learning and memory, Associative and nonassociative learning and their mechanism, types of memory and their mechanism, neurodegenerative disorders, Parkinson's disorder, Alzheimer's disorder, Amyotrophic Lateral Sclerosis, Senile Dementia.

**REFERENCES**

1. Basic Neurochemistry. Molecular, Cellular and Medical aspects- George J. Siegel, Bernard W.Agranoff, R. Wayne Albers, Stephen K. Fisher & Michael D. Uhler, L W W publishers

2. Ion channels. Molecules in Action-David J. Aidley& Peter R. Stanfield, Cambridge University Press
3. Neurobiology Molecules, Cells and System- Gary G. Matthews, Wiley Blackwell.
4. The Neurobiology of Memory, Concepts, Findings, Trends- Yadin Dudai, Oxford University Press.
5. The physiology of Excitable Cells- David J Aidley, Cambridge University Press.
6. Review of Medical Physiology-William F.Ganong, Mc Graw Hill.

**Course code: BC810301**

**BIOCHEMICAL TOXICOLOGY**

(Elective 1)

Hours/Week 3

Credits 3

**Course Outcome :**

- Understand the basic concepts in toxicology and the mechanisms of drug interaction.
- Understand the methods of toxicity studies, symptoms and treatment during poisoning.

**MODULE I**

**Fundamentals of Toxicology:**Dose-Response Relationships, Toxicity interactions-synergism, antagonism etc. Biomarkers, Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response Hormesis; Hazard and Risk Assessment Duration and Frequency of Exposure and Effects, Acute & Chronic exposures, ED50 & LD50.

**MODULE II**

**Factors Affecting Toxic Responses:** Disposition, Absorption ,Sites of absorption,(description about each site included),distribution, Excretion; Pharmacodynamics, Biotransformation & Metabolism: types of Metabolic change - phase I reactions, Phase 2 reactions. Enzymes & proteins involved in metabolism. Toxication vs. Detoxication.

**MODULE III**

**Toxicity testing:** Test protocol, Genetic toxicity testing & Mutagenesis assay-*In vitro* test systems: bacterial mutation tests-Reversion test, Ames test, Fluctuation test, and Eukaryotic mutation test. *In vivo* test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules.

**MODULE IV**

**Developmental Toxicology:** Teratogenesis, Immunotoxicity, Genetic Toxicity; Chemical Carcinogenesis. Metal Toxicity, Food Toxicology & Food allergies -toxicity of food additives, bacterial toxins, toxins in seafood etc. Environmental Toxicology-air pollution & occupational hazards.

## MODULE V

**Tissue specific toxicity:** kidney Damage, Lung Damage, Liver damage, Cardiac damage; Neurotoxicity; Exaggerated and Unwanted pharmacological effects; Toxic effects of pesticides; effects on ecosystem & health. Multi-Organ Toxicity.

## REFERENCES

1. Principles Of Toxicology by: Karen E Stine, Thomas M Brown. Crc Press
2. Principles of Biochemical Toxicology by John A. Timbrell, Informa Healthcare
3. Environmental Toxicology by Sigmund F. Zakrzewski, Oxford University Press, USA
4. Casarett & Doull's Toxicology, The Basic Science of Poisons-Curtis .D.Klassen- 7th Edition -Mc Graw Hill Medical Publishing Division.
5. Basic Environmental Toxicology by Lorris .G.Cockerham and Barbara S Shane CRC Press Inc.

**Course code: BC820301**

**PHARMACOLOGICAL BIOCHEMISTRY**

(Elective 1)

Hours/Week-03

Credits-03

**Course Outcome**

- Understand the scope of pharmacology and the route of administration of drugs: the principles of drug absorption, distribution, metabolism and excretion.
- Understand the pharmacokinetics of drugs with the molecular mechanisms of drug action including drug receptor interactions.
- Describe the drug designing and development.

**MODULE I**

**Introduction to pharmacology:** Sources of drugs, dosage forms & routes of administration, Mechanism of drug action, synergistic effect of drugs, factors modifying drug action, Drug tolerance & dependence. Therapeutic drug monitoring. Adverse responses and side effects of drugs, allergy, Drug intolerance, Drug addiction, drug abuse and their biological effects.

**MODULE II**

**Classification of drugs based on sources:** mode of administration, site of action, and absorption of drugs, Drugs distribution, Drug metabolism: chemical pathways of drug metabolism, Phase I and Phase II reactions, role of cytochrome P450, drug metabolizing enzymes, Drug elimination: Role of kidney in elimination.

**MODULE III**

**Molecular basis of drug action:** a) Receptor: Drug Receptor Interaction: Basic ligand concept, agonist, antagonist, partial agonist, inverse agonist, receptor theories - Occupancy, Rate & Activation Theories, receptor Binding Assays, Dose response curve: LD50, ED50

b) Enzyme Inhibition: enzyme Inhibitors as drugs – Angiotensin converting enzyme, Lipoxigenase, Cyclooxygenase, Aromatase, Xanthine oxidase, DNA Polymerase Inhibitors, HIV - Protease / Reverse Transcriptase, Integrase and Cytochrome P-450 Inhibitors.

c) Drugs binding to nucleic acids -- Antimalarial, anti-cancer, antiviral.

**MODULE IV**

**Chemotherapy:** General Principles of Chemotherapy, Chemotherapy of Cancer

Mode of action, uses, structure-activity relationship of the following classes of drugs: Androgens and Anabolic steroids – Testosterone, Stanozolol; Estrogens and Progestational agents – Progesterone, Estradiol; Adrenocorticoids – Prednisolone, Dexamethasone, Betamethasone; Antibiotics-Penicillins, streptomycin, tetracyclines, Cephalosporins.

## MODULE V

**Drug development:** Phases of drug development, Molecular modification of lead compounds, pharmacophore modelling, Computer aided drug design: Ligand based and Structure based methods, QSAR, Prodrugs and soft drugs. General overview of Immunopharmacology and Pharmacogenomics

## References

1. Organic Pharmaceutical Chemistry by Harkishan Singh, Kapoor V. K. Publisher: Vallabh Publications/Prakashan
2. Organic Chemistry Vol-1 Part I, Dorling Kindersley, India. (India) Pvt Ltd
3. Principles of Organic Medicinal Chemistry by Rama Rao Nadendla New Age International (p) Limited
4. Basic & Clinical Pharmacology by Bertram G. Katzung McGraw-Hill
5. Essential of Medical Pharmacology by Tripathi K.D Jaypee Brothers
6. Of Experimental Pharmacology - Kulkarni Vallabh Publications
7. Drug design :Structure and Ligand Based Approches KM Merz Jr, D Ringe, CH Reynolds, Cambridge university press
8. Computer aided drug design and delivery systems Ahindra Nag and Baishakhidey McGraw-Hill.



**Course code: BC010304**

**LABORATORY COURSE III**

**Hours/ Week-10**

**Credis-4**

**1. Extraction and Estimation of total proteins from plant or animal sources.**

Total protein by biuret method, Lowry method.

Albumin by Bradford method, BCG method.

Total liver protein by Lowry and Biuret method.

**2. Extraction and Estimation of carbohydrates from plant or animal sources**

Glucose, lactose, glycogen and total carbohydrates (OT method, Folin-wu method, anthrone method, phenol sulphuric acid method)

**3. Estimation of lipids from plant or animal sources.**

Cholesterol by Zaks method.

Triglycerides by Van Handel and Zilversmit method.

Phospholipids by Zilversmit and Davis method.

**4. Determination of enzyme activity( in terms of IU/L & Specific activity) in biological tissues- serum, plasma, liver or plant extracts (Any five)**

Alanine transaminase (GPT)

Aspartate transaminase(GOT)

Lactate dehydrogenase

Acid phosphatase

Alkaline phosphatase

Amylase

Trypsin

Urease

**5. Enzyme kinetics (Any four)**

Effect of substrate concentration on enzyme activity

Effect of pH on enzyme activity

Effect of enzyme concentration on enzyme activity

Effect of temperature on velocity of enzyme catalysed reaction.

Determination of Q 10

Effect of activators on velocity of enzyme catalysed reaction.

**6. Extraction and estimation of enzymes and secondary metabolites from plant sources(Any two enzymes and two metabolites)**

1. Total phenols, total Alkaloids and flavanols
2. Acid phosphatase from fresh potato.
3.  $\beta$  amylase from sweet potato.
4. Urease from Jackbean or horsegram
5. Polyphenol oxidase
6. Peroxidase

**REFERENCES**

1. Introductory practical Biochemistry SK Sawhney and Randhir Singh (eds)  
Narosa publishing House, New Delhi.
2. Standard Methods of Biochemical Analysis, S.K. Thimmaiah (ed), Kalayani  
Publishers, Ludhiana
3. Hawk's physiological Chemistry, Bernad L. Osker (ed) TATA MC GRAW  
Hill publishing Company Ltd, New Delhi.
4. Experimental Biochemistry: A student Companion Beedu Sasidhar Rao &  
Vijay Deshpande (ed), I.K International Pvt Ltd, New Delhi.
5. Practical Biochemistry, R.C Gupta and S. Bharghava (eds) CBS Publishers  
and Distributors, New Delhi.
6. Practical Clinical Chemistry, Harold Varley, CBS Publishers and  
Distributors, New Delhi.
7. Enzymes Assays, Jeans-Louis Reymond (ed) Wiley- Vch Publishers,  
Germany.
8. Practical Enzymology, H. Bisswanger (ed)
9. Medical Biochemistry- Principles and Experiments, John F Van Pilsum and  
Robert J Roon(eds) University of Minnesota press, Minneapolis.

### MSC BIOCHEMISTRY – FOURTH SEMESTER

<b>NAME OF THE COURSE</b>	<b>COURSE CODE</b>	<b>CREDITS</b>
Clinical Biochemistry	BC010401	04
Nutritional Biochemistry	BC800402	03
Research Methodology, IPR and Bioethics	BC810402	
Genomics and Proteomics	BC820402	
Plant and Animal Cell Culture	BC800403	03
Nanobiology	BC810403	
Ecology and Environmental Biochemistry	BC820403	
Laboratory course IV	BC010402	05
Project	BC010403	05
Viva voce	BC010404	03
	Total credits	23

**Course code : BC010401**

**CLINICAL BIOCHEMISTRY**

**Hours/Week 4**

**Credits 4**

**Course outcome:**

- Understand the inborn errors of metabolism, indepth.
- Analyse, evaluate and interpret the common result patterns in routine clinical biochemistry.
- Understand the importance of quality control in clinical laboratories.
- Evaluate the various molecular markers in the diagnosis of diseases.

**MODULE 1**

**Automation and Quality control in clinical biochemistry :** Accuracy, precision, reliability, reproducibility in quality control. Quality control-use of control charts,preanalytical analytical and post analytical variables in quality analysis. Specimen collection, storage and processing of specimens (blood, urine, feces).

Automation in clinical biochemistry:- classification of auto analysers-single channel and multi-channel analysers, working principles of continuous flow and discrete analysers.

**MODULE II**

**Function Tests :** Renal function tests - urea clearance, creatinine clearance and inulin clearance tests, PAH, filtration fraction, concentration and dilution tests, 15' - PSP excretion test.

Liver function tests – tests based on excretory metabolic and synthetic functions of liver, serum enzymes.

Gastric function tests – collection of gastric contents, examination of gastric residium, FTM, stimulation tests, tubeless gastric analysis.

Thyroid function tests –tests based on blood levels and, metabolic effects of thyroid hormones, tests to detect auto immune diseases of thyroid gland, Radio-iodine uptake studies and turn over studies.

**MODULE III**

**Disorders of Metabolism :** Carbohydrate metabolism- DM and GTT, assay of insulin, proinsulin and insulin antibodies, HbA1c, GSD, galactosemia, fructosuria, pentosuria, Lactose intolerance.

Lipid and Lipoprotein Metabolism – atherosclerosis, coronary heart disease, and fatty liver, Taysach's and Niemann Pick diseases. Hyper and hypo lipoproteinemia.

Nucleic acid Metabolism- Hypo and hyper uricemia, gout

Erythrocyte and heme metabolism –Porphyria, hemoglobinopathies, thalassemia, sickle cell anaemia

Protein and amino acid Metabolism- PKU, Tyrosinemia, MSUD, Alkaptonuria, Hartnup's disease

#### **MODULE IV**

**New-born screening :** Importance of new-born and prenatal screening in the diagnosis of inborn errors of metabolism-amniotic fluid and fetal blood examination. Chromosomal abnormalities by cytogenetics.

#### **MODULE V**

**Molecular diagnosis of genetic defects :** Diagnosis of genetic defects (cystic fibrosis, hemochromatosis, thalassemia and sickle cell anaemia) by using DNA Probes, RFLP, PCR, and amplification of mRNA.

Clinical diagnosis of AIDS. Importance of acid phosphatase, alkaline phosphatase, lactate dehydrogenase and tumour markers in diagnosis of diseases.

#### **REFERENCES**

1. Notes on Clinical Biochemistry by John K. Candlish, World Scientific Publishing Company
2. Clinical Biochemistry: Metabolic and Clinical Aspects by William J. Marshall, Stephan K. Bangert, Elizabeth S.M. Ed. S.M (ed) Marshall, Elsevier Science Health Science Division.
3. Biochemistry by John K. Joseph, Campus Books International
4. Basic Medical Biochemistry: A Clinical Approach by Dawn B PH.D. Marks, Allam D. Marks colleen M. Smith , Lippincott Williams & Wilkins; illustrated edition
5. Clinical Chemistry, 6/e 1e by William J Marshall, Stephen K Bangert(2008) Publisher: Elsevier
6. Tietz fundamentals of clinical Chemistry, Carl A Burits, Edward R Ashwood (2008) Elsevier.

**Course code :BC800402**

**NUTRITIONAL BIOCHEMISTRY**

**( Elective 2)**

**Hours/Week 4**

**Credits 4**

**Course outcome**

- Understand the concept of ‘nutrition’ and the important nutrients.
- Describe the causes symptoms and management of lifestyle diseases.

**MODULE 1**

**An overview of nutrition & Dietetics:** Introduction to nutrients, nutrition assessment, diet & health, planning a healthy diet, digestion, functions, absorption & transport of nutrients.

The carbohydrates – sugars, starch, & fibre, Alternatives to sugars

Lipids- Triglycerides, phospholipids & sterols-its role in diet & nutrition

Health effects of protein, Protein energy malnutrition

Recommended intake of carbohydrates, lipids & proteins

**MODULE -II**

**Energy balance and weight management:** Energy balance and body composition, Energy values of carbohydrates, protein and fats, Body weight and health - weight management, overweight, obesity and underweight, nutritional treatment for obesity.

Nutritional importance of vitamins, Major minerals and trace minerals, Role of calcium, iron and zinc in the body, consequences of calcium deficiency, osteoporosis, consequences of iron and zinc deficiency and toxicity.

Functional foods.

**MODULE III**

**Life cycle nutrition:** Nutrition during pregnancy and lactation. Fetal alcoholic syndrome, factors incompatible with pregnancy, Nutrition in childhood, adulthood and later years. Nutritional intervention, Medical nutrition therapy, Regular hospital diets, enteral and parenteral nutrition.

**MODULE IV**

**Nutrition for disorders I:** Nutrition for GI tract disorders, stress nutrition, Medical nutrition therapy for diabetes mellitus. Diet in cardiovascular diseases - atherosclerosis, coronary heart diseases and hypertension.

## **MODULE V**

**Nutrition for disorders II:** Nutrition and renal disorders - kidney stones, nephrotic syndrome, renal failure. Nutrition during kidney transplant, dialysis. Nutrition and liver disorders - fatty liver, hepatitis, cirrhosis and gall stones. Nutrition for Cancer and HIV infection.

### **REFERENCES**

1. Understanding normal and Clinical nutrition, Sharon Rady Rolfes, Kathryn Pinna & Ellie Whitney, Cataldo, Cengage Learning, Stanford.
2. Nutritional Biochemistry- Tom Brody, Elsevier.
3. A text Book of Medical Biochemistry- M.N Chatterje and R. Shindea, Jaypeepublishers.
4. Harpers Illustrated Biochemistry- R.K murray, D.K Garnnes. and V.V Rodwell, McGraw Hill.
5. Medical Physiology- A.C. Guyton and J.E Hall, Saunders publishers.
6. Human Physiology. C.C. Chatterjee, C B S Publishers and Distributors.
7. Nutritional Biochemistry- Swaminathan M, Ganesh & Co., Madras
8. Normal and Therapeutic nutrition CH Robinson, Wads worth Publishing Co Inc

**Course code : BC810402**

**RESEARCH METHODOLOGY, IPR AND BIOETHICS**

**( Elective 2)**

**Hours/Week 4**

**Credits 4**

**Course Outcome:**

- Be familiar with the different types and methods of research and how to present scientific data.
- Be aware of legal rights of intellectual activity in the industrial, scientific, literary and artistic fields.
- To realise the problems and ethical issues related to Bioscience research.

**MODULE -I**

**Research Methodology:** Definition, objectives and motivation in research. Research methods vs Methodology. Various types of research, multidisciplinary research, methods of research. Research problem. Goals of Research – Characteristics and purpose of research, essential qualities of a researcher. Criteria of Good Research. Difference between hypothesis, theory and scientific law.

**MODULE -II**

**Data and Methods of Data Collection:** primary data, secondary data. Methods of data collection-observation method, interview, questionnaire, schedules etc., selection of appropriate method of data collection, limitations and precautions in data collections.

Steps in doing research - Review of literature, primary and secondary sources, Research process: formulation of research problem, hypothesis, research design, data collection, analysis and interpretation etc. National institutions useful in search of literature –NISCAIR- Library resources, searching of web resources- electronic databases-critical review of literature.

**MODULE –III**

**Scientific Writing and Presentation of Scientific Data:** Guidelines for scientific writing - Article, Essay, Research Paper, Research Project, Thesis or Dissertation, Book, Reviews, Research proposals, Research reports. Presentation of tables and figures. Peer review and manuscript submission. Presentation tool, oral and poster presentation. Microsoft power point and pdf slides, open office or similar tool.

**MODULE IV**

**Intellectual Property Rights (IPR):** Introduction and the need for intellectual property right (IPR), IPR in India and abroad, IPR infringement. Patent system: Objectives, basic principles and general requirements of patent law, Criteria for patentability and non-patentable



inventions. Procedure for registration, term of patent, rights of patentee. Patent document, granting of patent, rights of a patent. Patentable subjects and protection in biotechnology, International convention for the protection of new varieties, Strasbourg convention, UPOV Convention. Patent office practice, trade secrets, harmonization of patent law. Copyrights and trademark- meaning and scope.

The patentability of microorganisms-claims, Characterization and repeatability disposition in the culture collections, legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols, transfer of technology, patentability of inanimate products of nature vectors, FDA, FPA, Patent office practice, trade secrets, copy right infringement problems, harmonization of patent law. IPR and plant genetic resources

## MODULE V

**Ethics in Research:** Research output- Honesty and integrity of a good researcher. Proper interpretation of results and proper scientific presentation. Bioethics: Bioethical issues- bio-safety environmental impacts, ecological ethics, Ethics related to research on human subjects and animal samples. Plagiarism, fabrication and falsification. Software to check plagiarism in publications.

## REFERENCES

1. Brody, B.A. The Ethics of Biomedical Research: An International Perspective. Oxford University Press: NY. 1998.
2. Hart, L.A. (Ed.) Responsible Conduct with Animals in Research. Oxford University Press: NY. 1998.
3. Kothari C.R., Research Methodology: Methods and Techniques. New Age International, 2004.
4. Paul D. Leedy, Jeanne Ellis Ormrod, Practical Research: Planning and Design. Prentice Hall Publications. 2004.
5. Panneerselvam R Research Methodology, Prentice Hall of India, New Delhi. 2001
6. Jerrord HZ Biostatistical analysis (5<sup>th</sup> edition), Prentice Hall International, London. 2014.
7. Imre Lakatos, Falsification and the Methodology of Scientific Research Programme. In Imre Lakatos and Alan Musgrave (eds), Criticism and the Growth of Knowledge, Cambridge University Press. 1970.
8. Booth W C, Colomb G G, and Williams J M. The Craft of Research (2<sup>nd</sup> edition), Chicago University Press. 2003.
9. Marshall C and Rossman GB. Designing Qualitative Research. Sage Publications, London. 1989.
10. Montgomery, Douglas C. Design and Analysis of Experiments (9<sup>th</sup> edition), Wiley India. 2017
11. Carlos CM. Intellectual Property Rights, the WTO and Developing countries; The TRIPS agreement and policy options, Zed Books, New York. 2000.
12. Day RA, How to write and publish a scientific paper (4<sup>th</sup> edition), Cambridge University Press, London. 1995.
13. Golafshani N, Understanding reliability and validity in qualitative research. The Qualitative Report, 8(4) 597-607. 2003

14. Leedy PD and Ormrod JE, Practical Research: Planning and design (11<sup>th</sup> edition), Prentice Hall India, New Delhi. 2016.  
Graziano AM, Raulin ML.. Research Methods: A process of Inquiry (8<sup>th</sup> edition), Allyn

**Course code: BC820402**  
**GENOMICS and PROTEOMICS**  
(Elective 2)

**Hours/Week-04**

**Credits-04**

**Course outcome**

- To get an overview of genome variation in population and technologies to detect these variations.
- Understand how High-throughput DNA sequencing (HTS) can be used to identify disease causing genetic variants in monogenic diseases.
- Understand the application of various Omics technologies in disease diagnosis.
- Understand the importance of bioinformatics tools in proteomics and genomic studies.

**MODULE I**

**Overview:** Genomes of Bacteria, Archaea, and Eucarya; Genome and topology; chromatin, supercoiling and packaging; Genome Organization (intron, exon, promoter, intergenic region, ORF); Genome Sequencing: Maxam-Gilbert Method, Sanger Methods, Pyro-sequencing. Next Generation sequencing methods (NGS).

**MODULE II**

**Study of genomes-** Mapping; Genetic and Physical mapping, Single Nucleotide Polymorphism and RFLP's. The nature of SNPs, mining of SNPs, distribution of SNPs, Applications of SNP technology; Role of SNPs in Pharmacogenomics, Metagenomics; The Human Genome Project, Ethical issues in human Genome Research

**MODULE III**

**Gene finding and annotation:** Sequence annotation and bioinformatics tools for genomics and genome comparison; analyzing gene expression-DNA microarray-design, analysis and visualization of data. Types of microarray - expression arrays, protein arrays, Comparative Genomic Hybridization (CGH) arrays, Resequencing arrays. Applications of Microarray technology.

## MODULE IV

**Overview of protein structure:** Primary, secondary, tertiary and quaternary structure; Protein structure and function- two dimensional gel electrophoresis, mass spectrometry - ESI, Chemical Ionisation, Hybrid MS. Prediction of protein secondary structure: Chou-fasman/GOR method, Nearest Neighbour method, Homology modeling, Active site mapping and prediction.

## MODULE V

**Post translational Modifications:** Quantitative proteomics, clinical proteomics and disease biomarkers, mass spectral tissue imaging and profiling; Protein-protein interactions: Surfaceomes and Secretomes, Solid phase ELISA, pull-down assays (using GST-tagged protein) tandem affinity purification, far western analysis, by surface plasmon resonance technique; Protein microarray.

## References

1. Brown TA *Genomes*, Garland Science
2. Mount David W. *Bioinformatics Sequence and Genome Analysis*. Cold Spring Harbor Lab Press, CSH New York.
3. Stephen Misener and S. A. Krawetz. *Bioinformatics Methods and Protocols*. Humana Press.
4. Rastogi, S.C, N. Mendiratta, P. Rastogi. *Bioinformatics Methods and Applications*. Prentice Hall of India.
5. Campbell AM and Heyer LJ *Discovering Genomics, Proteomics and Bioinformatics*. Benjamin Cummings.
6. Primrose S and Twyman R *Principles of Gene Manipulation and Genomics*, 7th Edition, Blackwell.
7. Rehm H *Protein Biochemistry and Proteomics*, 4th Edition, Academic Press.
8. Twyman RM. *Principles of Proteomics*, Second Edition by Garland Science Taylor & Francis Group New York and London.
9. Liebler DC *Introduction to Proteomics: Tools for the New Biology*, Humana Press, Totowa NJ. USA.
10. Griffiths WJ, *Metabolomics, Metabonomics and Metabolite Profiling*, The Royal Society of Chemistry UK.

**Course code : BC800403**

**PLANT AND ANIMAL CELL CULTURE**

**( Elective 3)**

**Hours/Week 3**

**Credits 3**

**Course outcome:**

- Understand the basics of Plant and animal cell culture.
- Describe sources, selection, potential manipulations and challenges of using stem cells for tissue engineering.
- Identify the key challenges in gene editing technology.

**MODULE I**

**Animal Cell Culture** : Historical Background, Importance and progress in Animal Cell Culture Technology, Laboratory setup and equipments, aseptic technique, different cell culture media and supplements, Importance of Serum and Serum Free Media, preparation and sterilization of cell culture media and supplements

**MODULE II**

**Tissue culture techniques:** Disaggregation of tissue and primary culture, Types of primary culture; Chick embryo fibroblast culture; Chick liver and kidney culture; Secondary culture; Trypsinisation; Cell separation ; Continuous cell lines; Passage number; Anchorage and Anchorage independent cells and cultures; Suspension culture; Organ culture and Histotypic cultures: tissue specific stem cells; embryonic hematopoietic and neural stem cells, classification and sources,uses.

**MODULE III**

**Production of novel plants:**Tissue culture as a technique to produce novel plants and hybrids, tissue culture media , initiation and maintenance of callus and suspension cultures, single cell clones . Organogenesis, somatic embryogenesis. Transfer and establishment of whole plants in soil. Shoot tip culture, rapid clonal propagation and production of virus free plants, embryo culture and embryo rescue.

**MODULE IV**

**Protoplast culture:** Protoplast isolation, culture and fusion; Selection of hybrid cells and regeneration of hybrid plants; Symmetric and asymmetric hybrids, cybrids, anther, pollen and ovary culture for production of haploid plants and homozygous lines. Somaclonal variation. In vitro mutation-sexual incompatibility and male sterility .

## MODULE V

**Cell culture reactors:** Scale up in suspension and in monolayers with an example each. Gene editing, gene knock out, Applications in cell culture

### REFERENCES

1. Freshney, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, WileyBlackwell
2. Ed. John R.W Masters Animal cell culture-Practical approach 3<sup>rd</sup> edition, Oxford university press.
3. R. Sasidhara, Animal Biotechnology MJP publishers-Chennai.
4. Plant biotechnology-J Hammond, et.al; Springer Verlag.
5. Biotechnology in crop improvement –H S Chawla.
6. Practical application of plant molecular biology-R J Henry, Chapman and Hall.
7. An introduction to plant tissue culture-M K Razdan, Oxford &IBH
8. Cell culture and somatic cell genetics of plants (Vols.1to3)-A K Vasil, Academic Press.
9. Principles of plant biotechnology: An introduction to genetic engineering in plants SH Mantell, Blackwell Scientific Publications.
10. Advances in biochemical engineering/ Biotechnology-Anderson, et.al, Springer.
11. Plant cell and tissue culture-S Narayanswamy, Tata McGraw Hill Education India

**Course code : BC810403**

**NANO BIOLOGY**

**( Elective 3)**

**Hours/Week 3**

**Credits 3**

**Course Outcome**

- Analyse cutting edge concepts and technologies of nanotechnology in the field of Biology
- Discuss different tools and techniques that are being used in the field, and where these technologies are heading to.
- Understand about the applications of nanobiology in the emerging areas such as Nano-medicine, Bio-mimicry to create Nano-materials, and Nano-biotechnology.
- Gain an insight into the ethical issues that are associated with the study of nanoscience, its role in law and policy making.

**MODULE I**

**Introduction to nanomaterials:** Dimension of nanomaterials, Top-down and Bottom-up approach, Nano-Biomimicry and applications, Synthesis of nanomaterials by physical and chemical methods, Nucleation and growth, Synthesis of nanomaterials by biological methods, Mechanism of synthesis, Characterisation of nanoparticles, UV-Visible Spectroscopy, Dynamic Light scattering (DLS), Electron microscopy (TEM & SM), Atomic force microscopy (AFM),

**MODULE II**

**DNA nanotechnology:** Self-assembly, DNA origami, Application of DNA nanotechnology. Drawbacks of DNA origami, Protein & glyco nanotechnology and applications, Bio-nanomachines, Carbon nanotube, Functionalization of carbon nanotubes, Application of CNT.

**MODULE III**

**Nanomaterials for diagnosis and therapy:** Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering- Nanofibrous scaffolds - relevance and role in vascular, neural and cardiac tissue engineering, nanocomposites and applications in tissue engineering, Nano artificial cells, Nanotechnology in organ printing.

**MODULE IV**

**Nanopharmacology & drug targeting:** Nano-Biosensors, Cellular uptake mechanisms of nanomaterials, development of nanostructures for drug delivery applications - polymeric

nanoparticles - nanofibres- dendrimers -liposome and lipid nanoparticles - nanotubes and fullerenes – nanogels - nanocrystals – protein nanoparticles.

## MODULE V

**Nanotoxicology:** Physiological and biochemical effects, Modes of exposure, effect of environmental exposure, effects on human health, blood-brain barrier effects, ethical issues related to nanoparticles, Methodology for toxicity studies of nanoparticles.

### Reference :

1. Poole Jr, C. P., & Owens, F. J. *Introduction to nanotechnology*. John Wiley & Sons.
2. Malsch, N. H. (Ed.). *Biomedical nanotechnology*. Crc Press.
3. Bhushan, B. (Ed.)*Springer handbook of nanotechnology*. Springer.
- 4.
5. Greco, R. S., Prinz, F. B., & Smith, R. L. (Eds.) *Nanoscale technology in biological systems*. CRC press.
6. Wolf, E. L. *Nanophysics and nanotechnology: an introduction to modern concepts in nanoscience*. John Wiley & Sons.
7. Cancer Nanotechnology, eds. H. S. Nalwa and Thomas Webster, American Scientific Publishers.
8. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens; John Wiley & Sons.
9. L.E.Foster, Nanotechnology-Science, Innovation and opportunity, Pearson eduction inc.,.
10. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Wiley- Liss



**Course code : BC820403**

**ECOLOGY AND ENVIRONMENTAL BIOCHEMISTRY**

**( Elective 3)**

**Hours/Week 4**

**Credits 4**

**Course outcome**

- Understand the ecological homeostasis.
- Analyse and explain current threats to the environment by pollution and the technological solutions leading to sustainable environment.
- Be aware of environmental policies.

**MODULE 1**

**Basic Concepts of Ecology:** Principles and Concepts of ecosystem- Structure of ecosystem- cybernetics and Homeostasis- Energy transfer in an ecosystem; Food chain, Food web and energy pyramids- Habitat and Niche, Biogeochemical cycles(N, C, P cycles)

Biodiversity: Types of diversity; Genetic diversity, Species diversity and Ecosystem diversity- Methods of biodiversity conservation- Gene banks; Cryopreservation – Vulnerability and extinction of biodiversity- endangered animals, endemism and Red data books.

Population Ecology:- Characteristics of a population, population growth curves, population regulation, life history strategies (r and K selection), concept of metapopulation- demes and dispersal, inter-demic extinctions, age structured populations.

**MODULE II**

**Chemistry of Environment :** Atmosphere, Hydrosphere; Lithosphere. Properties of water- water quality parameters- pH, Dissolved Oxygen (DO), Chemical Oxygen demand (COD); Biological Oxygen demand (BOD). Atmospheric toxicants- CO, NO<sub>2</sub>, CO<sub>2</sub>, SO<sub>2</sub>-; Toxic heavy metals -Sampling of air and water pollutants- Monitoring techniques and methodology; Chemistry of soil: Formation; Constituents and properties of soils; Composition and type of soil

Organic chemicals in the environment; Aliphatic/aromatic hydrocarbons (hydrocarbon decay, environmental effects); Soaps and surfactants (cationic, anionic and nonionic detergents, modified detergents); Pesticide residue – classification, degradation, analysis, pollution due to pesticides; phenols and petrochemicals

**MODULE III**

**Treatment Technologies for Polluted Environment :** Biosensors- types and applications in environmental pollution detection and monitoring, Traditional Biological treatment: stabilization pond, aerated lagoon, activated sludge process trickling filter anaerobic treatment

Environment-friendly use of microbes (bacteria and fungi) in biodegradation and Biotransformation: Bioremediation In situ and Ex situ bioremediation; Constrains and priorities of bioremediation; Evaluating Bioremediation; Bioremediation of VOCs; Biodegradation-Factors affecting process of biodegradation; Methods in determining biodegradability. Microbial transformation; Accumulation and concentration of metals; Biosorption- Oil field microbiology; Improved oil recovery; Biotechnology and oil spills- Use of plants in biodegradation and environment cleaning- phytoremediation. Xenobiotics; Persistence and bio magnificationsof Xenobiotic molecules.

#### **MODULE IV**

**Technology for Sustainable Environment :** Biodegradation of agricultural chemicals; Bio fertilizers; Biological control of insect pests; Role of bio pesticides/ insecticides; Biocontrol of plant pathogens; Integrated pest management-practical implementation

#### **MODULE V**

**Technology for Resource Management and Environment Policies :** Role of biotechnology in management of resources- Reclamation of wasteland: Biomass production: Biogas and biofuel production; Development of environment-friendly processes such as integrated waste management

Nature of Environmental Policies; International Agreements and Treaties -Stockholm Conference (1972); Rio Conference (UNCED) (1992); Merits of the Conference (Agenda 21): Failures of the Conference Johnesburg treaty; GAAT and Environment; CITES; Montreal protocol National Policy on Environment, Constitutional provisions for Environmental Protection.

#### **References:**

1. Fundamentals of Ecology- E.P Odum, IBH publishing Co.
2. Environmental chemistry, B.K.Sharma, Goel Publishing House
3. Chemicals in the environment, Y. Mido& M. Satake, Discovery publishing House, New Delhi
4. Text book of Environmental Chemistry-O.D. Tyagi and M.Mehra, AnMol publications.

5. Biotechnology: A textbook of Industrial Microbiology, Crueger and Crueger, Sinauer Associates Inc.,U.S
- 6 Environmental, Biotechnology: Principles and Applications, 2nd Edition –Brace Rittman, Perry L. Mc Carty, Wiley.
7. Biodegradation and Bioremediation, 2nd Edition –Martin Alexander, Elsevier.
8. An Introduction to Environmental Biotechnology-Milton Wainwright, Kluwer Academic publishers.
9. Physiology and Biochemistry of metal Toxicity and tolerance in plants-M.N.V. Prasad Kazimierz strzalka, Kluwer Academic publishers.

**Course code : BC010402**

**LABORATORY COURSE IV**

**Hours /week 10**

**Credits 03**

**Clinical Biochemistry Experiments**

**1. Liver function tests**

Estimation of total proteins in serum

Estimation of serum albumin by BCG method

Estimation of albumin – globulin ratio in Serum

Estimation of serum bilirubin

Assay of SGOT& SGPT-DNPH method

Assay of alkaline phosphatase-King &Amstrong method

**2. Renal Function tests**

Estimation of blood urea by Diacetyl monoxime method

Urea clearance test

Estimation of creatinine by Jaffe's method

Creatinine clearance test

Estimation of uric acid-Caraway method

Estimation of plasma bicarbonate

**3. Glucose tolerance test**

**4. Fructose tolerance test**

**5. Analysis of normal and abnormal urine.**

**6. Check the reliability of various methods using Levy Jenning plot**

**REFERENCES**

1. Introductory Practical biochemistry, S.K sawhney&Randhir Singh (eds)  
Narosa Publishing House, New Delhi.
2. Standard Methods of Biochemical Analysis, S.K Thimmaiah (ed), Kalayani  
Publishers, Ludhiana
3. Experimental Biochemistry: A Student companion, BeeduSasidharRao&  
Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi

4. Practical Biochemistry, R.C Gupta & Bhargava (eds) CBS Publishers and distributors, New Delhi.
5. Practical Clinical Chemistry, Harold Varley, CBS Publishers and distributors, New Delhi.
6. Gradwhols Clinical Laboratory Techniques. Stanley & Raphael. W.E. company, London, UK