# SACRED HEART COLLEGE (AUTONOMOUS)

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*Ready for Every Good Work*



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Accredited by NAAC (4th Cycle – under RAF) with CGPA of 3.31 / 4 at 'A+' Grade


## PG & RESEARCH DEPARTMENT OF BIOCHEMISTRY
## SACRED HEART COLLEGE (AUTONOMOUS), TIRUPATTUR-635 601
## M.Sc. BIOCHEMISTRY SYLLABUS
## UNDER CBCS (With effect from 2021-2022)

### PROGRAMME STRUCTURE

| Sem | Subject Code | Paper | Title of the Paper | Ins. Hrs/ Week | Cr | Exam Hrs | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CA | Sem | Tot |
| I SEMESTER | BC709 | Core Paper I | Cell Dynamics | 4 | 4 | 3 | 50 | 50 | 100 |
| | BC710 | Core Paper II | Biomolecules | 4 | 4 | 3 | 50 | 50 | 100 |
| | BC711 | Core Paper III | Human Physiology and Nutrition | 4 | 4 | 3 | 50 | 50 | 100 |
| | PBC807 | Core Practical I | Lab Course – I: Isolation, Quantitative Analysis and Techniques | 5 | - | - | - | - | - |
| | PBC808 | Core Practical II | Lab Course – II: Industrial and Clinical Enzymology | 5 | - | - | - | - | - |
| | PBC809 | Core Practical III | Lab Course – III: Microbial Biochemistry | 4 | - | - | - | - | - |
| | BC712A<br>BC712B<br>BC712C | Elective Paper I | (to choose 1 out of 3)<br>1. Bioinformatics<br>2. Industrial Microbiology<br>3. Stem Cell Technology | 4 | 4 | 3 | 50 | 50 | 100 |
| | | | | **30** | **16** | | | | **400** |
| II SEMESTER | BC809 | Core Paper IV | Instrumentation Biochemistry | 4 | 4 | 3 | 50 | 50 | 100 |
| | BC810 | Core Paper V | Advanced Enzymology | 4 | 4 | 3 | 50 | 50 | 100 |
| | BC811 | Core Paper VI | Intermediary Metabolism | 4 | 4 | 3 | 50 | 50 | 100 |
| | PBC807 | Core Practical I | Lab Course – I: Isolation, Quantitative Analysis and Techniques | 5 | 4 | 6 | 50 | 50 | 100 |
| | PBC808 | Core Practical II | Lab Course – II: Industrial and Clinical Enzymology | 5 | 4 | 6 | 50 | 50 | 100 |
| | PBC809 | Core Practical III | Lab Course – III: Microbial Biochemistry | 4 | 4 | 6 | 50 | 50 | 100 |
| | BC812A<br>BC812B<br>BC812C | Elective Paper II | (to choose 1 out of 3)<br>1. Advanced Endocrinology<br>2. Pharmaceutical Biochemistry<br>3. Environmental Toxicology | 4 | 4 | 3 | 50 | 50 | 100 |
| | | | **Summer Training*** | - | **2*** | - | - | - | - |
| | | | **Certificate Course- CMLT*** | - | **2*** | - | - | - | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **30** | **28 +4 *** | | | | **700** |
| **Sem** | | **Paper** | **Title of the Paper** | **Ins. Hrs/ Week** | **Cr** | **Exam Hrs** | **Max. Marks** | | |
| | | | | | | | **CA** | **SE M** | **Tot** |
| **III SEMESTER** | BC911 | Core Paper VII | Molecular Biology | 6 | 5 | 3 | 50 | 50 | 100 |
| | BC912 | Core Paper VIII | Immunology | 5 | 4 | 3 | 50 | 50 | 100 |
| | BC913 | Core Paper IX | Research Methodology | 5 | 4 | 3 | 50 | 50 | 100 |
| | PBC1005 | Core Practical IV | Lab Course – IV: Biochemical, Immunological and Molecular Biology Techniques | 5 | - | - | - | - | - |
| | PBC1006 | Core Practical V | Lab Course– V: Haematological Methods | 5 | - | - | - | - | - |
| | BC914A BC914B BC914C | Elective Paper III | (to choose 1 out of 3) 1. Ecology, evolution & biodiversity 2.Food Biochemistry 3.Bionanotechnology | 4 | 4 | 3 | 50 | 50 | 100 |
| | | SSP | **Self-Study Paper*** (CSIR/SET – Objective Type Questions) **OR** **Online Course [ NPTEL/MOOC]** | - | **2*** | - | - | - | - |
| | | | | **30** | **17 +2 *** | | | | **400** |
| **IV SEMESTER** | BC1009 | Core Paper X | Advanced Clinical Biochemistry | 5 | 5 | 3 | 50 | 50 | 100 |
| | BC1010 | Core Paper XI | Biotechnology | 4 | 4 | 3 | 50 | 50 | 100 |
| | BC1012J | Core Paper XII | Project/Dissertation with Viva-Voce | 5 | 5 | - | 50 | 50 | 100 |
| | PBC1005 | Core Practical IV | Lab Course – IV: Biochemical, Immunological and Molecular Biology Techniques | 5 | 5 | 6 | 50 | 50 | 100 |
| | PBC1006 | Core Practical V | Lab Course– V: Haematological Methods | 5 | 5 | 6 | 50 | 50 | 100 |
| | BC1011A BC1011B BC1011C | Elective Paper IV | (to choose 1 out of 3) 1.Plant :Biochemistry and Molecular Biology 2.Herbal Technology 3.Medical Diagnostic Technology | 4 | 4 | 3 | 50 | 50 | 100 |
| | **VE1004** | | Human Rights | 2 | 1 | 3 | 50 | 50 | 100 |
| | | | | | | | | | |
| | | | | **30** | **29** | | | | **700** |
| | | | **TOTAL** | **120** | **90 +6 *** | | | | **220 0** |

**Required Credits = 90**

**<u>Additional Credits for Biochemistry students</u> = 6* Credits + 6# Credits**
**[*- Parent Department and #-Other Department]**

Self-Study Paper (CSIR/SET – Objective Type Questions)/
Online Course [NPTEL or MOOC Course - Minimum of 4 week course -
Before the end of 4th semester] : 2* Credits
Summer Training : 2* Credits
Certificate Course- CMLT* : 2* Credits

**Additional credits offered to other departments**

Inter Disciplinary Course (IDC)

1. Agricultural Biochemistry : 2* Credits
2. Biochemical and Microbial Techniques : 2* Credits

**Regulation for Theory Courses**

1. Evaluation Scheme for Continuous Assessment [50 Marks]

| | |
|---|---|
| Written tests (CA - 2) | 30 Marks |
| Other Components (45 Marks- Converted into 20 Marks) | |
| MCQ-1 | 10 Marks |
| MCQ-2 | 10 Marks |
| Seminar-1 | 10 Marks |
| Seminar-1 | 10 Marks |
| Library | 05 Marks |

**Question Paper Pattern for CA**

The question paper shall have three sections with the maximum of 50 marks with the following break-up:

**Section-A**

Section A shall contain 6 short answer questions without choice drawn from two units
Each question shall carry 2 marks. (6 x 2 = 12 marks)

**Section-B**

Section B shall contain 3 either or questions drawn from two units.
Each question shall carry 6 marks. (3 x 6 = 18 marks)

**Section–C**

Section C shall contain 3 questions from two units.
Two questions out of the three are to be answered each carrying 10 marks.
(2 x 10 = 20 marks)

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**Question Paper Pattern for Semester Examinations**

The question paper shall have three sections with the maximum of 100 marks with the following break-up:

**Section - A**

Section A shall contain 10 short answer questions drawn from all the units on the basis of minimum two from units. All ten are to be answered each carrying 2 marks. (10 x 2 = 20 marks)

**Section - B**

Section B shall contain 5 either or questions drawn from all the five units.
Each question shall carry 7 marks. (5 x 7 = 35 marks)

**Section – C**

Section C shall contain 5 questions drawn one each from the five units.
Three questions out of the five are to be answered each carrying 15 marks. (3 x 15 = 45 marks)

**Regulations for Core Practicals**

Total: 100 Marks
Time: 6 Hours

The practical papers consist of the internal assessment (50 marks) and semester examination (50 marks)

Internal Assessment (50)

Class Work - 25 marks

Model exam - 25 marks

Semester Examination (50) Total : 50 Marks

Time : 6 Hours

1. Experiment-I - 15 Marks
2. Experiment-II - 15 Marks
3. Viva-Voce - 10 Marks
4. Record - 10 Marks

**Regulations for Project**

**Plagiarism Check:** The entire PG dissertation has to be checked for plagiarism using the TurnitIn tool. The acceptable level of similarity would be 30% for the specific topics such as Introduction, results and discussion and conclusion.

**Pattern for Project**

**Total Marks: 100**

| | | | |
|---|---|---|---|
| **1.** | **Internal** | **:** | **50** |
| | I Review | : | 25 |
| | II Review | : | 25 |
| **2.** | **External** | **:** | **50** |
| | a. Presentation | : | 20 |
| | b. Dissertation | : | 20 |
| | c. Viva voce | : | 10 |

**Regulations for Inter Disciplinary Course [IDC]**

**IDC-** Agricultural Biochemistry / Biochemical and Microbial Techniques

Credit : 2*Credits
Hours : 20 Hrs
Semester : II Year [Sem III & Sem IV]
Evaluation Pattern : Assignment

**Regulations for Self Study Paper [SSP]**

1. (CSIR/SET – Objective Type Questions)
   Credit: : 2*Credits
   Semester : III Semester
   Evaluation Pattern : MCQ Test
   Maximum Marks : 100 Marks
   Minimum Marks : 60 Marks
2. Online Course [NPTEL or MOOC Course
   Credit : 2*Credits per course
   Semester : Before the end of 4th semester
   Evaluation Pattern : Submission of certificates
   Duration : Minimum of 4 week course
   [Maximum of two courses per student]

**Regulations for Summer Training**

Credit : 2*Credits
Duration : 20 -30 Days
Semester : End of 2nd semester
Evaluation Pattern : Report Submission with certificate

**Regulations for Certificate Course**

**CMLT - Certificate in Medical Laboratory Technology**

Credit : 2*Credits
Hours : 30 Hrs
Evaluation Pattern : Assignment Submission

## SEMESTER I

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| I | BC709 | Cell Dynamics | 4 | 4 |

**Course Objectives**

- To learn the prokaryotic and eukaryotic cellular organization and acquire knowledge on cell cycle and cell division.
- To understand the communication and transport across the cell membrane.
- To know the histopathology techniques and staining methods.
- To understand the membrane proteins and their interactions with other cellular components.
- To explain the molecular basis of apoptosis and necrosis.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO1** | Acquire broad knowledge on prokaryotic and eukaryotic cellular organization, cell cycle and cell division. | K3 |
| **CO2** | Define and provide an understanding of the structure of cell and function of various subcellular organelles. | K1, K2 |
| **CO3** | Examine the theory and practice of histological techniques and staining of tissues using routine and specialized techniques. | K4 |
| **CO4** | Learn the basic concepts on the membrane proteins and their interactions with other cellular components. | K1 |
| **CO5** | Determine the transport mechanisms across biological membranes and learn the concept and mechanism of ATP synthesis. | K1, K3 |
| **CO6** | Compile the information on cell aging and cell death mechanisms. | K5, K6 |

**UNIT-I**

Cell types–Organization of Prokaryotic and Eukaryotic cells, Cell division –Mitosis and Meiosis, Cell cycle–Phases of cell cycle, Cell motility–Molecular motors, Microtubules, Structure and composition, Microtubular associated proteins–Role in intracellular motility.

**UNIT-II**

Cellular organelles–Nucleus-internal organization, Traffic between the Nucleus the Nucleolus, and Cytoplasm, Endoplasmic reticulum–Protein sorting and transport, Golgi apparatus and Lysosomes, Morphology and Functions of mitochondria, Chloroplasts, Peroxisomes and Glyoxysomes.

**UNIT-III**

Histopathological Studies–Methods for disrupting tissues and cells, Organ and tissue slice techniques, Cell fixation–fluid fixatives, freezing and section drying, Staining techniques–acid and basic, fluorescent and radioactive dyes, staining of lipids, steroids, nucleic acids, proteins and enzymatic reaction products.

**UNIT-IV**

Differentiation of Cell membrane–microvilli, tight junctions, epithelia, Bell and sqot desmosomes–Mechanical function, cell-cell interaction, cell adhesion proteins and tight junctions. Overview of membrane protein– Peripheral and Integral, molecular model of cell membrane–Fluid mosaic model and membrane fluidity, Solute transport across membrane–Passive and Active transport by ATP powered pumps.

**UNIT-V**

Cell Aging and Death–Necrosis and Apoptosis. Cell Signaling–Signaling molecules and their receptors, Functions of cell surface receptors, Pathways of intracellular signal transduction, ras, MAP kinase pathways.

**References**


1. The Cell-Biochemistry, physiology and morphology by J. Brachet and A.
2. E. Mirsky, Academic Press (1963).
3. Cell and Molecular Biology by concepts and experiments by Gerald Karp (2005) John Wiley sons & Inc.
4. The World of the cell by Becker, Kleinsmith and Harden Academic Internet Publishers; 5th edition (2006).
5. The Cell: A Molecular Approach, Fourth Edition by Geoffrey M. Cooper and Robert E. Hausman (2006).
6. Molecular cell Biology by Harvey Lodish. W. H. Freeman; Sol edition (2007).

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| I | BC710 | Biomolecules | 4 | 4 |

**Course Objectives**

- To understand the nature of various biomolecules present in living cells.
- To get exposed to key contributions of scientists such as G.N. Ramachandran and Watson - Crick etc. in order to create scientific interest amongst students in life processes.
- To learn the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.
- To understand the organic chemical principles in life processes.
- To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively.

**Course Outcomes**

| S. No | Description | Cognitive Level (K-level) |
|---|---|---|
| CO-1 | Describe the role of biomolecules in biosystem | K6 |
| CO-2 | Summarize the Carbohydrates–classification, structure and functions | K2 |
| CO-3 | Categorize the proteins based on its structure and function | K4 |
| CO-4 | Determine the structure and functions of Nucleic acids | K3 |
| CO-5 | Perceive Lipids based on its structure and functions | K5 |
| CO-6 | Identify the Water soluble and Fat soluble Vitamins | K1 |

**UNIT-I**

Polysaccharides–Occurrence, Structure and Functions of homoglycans–Starch, Glycogen, Cellulose, Dextrin, Inulin and Chitins. Occurrence, structure and functions of heteroglycans–bacterial cell wall polysaccharides, glycosaminoglycans, agar, alginic acid, pectins, amino sugars and deoxy sugars, blood group substances and sialic acids. Glycoproteins and Lectins–Structure and functions.

**UNIT-II**

Classification of Proteins on the basis of solubility and shape, structure and biological functions. Isolation, fractionation and purification of Proteins. Primary structure–determination of amino acid sequences and Ramachandran plot. Secondary structure–weak interactions involved– alpha helix and beta pleated sheets and beta turns. Collagen triple helix, super secondary structures–helix-loop-helix. Tertiary structure–alpha and beta domains. Quaternary structure–Structure of Haemoglobin. Denaturation and renaturation of Proteins.

**UNIT-III**

Watson -Crick Model of DNA structure. A, B and Z–DNA, Cruciform - structure in DNA, formation and stability, Miscellaneous alternative conformation of DNA-slipped mispaired DNA, parallel stranded, isomorphic DNA, palindrome, isolation and purification of DNA, Molecular hybridization, Cot value curve and hypochromic effect, secondary and tertiary structure of RNA, hnRNA, methods for nucleic acid sequence.

**UNIT-IV**

Lipids–Classification, saturated and unsaturated fatty acids, phospholipids–classification, structure and functions. Eicosanoids- Structure and functions of prostaglandins, thromboxanes

and leukotrienes. Types and functions of plasma lipoproteins. Amphipathic lipids–membranes, micelles, emulsions and liposomes. Steroids–Structure and biological role of cholesterol, bile acids and bile salts.

**UNIT-V**

Vitamins–Water soluble-Thiamine, Riboflavin, Niacin, Pyridoxine, Biotin, Cyanocobalamin, Folic acid, Ascorbic acid–Sources, structure, biochemical functions, deficiency diseases and daily requirements. Fat soluble–Vitamin A, vitamin D, vitamin E and vitamin K–Sources, structure, biochemical functions, deficiency diseases and daily requirements.

**References**


1. Biochemistry by Zubey, GL WCB Publishers (1998).
2. Biochemistry by L. Stryer, W.H. Freeman and Co. 5th Edition (2002).
3. Fundamentals of Biochemistry by Voet and Voet, John Wiley and sons NY (2002).
4. Lehninger's Principle of Biochemistry by David L. Nelson and Michael M. Cox. W. H. Freeman; 4th edition (2004)
5. Text Book of Biochemistry with clinical correlation by Thomas .M. Devlin, John Wiley-Liss, Hobokhen NJ publishers (2006).


| Semester | Course Code | Title of the Course | Hours /Week | Credits |
|---|---|---|---|---|
| **I** | **BC 711** | **Human Physiology and Nutrition** | **4** | **4** |

**Course Objectives**

- To understand the composition and functions of Blood and Plasma.
- To know the process of gaseous exchange in tissues and lungs, respiratory adaption to high altitude.
- To understand the nerve physiology and muscle physiology.
- To gain insight into digestive system and renal physiology.
- To gain awareness on nutritional requirements and energy measurements.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO-1** | Describe the structure of major human organs and explain their role in the maintenance of healthy individuals. | **K1** |
| **CO-2** | Correlate the process of gaseous exchange in tissues and lungs, respiratory adaption to high altitude. | **K4** |
| **CO-3** | Measure the heart function and learn the circulatory system | **K5** |
| **CO-4** | Determine the muscular system and excretory system | **K3** |
| **CO-5** | Classify the nutritional requirement for different age people, during pregnancy and Lactation | **K2** |
| **CO-6** | Compile the energy measurements, BMR, SDA, RNI and RDA | **K6** |

**UNIT-I**

Composition and functions of Blood and Plasma, Blood volume regulation, Blood groups. Blood coagulation mechanism, anticoagulants and its mode of action. Formation and mechanism of Heamoglobin. Cardiophysiology- functional anatomy of heart- genesis and spread of cardiac impulses- cardiac cycle- heart sound- cardiac output- cardiovascular regulatory mechanisms- ECG. Lymph– Composition and function of lymph.

**UNIT-II**

Respiratory physiology- functional anatomy of air-passages and lung- respiratory muscles- mechanism of respiration- lung volumes and capacities- gas exchange in the lungs- regulation of respiration. Mechanism of transport of blood gases–$O_2$ and $CO_2$. Acid-base balance–Role of buffers, erythrocytes, respiratory system and kidneys.

**UNIT-III**

Nerve physiology-Structure of neuron and synapse- excitability- action potential conduction of never impulse-synaptic transmission- neurotransmitter systems- Types & role of cranial and spinal nerves – Mechanism of reflex action. Muscle physiology- skeletal, cardiac and smooth muscles- electrical properties and ionic properties- types and mechanism of muscle contraction-role of muscle proteins in contraction and relaxation – Neuromuscular transmission.

**UNIT-IV**

Digestive system – digestive processes at various regions, internal environment and homeostasis- coordinated body functions, mode of absorption of various food, gastric secretions- regulation and motility, intestinal secretion and motility-role of gastrointestinal hormones. Renal physiology- structure of nephron, mechanism of urine formation. Regulation of water and mineral excretion.

**UNIT-V**

Basal metabolism, Basal Metabolic Rate, factors affecting BMR, determination of BMR–direct and indirect method, respiratory quotient and SDA. Role of fiber in diet, role of essential amino acids–relation with Marasmus, Kwashiorkar disease, role of essential fatty acids, disorders of fatty acid metabolism, Refsum's disease. Trace elements–macro and micro, daily requirements, functions and deficiency manifestations.

**References**


1. Human physiology by C.C. Chatterjee, 11th Edition (1985)
2. Human Nutrition and Dietetics by Davidson and Passmore. Churchill Livingstone; 8th Edition (1986)
3. Principles of Nutrition and Dietetics by M.S. Swaminathan, Bappco Publishers (1995)
4. Human Physiology and Mechanisms of Disease by Guyton. Saunders Publications; 6th Edition (1996)
5. Review of Medical Physiology by William. F. Ganong, McGraw-Hill Medical; 22nd Edition (2005)
6. Barrett KE, Brooks HL, Boitano S and Barman SM, Ganong's Review of Medical Physiology, 23rd Ed., McGraw-Hill Medical, 2009.
7. Pal, G.K. Textbook of Medical Physiology, Ahuja Publishing House, Delhi, 2007
8. Hall. J.E. Guyton and Hall Textbook of Medical Physiology. 12th ed. Saunders, Elsevier Inc., 2011.


| Semester | Course Code | Title of the course | Hrs | Credits |
|---|---|---|---|---|
| **I** | **BC812A** | **Elective – I – Bioinformatics** | **4** | **4** |

**Course Objectives**

- To give focus on online resources in life sciences and applications of Bioinformatics in scientific research.
- To determine the function of genes and proteins, to establish evolutionary relationships, and to calculate the three-dimensional shape of proteins by using computer programs.

- ❖ To learn algorithms and statistics for assessing the relationships among large sets of biological data.
- ❖ To know the tools for the analysis and interpretation of the various biological data.
- ❖ To understand various databases and learn the useful biological information.

**Course Outcomes**

| S. No | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO1** | Understand the history and basic concepts in bioinformatics. | **K2** |
| **CO2** | Determine the formative databases available for all the biological macromolecules. | **K3** |
| **CO3** | Analyze global and local sequence alignment tools and their importance. | **K4** |
| **CO4** | List the various protein structure prediction methods through computational approaches. | **K1** |
| **CO5** | Integrate the significance of gene prediction methods. | **K6** |
| **CO6** | Evaluate the tools and software in the analysis of nucleic acid and protein. | **K5** |

**UNIT-I**

Introduction to Computers-Computer Peripherals and Hardware description. Computer system design, Respective Usage I/O and Storage Devices. Internet Service requirements and applications-E-Mail, World Wide Web, URL, HTML and TCP/IP.

**UNIT-II**

Operating systems. Evolution, types-system and applications of operating systems, layered structure of operating system, CUI and GUI's DOS internet and external commands, anatomy of windows, features and multitasking. Office applications□MS-Office, MS-Word, MS-Excel and MS PowerPoint.

**UNIT-III**

Bioinformatics-definition, application, challenges and opportunities. Internet, Database- types, classification, sequence formats, DBMS, RDBMS and SQL, NucleicAcid Database-NCBI, EMBL, DDBJ and Phylogenetic tree. Protein Sequence Database- BLAST, FASTA, PIR and SWISS-PROT, Structure database-PDB, CDS, ORFand EST motifs.

**UNIT-IV**

Secondary structure prediction of RNA and protein. RNA Structure Prediction–mFold, Vienna RNA Package and Circles. Protein structure prediction□kPROT, Jnet and SSA. Structural classification of proteins (SCOP), Classification of protein (CATH), Structural and functional genomics and proteomics, DNA microarrays□Principle, applications and future prospects.

**UNIT-V**

Molecular Visualization Tools,Rasmol, Chime, Weblab Viewer, Deep View, ISIS Draw, Chemdraw and Molmol and Drug Designing- drug target, computer aided drugdesign, types and applications. Emulation of common DOS commands using PERL and BIOPERL.

**References**


1. Bioinformatics Computing by Bergeron, B.P. 1st Edition, Printice Hall (2000).
2. Introduction to Bioinformatics by Lesk, A.M. 1st Edition, Oxford University Press,(2002).
3. Discovering Genomics, Proteomics and Bioinformatics by Campbell and Heyer
4. Cold Spring Harbour Laboratory Press & Benjamin Cummings, (2002).
5. Fundamental concepts of bioinformatics by Dan E. Krane and Michael L. Raymer, Benjamin Cummings, (2003).


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|

| I | BC 712B | Industrial Microbiology | 4 | 4 |
|---|---|---|---|---|

**Course Objectives:**

- To learn about the basic concepts of industrial microbiology and industrially important microbes.
- To understand the microbial fermentation process, fermenters types and fermentation techniques.
- To gain the knowledge about inoculum development, raw materials used in fermentation process.
- To become familiar with the food preservation techniques and fermented dairy, brewers products.
- To understand the food preservation techniques and uses of microbes in waste management.

**Course Outcomes:**

| S.No. | **Description** | **Cognitive Level (K- level)** |
|---|---|---|
| CO-1 | Identify the different types of fermenters and explain the various fermentation strategies and the growth of industrial microorganisms. | **K1** |
| CO-2 | Explain the inoculum development methods, various types of raw materials used in fermentation process and scale up process of fermentation | **K2** |
| CO-3 | Manipulate the fermentation media, microbial inoculum and strain for different types of microbial fermentation process. | **K3** |
| CO-4 | Categorize the primary and secondary metabolites production techniques and Describe about industrially important microbes. | **K4** |
| CO-5 | Evaluate the various food preservation methods and identify the fermented dairy, baker's and brewing products. | **K5** |
| CO-6 | Propose a waste management system, design new composting technique and biogas unit. | **K6** |

**UNIT – I:**

General concepts of Industrial Microbiology, Industrially important microorganisms, Primary and Secondary metabolites from microorganisms, Microbial fermentation and its types, Fermentor–Design and types, Factors affecting fermentor design, Sterilization of Fermentor, media and air.

**UNIT – II:**

Inoculum development for fermentation process, Raw material for media preparation, Strain improvement strategies, Foam formation during fermentation and Antifoam agents, Scale up of fermentation process– Upstream and Downstream process.

**UNIT – III:**

Microbial products of industrial value–Penicillin, Streptomycin, Ethanol, Amylase, Vitamin – B12, Acetic acid, Citric acid and Glutamic acid. Probiotics-types.

**UNIT – IV:**

Principles of food preservation; Single cell proteins – *Spirulina*; Lactic acid bacteria and Propionic acid bacteria, Fermented dairy products–Cheese and Yoghurt; Baker's yeast–Bread making, Beer and Wine production. Food Spoilage –Mycotoxins.

**UNIT – V:**

Wastes - Types of wastes; Solid waste treatment – Saccharification, Gasification and Composting; Liquid waste treatment – Aerobic and Anaerobic methods; Bioremediation and

*Biodeterioration* of Industrial wastes. Composting and Vermicomposting of industrial wastes. Biogas Production.

**References:**


1. A.H. Patel (2007). Industrial Microbiology, Pan MacMillan Publication, UK.
2. R. Ananthanarayan and C.K. Jayaram Paniker (2000). Text book of Microbiology. 6th Edition, Orient Longman Limited, Chennai.
3. R.M. Atlas and R. Bartha (1992). Microbial ecology. Fundamentals and applications. 3rd Edition. Red Wood City. C.A. Benjamin
4. W.C. Frazier and D.C. Westhoff (1988). Food microbiology. 4th Edition. McGraw Hill NY.

M.J. Waites (2007). Industrial Microbiology. Blackwell Publishing Company. UK.

5. U. Satyanarayana (2005). Biotechnology. 1st Edition, Books and Allied (P) Ltd., Kolkata.
6. Martin Adams and Maurice Moss (2008). Food Microbiology, 3rd Edition, RSC Publications, UK.


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **I** | **BC712C** | **Stem Cell Technology** | **4** | **4** |

**Course Objectives**

- To learn about the basics of stem cells.
- To understand the embryonic and adult stem cell therapy.
- To examine the increasing potential of stem cell in medicine and understanding of the molecular determinants.
- To develop the ability to understand the role of stem cells in research.
- To learn about Stem cell based therapies in animal models.

**Course Outcomes**

| S.No. | Description | Cognitive Level |
|---|---|---|
| **CO-1** | Enumerate the basics of stem cells and the concepts of embryonic and adult stem cell therapy. | **K1** |
| **CO-2** | Examine the increasing potential of stem cell science to contribute to medicine and understanding of the molecular determinants that define stem cells. | **K4** |
| **CO-3** | Demonstrate *in vitro* manipulation to create distinct cell lineages and understanding of the methodologies used for reverse engineering of mature cells to create induced pluripotent stem cells. | **K2** |
| **CO-4** | Compile the basic research methodologies used in current stem cell research. | **K6** |
| **CO-5** | Determine the ethical issues associated with stem cell research. | **K3** |
| **CO-6** | Defend the stem cell based therapies in animal models. | **K5** |

**UNIT- I**

Stem cells-Definition, Sources, Classification and Types–Human Embryonic and Adult Stem Cells. Blastocyst Culture–Stages of embryonic development. Properties of Stem cells-Self Renewal, Clonality and Plasticity.Cryopreservation of Stem cells-Conventional, Slow freezing and Vitrification Methods.Pluripotent nature of stem cells-Extrinsic and Intrinsic factors.

**UNIT- II**

Characteristics of Stem cells and their developmental potentials; Ips- Induced pluripotent stem cells, Blastocyst and inner cell mass, Organogenesis, Mammalian Nuclear Transfer Technology, Stem cell differentiation–*in vitro* and *in vivo*. Applications of Stem cells.

**UNIT-III**

Therapeutic Cloning Strategies, Derivation and propagation of human embryonic stem cells, Reproductive cloning by Somatic Cell Nuclear Transfer (SCNT) and its uses, Limitations of Cloning, Human stem cell research–Ethical consideration, Stem cell religion consideration. Stem cell based therapies–Preclinical regulatory consideration and Patient advocacy.

**UNIT- IV**

Overview of Embryonic and Adult stem cells Therapy. Neurodegenerative diseases–Parkinson, Alzheimer, Spinal cord injuries and other brain syndromes.Tissue system failures–Cardiomyopathy, Kidney and Liver failure, Cancer and Hemophilia.

**UNIT-V**

Skeletol Muscle Stem cells–Development and Functions. Tumor stem cells–Basic differences and similarities of cancer stem cells.Cancer stem cell signaling–NOTCH pathway; Canonical Wntsignaling pathways in hematopoietic stem cells. Stem cell therapies in animal models.

**References**


1. Stem Cell Biology and Gene Therapy by Peter J. Quesenberry, 1st Edition, Willy-Less Publishers (1998).
2. Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential by Ann A. Kiessling, Jones and Bartett Publishers (2003).
3. Stem Cells by Potten, C.S., Elsevier (2006).
4. Essential of Stem Cell Biology by Robert Lanja, 2nd Edition, Academic Press (2006).
5. Stem cell Transplantation Biology Processes Therapy by Ho, A.D. and Hoffiman, R., Willy-VCH (2006).


## SEMESTER II

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **II** | **BC 809** | **Instrumentation Biochemistry** | **4** | **4** |

**Course Objectives:**

- To study the principle, procedure and applications of electrophoresis.
- To understand the principle, procedure and applications of microscopes.
- To study the principle, procedure and applications of chromatography.
- To learn the principle, procedure and applications of centrifugation techniques.
- To know the principle, procedure and applications of spectrophotometry.

**Course Outcomes:**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO-1** | Understand the core concepts of all analytical techniques | **K1, K2** |
| **CO-2** | Describe the basic principle, types, procedure and applications of electrophoresis | **K1** |
| **CO-3** | Acquire knowledge about advanced microscopy techniques | **K3** |
| **CO-4** | Correlate the various types of chromatographic techniques | **K4** |
| **CO-5** | Justify the principle, instrumentation and applications of various spectroscopy techniques | **K5** |

| | | |
|---|---|---|
| **CO-6** | Schematize the Principle and applications of Atomic flame and flameless spectrophotometry | **K6** |

**UNIT-I**

Electrophoresis−General Principles, Factors affecting electrophoretic mobility, Support media. Paper and Gel electrophoresis. SDS-PAGE, 2D PAGE, Native gel Electrophoresis. Detection, estimation and recovery of proteins in gels. Agarose gel, Capillary Electrophoresis and pulsed field gel electrophoresis. Isoelectric focusing, Immunoelectrophoresis and ELISA. Types of Blotting−Southern, Northern, Western, Dot-blot and Slot-blot.

**UNIT-II**

Microscopy−Bright field, Dark field, Phase contrast, Confocal microscopy and Fluorescence microscope. Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, fixation and staining techniques for EM.

**UNIT-III**

General principle of Chromatography, Types− Paper, TLC, Ion exchange, Molecular gel exclusion, Affinity, Gas Liquid, HPLC and HPTLC. Basic principle of Centrifugation, Types−Preparative ultracentrifuge, Differential, Density gradient, Rate zonal, isopycnic isodensity and equilibrium isodensity centrifugation. Determination of molecular weight by sedimentation in an ultracentrifuge.

**UNIT-IV**

UV-Visible spectral analysis of colouring pigments (Beta cyanin, Anthocyanin, Xanthine, Lycopene and Curcumin), Atomic force microscopy, Circular Dichorism spectroscopy, OpticalRotatory Dispersion spectroscopy and X-ray diffraction −Principle, instrumentation and application.

**UNIT-V**

Principle and applications of Atomic flame and flameless spectrophotometry. Electron spin Resonance, Nuclear Magnetic Resonance, Infrared, Raman spectroscopy and Mass spectroscopy.

**References**


1. Introduction to Medical Laboratory Techniques by Mukherjee, Volume I, II and III, Oxford University Press (1976).
2. Physical Biochemistry by David Friefielder, W.H. Freeman 2nd Edition (1982).
3. Introductory Practical Biochemistry by K. Shawney and Randhir Singh (2000).
4. Practical Biochemistry by K. Wilson and J. Walker. 5th Edition Cambridge Univ. (2005).
5. Introduction to instrumental analysis by Robert D. Brown, Pharma Book Syndicate (2006).
6. Introduction to Experimental Biophysics (set): Textbook and Lab manual by CRC press. Jay Nadeau (2015).


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **II** | **BC 810** | **Advanced Enzymology** | **4** | **4** |

**Course Objectives**

- To acquire fundamental knowledge on enzymes and their importance in biological reactions.
- To understand the ability to difference between a chemical catalyst and biocatalyst.
- To know the mechanism of enzyme and its importance in biological reactions.
- To learn the kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.

- ❖ To understand the role of enzymes in clinical diagnosis and industries.

**Course Outcomes**

| S. No | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO-1** | Describe the structure, classification and functions of enzymes | K6 |
| **CO-2** | Analyze the kinetics of enzyme and chemical catalyzed reactions | K4 |
| **CO-3** | Assess the mechanism of enzyme action and enzyme inhibitory and regulatory process. | K5 |
| **CO-4** | Summarize the isolation and purification of enzymes | K2 |
| **CO-5** | Identify the enzyme immobilization methods and their applications | K1 |
| **CO-6** | Determine the applications of enzymes and their future potential | K3 |

**UNIT-I**

Introduction to Enzymes, Nomenclature and IUBMB classification of enzymes. Enzyme activity, factors contributing to the catalytic efficiency of enzyme. Enzyme Units–Specific activity, Turn over number, Katal and IU. Enzyme Active site–determination of active site amino acids–Chemical probe, Affinity label and Site-directed mutagenesis. Investigation of 3D structure of active site. Coenzymes–Prosthetic group, Classification– Vitamin and non-vitamin Coenzymes and Cofactors.

**UNIT-II**

Theories of enzyme substrate complex- Lock and key, induced fit theory, Kinetics of Single Substrate-enzyme catalysed reactions–Michaelis-Menten equation, importance of $V_{max}$, $K_m$ and MM equation. Modification of MM equation–Lineweaver-Burk plot, Eadie-Hofstee plot, Hanes-Woolf plot and Eisenthal and Cornish-Bowden plot. Kinetics of multi substrate-enzyme catalysed reactions: Non Sequential-Ping-pong, bi-bi, Sequential- random order and compulsory order mechanism.

**UNIT-III**

Mechanism of Enzymic Action–general acid-base catalysis, covalent catalysis, role of metal ion in enzyme catalysis, mechanism of Serine proteases-chymotrypsin and lysozyme. Inhibitors-Definition, Types and kinetics of Reversible inhibition–Competitive, uncompetitive, non-competitive. Irreversible inhibition and Allosteric regulation.

**UNIT-IV**

Isolation and Purification of enzymes, Preparation of purification chart, Purification techniques, Enzyme Immobilization- methods and their applications, RNA catalysis-Ribozymes, Catalytic antibodies – abzymes and synzymes. Multi enzyme complex- Pyruvate dehydrogenase, Isoenzymes- LDH and CPK.

**UNIT-V**

Industrial Uses of Enzymes–Sources, thermophilic enzymes, amylases, glucose isomerases, cellulases, lipases, proteases in meat and leather industry, detergents and cheese production. Enzymes as thrombolytic agents, anti-inflammatory agents and digestive aids.

**References**


1. Enzymes by Dixon and Webb, Academic Press (1964).
2. Enzymes by Boyer. Academic Press, 3rd edition (November 1983).
3. Understanding enzymes by Palmer, Prentice Hall; 4th Edn. (1995).
4. Biochemistry by Metzler, Academic Press (2000).
5. Biochemistry by Stryer. W. H. Freeman; 6th Edition (2006).

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **II** | **BC 811** | **Intermediary Metabolism** | **4** | **4** |

**Course Objectives**

- To determine the biochemical reactions, central metabolic pathways and kinetics of energy and homeostasis of metabolism.
- To learn the importance of lipids as storage molecules and as structural component of biomembranes.
- To understand the importance of high energy compounds, electron transport chain, and synthesis of ATP under aerobic and anaerobic conditions.
- To acquire knowledge related to the role of TCA cycle in central carbon metabolism, importance of anaplerotic reactions and redox balance.
- To gain insights into metabolic engineering for the production of useful biomolecules.

**Course Outcomes**

| S.No | Description | Cognitive Level (K-Level) |
|---|---|---|
| CO-1 | Observe the basic concepts of Bioenergetics, mechanisms of oxidative phosphorylation and photophosphorylation | K2 |
| CO-2 | Analyze how various biomolecules are metabolized inside the body in order to produce energy for various functions and how various metabolic pathways regulate growth and development of living beings | K4 |
| CO-3 | Determine the composition and structure of biomembranes, transport mechanisms across biological membranes and learn the concept and mechanism of ATP synthesis. | K3 |
| CO-4 | Justify the role of high energy compounds, how carbohydrates serve as energy source to power various functions, interplay of regulatory networks in the body, hormonal regulation of metabolism, etc. | K5 |
| CO-5 | Recognize the role of lipids as storage molecules, role of TCA cycle in central carbon metabolism, importance of anaplerotic reactions, and redox balance occurring in the cells. | K1 |
| CO-6 | Integrate how metabolism can be related with issues in lifestyle, health and disease | K6 |

**UNIT-I**

Introduction to Metabolism of Cells, Aerobic Glycolysis and Fermentation–Energetics, Citric Acid Cycle – PDH complex, energetics and regulation, Pentose Phosphate Pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis and their regulation. Glyoxylate Pathway and Uronic acid pathway. Metabolism of Fructose and Galactose, Futile cycle.

**UNIT-II**

Energy Transformation, Free Energy changes and Redox Potential, Biological Oxidation–Enzymes involved in Redox Reactions. Phosphoryl group transfers and ATP. Components of Electron Transport Chain and the sequence of electron transport. Oxidative Phosphorylation–Chemiosmotic Theory. Structure and Mechanism of ATP synthesis ($F_1F_0$ complex). Inhibitors

of respiratory chain and oxidative phosphorylation - Uncouplers. Regulation of oxidative phosphorylation. Mitochondrial Transport Systems-ATP/ADP exchange, malate aspartate shuttle, glycerol phosphate shuttle and creatine-phosphate shuttle.

**UNIT-III**

Metabolism of Triglycerides, phospholipids and Sphingolipids. Fatty acid biosynthesis, Fatty acid oxidation (α, β and ω) and lipid peroxidation. Ketone bodies-Formation, utilization, excretion and clinical significance. Cholesterol-Biosynthesis, regulation, transport and excretion. Prostaglandins and thrombaxene metabolism.

**UNIT-IV**

Biosynthesis of aromatic aminoacids. Catabolism of amino acid nitrogen– Transamination, deamination, ammonia formation and the urea cycle.Disorders of the urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to specialized products. Biosynthesis and degradation of Porphyrin and Heme. Metabolism of purines–De novo and salvage pathways for biosynthesis. Purine catabolism. Biosynthesis and Catabolism of pyrimidines.

**UNIT-V**

Interrelationship of carbohydrates, Proteins and Fat metabolism- Integration of different metabolic pathways and role of acetyl CoA and TCA cycle. Metabolic profile of the principle organs (liver, adipose tissue and brain) and their relationships. Altered metabolism in starvation. Metabolism under different stress conditions.

**References**


1. Biochemistry by Zubay, G.L, 4th edition, WMC Brown publishers (1988).
2. Principles of Biochemistry by Garrette and Grisham, Saunders College publishing (1994).
3. Biochemistry by Donald Voet, J.G. Voet and John Wiley, (1995).
4. Biochemistry by Kuchel and Ralston, 2nd ed. Schaum's Outlines McGraw Hill (1998).
5. Biochemistry by Davidson and Sittman,. NMS. 4th ed. Lippincott. Willams and Wilkins, (1999).
6. Biochemistry by Campbell and Farrell, 4th ed. Brooks/Cole Pub Co. (2002).
7. Lehninger's Principles of Biochemistry by Nelson Cox, 4th ed. McMillan Worth (2004).
8. Biochemistry by Stryer. W. H. Freeman; 6 editions (2006).


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **II** | **BC812A** | **Elective II - Advanced Endocrinology** | **4** | **4** |

**Course Objectives**

- To learn the basic aspects of hormones and endocrine glands.
- To provide in depth knowledge about chemical structures of hormones.
- To understand the classification of hormones.
- To identify about the functions of hormones.
- To compile information about new diseases associated with hormones.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-Level) |
|---|---|---|
| **CO-1** | Demonstrate the basic aspects of hormones, glands, chemical classification and functions. | **K2** |
| **CO-2** | Exhibit the daily secretion of hormones and abnormal values. | **K1** |

| | | |
|---|---|---|
| **CO-3** | Acquire knowledge about Reproductive Endocrinology. | **K3** |
| **CO-4** | Make inferences of Neuroendocrine integration in homeostasis. | **K4** |
| **CO-5** | Make judgments about Pathophysiology of Hormones. | **K5, K6** |
| **CO-6** | Compile information about new diseases associated with hormones. | **K6** |

**UNIT-I**

Hormones–Introduction and Chemical nature.Neuroendocrine integration in homeostasis.Classes of chemical messengers.Hormone secretion, Transport and clearance. Feed-back Regulation of hormonal secretion. Mechanism of Group I and Group II hormone action, Receptors and its types, Second messengers. Signal Transduction.

**UNIT-II**

Endocrine hypothalamus–Structure, hypophysiotropic hormones, regulation of hypothalamic hormone secretion. Pituitary hormones– Anatomy of pituitary gland, hormones of the anterior pituitary– Synthesis, chemistry, physiological roles, mechanism of action, regulation of secretions and pathophysiology. Neurohypophysis–Synthesis, chemistry, physiological roles, Regulation of secretions and pathophysiology of neurohypophyseal hormone secretion

**UNIT-III**

Thyroid gland–Synthesis, chemistry, physiological roles, mechanism of action. Regulation of thyroid hormone secretion and Pathophysiology.Parathyroid gland–Synthesis, chemistry, physiological roles, mechanism of action, regulation of parathyroid hormone secretion and pathophysiology.Pineal gland–Melatonin hypothesis, secretion and circulation, proposed role of pineal. Melanotropic hormones–Chemistry, role of MSH, mechanism of action and pathophysiology.

**UNIT-IV**

Pancreas–Synthesis, chemistry, physiological roles, mechanism of action, regulation of secretion and pathophysiology of Insulin, Glucagon and Somatostatin.Neurohormones–chemistry, physiological roles, mechanism of action, regulation of secretion and pathophysiology of Catecholamines and endorphins.

**UNIT-V**

Reproductive Endocrinology–Male reproductive system-Synthesis, chemistry, physiological roles, mechanism of action, and pathophysiology of Androgens. Female reproductive system–Synthesis, chemistry, physiological roles, mechanism of action, regulation of secretion and pathophysiology of Ovarian hormones. Endocrinology of pregnancy, parturition and lactation, puberty and hormone regulation.Human infertility–Reasons, therapy and treatment.

**References**


1. William's Textbook of endocrinology by Wilson, Foster, 8th Edition (2002).
2. Principles of Biochemistry by Smith et al., 7th Edition, McGraw Hill (2003).
3. Harper's Biochemistry by R.K. Murray et al. McGraw-Hill Medical; 27th Edition (2006).
4. Medical Endocrinology by Goodman HM, Basic. Academic Press. 4th Edition (2008).
5. Endocrine and Metabolic Disorders: Clinical Lab Testing Manual by Robert F. Dons., 4th Edition, CRC Press (2009).


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **II** | **BC812B** | **Elective – II – Pharmaceutical Biochemistry** | **4** | **4** |

**Course Objectives**

- To gain the knowledge on basic concepts of pharmacology to understand the mechanisms of drug action and toxicity.
- To understand the chemistry of drugs with respect to their pharmacological activity.
- To learn the drug metabolic pathways, adverse effect and therapeutic value of drugs.
- To know the mechanism of action of drug therapy.
- To study about the natural drug development.

**Course Outcomes**

| S.No | Description | Cognitive Level (K-Level) |
|---|---|---|
| **CO1** | Enumerate the relevance, basic concepts of pharmacology, ADME properties and drug metabolism | K1 |
| **CO2** | Interpret the pharmacological actions of different categories of drugs and factor that modifies the effect of drug and drug potency | K2 |
| **CO3** | Apply the basic principle of genetic engineering and enzyme technology | K3 |
| **CO4** | Outline the mechanism of action of drugs used in therapy of Respiratory system. | K4 |
| **CO5** | Perceive the information of drugs used for cancer, inflammation, respiratory system, GIT, immune system and hormones. | K5 |
| **CO6** | Formulate natural products for chemotherapy, anti-hypertensive, anti-platelet, anti-inflammatory and anti-cholinergic drugs. | K6 |

**UNIT-I**

Drug: Structural feature and pharmacology activity, Prodrug concept. Absorption–first Pass effect. Distribution and Metabolism–Phase I, II reactions, action of cytochrome p450 and elimination of drug. Receptor: localization, types, models and their drug– Receptor interaction, agonist and antagonist.

**UNIT-II**

Adverse response to drugs, Drug tolerance and intolerance, Idiosyncrasy, drug allergy. Tachyphylaxis, Drug abuse, Vaccination against infection, Factor that modifies the effect of drug. Assay of drug potency-Bioassay and Immunoassay.

**UNIT-III**

Biotechnology and pharmacy: Genetically engineered protein -Insulin, drug delivery systems, Non-conventional routes of administration. Anti-AIDS drugs, Anti-cancer drugs, Covid-19 drugs and Multi-drug resistance.

**UNIT-IV**

Mechanism of action of drugs used in therapy of Respiratory system–Cough, Bronchial, Asthma and Pulmonary tuberculosis. GIT–Digestants and Appetite suppressants. Hypo lipidemia agents, Antimicrobial drugs, Aminoglycosides. Insulin and oral diabetic drugs, antifertility and ovulation inducing drugs.

**UNIT-V**

Role of natural products in drug development, Drug dependence and abuse, Chemotherapy-Immuno suppressive drugs, Anti-hypertensive, Anti-platelet, Anti-inflammatory and Anti-cholinergic drugs.

**References**

1. Oxford text book of Clinical pharmacology and drug therapy by A. Burger, D. J. Abraham. Burger's medicinal Chemistry & Drug Discovery, (2003).

2. Essentials of Medical Pharmacology by K. D. Tripathi 5th Edition, Jaypee, New Delhi, (2004).
3. Pharmacology (Lippincott Illustrated Reviews Series) by Richard A. Harvey, Pamela C.Champe, Richard Finkel, Luigi Cubeddu, Michelle A.Clarke 4th Edition,Wolterskluwer, (2008).
4. Principles of medicinal chemistry by William, O. and Foge, B.I., Waverks Pvt.Ltd.,New Delhi,(2008).
5. Pharmacology and Pharmacotherapeutics by Bhandarkar, 10th Edition, Elseveir (2010).
6. The pharmacological basis of therapeutics by Laurence Brunton, Bruce A.Chabne and Bjorn Knollman Goodman and Gillman, Vol. I and II,Mc Graw Hill (2011).
7. Pharmacology and Pharmacotherapeutics by Satoskar, 24th Edition, Elseveir (2015).
8. Pharmacology and Pharmacotherapeutics by R.S. Satoskar, S.D.Bhandhakar and S.S. Anilapure, Elsevier (2015).

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **II** | **BC812C** | **Elective II - Environmental Toxicology** | **4** | **4** |

**Course Objectives**

- To gain knowledge on toxic substances and biochemical basis of toxicity.
- To understand the sources and routes of the various toxic substances in the environment.
- To learn about environmental impacts of pesticides and xenobiotics.
- To study about the toxicity testing and their interpretations.
- To understand the causes of organ toxicity.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K- level) |
|---|---|---|
| CO-1 | Demonstrate the degradable and non-degradable toxic substances and action mechanism of toxicity. | K1 |
| CO-2 | Define the transport of toxins by air, water and food chain; explain the combined effect of xenobiotics. | K2, K1 |
| CO-3 | Determine the environmental impacts of various pesticides and effect of xenobiotics on aquatic organisms. | K3 |
| CO-4 | Outline the legal, regulatory and ethical considerations relating to toxicity within the broader societal context. | K4 |
| CO-5 | Find the lethal concentration and lethal dose of toxic substances by toxicity testing. | K5 |
| CO-6 | Compile the causes of hepatotoxicity, nephrotoxicity, pulmonary toxicity and neurotoxicity. | K6 |

**UNIT-I**

Ecotoxicology–Introduction, Principles and Scope. Types of toxic substances-Degradable and Non-degradable. Factors influencing toxicity. Biochemical basis of toxicity–Mechanism of toxicity and Receptor mediated events, Acute and Chronic toxicity.

**UNIT-II**

Toxic substances in the environment, their sources and entry routes. Transport of toxicants by air and water–Transport through food chain–bioaccumulation and biomagnifications of toxic

materials in food chain. Xenobiotics, Combined effect of xenobiotics on physiology and Biochemistry of organisms.

**UNIT-III**

Toxicology of major pesticides–Environmental impacts of pesticides, biotransformation, biomonitoring, concept of bioindicator groups and examples. Combined effect of xenobiotics on physiology and biochemistry of aquatic organisms.

**UNIT-IV**

Toxicity testing–Laboratory animals, estimation of $LC_{50}$ and $LD_{50}$, Interpretation of laboratory data–distinction between adverse and non-adverse effects. Human data–ethical consideration, need for human investigation and clinical toxicology.

**Unit-V:**

Hepatotoxicity–Common examples of hepatotoxicants, injuries caused to liver, Nephrotoxicity–Common examples of nephrotoxicants, injuries caused to kidney, Pulmonary toxicity–Common examples of pulmonary toxicants, injuries caused to lungs, Neurotoxicity–Common examples of neurotoxicants, injuries caused to nervous tissues.

**References**


1. Text Book of Preventive and Social Medicine by Park, J.E. and Park, K., Banosidas Bharat Publishers, Jabalpur (1985).
2. Environmental Pollution and Toxicology by Meera Asthana and Astana D.K., Alka Printers, Chandigarh (1990).
3. Environmental Biology and Toxicology by Sharma, P.D, Rastogi and Lamporary, Rajpal and Sons Publishing, New Delhi (1994).
4. Environmental Epidemiology by Anisa Basheer, Rawat Publications, New Delhi (1995).

   Toxicology by Sood, A, Sarup and Sons, New Delhi (1999).


## CORE PRACTICALS

**SEMESTER I & II** **5 Hrs/Week (4 Credits)**

### CORE PRACTICAL-I

**Lab Course–I: Isolation, Quantitative Analysis and Techniques**

**I. Isolation, Quantitative Analysis**

1. Isolation and estimation of Glycogen from Liver.
2. Isolation and estimation of DNA from Liver/Spleen.
3. Isolation and estimation of RNA from Yeast.
4. Isolation of Lecithin from Egg yolk.
5. Estimation of Ascorbic Acid isolated from Lemon.
6. Estimation of Inorganic Phosphorus by Fiske and Subbarow method.
7. Estimation of Pyruvate.
8. Estimation of Tryptophan.
9. Estimation of Protein by Lowry's method.
10. Estimation of Sodium by Flame photometry.
11. Estimation of potassium by Flame photometry

**II. Techniques**

1. Preparation of buffers and measurement of pH using indicators and pH meter.
2. Separation of Amino acids/Sugar by Thin Layer Chromatography.
3. Separation of Amino acids/sugar by Paper Chromatography
4. Separation of Plant pigments by Column Chromatography.
5. Separation of Serum Proteins by SDS-PAGE.

## CORE PRACTICAL-II

**SEMESTER I & II** **5 Hrs/Week (4 Credits)**

### Lab Course–II: Industrial and Clinical Enzymology

**I. Assay of Industrial enzymes**

**1. Acid Phosphatase**

1. Assay of Acid Phosphatase activity from Potato.
2. Determination of optimum pH on Acid phosphatase activity.
3. Determination of Optimum Temperature on Acid phosphatase activity.
4. Effect of Substrate concentration on Acid phosphatase activity.

**2. Alkaline Phosphatase**

1. Assay of Alkaline Phosphatase activity from Green gram.
2. Determination of optimum pH on Alkaline phosphatase activity.
3. Determination of Optimum Temperature on Alkaline phosphatase activity.
4. Effect of Substrate concentration on Alkaline phosphatase activity.

**3. Urease**

**1.** Assay of Urease activity from horse gram.
2. Determination of optimum pH on Urease activity.
3. Determination of Optimum Temperature on Urease activity.

4. Effect of Substrate concentration on Urease activity and calculate $K_m$ and $V_{max}$ using MM Curve and LB Plot.

**4. Salivary Amylase**

1. Assay of Salivary amylase activity from Saliva.
2. Determination of optimum pH on Salivary amylase activity.
3. Determination of Optimum Temperature on Salivary amylase activity.
4. Effect of Substrate concentration on salivary amylase activity and calculate $K_m$ and $V_{max}$ using MM Curve and LB Plot.

**II. Assay of clinically important enzymes**

a. Assay Serum Alanine aminotransferase activity.
b. Assay of serum Aspartate aminotransferase activity.

**III.Techniques**

1. Immobilization of enzymes by sodium alginate method.
2. Subcellular fractionation of organelles from liver cells and identification by marker enzyme –LDH.
3. Enzymes purification by Ammonium sulphate fractionation.

## CORE PRACTICAL-III

**SEMESTER I & II** **4 Hrs/Week (4 Credits)**

### Lab Course–III: Microbial Biochemistry

1. Cleaning of Glasswares and Sterilization techniques.
2. Preparation of Culture medium used for the cultivation of bacteria and fungi–Broth and Agar.
3. Staining techniques–Simple staining, Gram staining, Capsule staining, Endospore staining and Acid fast staining.
4. Hanging drop method.
5. Antibiotic sensitivity test.

6. Slide culture technique for fungal identification and Lactophenol cotton blue (LPCB) Staining method.
7. Pure culture techniques–Serial dilution (Pour plate and Spread plate) and Streak plate.
8. Growth curve of bacteria.
9. Effect of pH, Temperature and Salinity on the growth of bacteria.
10. Isolation of *Rhizobium* from rhizosphere soil.
11. Isolation of yeast (*Saccharomyces cerevisiae)* from grapes.
12. Isolation and enumeration of microorganisms in milk and water by Standard Plate Count (SPC Method).
13. Analysis of water quality by Most Probable Number (MPN) Technique.

## Semester III

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **III** | **BC911** | **MOLECULAR BIOLOGY** | **6** | **5** |

**Course Objectives**

- To learn the basic information about Mendelian genetics and the basic aspects of molecular theories.
- To understand the process of DNA replication involving the roles of various DNA polymerases and other proteins with special reference to the events in prokaryotes and eukaryotes.
- To Gain the insights on the various kinds of DNA repair and major diseases resulting from defective DNA repair
- To acquire the knowledge on various kinds of DNA recombination and a detailed understanding of the process of Holliday recombination
- To acquire the knowledge related to major features of chloroplast and mitochondrial DNA.

**Course Outcomes**

| S.No | Description | Cognitive Level (K-Level) |
|---|---|---|
| CO-1 | Observe the basic information about Mendelian genetics and the basic aspects of molecular theories. | K2 |
| CO-2 | Analyse the processes involved in replication and the role of DNA polymerases. | K4 |
| CO-3 | Determine the composition, structure and types of RNAs and its mechanisms. | K3 |
| CO-4 | Justify the role of peptides and protein molecules produced during translation process. | K5 |
| CO-5 | Recognize the role of proteins during gene expression and its regulations. | K1 |
| CO-6 | Integrating mol. Bio mechanism with clinical concepts | K6 |

**UNIT-I**

Genetics–History, Definition and Scope. Premendelian genetic concepts –Preformation, Epigenesis, Inheritance of acquired characters and germplasm theory. Hereditary and Environment, Genotype and Phenotype; Heredity and Variation. Clones, Pure lines, Inbred lines and Phenocopies. Biography of Mendel and his experiments with Pea plant. Law of Segregation–Monohybrid cross, back and test cross, Dominance and Recessive, Co-dominance and Incomplete dominance. Law of Independent Assortment–Dihybrid crosses in Pea plant.

**UNIT-II**

Types of Replication, Evidence for Semiconservative replication–Meselson and Stahl experiment. Replication in Prokaryotes, Replication bubble, bidirectional replication, replicon, action of SSB, primase, DNA gyrase, topoisomerases, Telomerases, DNA polymerase I, II, and III, lagging and leading strand synthesis and Inhibitors of replication. Replications in circular chromosomes–Cairns and Rolling circle model. Replication in RNA virus, Plasmid Replication, temporal control of replication. Eukaryotic replication.

**UNIT-III**

Transcription–Definition, Coding strand, Template strand, Sense strand and Antisense strand. Prokaryotic transcription: Initiation- Promoter region, role of Pribnow box, DNA–dependent RNA polymerase, Foot-printing experiment, Elongation and Termination-Rho–Dependent and independent termination, Post - transcriptional processing in prokaryotes, split genes, over lapping genes, housekeeping genes, biosynthesis of rRNA and tRNA. Eukaryotic transcription, RNA editing. Post-transcriptional modifications in eukaryotic RNAs, RNA splicing–Introns and splicing reactions, Types of introns. Exons, spacer sequences and enhancers. Inhibitors of Transcription.

**UNIT-IV**

Genetic code–Definition, deciphering of the genetic code, codon dictionary and its salient features. Wobble mechanism and its significance, Structure of tRNA and composition of prokaryotic and eukaryotic ribosomes. Steps - Activation of amino acids, Initiation-Shine-Dalgarno sequence, reading frame-shift, Elongation and Termination. Eukaryotic Protein synthesis–initiation, elongation and termination. Polysomes, Post-translational modifications in Prokaryotes and Eukaryotes. Inhibitors of protein synthesis.

**UNIT-V**

Gene expression and regulations, Molecular mechanism of regulation, Prokaryotes–Operon model, lac, trp, ara operons, repression and attenuation. Eukaryotes–C value paradox, repetitive DNA, gene dosage and gene amplifications. Mutagenesis and replication fidelity, frame-shift mutagenesis, DNA damage–different types, DNA repair–Direct reversal repair, direct repair of nicks, excision repair, nucleotide excision repair, mismatch repair, long and short patch mismatch repair, recombination error, SOS response and mutagenic repair.

**References**


1. Biochemistry by D. Voet and J. Voet. John Wiley and Sons Ltd. (1990)
2. Advanced molecular biology by R. M. Twyman (1998).
3. Genes VII by B. Lewin, Oxford University Press, Cell Press, London (2000).
4. Cell and molecular biology by G. Karp, John Wiley & Sons Inc. (2002).
5. Molecular biology by Robert F. Weaver, McGraw-Hill, 4th Edition (2007).


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **III** | **BC912** | **Immunology** | **5** | **4** |

**Course Objectives**

- ❖ To gain acquaintance on the organs involved in the immune system, antigens and different types of antibody.
- ❖ To acquire knowledge on types of immunity, immune response and complement system.
- ❖ To gain knowledge about different vaccines and the importance of different immunological techniques.
- ❖ To acquire knowledge about the MHC complex, transplantation immunology and tumor immunology.
- ❖ To comprehend the complications of hypersensitivity, Autoimmune diseases and Immunodeficiency disorders.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO1** | Anatomy of Lymphoid organs, immune cells and its associated theories | K3 |
| **CO2** | Discuss the Types of Immunity, Immune response and Complement system. | K2 |
| **CO3** | Focus on different vaccines and the importance of different immunological techniques. | K1 |
| **CO4** | Compile the MHC complex and Transplantation immunology | K6 |
| **CO5** | Explores the properties of tumor cells, Immune surveillance and tumor antigens. | K5 |
| **CO6** | Outline the complications of hypersensitivity, Autoimmune diseases and Immunodeficiency disorders. | K4 |

**UNIT-I**

Lymphoid system–Central and Peripheral Lymphoid Organs and Cells involved in immune system. Antigen, haptens, adjuvants, antigenicity, immunogenicity, antigenic determinants. Immunoglobulins - structure, classification, functions, allotypes and idiotypes. Theories of antibody formation–Side chain and clonal selection theory.

**UNIT-II**

Types of Immunity–Innate and Acquired immunity, antitoxin, antibacterial and antiviral immunity. Immune response–Humoral and Cell mediated immunity. Antigen recognition–T and B cell receptor complexes, antigen processing and presentation. Interaction of T and B cells, Cytokines and Immunological memory. Cytotoxicity– immunotolerance and immunosuppression. Complement system– Components, nomenclature and complement activation pathway.

**UNIT-III**

Vaccines–Attenuated organisms, toxoid, recombinant vaccines, subunit vaccines–DNA vaccines, synthetic peptide vaccines, antiidiotypic vaccines. Immunization practices–Immune prophylaxis and Immunotherapy. Immunological techniques–Production of polyclonal and monoclonal antibodies. Immunoprecipitation, RIA, ELISA, fluorescent Immunoassay, Avidin–Biotin mediated assay, Immunohistochemistry, Immunoelectrophoresis, immunoblotting, Complement fixation test.

**UNIT-IV**

MHC Complex–Gene organization. MHC complex class I, II and III molecules, Histocompatibility testing–Lympho cytotoxicty test and cross matching MHC.

Transplantation–Types, genetics of transplantation, organ transplantation and graft versus host reactions. Tissue matching and Immunosuppressive agents. Tumor immunology–Types, properties of tumor cells, Immune surveillance, tumor antigens, immune response to tumors, Immunotherapy of tumors, DNA tumor virus and Retro virus.

**UNIT-V**

Hypersensitivity–Definition and classification–Type I, II, III, IV and V hypersensitivity, mechanism , diagnosis and treatment. Autoimmunity and Autoimmune diseases–Mechanism of development, diagnosis and treatment. Immunodeficiency disorders–B and T cell deficiencies. Secondary Immunodeficiency diseases–Pathogenesis, diagnosis and treatment of AIDS.

**References**


1. Basic and Clinical Immunology by Daniel P. Stites, John D. Stobo, J. Vivian Wells, Appleton & Lange, 6th Edition (1987).
2. Immunology by Geoffrey Zubay, W.M.C. Brown publisher, 4th Edition (1992).
3. Immunology by Janis Kuby, 4th Edition, W.H. Freeman and Company (2000).
4. Cellular and Molecular Immunology by Abul K. Abbas, Andrew Lichtman, Saunders, 5th Edition (2005).
5. Essential Immunology by Ivon Roitt, Blackwell Publishing, 11th Edition (2006).


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **III** | **BC913** | **RESEARCH METHODOLOGY** | **5** | **4** |

**Course Objectives**

- To learn the Importance of Research and Ethics in Scientific research
- To understand the collection and classification of research data.
- To know the scope of Bioinformatics, the role of Computers in Biology and Useful search engines.
- To acquire in-depth knowledge about the Laboratory animals used for Life science research.
- To explain the Composition of the Institutional Ethical Committee (IEC) and General ethical issues.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO1** | Observe the basic concepts of scientific research, types of research and research design. | K1 |
| **CO2** | Establish the knowledge about scientific writing and research publications | K3 |
| **CO3** | Generalise the Collection and Classification of Data and its analysis. | K2 |
| **CO4** | Perceive the Scope of Bioinformatics, and useful search engines for finding scientific articles. | K5 |
| **CO5** | Point out the Laboratory animals used for Life science research and its ethical issues. | K4 |
| **CO6** | Develop an understanding of the Composition of the Institutional Ethical Committee (IEC), IPR and Patenting. | K6 |

**UNIT–I**

Importance and Need for Research, Ethics in Scientific research, Designing a Research work, Formulation of Hypothesis, Scientific writing–Research and Review article. Logical format for Dissertation–Title, Certificate, Declaration, Acknowledgement, Contents,

Abstract, Introduction, Review of Literature, Materials and Methods, Results, Discussion, Summary, Conclusion, Appendix and References–Harvard and Vancouver systems. Antiplagiarism.

**UNIT–II**

Collection and Classification of Data–Diagrammatic and Graphic representation of data–Measurement of Central tendency–Standard Deviation-Normal distribution-test of significance based on large samples and small samples, Student 't' test, Correlation and Regression, Chi-square test for independence of attributes, ANOVA and SPSS.

**UNIT-III**

Introduction and Scope of Bioinformatics, Role of Computers in Biology. Useful search engines–Boolean searching, Search engine algorithms. Finding scientific articles in Google scholar, Science Direct, Scopus, Web of Science and UGC-CARE.

**UNIT –IV**

Laboratory animals used for Life science research. Ethics in animal experimentation. CPCSEA guidelines–Animal care and technical personnel environment, animal husbandry, feed, bedding, water, sanitation and cleanliness, waste disposal, anesthesia and euthanasia. Research funding agencies in India.

**UNIT–V**

Composition of institutional Ethical Committee (IEC), General ethical issues. Specific principles for chemical evaluation of drugs and human genetics research, Ethics in food and drug safety. Environmental release of microorganisms and genetically engineered organisms. Ethical issues in human gene therapy and human cloning. IPR and Patenting.

**References**


1. The craft of scientific writing by Alley, Michael, Englewood Cliffs. N.N. Prentice (1987).
2. Molecular and cell biology of human gene therapeutics by Dickson, Series Chapman and Hall (1995).
3. Bioinformatics Computing by Bergeron, B.P. 1st Edition, Printice Hall (2000).
4. Ethical guidelines for biomedical research on human subjects. ICMR, New Delhi (2000).
5. Research methods for biological science by Gurumani, N , MJP Pub., (2007).
6. Statistical methods by S.P Gupta. 41st Edition, S. Chand and co. (2011).


| Semester | Subject code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| **III** | **BC914A** | **Elective III- Ecology, Evolution And Biodiversity** | **4** | **4** |

**Course Objectives**

- To learn the fundamental principles of evolutionary theory to explore the evolution of biodiversity.
- To make familiar with the major groups of organisms related to one another.
- To learn the basic ecological theory and proposing solutions to the major environmental problems.
- To understand the concepts of genetic variation, Mendelian genetics and recombination**.**
- To gain the knowledge about aquatic biotic production and biodegradation in different ecosystems.

**Course Outcomes**

| S. No. | **Description** | Cognition level (K-level) |
|---|---|---|
| CO1 | Provide in-depth knowledge about emergency of evolutionary thoughts and Darwin concepts. | K1 |
| CO2 | Review the origin of cell, unicellular evolution, Abiotic synthesis and prokaryotic evolution. | K2 |
| CO3 | Analyze the population genetics with various types of selection like sexual selection, gene drift and gene flow. | K4 |
| CO4 | Establish the ecological interaction between an organism and environment. | K3 |
| CO5 | Manage the ecosystem dynamics, stability and complexity by knowing the N, P, C and S cycles. | K6 |
| CO6 | Assess the various kinds of aquatic habitat in the eco-management process and biodegradation of different ecosystem. | K5 |

**UNIT-I**

Evolutionary Thoughts−Emergency of evolutionary thoughts. Lamarck, Darwin–Concepts of variation, adaptation, struggle, fitness and natural selection. Mendelism, spontaneity of mutations and evolutionary synthesis.

**UNIT-II**

Evolutionary Theory−Origin of cells and unicellular evolution, Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane, Experiments of Miller (1953), First cell, Evolution of Prokaryotes, Origin of Eukaryotic cells, Evolution of Unicellular Eukaryotes.

**UNIT-III**

Origin of genetic variation; Mendelian genetics; polygenic traits, linkage and recombination; epistasis, gene-environment interaction; heritability; population genetics; Molecular evolution; molecular clocks; systems of classification: cladistics and phenetics; molecular systematics; gene expression and evolution. Types of selection (stabilizing, directional etc.); sexual selection; genetic drift; gene flow; adaptation; convergence; species concepts

**UNIT-IV**

Ecology -Interaction between an organism and environment Concept of habitat and ecological niches, Contributing and Limiting factors for population growth, Energy flow, Food web and Tropic levels. Ecological pyramids and recycling, Communities – population dynamics and community level interactions, N, P, C, S cycles in nature, Ecosystem dynamics and management, stability and complexity of ecosystems, Biogeography and Conservation.

**UNIT-V**

Ecomanagement−Physio–chemical properties of water, kinds of aquatic habitat (fresh water and marine), distribution and impact of experimental factors on the aquatic biotic productivity and biodegradation in different ecosystems, fish and fishes of India with respect to the management of estuarine, coastal water systems and manmade reservoirs, biology and ecology of reservoirs.

**References**

1. Ecology Environment and Pollution by A. Balasubramanian, First edition, Publisher: Indira Publishers, Mysore (1995).

2. Biodiversity of Microbial Life by Staley Reysenbach, Wiley Publishers (2001).

3. Glimpses of Biodiversity by B. Bhosetti, Daya Publishing House (2002).

4. Text Book of Ecology by Eugene P. Oodum, Brooks/Cole; 5th Revised Edition (2004).

5. Environmental Biodiversity by P.R. Yadav, Discovery Publishing Pvt. Ltd. (2016).

| Semester | Subject Code | Title of the Course | Hours/week | Credits |
|---|---|---|---|---|
| **III** | **BC914B** | **Elective III - Food Biochemistry** | **4** | **4** |

**Course Objectives**

- To learn the structure, composition, nutritional value, processing and storage of cereals.
- To understand the importance, composition, classification, processing and toxic constituents of spices and pulses.
- To know the classification of nuts and oils, fat and oils, milk and milk products; nutritive values and significance.
- To understand the composition, classification, importance of vegetables and non-vegetable foods.
- To learn about the sugar, sugar products, baking and beverages of food.

**Course outcomes**

| S.No. | Description | Cognitive Level (K- level) |
|---|---|---|
| **CO1** | Identify the structure and composition, nutritional value, processing, storage and care of cereals. | **K1** |
| **CO2** | Focus the importance, composition, classification of spices, composition, classification, nutritional value, processing and fermentations, toxic constituents of pulses. | **K4** |
| **CO3** | Justify the nutritive value, importance and classification of nuts , oils, milk and milk products. | **K5** |
| **CO4** | Integrate the selection, storage, uses and nutritional aspects of meat, fish and poultry. | **K6** |
| **CO5** | Explain the composition, classification of egg products, storage of fruits and vegetables. | **K2** |
| **CO6** | Determine the sugar products, baking products and processing of beverages. | **K3** |

**UNIT-I:**

Cereal- Structure and composition, Nutritional value, Processing-Milling, polishing. Parboiling, flaking, parching, roasting, use in variety of preparations selection, storage and care, breakfast cereals.

**UNIT-II:**

Role of spices in food science - Importance, composition & classification. Pulses: Composition and nutritional value, processing, soaking, germination. Cooking and fermentations: Toxic constituents of pulses, Lathyrism.

**UNIT-III:**

Nuts and oil seeds: Nutritive value, importance & classification. Fats and oils: Types, role of fat in cookery. Milk and milk products: Composition of milk, properties and effect of heat, nutritional importance, milk processing, milk products.

**UNIT-IV:**

Flesh foods - selection, storage, uses and nutritional aspects of meat, fish and poultry, spoilage of fish. Egg- composition & classification of egg & egg products, its nutritive value. Fruits and vegetables: Classifications, composition and importance in human nutrition storage, cooking of vegetables, changes during cooking, effect of heat, acid and alkali.

**UNIT-V:**

Sugar and Sugar products – Form of sugar and liquid sweetness, Caramelization, Hydrolysis, Crystallization, Indian confectionery. Baking- Types of bake products & its nutritive value. Beverages: Coffee, tea, and cocoa, processing composition and preparation.

**References**


1. Srilakshmi, B. 2005. Food Science, New Age International (P) Ltd., Publishers, New Delhi.
2. Chemists, St. Paul Mimesota, USA. 4. Charley, H.(1982).Food Science, 2nd edition, John Wiley & Sons, New York.
3. Desrosier, N.W. and James N.(2007).Technology of food preservation. AVI Publishers.
4. Meyer, L.H.1974. Food Chemistry, AVI Publishing Co. Inc,
5. Manay, S. and Shadaksha ramasamy, Food: Facts and Principles, New Age International (P) Publishers, New Delhi.
6. Srilakshmi, B. (2010), Food Science, 5th edition, New age international publishers, New Delhi.


| Semester | Subject Code | Title of The Course | Hours | Credits |
|---|---|---|---|---|
| **III** | **BC914C** | **Elective III - Bionanotechnology** | **4** | **4** |

**Course Objectives**

- To understand the fundamental principles of nanotechnology and its applications.
- To study about the basic knowledge about nanoparticles and its biological applications.
- To apply engineering concepts and demonstrate a comprehensive understanding of state-of-the-art nano- scale and nano-fabrication methods.
- To evaluate the processing conditions to engineer functional nanomaterials.
- To apply and transfer interdisciplinary approaches to bionanotechnology.

**Course outcomes**

| S.No. | CO Statement | Cognitive Level |
|---|---|---|
| **CO-1** | Demonstrate the fundamental principles of nanotechnology and their application to biomedical engineering. | **K2** |
| **CO-2** | Exhibit the state-of-the-art nano-fabrication methods | **K1** |
| **CO-3** | Apply the knowledge of assessing nanomaterials and their safety | **K3** |
| **CO-4** | Make inferences on handling methods required during characterization | **K4** |
| **CO-5** | Justify the usage of nanomaterials in biological applications. | **K5** |
| **CO-6** | Compile the information about nanomedicines and their uses. | **K6** |

**UNIT-I**

Bionanotechnology–Concepts, Definitions, Biosystems, Biological networks, Benefits and Applications of Nanotechnology in medicine and agriculture. Nanorobots.

**UNIT-II**

Biomaterials- Introduction and Types. Biodegradable polymers. Biocompatibility, mechanical properties and Antibacterial Activity. DNA based nanomechanical devices,

Biomaterial Nanocircuitry-DNA nanostructures for mechanics, computing and DNA based computation.

**UNIT-III**

Nanoparticle synthesis using Plants, Bacteria, Fungi and Virus. Metal nanoparticle synthesis and mechanism – Silver, Gold, Copper and Zinc. Magnetic Nanoparticles - Synthesis and Applications.

**UNIT-IV**

Techniques to construct nanostructures–Scanning probe instruments, nanoscale lithography. Characterisation of nanoparticles: UV -Visible Spectroscopy, FTIR, SEM, TEM, AFM, XRD and DLS.

**UNIT V**

Nanomedicines, Nanodrug administration. Drug delivery systems and its mechanism–Polymer therapeutics, conjugates, micelles and liposomes. Mechanical testing; elasticity; toughness; effect of fabrication on strength. Dendrimers as nanoparticulate drug carriers.

**References**


1. Nanotechnology: A Gentle Introduction to the Next Big Idea by Mark Ratner and Daniel Ratner, Pearson Education Publishers (2002).
2. Nanobiotechnology: Concepts, applications and perspectives by Christ M. Niemayer, Chad A. Mirkin, Wiley VCH publishers (2004).
3. Encyclopedia of Nanoscience and Nanotechnology by H.S. Nalwa (Ed.,), American Scientific Publishers, California (2004).
4. Bionanotechnology: Lessons from Nature by David S. Goodsell, Jhonwiley (2006).
5. Lehninger's Principles of Biochemistry by David L. Nelson and Michael M. Cox, 4th Edition (2006).


**Semester IV**

| Semester | Subject code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| **IV** | **BC1009** | **Advanced Clinical Biochemistry** | **5** | **5** |

**Course Objectives**

- To learn about the specimen: composition, collection and various clinical methods.
- To gain the knowledge about metabolic disorders associated with carbohydrate and lipids.
- To familiarize with the renal disorders linked with protein metabolism and non-protein nitrogenous constituents.
- To understand the functions of liver and its associated disorders.
- To understand the oxidative stress and damage to the macromolecules.

**Course Outcomes**

| S. No. | **Description** | Cognition level (K-level) |
|---|---|---|
| CO1 | Express the various methods in collection and analysis of clinical specimens like blood and urine. | K2 |
| CO2 | Determine the clinical defect of numerous disorders linked to carbohydrate and lipoprotein metabolism. | K3 |
| CO3 | Examine the type of renal disorder based on the concentration of blood substances like urea, creatinine and uric acid. | K1 |

| | | |
|---|---|---|
| CO4 | Categorize the disorder associated with serum enzymes like Acid phosphatase, Streptokinase, Asparaginase, Isocitrate dehydrogenase, Ceruloplasmin, CK and LDH. | K4 |
| CO5 | Evaluate the types of jaundice by the level of serum conjugated and unconjugated bilirubin. | K5 |
| CO6 | Compile the effect of free radicals and role of enzymatic and non-enzymatic antioxidants on the macromolecules. | K6 |

**UNIT-I**

Collection of specimens– Blood collection methods: Vein, Skin and arterial puncture. Collection and analysis of urine samples: Types of urine sample and Physical, Chemical and microscopic examinations, timed urine specimens, preservatives. CSF-Collection, Composition and Analysis. Amniotic fluid-Origin, Collection Composition and analysis.

**UNIT-II**

Diabetes Mellitus- Insulin receptors, renal threshold value, GTT, Hypo and Hyperglycemia, Galactosemia, Fructosuria, Glycated hemoglobin and Glycogen Storage Disease. Disorders of lipid metabolism- functions, metabolism and abnormalities of Lipoproteins, Lipid storage disease- Sudden infant death syndrome (SIDS), Zellweger's Syndrome, Niemann Picks disease, Gaucher's disease, TaySach's disease, Disorders associated with lipoprotein metabolism – Hyper, Hypo and dyslipoproteinemia.

**UNIT-III**

Disorders of protein metabolism-Non-protein nitrogenous constituents in blood-Urea, uric acid and creatinine. Plasma protein abnormalities-deficiency, Agammaglobulinemia, Multiple myeloma, Proteinuria, Glomerulonephritis, Nephrotic syndrome. Haemoglobinopathies-Sickle cell anaemia and Thalassemia. Phenylketonuria, Tyrosinosis, Alkaptonuria, Maple syrup urine disease, Hartnup disease, Homocystinuria and Albinism. Serum enzyme activities in diseases-Acid phosphatase, Streptokinase, Asparaginase, Isocitrate dehydrogenase, Ceruloplasmin, γ-Glutamyl transpeptidase, Creatine kinase and Lactate dehydrogenase.

**UNIT-IV**

Liver function tests, Liver Disorders- Hepatitis types, Non-alcoholic Steatohepatitis, Cirrhosis, Alcoholic liver disease, Hepatic tumor and Biliary tract diseases. Disorders of bilirubin metabolism - Jaundice. Gastric Function Tests. Renal Function Tests and related disorders-Acute and Chronic renal failure, Urinary tract obstruction and analysis of Urinary calculi.

**UNIT-V**

Free radicals in health and disease-Endogenous and exogenous. Oxidative damages to carbohydrate, protein and fat metabolism. Role of enzymatic and non-enzymatic antioxidants. Cancer-Carcinogenic agents, Morphological and metabolic changes in tumors – Ovarian, breast, GIT, colon, and prostate cancers. Tumor markers- AFP, CEA and hCG.

**References**


1. Fundamentals of clinical chemistry by N.W. Teitz, W.B. Saunders Company, 2nd Edition (1994).
2. Clinical biochemistry in diagnosis and treatment by Philip. D. Mayne, ELBS Publication, 6th Edition (1994).
3. Clinical Biochemistry–Metabolic and clinical aspects, William J. Marashall and Stephen K. Bangert, Pearson professional Ltd. (1995).
4. Textbook of Medical Biochemistry by N. Chatterjee, 4th edition, Rana Shinde–Jaypee publication (2000).
5. Biochemistry by Zubay, G.L., W.M.C. Brown publishers. New York (2002).

| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| IV | BC1010 | Biotechnology | 4 | 4 |

**Course Objectives**

- To impart knowledge on basic tools in genetic engineering.
- To provide knowledge on cloning vectors and DNA sequencing.
- To create awareness on gene transfer and its applications.
- To understand basics on Industrial biotechnology.
- To develop sound knowledge on Bio-safety and bio-hazards.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO1** | Perceive a broad knowledge on gene transfer system, restriction enzymes and hybrid vectors in genetic engineering. | K5 |
| **CO2** | Explain the gene cloning technique, gene library, PCR and Blotting Techniques. | K2 |
| **CO3** | Outline the Tissue Culture, protoplast fusion, GM foods and xenografting. | K4 |
| **CO4** | Describe the basic concepts of fermentation and their industrial applications. | K1 |
| **CO5** | Determine the biological weapons, gene drain and tangled genes. | K3 |
| **CO6** | Interpretation of Vaccines with RNA virus and safety of GMOs | K6 |

**UNIT-I**

Basic Principles–Mechanism of natural gene transfer by Agrobacterium, Generation of foreign DNA molecules, Restriction enzymes–Types and target sites, Cutting and joining DNA molecules, linkers, adapters, homopolymers, enzymes used in genetic engineering, cloning vehicles and their properties, natural plasmids, *in vitro* vectors, cosmids and T-DNA based hybrid vectors.

**UNIT-II**

Cloning strategies–Cloning with single strand DNA vectors, cDNA cloning and gene libraries, Recombinant selection and screening methods, Expression of cloned genes, Shuttle vectors, DNA sequencing strategies–Sanger's and Maxam-Gilbert's methods, Applications of PCR and DNA hybridization, Southern, Northern and Western blotting. Chromosome Walking and Jumping, DNA foot printing, DNA finger printing, RFLP, RAPD–Principles, Procedures and Applications.

**UNIT-III**

Techniques of tissue culture–Culturing explants and haploids, Protoplasts fusion, Methods of gene transfer to plants, animals and bacteria-Ca transfection, electroporation, shotgun, transgenic plants, GM foods, and biopesticides, gene knockouts and transgenic animals and xenografting.

**UNIT-IV**

Industrial biotechnology- Fermentation, Fermentor-common features and operation for a conventional bioreactor, classification of fermentation, factors affecting fermentation process, media– synthetic and crude media. Industrially important fermentation products.

**UNIT-V**

Biotechnology–Potential hazards, biological weapons, biosafety of GM foods and GMOs–Substantial equivalence and safety testing, gene drain, the tangled genes. Production

of vaccines in animal cells-traditional and recombinant vaccines -subunit vaccines-Hepatitis B, Corona virus, DNA and RNA vaccines.

**References**


1. Glick R. and J. J. Pasternak. 2002. Molecular Biotechnology (3rd Edition). ASM Press, Washington, USA.
2. Praful. B. Godkar, 2014, Text book of Medical laboratory technology; III Edition, Volume I and II, Bhalani Publishing house.
3. Verma P.S & V.K. Agarwal, 2003, Cytology, Genetics, Evolution and Ecology, S.Chand & Co Ltd., New Delhi.
4. K. G. Ramawat and J. M. Merillon (Eds.), 2010, Biotechnology - secondary metabolites, Oxford & IBH publishing Co. Pvt. Ltd.
5. Basic Biotechnology - Ratledge & Kristianeen, Cambridge University press 2nd ed.
6. Gene cloning - an introduction by TA Brown, Chapman and Hall.
7. Molecular Biotechnology, 2nd ed - Glick & Pasternak, Panima Publications.
8. Gene cloning - an introduction by TA Brown, Chapman and Hall.
9. Molecular Biotechnology, 2nd ed - Glick & Pasternak, Panima Publications.


| Semester | Subject Code | Title of the Course | Hours / Week | Credits |
|---|---|---|---|---|
| **IV** | **BC1011A** | **Elective IV - Plant: Biochemistry and Molecular biology** | **4** | **4** |

**Course Objectives**

- To explain and understand the Biochemistry of photosynthetic system.
- To learn and understand the basics of plant cell and its physiology.
- To create awareness on Plant diseases and their metabolism.
- To impart basic knowledge on plant biotechnology.
- To develop sound knowledge on biochemical events associated with growth regulators and herbicide.

**Course Outcomes**

| S.No. | Description | Cognitive Level (K-level) |
|---|---|---|
| **CO1** | Acquire broad knowledge on Photosynthesis, Cyclic and non-cyclic photophosphorylation and Calvin cycle. | K3 |
| **CO2** | Infer the different types of plant hormones, Symbiotic and Non-symbiotic nitrogen fixation. | K2 |
| **CO3** | Integrate about stress physiology and secondary metabolites | K6 |
| **CO4** | Recall the basic concepts of plant physiology, Biochemistry of seed democracy and phytochromes. | K1 |
| **CO5** | Outline the DNA Polymorphism and plant genetic engineering. | K4 |
| **CO6** | Provide the information on plant vectors, plasmid, biodegradable plastics and fruit ripening. | K5 |

**UNIT-I**

Structure & synthesis of chlorophyll, phycobilins and carotenoids. Photosynthesis: photosystem I & II, Light absorption, Hill reaction, Red drop & Emerson's enhancement effect. Cyclic and non-cyclic photophosphorylation, C2, Calvin cycle, C4 & CAM. Photosynthesis factors and regulation.

**UNIT-II**

Nitrogen metabolism and plant hormones−Nitrogen cycle Symbiotic and Non-symbiotic nitrogen fixation. Assimilation of ammonium, carbon- nitrogen ratio, Uride metabolism, Nitrate metabolism, genetics of nitrogen fixation, genetic manipulation of nif genes,

Biosynthesis, Mode of action, transport, distribution and physiological effects of Auxin, Gibberrilin, Cytokinin, ABA and Ethylene.

**UNIT-III**

Plant disease and Secondary metabolites. Biochemistry of plant disease, defence mechanism of plants, biosynthesis, distribution and biological functions of industrially important secondary metabolites. Principles of plant disease control.

**UNIT-IV**

Plant physiology. Water relations of plant, Mechanism of water absorption. Aquaporin Symplast−Apoplast concept. Ascent of sap, Transpiration and Stomatal mechanism. Source and sink relationship, Translocation of Inorganic and Organic substances. Biochemistry of seed dormancy, seed germination, fruit ripening and senescence. Phytochromes− Properties, Photochemicals, transformation, Mode of action and physiological effects.

**UNIT-V**

DNA polymorphism−Importance of RFLP and RAPD in plant breeding management. Aspects of plant genetic engineering. Tacking, Mapping and Cloning of plant genes and Selectable markers. Reporter genes and promoters used in Plant vectors. Ti plasmids and Crown gall tumor, Genetic engineering of plant for disease resistance, Cytoplasmic Male Sterility, Edible oil, Biodegradable plastics. Delay of fruit ripening.

**Reference:**


1. Ajoy Paul. 2007. Textbook of Cell and Molecular Biology. Books and Allied, Kolkata
2. De Robertis and De Robertis. 1990. Cell and Molecular Biology. Saunders, Philadelphia.
3. Gerald Karp. 2008. Cell and Molecular Biology. (Ed: 5). John Wiley and Sons, New York.
4. Handbook of medicinal plants by Prajapathi, Purohit and Sharma kumar.
5. Plant Biochemistry by P.M. Dey and J.B. Harborne.
6. David Freifelder, 2008. Molecular Biology. (Ed: 2). Narosa Publications. New Delhi.
7. Modern Plant Physiology by R.K. Sinha, Narosa Publishing House (2004).
8. Plant Physiology by S.N. Pandey and B.K. Sinha, 3rd Edition, Vikas publishing House Pvt., Ltd. (2009).
9. Lewin's. 2017. GENES XII. 12th edition. Jones and Bartlett Publishers, Inc; Burlington, Massachusetts, USA.
10. Introduction to plant physiology, William. G.Hopkins, Norman. P.A. Hunger, 3rd Edition.
11. Biochemistry and Molecular Biology of plants by Buchannan, Grvissem and Jones.


| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **IV** | **BC1011B** | **Elective IV Herbal Technology** | **4** | **4** |

**Course Objectives**

- To learn about the preparation of drugs.
- To know about Herbal remedies for human ailments.
- To evaluate the propagation of medicinal plants.
- To study the Nutritive and medicinal value of fruits.
- To know the applications of Herbal foods.

**Course Outcomes**

| S.No. | CO-Statement | Cognitive Level |
|---|---|---|

| | | (K-level) |
|---|---|---|
| **CO-1** | Discuss the importance of Nutritive and medicinal value of fruits | **K2** |
| **CO-2** | Acquire knowledge of Collection of wild herbs and its formulations | **K3** |
| **CO-3** | Perceive the knowledge of Systems of Indian Medicines–Siddha, Unani, Ayurveda and Homeopathy. | **K5** |
| **CO-4** | Evaluate the Drugs for common disorders and its mechanism of action. | **K1** |
| **CO-5** | Analyse the applications of Herbal foods− Food processing and packaging. | **K4** |
| **CO-6** | Integrate the biotechnological principles in propagation of medicinal plants. | **K6** |

**UNIT-I**

Pharmacognosy- Definition, History and Scope. Systems of Indian Medicines–Siddha, Unani, Ayurveda and Homeopathy. Crude drugs – Definition, Classification - Pharmacological and chemical. Chemistry of drugs and its evaluation. Preparation of crude and commercial drugs.

**UNIT–II**

Herbal preparation–Collection of wild herbs–capsules–compresses- Hydrotherapy, Herbal bath, Herbal oils an tincture. Preparation of herbal syrups, herbal oils and herbal salves. Extraction of phytochemicals−Alkaloids, Volatile oils, Resin and Tannins. Herbal dye and perfumes.

**UNIT-III**

Traditional knowledge and utility of some medicinal plants−*Ocimum sanctum, Solanum trilobatum, Cassia auriculata* and *Aloe vera*. Nutritive and medicinal value of some fruits (*Psidium guajava, Manilkara zapota, Citrus sinensis, Citrus limon and Punica granatum*) and Green Vegetables−*Moringa, Solanum nigrum* and *Brassica oleracea*.

**UNIT-IV**

Drugs for urogenital disorders- roots of *Withania somnifera*, memory Stimulants – *Centella asiatica*, Kidney stones – *Musa paradisica*, Anticancer drugs – *Catharanthus roseus, Anti-inflammatory drugs – Cardiospermum* and *antipsychoactive drugs - Salvia divinorum* – basic mechanism of action.

**UNIT-V**

Propagation of Medicinal plants−Micro and macro propagation, Conservation of rare medicinal plants. Role of biotechnology in medicinal plant banks−Cultivation of medicinal and aromatic plants. Herbal foods− Food processing and packaging.

***References***


1. Indian Materia Medica by Nadkarni Bombay: Popular Prakashan (1976).
2. Glimpses of Indian Ethnobotany by Hemadri, K., Raj, P.V., Rao, S.S. and Rajeswarasarma, C.R., Oxford and IBH, New Delhi (1980).
3. A text book of Pharmacognosy by Shah, S.C. and Qudary, Elsevier India (1990).
4. An Introduction to Medical Botany and Pharmacognosy by Kumar N.C., CBS publishers and Distributors (1993).
5. Pharmacognosy by George Edward Trease and W.C. Evans, 12th Edition, English Language Books Society, (2009).
6. An introduction to medical botany and Pharmacognocy. Kumar . N.C. (1993)

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| IV | BC1011C | Elective IV MEDICAL DIAGNOSTIC TECHNOLOGY | 4 | 4 |

**Course Objectives**

- To gain knowledge about good laboratory practices.
- To study the collection and preservation of biological specimens.
- To evaluate the knowledge of Hematological parameters.
- To study about the Microscopic and Macroscopic Examination of Urine and Feces.
- To learn culturing of organisms using microbiological techniques.

**Course Outcomes**

| S.No. | CO-Statement | Cognitive Level (K-level) |
|---|---|---|
| CO-1 | Understand the knowledge about good laboratory practices. | K2 |
| CO-2 | Acquire a broad knowledge of collection and preservation of biological specimens. | K3 |
| CO-3 | Perceive a broad knowledge of haematological parameters. | K5 |
| CO-4 | Observe the microscopic and macroscopic examination of urine. | K1 |
| CO-5 | Analyse the microscopic and macroscopic examination of faeces. | K4 |
| CO-6 | Integrating the safety procedures in microbial culture techniques. | K6 |

**Unit- I:** Specimens: Collection and preservation of Blood, Urine, Faeces, Sputum, Semen, Throat swab and CSF. Good laboratory practices.

**Unit-II:** Blood: Blood pressure (BP), Clotting time, Bleeding time, Hemoglobin Estimation, RBC count and WBC count, Differential count, Erythrocyte Sedimentation Rate (ESR), Hematocrit value (Packed cell volume) and platelet counting.

**Unit-III:** Urine: Composition, Preservation, Microscopic and Macroscopic Examination (Physical and Chemical examination)

**Unit-IV:** Faeces: Composition, Macroscopic and Microscopic Examination, Chemical examination – occult blood and steatorrhoea.

**Unit-V:** Culturing of organism from various specimens (Pus, Urine, Blood, Sputum, Throat Swab), Antibiotic sensitivity test and Gram staining (acid fast, base & neutral). Safety procedures in microbiological techniques.

**References**

1. D.Sahu (1997), Critical approach to clinical medicine, Vikas Publishing, Noida.
2. Devlin, T.M. (2002), Textbook of Biochemistry with Clinical correlations, 5th edition, John Wiley & Sons Inc, Publications.

3. P.D.Mayne (1994), Clinical chemistry in diagnosis and treatment. A Hodder Arnold Publication; 6Rev Ed edition.
4. W.J. Marshall and S.K. Bangeit, (1995), Clinical biochemistry - Metabolic concepts and clinical aspects, Churchill Livingstone.
5. K.V. Krishna Das, Text Book of Medicine, (1996), Jaypee publication, New Delhi.
6. A.C. Guyton and J.E. Hall, (2000), Text Book of Medical PhysiologyHarcourt Asia.
7. Guyton (1996) Human Physiology and Mechanisms of Disease. Saunders Publications; 6th edition.
8. N.Chatterjee and Rana Shinde (2012) Textbook of Medical Biochemistry - eighth edition, Jaypee publication, New Delhi.
9. K. Sampath (1999), Hospital and Clinical Pharmacy, Vikas Publishing. Noida.

## CORE PRACTICAL–IV

**SEMESTER–III & IV** **5 Hrs/Week (5 Credits)**

### Lab Course IV: Biochemical, Immunological and Molecular Biology Techniques

**A. BIOCHEMICAL ANALYSIS OF BLOOD**

1. Estimation of Blood Glucose by O-Toluidine method.
2. Estimation of Serum Proteins by Bradford's Method.
3. Estimation of Plasma Fibrinogen.
4. Estimation of A/G ratio in Serum.
5. Estimation of Blood Urea by DAM method.
6. Estimation of Serum Uric acid by Phosphotungstate method.
7. Estimation of Serum Creatinine by Alkaline picrate method.
8. Estimation of Serum Triglycerides.
9. Estimation of Serum Cholesterol by Zlatkis, Zak and Boyle method.
10. Estimation of Serum Phospholipids.
11. Estimation of Serum Calcium.
12. Estimation of Serum Bilirubin by Evelyn Malloy method.

**B. IMMUNOLOGICAL AND MOLECULAR BIOLOGY TECHNIQUES**

1. Grouping of Blood and Rh typing.
2. Determination of Pregnancy.
3. Widal Test.
4. Agarose gel Electrophoresis.
5. Immuno diffusion/Precipitation Methods.
6. ELISA
7. PCR technique

**SEMESTER–III & IV** **5 Hrs/Week (5 Credits)**

## CORE PRACTICAL-V

### Lab Course V: HAEMATOLOGICAL METHODS

**A. HAEMATOLOGICAL METHODS**

1. Collection and Storage of Blood.
2. Total RBC count.
3. Total WBC count.
4. Total Platelet count.
5. Differential WBC count.

6. Absolute Eosinophil count.
7. Determination of Heamoglobin content.
8. Determination of clotting time.
9. Determination of ESR.
10. Pathological examination of Blood film.

**B. URINE ANALYSIS**

1. Qualitative analysis of Normal and Pathological constituents in urine.
2. Microscopic analysis of Urine.
3. Estimation of Titrable acidity.
4. Estimate of True acidity.
5. Estimation of Protein by Biuret method.
6. Estimation of Urea.
7. Estimation of Uric acid.
8. Estimation of Calcium.