

**ST. JOSEPH'S COLLEGE OF ARTS & SCIENCE**  
**(AUTONOMOUS)**  
**CUDDALORE-1**



**PG & RESEARCH DEPARTMENT OF BIOCHEMISTRY**  
**UG SYLLABUS**  
**2016-2017**

**B.Sc. BIOCHEMISTRY**  
**CURRICULUM DESIGN TEMPLATE FROM 2016**

| Sem        | Subject code | Part | Subject Title                                   | Hrs       | Cr        | Exam. Hrs |
|------------|--------------|------|---|-----------|-----------|-----------|
| <b>I</b>   | LE101T       | I    | English- I                                      | 4         | 3         | 3         |
|            | LT101T       | II   | Language - I                                    | 4         | 3         | 3         |
|            | BC101S       | III  | Main Paper – I(Biomolecules-1)                  | 4         | 3         | 3         |
|            | BC102S       | III  | Main Paper – II(Cell Biology)                   | 4         | 3         | 3         |
|            | BCP201S      | III  | Main Practical – I *                            | 3         |           |           |
|            | ACH101T      | III  | Allied 1 (Chemistry)                            | 5         | 3         | 3         |
|            | ACHP101      | III  | Allied 1 (Chemistry Practical)                  | 3         | 2         | 3         |
|            | VE101T       | IV   | Value education                                 | 3         | 2         | 3         |
|            |              |      | <b>Total</b>                                    | <b>30</b> | <b>19</b> |           |
| <b>II</b>  | LE202T       | I    | English-II                                      | 4         | 3         | 3         |
|            | LT202T       | II   | Language-II                                     | 4         | 3         | 3         |
|            | BC203S       | III  | Main Paper – III (Biomolecules-II)              | 4         | 3         | 3         |
|            | BC204S       | III  | Main Paper – IV<br>(Nutritional Biochemistry)   | 4         | 3         | 3         |
|            | BCP201S      | III  | Main Practical – I *                            | 3         | 4         | 6         |
|            | ACH202T      | III  | Allied 2 (Analytical Chemistry)                 | 5         | 3         | 3         |
|            | ACHP202      | III  | Allied 2 Analytical chemistry Practical         | 3         | 2         | 3         |
|            | EPD201T      | IV   | Personality development                         | 3         | 2         | 3         |
|            |              |      | <b>Total</b>                                    | <b>30</b> | <b>23</b> |           |
| <b>III</b> | LE303T       | I    | English III                                     | 4         | 3         | 3         |
|            | LT303T       | II   | Language III                                    | 4         | 3         | 3         |
|            | BC303S       | III  | Main Paper – V(Enzymes)                         | 4         | 4         | 3         |
|            | BC304S       | III  | Main Paper – VI(Analytical<br>Biochemistry-I)   | 4         | 4         | 3         |
|            | BCP402S      | III  | Main Practical – II *                           | 3         |           | -         |
|            | AMBC302      | IV   | Allied 3 Principles of Microbiology             | 5         | 3         | 3         |
|            | AMBCP301     | III  | Allied 3 Microbiology Practical                 | 3         | 2         | 3         |
|            | AOFA301      | IV   | Skill - First aid                               | 3         | 4         | 3         |
|            |              |      | <b>Total</b>                                    | <b>30</b> | <b>23</b> |           |
| <b>IV</b>  | LE404T       | I    | English-IV                                      | 4         | 3         | 3         |
|            | LT404T       | II   | Language-IV                                     | 4         | 3         | 3         |
|            | BC405S       | III  | Main Paper – III(Intermediary<br>Metabolism)    | 4         | 4         | 3         |
|            | BC406S       | III  | Main Paper – IV(Analytical<br>Biochemistry -II) | 4         | 4         | 3         |
|            | BCP402S      | III  | Main Practical – II *                           | 3         | 4         | 6         |
|            | AZBC401T     | III  | Allied 4 Advanced Zoology                       | 5         | 3         | 3         |
|            | AZBP401      | III  | Allied 4 Advanced Zoology Practical             | 3         | 2         | 3         |
|            | EVS401S      | IV   | EVS   | 3         | 2         | 3         |
|            |              |      | <b>Total</b>                                    | <b>30</b> | <b>25</b> |           |

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| <b>V</b>  | BC507S  | III |                  | Main Paper - IX(Molecular Biology)                     | 6         | 5          | 3 |
|           | BC508S  | III |                  | Main Paper - X(Immunology)                             | 6         | 5          | 3 |
|           | EBC509A | III | Elective paper-1 | Food Technology  | 5         | 5          | 3 |
|           | EBC509B |     |                  | Environmental Toxicology & Herbal Medicine             |           |            |   |
|           | EBC510A | III | Elective papers  | Plant Biochemistry                                     | 5         | 5          | 3 |
|           | EBC510B |     |                  | Pharmaceutical Biochemistry and Bioinformatics         |           |            |   |
|           | BCP603S | III |                  | Main Practical - III *1                                | 4         |            | - |
|           | BCP604S | III |                  | Main Practical - IV *1                                 | 4         |            | - |
|           |         |     |                  | <b>Total</b>   | <b>30</b> | <b>20</b>  |   |
| <b>VI</b> | BC611S  | III |                  | Main Paper - XII(Medical Biochemistry)                 | 6         | 5          | 3 |
|           | BC612S  | III |                  | Main Paper - XIII(Biotechnology & Genetic Engineering) | 6         | 5          | 3 |
|           | EBC613A | III | Elective papers  | Clinical Endocrinology                                 | 5         | 5          | 3 |
|           | EBC613B |     |                  | Medical Physiology                                     |           |            |   |
|           | EBC614A | III | Elective papers  | Biostatistics & Clinical research                      | 5         | 5          | 3 |
|           | EBC614B |     |                  | Medical Laboratory Technology                          |           |            |   |
|           | BCP603S | III |                  | Main Practical - III *1                                | 4         | 4          | 6 |
|           | BCP604S | III |                  | Main Practical - IV *1                                 | 4         | 4          | 6 |
|           |         |     | <b>Total</b>     | <b>30</b>  | <b>28</b> |            |   |
|           | EU601   | V   |                  | Extension activities                                   |           | 2          |   |
|           |         |     |                  | <b>Total credits</b>                                   |           | <b>140</b> |   |

\*End of the Academic Year

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| <b>I B.Sc<br/>(Biochem)</b> | <b>BIOMOLECULES-I(60 hrs)<br/>For the students admitted from<br/>the year 2015</b> | <b>BC101S</b>   |
| <b>SEMESTER-I</b>           |  | <b>HRS/WK-4</b> |
| <b>CORE-1</b>               |  | <b>CREDIT-3</b> |

**OBJECTIVE**

To understand the importance of biomolecules by studying the structure and its functions.

**UNIT I SCOPE AND CHEMICAL NATURE [10 hrs]**

Scope of Biochemistry, Importance of Biomolecules. Chemical Bonding- nature and types- ionic bond (or) polar bond, covalent (or) non-polar bonds, co-ordinate bond and non-covalent bonds (Hydrogen, hydrophobic, Vander walls interactions). Isomerism - structural isomerism and stereoisomerism.

**UNIT II CARBOHYDRATES I [15 hrs]**

Introduction and definition of carbohydrates, classification – monosaccharides, oligosaccharides and polysaccharides; occurrence, structure and functions of monosaccharides (glucose and fructose). General properties with reference to glucose, anomers, epimers and mutarotation .Ring and straight chain structure of glucose (Haworth projection formula). Kiliani synthesis. Inversion of sucrose.

**UNIT III CARBOHYADRATES II [10 hrs]**

Structure, occurrence, properties and biological importance of disaccharides (sucrose, lactose, maltose). Structure, occurrence, properties and biological importance of polysaccharides: Storage polysaccharides (starch, glycogen, inulin), Structural polysaccharides (cellulose, chitin, pectin), Heteropolysaccharides (hyaluronic acid, heparin).

**UNIT IV NUCLEIC ACIDS****[10 hrs]**

Nucleic acids – Bases ,Nucleosides and Nucleotides, Phosphodiester linkage, DNA and RNA, Structure –double helical structure of DNA, Properties of DNA – Denaturation, Renaturation, T<sub>m</sub> and Hyperchromicity, Types of DNA, Structure of RNA- tRNA, mRNA and rRNA.

**UNIT V HEMESYNTHESIS****[15 hrs]**

Porphyrin nucleus and its classification. Heme synthesis. Bile pigments- chemical nature and physiological significance. Biological importance of Heterocyclic compounds- Thiazole, Indole, Pyridine, Pteridine, Pyrrole and Imidazole.

**TEXTBOOKS:**

1. Renuka Harikrishnan ,1995, “ Biomolecules and Enzymes” (second edition), Madurai, Indrajai Pathipagam
2. J.L.Jain, Sanjay Jain and Nitin Jain, 1997, “Fundamentals of Biochemistry”(6<sup>th</sup> Edition) , New Delhi, S.Chand& Company Ltd

**REFERENCES:**

1. Power & Chatwal “Biochemistry”, 4<sup>th</sup>edition , Himalaya Publishing House
2. Cambell &Farrell, 2007, “Biochemistry” 5<sup>th</sup> edition, Delhi, Baba Borkhanath printers
3. T.N.Pattabiraman, 1993“Principles of Biochemistry” 5<sup>th</sup> edition, Bangalore,  
Gajanana Book Publishers and Distributors
4. Dr.A.C.Deb, 1983,“Fundamentals of Biochemistry” (8<sup>th</sup> edition), Kolkata, New Central Book Agency
5. Lehninger, Nelson And Cox ,1982, “ Principles of Biochemistry”, (4th ed)UK, Macmillan Worth Publishers.

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| <b>I B.Sc<br/>(Biochem)</b> | <b>CELL BIOLOGY (60 hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC102S</b>   |
| <b>SEMESTER-I</b>           |   | <b>HRS/WK-4</b> |
| <b>CORE-2</b>               |   | <b>CREDIT-3</b> |

**OBJECTIVE**

To study the structural and functional organization of cell and its organelles

**UNIT I CELL AND TRANSPORT [15 hrs]**

Introduction: Classification of cell - Prokaryotic and eukaryotic cell. Cell membrane: structure and functions of Fluid Mosaic Model. Membrane proteins: Carbohydrate, lipids, proteins and their function in FMM. Membrane transport – Types of transport, passive and active transport, sodium potassium pump,  $\text{Ca}^{2+}$  and  $\text{ATP}_{\text{ase}}$  pumps, symport and antiport, endocytosis and exocytosis, liposomes.

**UNIT II CELL ORGANELLE -I [10 hrs]**

Endoplasmic reticulum: occurrence, morphology and function. Enzymes of the ER membrane. Lysosomes: structure and chemical composition. Ribosomes: structure and functions.

**UNIT III CELL ORGANELLE -II [10 hrs]**

Mitochondria: morphology and function. Golgi complex : structure & function. Microbodies: structure, morphology and function, peroxisomes and glyoxysomes

**UNIT IV CELL DIVISION AND CELL CYCLE [15 hrs]**

Nucleus – structure composition and biochemical function, chromosome structure – structure and organisation of chromatin, polytene and lambrush chromosome with example. Cell cycles – Phases of cell cycle, mitotic and meiotic cell cycle

**UNIT-V MICROTUBULES AND MICROFILAMENTS [10 hrs]**

Cytoskeleton - components and biological functions. Microtubules, Microfilaments and IF proteins: Distribution, chemical composition and function.

**TEXTBOOKS:**

1. Verma. P.S and Agarwal .P.K,1999, “Cell biology, Genetics, Molecular biology, Evolution and Ecology”,( 24th edition) New Delhi, S.Chand & Company Ltd
2. De Robertis EDP and De Robertis EMF, 1987, “Cell and Molecular Biology”, (8<sup>th</sup> edition ),New Delhi, B.I.Waverly Pvt Ltd

**REFERENCES:**

1. Sheela A. Stanly ,2008,“Cell biology for biotechnologist”, (I Edition), Narosa Publishing House Pvt-Ltd
2. Prakash S.Lohar, 2007, “Cell and Molecular biology” (I edition),Chennai, MJP publishers
3. Darnell J, Lodish H, Baltimore D,1986, “Molecular cell biology”, England, WH Freeman.
4. Cell biology –Gerald karp (7<sup>th</sup> edition) –International student version, wiley publications

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| <b>I B.Sc<br/>(Biochem)</b> | <b>BIOMOLECULES-II(60 hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC203S</b>   |
| <b>SEMESTER-<br/>II</b>     |   | <b>HRS/WK-4</b> |
| <b>CORE-3</b>               |   | <b>CREDIT-3</b> |

**OBJECTIVES :**

To study the basic structure and functions of complex biomolecules.

**UNIT I LIPIDS****[15 hrs]**

Introduction , definition and classification of lipids, Physical properties ,classification of fatty acids –saturated, unsaturated and essential fatty acids, properties of fatty acids{Iodine number, Acid number, RM number, Saponification number and Rancidity}. Structure and function of commonly occurring phospholipids (esp.Lecithin, cephalin, phosphatidyl inositol and serine}Sphingomyelin, plasmalogen, sterols{cholesterol}. Glycolipids- cerebrosides and gangliosides.Steroids and carotinoids.

**UNIT II AMINO ACIDS****[10 hrs]**

Definition and classification of Amino acids based on structure, metabolism & Polarity .Essential & Non essential amino acids, Non protein amino acids. General properties of amino acids.Titration curve of amino acids.

**UNIT III PROTEIN INTRODUCTION****[10 hrs]**

Protein- Definition, Peptide bond, Classification based on size and shape, solubility, composition & functions. General reactions of proteins (Reactions of both NH<sub>2</sub> group & COOH group)



**UNIT IV PROTEIN STRUCTURE****[15 hrs]**

Structure of proteins- primary, secondary, tertiary & quaternary. Ramachandran plot and forces stabilizing the structure of proteins, Determination of amino acid sequence, N -terminal determination- Edman's and Dansylchloride method. C- terminal- hydrazinolysis and enzymatic method, solid phase polypeptide synthesis.

**UNITV PROTEIN BIOLOGICAL IMPORTANCE [10 hrs]**

Structure and functions of biologically important peptides- Glutathione, vasopressin & Insulin. Biologically important proteins- structure and functions of Globular proteins (Haemoglobin, Myoglobin),Fibrous protein (Keratins, collagen) and Lipoproteins.

**TEXTBOOKS:**

1. Renuka Harikrishnan ,1995, “ Biomolecules and Enzymes” (second edition), madurai, Indraja Pathipagam
2. J.L.Jain, Sanjay Jain and Nitin Jain,1997, “Fundamentals of Biochemistry”(6<sup>th</sup> Edition) ,New Delhi, S.Chand & Company Ltd

**REFERENCES:**

1. Power & Chatwal “Biochemistry” 4th edition , Himalaya Publishing House
2. Cambell &Farrell, 2007, “Biochemistry” 5th edition, Delhi ,Baba Borkhanath printers
3. Dr.A.C.Deb ,1983,“Fundamentals of Biochemistry” (8th edition), Kolkata,New Central Book Agency
4. Lehninger,Nelson And Cox ,1982, “ Principles Of Biochemistry”, (4TH Ed)UK, Macmillan Worth Publishers.
5. Donald Voet and Judith Voet,”Biochemistry”,2nd edition,John Wiley & Sons,Inc,NY

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| <b>I B.Sc<br/>(Biochem)</b> | <b>NUTRITIONAL BIOCHEMISTRY<br/>(60 hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC204S</b>   |
| <b>SEMESTER-<br/>II</b>     |   | <b>HRS/WK-4</b> |
| <b>CORE-4</b>               |   | <b>CREDIT-3</b> |

**OBJECTIVE**

To study the nutritional aspects of various food stuffs and the disorders associated with it

**UNIT I FOOD NUTRITION [15 hrs]**

Introduction and definition of food and nutrition, Basic food groups – Energy yielding, body building and protective foods. Basic concepts of energy expenditure, Unit of energy, measurement of food stuffs by bomb calorimeter, Calorific value of proteins, carbohydrates and lipids, RQ of foods, Basic metabolic rate (BMR), its measurements and influencing factors, SDA of foods.

**UNIT II BIOLOGICAL VALUE OF PROTEIN [10 hrs]**

Biological value of proteins, evaluation of proteins by nitrogen balance method – DC, BV, NPU and NAP, sparing action of carbohydrates, single cell proteins (SCPs) (e.g., spirulina only). PCM: Kwashiorkor and Marasmus- preventive and curative measures.

**UNIT III VITAMINS [10 hrs]**

Vitamins –classification- sources, RDA, deficiency and functions of fat soluble vitamins (A,D,E,K) and water soluble vitamins (B – complex – B<sub>1</sub>, B<sub>2</sub>, B<sub>5</sub>, B<sub>6</sub>, B<sub>9</sub>, B<sub>12</sub> and vitamin – C.)

**UNIT IV MINERALS****[10 hrs]**

Minerals – physiological role and nutritional significance of principal and essential trace elements (sodium, potassium, calcium, magnesium, phosphorous, copper, zinc, iron, iodine, fluorine, selenium, Molybdenum).

**UNIT V NUTRITIONAL REQUIREMENTS****[15 hrs]**

Composition of balanced diet. RDA. Nutritional requirements for infants, children, adolescents, adult (male and female), pregnant and lactating women and old age.

**TEXTBOOKS:**

1. Dr. M. Swaminathan, 1987, "Food and Nutrition Vol I&II ", Second edition, Bangalore, Bappco Publishers.
2. M.N Chatterjea and Rana Shinde," Text book of Medical Biochemistry", 4<sup>th</sup> edition, Jaypee Publishers, New Delhi

**REFERENCES:**

1. Patricia Trueman, 2007, "Nutritional Biochemistry" (I edition), Chennai, MJ publishers
2. Darnell J, Lodish H, Baltimore D, 1986, "Molecular Cell Biology", England, WH Freeman publishers.
3. William's Basic Nutrition and Diet Therapy Williams (14<sup>th</sup> edition), Staci Nix.
4. U. Sathyanarayana and U.Chakrapani ,"Biochemistry", Books And Allied Publishers.
5. Dr.A.C.Deb ,1983,"Fundamentals of Biochemistry" (8th edition), Kolkata, New Central Book Agency

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| <b>II B.Sc<br/>(Biochem)</b> | <b>ENZYMES<br/>(60hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC303S</b>   |
| <b>SEMESTER-<br/>III</b>     |   | <b>HRS/WK-4</b> |
| <b>CORE-3</b>                |   | <b>CREDIT-4</b> |

**OBJECTIVE:**

To understand the structure, classification and mechanism of enzyme action.

**UNIT I ENZYMES-CLASSIFICATION & MECHANISM OF ACTION [15 hrs]**

Introduction of Enzymes-Classification-nomenclature-chemical nature and general characterization, factors affecting enzyme activity, Active site determination- trapping ES complex, use of substrate analogue. Mechanism of enzyme action – Lock and key, induced fit theory. Coenzymes and Cofactor, units of enzyme activity, Monomeric and oligomeric enzymes.

**UNIT II ENZYME INHIBITION [10 hrs]**

Michaelis-Menten equation - determination of  $K_m$  and  $V_{max}$  and its significance. Line weaver Burk plot & Eadie-Hofstee plot. Enzyme inhibition – Competitive, Non-competitive and Uncompetitive inhibition (no derivation), reversible & irreversible inhibition, mixed - partial inhibition (definition) – suicidal inhibition

**UNIT III ALLOSTERIC INHIBITION [15 hrs]**

Allosterism, nature of allosteric enzymes, sigmoidal curve, mode of action (sequential & symmetry model), Allosteric inhibition and its regulation Eg. Aspartate transcarbamylase and PFK. Mechanism of enzyme action without cofactors eg. Chymotrypsin

**UNIT IV CHEMICAL NATURE OF ENZYMES [10 hrs]**

Chemical nature of enzyme catalysis: Acid base catalysis, covalent catalysis, metal ion catalysis, proximity, orientation effects. catalysis reaction, Co-enzymes –  $NAD^+$ ,  $NADP^+$ , FMN & FAD, COA, TPP.

**UNITV ISOLATION & APPLICATIONS OF ENZYMES[10 hrs]**

Purification of enzymes, immobilization of enzymes- methods: adsorption, entrapping, ionic bonding, cross -linking and encapsulation. Applications of enzymes - Therapeutic, analytical and industrial use.

**TEXT BOOKS:**

1. Trevor Palmer, (2004). Enzymes. 5th edition, Affiliated East – West press (P) Ltd. New Delhi
2. Renuka Harikrishnan ,1995, “ Biomolecules and Enzymes” (second edition), Madurai, Indrajaya Pathipagam
3. Dixon, Malcolm; Webb, Edwin Clifford, Enzymes: Third Edition, Published by Longman, USA, 1979.

**REFERENCES:**

1. Bery J.M., Tymoezko J.L. and Stryer L. (2008) Biochemistry, 5<sup>th</sup> Edition, W.H. Freeman and Company, New York.
2. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, 6<sup>th</sup> edition, 2012
3. Victor W. Rodwell, Harpers Illustrated Biochemistry 30<sup>th</sup> Edition Paper back– Import, 1 Jan 2015.
4. Nicholas C.Price. Fundamentals of enzymology –14<sup>th</sup> edition 1989 by Oxford University press.
5. Dixon, M. and Webb, J.F., 1979, Enzymes, Longman Publishing, London.
6. Price and Stevens, 1999, Fundamentals of Enzymology, Oxford University Press, UK.
7. Jain,J.L& Jain,(2005) Fundamentals of Biochemistry. Sixth Edition, S.Chand & Company, New Delhi.

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| <b>II B.Sc<br/>(Biochem)</b> | <b>ANALYTICAL BIOCHEMISTRY- I<br/>(60 hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC304S</b>        |
| <b>SEMESTER-<br/>III</b>     |   | <b>HRS/WK-<br/>4</b> |
| <b>CORE-4</b>                |   | <b>CREDIT-4</b>      |

**OBJECTIVE**

To impart knowledge about the principle and applications of various biochemical techniques

**UNIT I PHYSICAL PROPERTIES OF BIOMOLECULES [10 hrs]**

Units of measurements. Colloids - properties of colloids, osmosis and viscosity and its significance in biology, surface tension, factors affecting surface tension.

**UNIT-II ELECTRO CHEMICAL TECHNIQUES [10 hrs]**

Electro chemical techniques : Principles of electro chemical techniques pH, pOH, buffer, buffer capacity, Henderson-Hasselbalch equation, buffers in body fluids, Red blood cells and tissues, Measurement of pH using indicator – Glass electrode, Oxygen electrode – Principle and application of Clark electrode.

**UNIT III ELECTROMAGNETIC RADIATION [15 hrs]**

Electromagnetic radiation: Basic Principles of electromagnetic radiation. Energy, wavelength, wave number and frequency, absorption and emission spectra, Beer-Lambert Law, light absorption and its transmittance. UV and Visible Spectrophotometry – Principles, instrumentation and applications with examples, Infrared – principle and application of spectrophotometry.

**UNIT IV SPECTROSCOPY [15 hrs]**

Fluorescence and Phosphorescence. Spectrofluorimetry techniques- Principle, instrumentation and applications in Vitamin assays (Riboflavin and Thiamine), Flame photometry – Principle, instrumentation and applications in trace elements ( $\text{Na}^+$ ,  $\text{K}^+$  analysis), Principle and instrumentation of Atomic absorption spectrophotometer with one example.

**UNIT V CENTRIFUGATION****[10 hrs]**

Centrifugation technique: Basic principles - types of centrifugation, rotors, Sedimentation rate, Svedberg unit. Preparative centrifugation: Differential, Density gradient. Analytical ultracentrifugation techniques- Determination of molecular weight of proteins.

**TEXTBOOKS:**

1. Keith Wilson, and John Walker,(2010). Principles and Techniques of Practical Biochemistry. 7th edition, Cambridge University Press. UK.
2. Avinash Upadhyaye, and Nirmalendhe Nath, (2002). Biophysical Chemistry Principles and Techniques. 3rd edition, Himalaya Publishers, New Delhi.

**REFERENCES:**

1. Shawney, Randhir Singh, Narasa Pub, N. Introduction to Practical Biochemistry –Delhi.
2. Subramanian, M.A. (2005). Biophysics : Principles and Techniques. MJP Publishers, Chennai.
3. Pingoud, A., Urbanke, Claus, Hoggett, Jim, Jeltsch, Albert. Biochemical methods. Wiley
4. Rodney F. Boyer. 2011. Biochemistry Laboratory: Modern Theory and Techniques (2nd Edition)

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| <b>II B.Sc<br/>(Biochem)</b> | <b>INTERMEDIARY METABOLISM<br/>(60 hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC405S</b>        |
| <b>SEMESTER-<br/>IV</b>      |  | <b>HRS/WK-<br/>4</b> |
| <b>CORE-5</b>                |  | <b>CREDIT-<br/>4</b> |

## **OBJECTIVES**

To understand the pathways of various biomolecules and their energetics

### **UNIT I CARBOHYDRATE METABOLISM [15 hrs]**

Glycolysis – aerobic and anaerobic, energetics, Pyruvate dehydrogenase complex, oxidation of pyruvate, citric acid cycle (energetics included). Glycogenesis and glycogenolysis (key enzymes and regulation of these metabolic pathways are included). Pentose phosphate pathway and Gluconeogenesis.

### **UNIT II BIOSYNTHESIS OF FATTY ACIDS [15 hrs]**

Biosynthesis of fatty acids -saturated and unsaturated, Fatty acid synthase complex, Biosynthesis of cholesterol (regulation included), Biosynthesis of triglycerides and phospholipids (lecithin and cephalin only). Degradation of fatty acids, oxidation of fatty acids – alpha, beta, and omega oxidation.

### **UNIT III FATE OF DIETARY PROTEINS [10 hrs]**

Introduction – fate of dietary proteins – Glucogenic and Ketogenic amino acids, catabolism of amino acids – Transamination , oxidative and non-oxidative deamination, Decarboxylation – urea cycle .

### **UNIT IV BIOSYNTHESIS OF NUCLEOTIDES [10 hrs]**

Biosynthesis of purine and pyrimidine – de novo and salvage pathway. Degradation of purine and pyrimidine nucleotides. Biosynthesis of nucleotide coenzymes – NAD and FAD. Conversion of ribonucleotides to deoxyribonucleotides.



**UNIT V      ELECTRON TRANSPORT CHAIN      [10 hrs]**

The Electron transport chain - components and reactions of ETC. Oxidative phosphorylation – chemiosmotic theory, P/O ratio, uncouplers of oxidative phosphorylation.

**TEXT BOOKS:**

1. M.N Chatterjea and Rana Shinde,” Text book of Medical biochemistry”,8th edition,2012, Jaypee Publishers, New Delhi
2. Jain, J.L & Jain, (2005) Fundamentals of Biochemistry. Sixth Edition,S.Chand& Company,      New Delhi.
3. U.Sathayanarayana, (2006). Biochemistry. 3rd Edition by Books and Allied (P) Ltd., India.

**REFERENCES:**

1. Lehninger, 2012. Principles of Biochemistry 6th Edition by David L. Nelson
2. Victor W. Rodwell, 2015.Harpers Illustrated Biochemistry, 30<sup>th</sup> Edition.
3. Voet, D. & Voet, J. G. 2010. Biochemistry. 4<sup>th</sup> edition
4. Victor W. Rodwell, 2015. Harpers Illustrated Biochemistry 30<sup>th</sup> Edition.

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| <b>II B.Sc<br/>(Biochem)</b> | <b>ANALYTICAL BIOCHEMISTRY-<br/>II<br/>(60 hrs)<br/>For the students admitted from the<br/>year 2015</b> | <b>BC406S</b>   |
| <b>SEMESTER-<br/>IV</b>      |  | <b>HRS/WK-4</b> |
| <b>CORE-6</b>                |  | <b>CREDIT-4</b> |

## **OBJECTIVES**

To impart knowledge about the principle and applications of various biochemical techniques

### **UNIT I CHROMATOGRAPHY I [10 hrs]**

Paper chromatography, Thin layer chromatography, Column chromatography Gas liquid chromatography

### **UNIT II CHROMATOGRAPHYII [10 hrs]**

Procedure and applications of Molecular sieve chromatography, Ion exchange chromatography, Affinity chromatography, HPLC, Reverse phase chromatography (elementary knowledge)

### **UNIT III ELECTROPHORESIS [15 hrs]**

Electrophoresis-Factors affecting electrophoretic mobility, Tiselius moving boundary electrophoresis, Paper, Cellulose acetate, Gel electrophoresis: Polyacrylamide, SDS-PAGE. Blotting techniques- Southern blot, Northern blot, Western blot.

### **UNIT IV RADIO ISOTOPE TECHNIQUES I [10 hrs]**

Radio isotope Techniques: Atomic structure, isotopes, radiation, type of radioactive decay, half-life, and units of radioactivity. Detection and measurement of radioactivity – Methods based upon ionization - GM counter and Scintillation counter.

### **UNITV RADIO ISOTOPE TECHNIQUES II [15 hrs]**

Radio isotope Techniques: Auto radiography and isotope dilution techniques. Applications of radio isotopes in biology, clinical scanning and radio dating, Radio immuno assay. Biological hazards of radiation and its safety aspects.

**TEXTBOOKS:**

1. Keith Wilson, and John Walker, (2010). Principles and Techniques of Practical Biochemistry. 7th edition, Cambridge University Press. UK.
2. Avinash Upadhyaye, and Nirmalendhe Nath, (2002). Biophysical Chemistry Principles and Techniques. 3rd edition, Himalaya Publishers, New Delhi.
3. Analytical Biochemistry by Asokan, 3rd edition , 2006.

**REFERENCES:**

1. Introduction to Practical Biochemistry – Shawney, Randhir Singh, Narasa Pub, N. Delhi.
2. Subramanian, M.A. (2005). Biophysics : Principles and Techniques. MJP Publishers, Chennai.
3. Biochemistry Laboratory: Modern Theory and Techniques, 2011, 2nd Edition by Rodney F. Boyer.

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| <b>YEAR-III</b>   | <b>MOLECULAR BIOLOGY</b><br>(90 hrs)<br><b>For the students admitted from<br/>the year 2015</b> | <b>BC507S</b>   |
| <b>SEMESTER-V</b> |   | <b>HRS/WK-6</b> |
| <b>CORE-VII</b>   |   | <b>CREDIT-5</b> |

**OBJECTIVE**

To understand the biological activity of macromolecules at the molecular level.

**UNIT I CHROMOSOMES [15 hrs]**

DNA is the genetic material-Griffith, Avery *et al* and Hershey and Chase experiment, C value paradox, Cot value, organization of chromosomes and nucleosomes, Euchromatin, heterochromatin, centromeres and telomeres, central dogma of molecular biology.

**UNIT II REPLICATION [20 hrs]**

Replication-conservative and semi conservative methods, experimental proof for semi-conservative replication-factors involved in prokaryotic and eukaryotic replication, DNA polymerases in prokaryotes and eukaryotes, inhibitors of replication, repetitive DNA-Highly repetitive, moderately repetitive and unique DNA sequences. Satellite DNA, Transposons.

**UNIT III TRANSCRIPTION [20 hrs]**

Transcription-promoters, RNA polymerase in prokaryotes and eukaryotes, initiation, elongation and termination of transcription process in prokaryotes, inhibitors of transcription, post transcriptional modification of mRNA, tRNA and rRNA.

**UNIT IV GENETIC CODE & TRANSLATION [20 hrs]**

Genetic code-features and deciphering of genetic code, wobble hypothesis, Translation- activation of amino acids, initiation, elongation and termination process in prokaryotes, Inhibitors of protein synthesis, post translational modification. Operon concept-Lac and trp operon.

**UNIT V DNA REPAIR [15 hrs]**

DNA repair-photo reactivation, Excision repair, recombination, SOS and Mismatch repair, SNPs.

### **TEXTBOOKS:**

- Nelson, D. L. & Cox, M. M. 2008, Lehninger Principles of Biochemistry. Freeman, 5th edn,
- David Freifelder, 2008. Molecular Biology. (Ed: 2). Narosa Publications, New Delhi.
- Watson J.D., 2006. Molecular Biology of the gene (Ed. 5) Pearson Education, UK

### **REFERENCES:**

- EDP de Robertis and E M F de Robertis, (2001). Cell and Molecular Biology. 8th Edition, Lippincott W&W.
- Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. and James Darnell, J. 2012, Molecular Cell Biology , Freeman, 7th edn
- Karp, G. 2010, Cell and Molecular Biology: Concepts and Experiments. Wiley, 6th edn
- Primrose (2001) - Principles of gene manipulation. 6th Edition Blackwell Scientific Publishers. UK
- Krebs,J.E. 2011. Lewin's Genes IX.( Ed: 9).Jones and Barlett Publishers, US.
- Twyman. 2003. Advanced Molecular Biology, 3<sup>RD</sup> edition Bios Scientific Publishers LTD. Oxford, UK.

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| <b>YEAR-III</b>   | <b>IMMUNOLOGY</b><br><b>(90 hrs)</b><br><b>For the students admitted from</b><br><b>the year 2015</b> | <b>BC508S</b>   |
| <b>SEMESTER-V</b> |   | <b>HRS/WK-6</b> |
| <b>CORE-VIII</b>  |   | <b>CREDIT-5</b> |

**OBJECTIVE:**

To understand and study the various components of immune system and their functions.

**UNIT I IMMUNE SYSTEM [20 hrs]**

Immune system: Introduction and characteristics, classification of immunity-innate and acquired immunity structure and functions of Primary and secondary lymphoid organs. Structure and functions of immune cells [macrophage, T cell, B cell, NKC, KC, dendritic cell and APC]. Immune response - T and B cell mediated immune response, B & T lymphocytes cooperation. Phagocytosis and pinocytosis.

**UNIT II ANTIGEN&ANTIBODY [20 hrs]**

Antigen-properties, epitope, paratope, specificity, cross space reactivity, antigenicity and immunogenicity, haptens, adjuvants and multivalent binding sites. Antibody -structure, specificity and distribution of antibodies. Different classes and subclasses of immunoglobulins. Clonal selection theory and Antibody diversity.

**UNIT III COMPLEMENT & TRANSPLANTATION [20 hrs]**

Complement components- complement cascade-classical, alternate and lectin pathway, complement deficiencies. Major Histocompatibility Complex (MHC) - Structure and function of MHC-I, II & III molecules. Role of MHC antigen in immune response. Transplantation – Graft and its types, mechanism of graft rejection in skin, graft versus host reaction and Immunosuppressive drugs.

**UNIT IV HYPERSENSITIVITY****[15hrs]**

Allergy and hypersensitivity- type I, II, III and IV and their clinical manifestations, Autoimmune diseases-myasthenia gravis, rheumatoid arthritis, thyrotoxicosis and SLE. Immuno tolerance.

**UNIT V ANTIGEN & ANTIBODY REACTIONS [15 hrs]**

Antigen-antibody interaction : precipitation reaction, precipitation reaction in gel (double and radial immuno diffusion).Agglutination reaction - Widal, VDRL and pregnancy test. Principle and applications of immuno electrophoresis, RIA & ELISA.

**TEXTBOOKS:**

- Abbas,Lightman and Pober.W.B.Sounders, 1994. Cellular and Molecular Immunology”,2<sup>nd</sup> edition,
- Ananthanarayanan.K and Jayaraman Paniker, 1996. “Textbook of Microbiology”,
- Judith A. Owen , Jenni Punt, Sharon A. Kuby , 2013.Immunology, W H Freeman & Co (Sd); 7th edition

**REFERENCES:**

- David Male, Jonathan Brostoff, David Roth Ivan Roitt. 2005. Essential Immunology. 10th edition. Blackwell Science,
- Tizard.R, “Immunology-An introduction”, 1995 Saunders College Publishing 2<sup>nd</sup> Revised edition)
- Weir,D.N.(1997):Immunology(8th edition)(Churchil Livingstone).
- Ivan M. Roitt, D.Male, 1995. Immunology, Mosby Publishers; 4th Revised edition

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| <b>YEAR-III</b>     | <b>FOOD TECHNOLOGY</b><br><br>(75 hrs)<br><br><b>For the students admitted from<br/>the year 2015</b> | <b>EBC509A</b>  |
| <b>SEMESTER-V</b>   |   | <b>HRS/WK-5</b> |
| <b>Elective - I</b> |   | <b>CREDIT-5</b> |

**OBJECTIVE:**

To study the nature of food, spoilage, preservation and its applications.

**UNIT-I FOOD CONSTITUENTS AND ADULTERATION [20 hrs]**

**Constituents of food:** Introduction, water, carbohydrate, fat, oil, vitamins and minerals. Pulses, grams, vegetables and fruits-varieties, composition, nutritive value and cooking. Milk- kinds of milk, composition, nutritive value, pasteurization and homogenization. Food Adulteration: types of adulterants, common adulterants in foods, toxicants in foods, impact of food adulteration in humans.

**UNIT -II FOOD SPOILAGE [15 hrs]**

**Food spoilage:** Characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat poultry and sea foods, milk and milk products, packed and canned foods. Factors affecting growth & survival of microorganism in food, physical & chemical methods to control microorganism.

**UNIT -III FOOD PROCESSING AND PRESERVATION [20 hrs]**

**Food processing:** Principle and methods of food processing and preservation-freezing, heating, dehydration, canning, additives, fermentation, irradiation and osmotic pressure. Application of enzymes and microorganisms in food processing and preservation.



Food Additives - Definition, types and functions, permissible limits and safety aspects.

**UNIT –IV INDUSTRIAL PRODUCTIONS OF FOODS [10 hrs]**

Yogurt preparation, Cheese varieties and its classification, cheese making, fermented vegetables, production of oil from soya beans. Fruit and vegetable juices, jams, production of beer, wine and vinegar.

**UNIT -V LEGAL ISSUES AND GOVERNMENT NORMS [10hrs]**

Food regulations – History of Indian Food Regulations: BIS, ISI, FPO, PFA and FDA. Food Safety and Standards Act 2006. Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK and FSSAI. Legal aspects related to storage and disposal.

**TEXT BOOKS:**

- Gabriel Virella (1997), Microbiology and infectious disease, 3rd Ed, Ingraham international, New Delhi.
- John L Ingraham and Catherine A.Ingraham. Microbiology an introduction, 2rd Ed, Cengage learning, New Delhi
- Sivasankar,B.(2005),Food processing and preservation,3rd Ed, Prentice Hall India (P) Ltd.
- VijayaKhader (2009), Text book of food science and technology,5thEd, Indian council of Agricultural research.
- Avantina Sharma, Text book of food science and technology, 3rd Ed, CBS Publishers.

**REFERENCES:**

- Belitz, H.D. Grosch W et al., (2005). Food Chemistry. 4th edition, Springer Verlag.
- Adams, M.R. and M.G. Moss (2009): Food Microbiology, 1st edition, New AgeInternational (P) Ltd.
- Fellows, P.J. (2005). Food processing technology: Principle and Practice. 2nd Ed. CRC Publishers.
- BibekRay, Fundamental food microbiology, 3rd edition, PRC Press, Washington D.C.
- James, M.J. (2000) Modern Food Microbiology, 2<sup>nd</sup> Edition. CBS Publisher.

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| <b>YEAR-III</b>     | <b>ENVIRONMENTAL TOXICOLOGY<br/>AND HERBAL MEDICINE</b> | <b>EBC509<br/>B</b>  |
| <b>SEMESTER-V</b>   | (75 hrs)  | <b>HRS/W<br/>K-5</b> |
| <b>Elective – I</b> | <b>For the students admitted from the<br/>year 2015</b> | <b>CREDIT<br/>-5</b> |

**OBJECTIVES:**

- To study various harmful chemical agents in environment and its impacts.
- To study the basics of medicinal and therapeutic use of plants.

**UNIT-I TOXICOLOGY [20hrs]**

Toxic substances: Types-degradable & non-degradable. Factors influencing toxicity. Drug toxicity. Mechanism of toxicity. Receptor mediated events. Acute and chronic toxicity.

**UNIT-II TOXIC SUBSTANCES IN ENVIRONMENT [15hrs]**

Toxic substances in environment- sources and routes, Transport of toxicants through food chain- bioaccumulation and bio-magnification. Toxicology of major pesticides, Biotransformation, bio-monitoring, bio-indicator and its examples. Environmental impact of pesticides.

**UNIT-III BIOASSAY [20 hrs]**

Bioassay- Types, characteristics and importance. Microbial bioassay for toxicity testing. LC50, LD50. Hepatotoxicity- examples of hepatotoxicants and its impacts on liver. Nephrotoxicity - examples of

nephrotoxicants and its impacts on kidney. Neurotoxicity - examples of neurotoxicants and its impacts on brain.

#### **UNIT-IV INTRODUCTION TO HERBAL SCIENCE [10 hrs]**

Herbs, characterization of herbs based on plant properties, usage and active constituents. Preparation of herbal medicine. Herbs for common ailments. Dosage and formulation.

#### **UNIT-V HERBAL MEDICINE [10 hrs]**

Drugs for urinogenital disorders – roots of *Withania somnifera* – Memory stimulants – *Centella asiatica* – Drugs for dissolving kidney stones – *Musa paradisiaca* (pseudostem) – Anti-inflammatory drugs – *Curcuma longa*, *Cardiospermum* – Anticancer drugs – *Catharanthus roseus* and *Azardica indica*. Dengue fever – Papaya leaves.

#### **TEXT BOOKS:**

- David Hoffmann., 2003. Medical Herbalism: The Science Principles and Practices of Herbal Medicine, 1<sup>ST</sup> edition, Healing Arts Press publishers.
- Agnes Arbe, 1987. Herbals: Their Origin and Evolution, Cambridge University Press; 3 edition,
- Kumar, N.C. 1993. An Introduction to Medical botany and Pharmacognosy. Emkay Publications, New Delhi.
- P. D. Sharma, 2014. Environmental Biology and Toxicology, Rastogi Publications.

#### **REFERENCES:**

- Gupta, P.K. and Salunka, D.K. 1985. Modern toxicology. Vol I and II. Metropolitan, New Delhi.

- Ming-Ho Yu, HumioTsunoda, Masashi Tsunoda, 2011.Environmental Toxicology: Biological and Health Effects of Pollutants, CRC Press; 3 edition

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| <b>YEAR-III</b>      | <b>PLANT BIOCHEMISTRY</b><br>( 75 hrs)<br><b>For the students admitted from the</b><br><b>year 2015</b> | <b>EBC510A</b>  |
| <b>SEMESTER-V</b>    |   | <b>HRS/WK-5</b> |
| <b>ELECTIVE - II</b> |   | <b>CREDIT-5</b> |

**OBJECTIVE:**

To study the basic science, explaining the molecular functions of plant.

**UNIT I PLANT CELL & ABSORPTION [20 hrs]**

Discovery and definition of plant cell, cell wall, plasmodesmata, meristematic cells and secretory systems. Mechanism of absorption-Ion exchange, passive absorption & Active absorption.The carrier concept and Donnan membrane equilibrium.

**UNIT II PLANT HORMONES [10 hrs]**

Structure, biosynthesis, mode of action and physiological effects of auxins, gibberellins, cytokinins and IAA.Biochemistry of seed dormancy, seed germination, fruit ripening and senescence.

**UNIT III PLANT PIGMENTS & PHOTOSYNTHESIS [20 hrs]**

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, Calvin cycle, C3, C4 & CAM. Photosynthesis-factors and regulation.

**UNIT IV SECONDARY METABOLITES &STRESS****METABOLISM [15 hrs]**

Secondary metabolites in plants – classification & function of alkaloids, terpenoids, tannins, lignin and pectin. Stress metabolism in

plants - Environmental stresses, salinity, water stress, heat, chilling and their impact on plant growth, criteria of stress tolerance.

## **UNIT V NITROGEN FIXING ORGANISMS [10 hrs]**

Nitrogen fixing organisms: Structure and mechanism of action of nitrogenase: *Rhizobium* symbiosis. Leghaemoglobin, strategies for protection of nitrogenase against the inhibitory effect of oxygen, nif genes of *Klebsiella pneumoniae* and their regulation. Nitrate reductase.

### **TEXT BOOKS:**

- Jain.V.K., 2005. 'Fundamentals of Plant Physiology', Revised 1<sup>st</sup> edition, S.Chand & Company Ltd
- Pandey.S.N., and Sinha.B.K. 1999. Plant Physiology, Vikas Publishing House.
- Verma, S.K. 2005, Text Book of Plant Physiology, 7th Revised edition, Emkay Publications 2001, S. Chand & Co Ltd., New Delhi.

### **REFERENCES:**

- Solisbury and Ross, Plant Physiology, 3<sup>rd</sup> edition, CBS Publishers and Distributors.
- Hans-Walter Held, Plant Biochemistry, 3<sup>rd</sup> edition, Elsevier India Pvt.Ltd.
- Bonner and Varner, Plant Biochemistry, 3<sup>rd</sup> edition, Academic Press.
- Heldt, HW. (2005), Plant Biochemistry. 3<sup>rd</sup> edition, Elsevier Academic Press Publication, USA.

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| <b>YEAR-III</b>    | <b>PHARMACEUTICAL<br/>BIOCHEMISTRY AND<br/>BIOINFORMATICS</b><br>( 75 hrs)<br><b>For the students admitted from the<br/>year 2015</b> | <b>EBC510B</b>  |
| <b>SEMESTER-V</b>  |   | <b>HRS/WK-5</b> |
| <b>ELECTIVE-II</b> |   | <b>CREDIT-5</b> |

**OBJECTIVES:**

- To gain essential knowledge about drugs and their metabolism.
- To understand the biological database and their alignment.

**UNIT I DRUGS [15 hrs]**

Definition, source and Nature of common drugs - Antimalarial drugs – Chloroquine, quinine, Hydroxychloroquine, Amodiquine. Antifungal drugs - Chlorophenesin, Griesofulvin and Candicidin. Antiviral agents- Idoxuridine, Acyclovir, Methisazone, Amantadine hydrochloride (structure not required).

**UNIT II PHARMACOKINETICS [20 hrs]**

Factors affecting metabolism, site of metabolism, routes of elimination (kidney, biliary excretion) Phase-I: oxidation, microsomal oxidation, microsomal reduction, non-microsomal metabolism, hydrolysis, Phase-II: Conjugation-glucuronide conjugation, acylation, methylation, mercapturic acid formation and sulphate conjugation.

**UNIT III ANTIOXIDANT DEFENSE [10hrs]**

Antioxidant defense system-oxygen dependent and independent (NOS) antioxidant defense enzymes SOD, Catalase, Glutathione peroxidase, Glutathione reductase and lipid peroxidation.

**UNIT IV BIOINFORMATICS [15 hrs]**

Bioinformatics-definition, application, challenges and opportunities. Internet, www. Database-types, classification, sequence formats, DBMS, RDBMS, SQL (brief description), Nucleic Acid Database-

NCBI, EMBL & DDBJ. Protein Sequence Database-PIR, SWISS-PROT, Structure database-PDB, CDS, ORF, EST motifs, domain and annotation.

## **UNIT V SEQUENCE ALIGNMENT [15 hrs]**

Sequence alignment-algorithm, global and local alignment, sequence alignment methods, pairwise alignment-dot matrix, dynamic programming, FASTA & BLAST. Multiple sequence alignment-HMM & CLUSTAL[brief description]. Homology, orthology, paralogs & xenologs. Softwares used for phylogenetic analysis.

### **TEXTBOOKS:**

- Tripathi KD, 2013.Essentials Of Medical Pharmacology, 7<sup>th</sup>edition. Jaypee Brothers Medical Publishers
- Katzung Bertram, 2015. Basic and Clinical Pharmacology 13<sup>th</sup> ed., McGraw Hill,.
- S.Ignacimuthu, 2005. Basic Bioinformatics,Narosa publications
- Arthur M.Lesk. 2002. Introduction to Bioinformatics, Oxford University press.
- Rastogi,S.C. Mendiratta, N. and Rastogi P ,”Bioinformatics-Methods and applications”, Prentice-Hall of IndiaPvt. Ltd, New Delhi.
- Karen Whalen, 2014. Lippincott Illustrated Reviews: 6<sup>th</sup> edition. Pharmacology – Publisher: Wolter Kluwer

### **REFERENCES:**

- David R.Westhead,J.Howard Parish &Richard, 2003. Instant notes on bioinformatics” ,viva book Pvt ltd
- K.Mani&N.Vijayaraj,2004 “Bioinformatics- a practical approach”,Aparna publications,Coimbatore
- LubertStyrer,Biochemistry ,4<sup>th</sup> editon, W.H.Freeman and Company, New York.



- G.R.Chatwal, Pharmaceutical chemistry, Himalayaa Publishing House.
- Joseph R.Dipalma,,G.Johndi Gregorio, Basic Pharmacology in Medicine,3th edition.
- Attwood, T.K. and Parry-Smith, D.J. 1999. Introduction to bioinformatics. Pearson Education Ltd., Delhi, India.

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| <b>YEAR-III</b>   | <b>MEDICAL BIOCHEMISTRY</b><br><b>(90 hrs)</b><br><b>For the students admitted</b><br><b>from the year 2015</b> | <b>BC611S</b>   |
| <b>SEMESTER-V</b> |   | <b>HRS/WK-6</b> |
| <b>CORE IX</b>    |   | <b>CREDIT-5</b> |

## **OBJECTIVES**

To understand biochemical basis of various diseases and disorders

### **UNIT I COLLECTION & PRESERVATION OF SAMPLES [15 hrs]**

Biological samples, Specimen collection, anticoagulant, preservatives for blood and urine, transport of specimens. Normal and abnormal values of different blood parameters.

### **UNIT II DIABETES MELLITUS [15 hrs]**

Diabetes mellitus- definition, WHO criteria, classification of diabetes mellitus-signs, symptoms and complications, GTT, galactosemia, galactosuria and fructosuria.

### **UNIT III INBORN ERRORS & LIPID TRANSPORT [20 hrs]**

Inborn errors of metabolism- phenylketonuria, alkaptonuria, albinism, cystinuria and fanconi syndrome. Exogenous and endogenous transport of lipids- chylomicron transport, VLDL transport-reverse cholesterol transport. Atherosclerosis, fatty liver- risk and anti-risk factors.

### **UNIT IV LIVER & GASTRIC FUNCTION TEST [20hrs]**

Liver function test-Heme catabolism- Jaundice- classification- biochemical findings-liver function test based on bile pigments- Vanden bergh test, Detoxification-Hippuric acid excretion and BSP dye test, metabolism-galactose tolerance test, Prothrombin time, Gastric function test-gastric contents, resting stage gastric analysis-stimulation test (histamine, pentagastrin) - FTM-AZURE-A test. Hypo and hyperacidity.

**UNIT V RENAL FUNCTION TEST & DIAGNOSTIC****ENZYMES****[20 hrs]**

Renal function test-renal concentration test-PSP dye test-urea, creatinine and inulin clearance test. Plasma enzymes-functional and non-functional enzymes, isoenzymes, enzyme patterns in acute pancreatitis, liver diseases and myocardial infarction.

**TEXTBOOKS:**

- Textbook of Biochemistry for medical students- DM. Vasudevan, 5<sup>th</sup> edition, Jaypee publishers, 2008.
- Textbook of Medical Biochemistry, Chatterjee, M.N. and Rana Shinde, 5<sup>th</sup> ed. Jaypee Medical Publishers, 2002.
- Devlin, T.M, Textbook of Biochemistry with Clinical Correlations. John Wiley and sons, INC. New York, 2002.

**REFERENCES:**

- Robert K. Murray, Daryl K. Grammer “Harper’s Biochemistry”, (25<sup>th</sup> Edition) McGraw Hill, Lange Medical Books.
- Sathya Narayana U, 1999, “Biochemistry”, (2<sup>nd</sup> Edition), Kolkata, Allied Publishers..
- Mallikarjuna Rao N, 2002, “ Medical Biochemistry”, 2<sup>nd</sup> Edition, New Delhi, New Age International publishers.
- Bhagavan.N.V(2004),”Medical Biochemistry”,(4<sup>th</sup>ed) Noida, Academic press
- Harrison, T.R. Fauci, Braunwald, and Isselbacher, ”Principles of Internal Medicine, 1998, McGraw Hills.
- Victor W. Rodwell, 2015. Harpers Illustrated Biochemistry 30th Edition.
- Luxton R, 2010, Clinical Biochemistry, 2nd edition, VinothVashista Pvt. Ltd., New Delhi.

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| <b>YEAR-III</b>         | <b>BIOTECHNOLOGY AND<br/>GENETIC ENGINEERING<br/>(90 hrs)</b><br><b>For the students admitted from the<br/>year 2015</b> | <b>BC612S</b>   |
| <b>SEMESTER-<br/>VI</b> |  | <b>HRS/WK-6</b> |
| <b>CORE-X</b>           |  | <b>CREDIT-5</b> |

**OBJECTIVE**

To provide an insight into the basic concepts of biotechnology.

**UNIT I INTRODUCTION [15 hrs]**

Introduction to Biotechnology- scope & its importance. Enzymes involved in rDNA technology. Restriction and modification enzymes, vectors- plasmids, pBR322, Ti plasmid, bacteriophages-lambda, phage M13, cosmids, BAC, YAC, shuttle vectors. Gene transfer methods- Microinjection and Electroporation.

**UNIT II ANIMAL CELL CULTURE [20 hrs]**

Animal cell culture- requirements, sterilization& applications. Culture media- natural and artificial, properties & use of serum and serum-free media, cell adhesion molecules. Primary cell culture - mechanical disaggregation, enzymatic disaggregation and primary explants technique. Cell lines-finite and continuous.Subculture-mono layer and suspension cultures.

**UNIT III VACCINES & TRANSGENESIS [20 hrs]**

Production of vaccines in animal cells-traditional and recombinant vaccines -subunit vaccines-Hepatitis B, Vaccinia virus (Vector recombinant vaccine), DNA and RNA vaccines.Transgenic animals - techniques and applications - transgenic mice and sheep.Stem cells-isolation, identification and uses.Transgenic plants and its uses.

**UNIT IV PLANT TISSUE CULTURE [20 hrs]**

Totipotency, tissue culture-media, composition, nutrients, growth regulators, regeneration of plants-organogenesis and somatic embryogenesis, callus and cell suspension culture, micropropagation, production of haploid plants, protoplast isolation, fusion and regeneration.

## **UNIT V FERMENTATION**

**[15 hrs]**

Fermentation, Fermentor-common features and operation for a conventional bioreactor, classification of fermentation process - type 1, type 2 and type 3. Fermentation process-factors affecting fermentation process, media for fermentation – synthetic and crude media.

### **TEXTBOOKS:**

- Sathya Narayana U, 1999, “Biotechnology”, (2<sup>nd</sup> Edition), Kolkata, Allied Publishers.
- P.K.Gupta, “Biotechnology and Genomics”, 2004, Rastogi Publications.
- Dubey.R.C., A Textbook of Biotechnology, S.Chand & Company Ltds.,

### **REFERENCES:**

- Bernard, Glick Jack.R, Pasternak.J, Molecular Biotechnology- Principle and Application of Recombinant DNA, 3<sup>rd</sup> edition, 2003, Library of Congress Cataloging in Publication Data.
- Primrose (2001) - Principles of gene manipulation. 6th Edition Blackwell Scientific Publishers. UK
- Zubay, 1998, Biochemistry 4th Edition, WMC Brown Publishers, USA.

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| <b>YEAR-III</b>          | <b>CLINICAL ENDOCRINOLOGY</b><br><b>(75 hrs)</b><br><b>For the students admitted from the</b><br><b>year 2015</b> | <b>EBC613A</b>  |
| <b>SEMESTER-<br/>VI</b>  |   | <b>HRS/WK-5</b> |
| <b>ELECTIVE-<br/>III</b> |   | <b>CREDIT-5</b> |

**OBJECTIVE**

To provide an insight into the structure and functions of hormones.

**UNIT I INTRODUCTION TO HORMONES [15 hrs]**

Hormones - feedback regulation. Different mechanisms of signal transduction, secondary messengers - cAMP mediation, calcium and DAG mediation, cGMP mediation, ionic conduction.

**UNIT II PITUITARY & HYPOTHALAMUS HORMONES [15 hrs]**

Structure of pituitary gland, Hormones of anterior pituitary-FSH, LH, TSH and its functions. Posterior pituitary - oxytocin and vasopressin with its functions. Hormones of hypothalamus.

**UNIT III THYROID, PARATHYROID & PANCREATIC HORMONES [15 hrs]**

Thyroid hormones-structure and functions. Hypothyroidism-cretinism, myxedema, simple Goiter, Grave's disease. Parathyroid hormones-regulation of calcium homeostasis by PTH and calcitonin. Hormones of pancreas- insulin & glucagon.

**UNIT IV ADRENAL HORMONES****[15 hrs]**

Hormones of adrenal cortex - cortisol biosynthesis (structure not required) and its functions, Cushing's syndrome, Addison's disease - Aldosterone biosynthesis and its functions – renin - angiotensin mechanism, Conn's syndrome. Medullary hormones -biosynthesis of epinephrine and nor-epinephrine. Dopamine and its metabolic functions, pheochromocytoma.

**UNIT V GASTROINTESTINAL HORMONES & SEX HORMONES****[15 hrs]**

Gastrointestinal hormones- chemical nature, functions of gastrin, enterogastrone, secretin, and cholecystokinin. Sex steroids-male sex hormones - biosynthesis and its metabolic functions. Female sex hormones - biosynthesis and its metabolic functions.

**TEXTBOOKS:**

- Chatterjee, M.N. and RanaShinde. Textbook of Medical Biochemistry, 2002. 5<sup>th</sup> edition. Jaypee Medical Publishers.
- DM.Vasudevan. Textbook of Biochemistry for medical students. 5<sup>th</sup> edition, Jaypee Publishers, 2008.

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- U.Sathayanarayana, (2006). Biochemistry. 3rd Edition by Books and Allied (P) Ltd., India.
- Mallikarjuna Rao N,2002, “ Medical Biochemistry”,2<sup>nd</sup> edition, New Delhi,New Age International Publishers.
- Devlin, T.M. (2002) Textbook of Biochemistry with Clinical Correlations. John Wiley and sons, INC. New York.
- Ramakrishnan S, Prasanna K.G. and Rajan R,1980, “ Textbook of Medical Biochemistry”,3<sup>rd</sup> edition, Chennai, Orient Longman.
- Bhagavan.N.V (2004),”Medical Biochemistry”,4<sup>th</sup> edition, Noida, Academic Press.

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| <b>YEAR-III</b>     | <b>MEDICAL PHYSIOLOGY</b><br>(15 hrs)<br>For the students admitted from<br>the year 2015 | <b>EBC613B</b>  |
| <b>SEMESTER-VI</b>  |  | <b>HRS/WK-5</b> |
| <b>ELECTIVE-III</b> |  | <b>CREDIT-5</b> |

**OBJECTIVE:**

To understand the structure and functions of the organ systems in our body.

**UNIT I BLOOD AND CIRCULATORY SYSTEM [15 hrs]**

Composition of blood – types of blood cells, morphology and its functions, Blood groups - ABO group and Rh group. Composition of lymph, circulatory system: Heart - basic anatomy, cardiac cycle, cardiac output and pace maker.

**UNIT II DIGESTION [15 hrs]**

Definition, digestive system - chemical process of digestion. Salivary digestion, gastric digestion - Mechanism of Hcl secretion in stomach, pancreatic digestion, intestinal digestion, Role of bile salt in Digestion, Digestion and absorption of carbohydrates, proteins, and lipids.

**UNIT III RESPIRATORY SYSTEM AND EXCRETORY SYSTEM [15 hrs]**

Respiration, types of Respiration, Respiratory system of man, Transport of O<sub>2</sub> and CO<sub>2</sub>, Role of Hemoglobin in of O<sub>2</sub> and CO<sub>2</sub> transport. Oxygen Dissociation curve, Bohr Effect, Chloride shift. Excretory system of man, structure of nephron, Mechanism of urine formation – Ultra filtration, Reabsorption and Secretion.

**UNIT IV NERVOUS SYSTEM [15hrs]**

Neuron, types of neuron, conduction of nerve impulse, Synapse - types of synapse, synaptic transmission, Neurotransmitter, Neuromuscular junction, Reflex action.

Human brain - Anatomy of brain - meninges, cerebrum, brain stem, cerebellum and functions. Spinal cord and its function.



**UNIT V MUSCLE****[15 hrs]**

Introduction, types of muscle, Ultra structure of skeletal muscle - light band, dark band, Sarcomere, thick filament-myosin, thin filament - actin, tropomyosin and troponin. Muscle contraction – types of muscle contraction and theories of muscle contraction, Molecular basis of skeletal muscle contraction.

**TEXTBOOKS:**

- KA Goel, KV Sastri, A Text book of Animal Physiology, Rastogi publications, Meerut.
- Arthur C. Guyton and John E. Hall, 2016. Textbook of Medical Physiology, Harcourt Asia Pvt. Ltd, 10th edition.
- Sembulingam, Premasembulingam, 2012. Essentials of medical Physiology-K 6th edition, Jaypee Brothers Medical Publishers (P) Ltd.,
- A.K.Jain, 2016. Textbook of Physiology Vol - I & II, 6<sup>th</sup> edition Avichal Publishing Company.

**REFERENCES:**

- BJ Meyer, HsMeij, AC Meyer, Human Physiology, 2<sup>nd</sup> edition – AITBS Publishers and distributon.
- Giese, Cell Physiology, 5<sup>th</sup> edition, W .B Saunders company, Tokyo, Japan.
- Animal Physiology and biochemistry – RA Agarval, Anil. K. Srivastav, Kaushal Kumar, S .Chand & CO.,
- Ganong W. E. 2003. Review of Medical Physiology, 21<sup>st</sup> edition. McGraw Hill.
- West, E.S. and Todd, W.R., 1985, Textbook of Biochemistry, MacMillan, Germany.
- Zubay, 1998, Biochemistry 4th edition, WMC Brown Publishers, USA.

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| <b>YEAR-III</b>    | <b>BIostatistics AND CLINICAL RESEARCH</b><br>(75 hrs)<br><b>For the students admitted from the year 2015</b> | <b>EBC614A</b>  |
| <b>SEMESTER-VI</b> |   | <b>HRS/WK-5</b> |
| <b>ELECTIVE-IV</b> |   | <b>CREDIT-5</b> |

**OBJECTIVES:**

- To provide sufficient background to interpret statistical results in research papers.
- To ensure the students with requisite knowledge to pursue a career in the clinical research industry.

**UNIT I DATA COLLECTION AND PRESENTATION [15hrs]**

Introduction: Collection of data, primary data, secondary data, methods of data collection. Processing of data- classification and tabulation of statistical data, Frequency Distribution: Simple and Cumulative, Diagrammatic presentation of data - Histogram, Bar chart, Frequency polygon and Pie chart, graphical presentation of data- line graph.

**UNIT II MEASURES OF CENTRAL TENDENCY [15 hrs]**

Measurement of Central Value: Mean, Median, Mode, Geometric Mean (G.M) and Harmonic Mean (H.M), Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation.

**UNIT III STATISTICAL ANALYSIS [15hrs]**

Test for correlation and regression coefficients, Chi-square test for goodness of an independence of attributes. F-test for equality of variances, ANOVA – one way classification.

**UNIT IV CLINICAL RESEARCH [15hrs]**

Introduction to clinical research, origin and history of clinical research, Biochemical investigations in clinical research, difference

between clinical research and clinical practice, types of clinical research, phases of clinical research, career in clinical research.

## **UNIT V DRUG DEVELOPMENT [15 hrs]**

Drug discovery and development process, Preclinical testing, Clinical trials, ethical issues, new drug application and approval. Pharmacokinetics, Pharmacodynamics and Pharmacogenomics.

### **TEXT BOOKS**

- Green. R. H. 1979. 'Sampling Design and Statistical Methods for Environmental Biologists' .John Wiley & Sons.
- Gupta.S.C& Kapoor. 1978.V.K. "Fundamental of Applied Statistics" (2<sup>nd</sup>ed), MJP Publishers.
- Satoskar RS, bhandarkar SD, Ainapure SS,E.Padmini, 2003.Biochemical calculations and Biostatistics. Books and Allied (P) Ltd.Pharmacology &Pharmacotherapeutics. 18<sup>th</sup> ed. Mumbai: popular prakashan: 376.

### **REFERENCES**

- Thomas Glover, Kevin Mitchell.2001.' Introduction to Biostatistics', 1<sup>st</sup> ed. McGraw Hill Science
- Dr N .Gurumani,2015. "An Introduction to Biostatistics",MJP Publishers
- Wilson & Walker, 2000. Principles and Techniques in Practical Biochemistry' 5<sup>th</sup> ed.. Cambridge Univ. Press.
- Clinical Research Practice and prospects-T.K.Pal,Sangita Agarwal,1<sup>st</sup> edition.
- Essential of Medical Pharmacology, Sixth edition-KD.Thripathi MD, Jaypee brothers medical publishers (P) Ltd. St Louis (USA)

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| <b>YEAR-III</b>         | <b>MEDICAL LABORATORY<br/>TECHNOLOGY<br/>(75 hrs)</b><br><b>For the students admitted from the<br/>year 2015</b> | <b>EBC614B</b>       |
| <b>SEMESTER-<br/>VI</b> |  | <b>HRS/WK-<br/>5</b> |
| <b>ELECTIVE<br/>IV</b>  |  | <b>CREDIT-<br/>5</b> |

**OBJECTIVE**

To provide an insight into the basic techniques in medical diagnostics.

**UNIT I INTRODUCTION TO LABORATORY EQUIPMENTS [15 hrs]**

Introduction to laboratory equipments, Basic laboratory operation and the role of laboratory technician. Types of specimen collection and procedure - blood, urine, sputum, throat swab, stool and CSF. Unit of measurement, reagent preparation and laboratory calculation-metric system. Smear preparation and types, calibration, measurements, quality control & GLP.

**UNIT II HEMATOLOGY [15 hrs]**

Blood grouping and Rh factor, cross matching, clotting time, bleeding time, hemoglobin estimation, total count-RBC count and WBC count, Differential WBC count, Erythrocyte Sedimentation Rate (ESR), Hematocrit value (Packed Cell Volume). Screening test-HIV (ELISA) HBs Ag, TPHA.

**UNIT III CLINICAL PATHOLOGY [15hrs]**

Brief outline of histopathology: Tissue cutting, fixation, embedding, tissue slicing by microtome, slide mounting and staining techniques: types – carbohydrates, proteins & lipids.

**UNIT IV CLINICAL BIOCHEMISTRY [15 hrs]**

Blood glucose, urea, uric acid, triglycerides, SGOT, SGPT, serum alkaline and Acid phosphatase, calcium, phosphorous, total protein, albumin, amylase, lactic dehydrogenase, electrolytes-sodium and potassium role and its significance.

**UNIT V MICROBIOLOGY [15 hrs]**

Culturing of organisms from various specimens, culture media and antibiotic sensitivity test (pus, urine, blood, sputum, throat swab). Gram stain & Ziehl-Neilson staining method (TB, Lepra bacilli). Safety procedure in microbiological techniques.

**TEXTBOOKS:**

- Kanai L. Mukherjee, 1996. Medical Laboratory Technology Vol. I, II & III Tata McGraw Hill New Delhi.
- Gradwohl, Clinical Laboratory-Methods and Diagnosis, 8<sup>th</sup> edition, mosby year book publisher, Vol-I.
- Mukherj, 2000. Medical Laboratory Technology, Tata McGraw Hill Education
- Darshan P. Godkar Praful B. Godkar, 2014. Textbook of Medical Laboratory Technology Vol 1 & 2, Bhalani Publishing House; 3<sup>rd</sup> edition

**REFERENCES**

- Henry, John Bernard, Todd Sanford and Davidson, 2002. Clinical diagnosis and management by laboratory methods. W.B. Saunders & Co.
- Fischbach Francis A, 2003. Manual of laboratory and diagnostic tests. Philadelphia, J.B. Lippincott & Co, N.Y.
- Gradwohls, 2000. Clinical laboratory methods and diagnosis Alex.C. Sonnenwirth & Leonard Jarret. M.D.B.I. Publications, New Delhi,
- Sood R, 2005, Medical Laboratory methods and interpretation, Jaypee Brothers Medical Publications, New Delhi.
- Arundhati Kolhatkar, J. Ochei, 2000. Medical Laboratory Science: Theory and Practice, Tata McGraw-Hill Education Pvt. Ltd.

**MAIN PRACTICAL SYLLABUS-1**  
**(Students Admitted From the Year 2015)**  
**(I & II SEMESTER)**

**VOLUMETRIC ANALYSIS**

1. Estimation of Glycine by formal titration method
2. Estimation of ascorbic acid using dichlorophenolindophenol dye as link solution
3. Determination of Saponification value of an edible oil
4. Determination of acid number of an edible oil
5. Determination of iodine value of an edible oil
6. Estimation of chloride by Mohr's method and Volhard's method
7. Estimation of reducing sugar from biological fluids by benedict's method
8. Titration curve of amino acids

**BIOCHEMICAL PREPARATION**

9. Preparation of albumin from egg
10. Preparation of albumin from milk
11. To find out the moisture and water content in food stuffs.

**QUALITATIVE ANALYSIS**

12. Qualitative analysis of carbohydrates - Glucose, fructose, arabinose, maltose, lactose, galactose, dextrin, mannose, sucrose and starch
13. Qualitative analysis of amino acids - Tyrosine, tryptophan, arginine, Histidine, Proline and cysteine

**SPOTTERS.**

14. Cell division identification (mitosis & meiosis)
15. BMI calculation

**BCP402 - MAIN PRACTICAL II  
(III & IV SEMESTER)****1. PREPARATION OF BUFFERS**

- Saline
- Bicarbonate buffer
- Phosphate buffer
- Tris buffer

**2. FOOD AND BIOCHEMICAL ANALYSIS**

- Carbohydrate content
- Protein content
- Fibre content
- Water content
- Ash content

**3. COLORIMETRIC ANALYSIS**

- Estimation of proteins by Biuret method
- Estimation of phosphorous –Fiske and Subarrow method
- Estimation of DNA
- Estimation of RNA

**4. BIOCHEMICAL ANALYSIS (Demonstration)**

- Aminoacids by paper chromatography
- Lipids by thin layer chromatography
- SDS-PAGE electrophoresis

## 5. BIOCHEMICAL PREPARATION

- Preparation of starch from potatoes
- Preparation of casein and lactalbumin from milk
- Preparation of albumin from egg

## 6. VOLUMETRIC ANALYSIS

- Estimation of iron, copper, oxalate, potassium dichromate and calcium

### PRACTICAL MARKS: 60

|   |      |
|---|------|
| Volumetric analysis                               | - 24 |
| Biochemical preparation/<br>Colorimetric analysis | - 20 |
| Spotters  | - 6  |
| Record  | - 10 |

## MAIN PRACTICAL SYLLABUS-III

### Subject code: BCP603S

### 1. COLORIMETRIC ESTIMATION

- Estimation of creatinine by Jaffe's method
- Estimation of urea by DiacetylMonoxime method.
- Estimation of triglycerides in blood
- Bilirubin in blood
- Uric acid estimation

### 2. EXPERIMENTS ON ENZYMES BY COLORIMETRY

- Effects of pH, temperature and substrate concentration for amylase and urease.



### 3. CHROMATOGRAPHY

- Thin layer chromatography - Amino Acids & Carbohydrates
- Column chromatography – leaf pigments.

### 4. Food & biochemical analysis

- Estimation of gluten content in wheat flour.
- Gelatinization of starch.
- Determination of pH density of milk & milk products.
- Lipid content in food
- Nutritive value of foods.
- Oxidative rancidity of potato chips
- Fibre in food
- Iron in food
- Food additives/adulterants

#### **PRACTICAL MARKS: 60**

Colorimetric analysis I &II - 20

Enzyme assay- 15

Spotters/estimation(food)- 15

Record - 10

### **MAIN PRACTICAL SYLLABUS-IV**

**Subject code: BCP604S**

#### **1. COLORIMETRIC ESTIMATION**

- a. Estimation of glucose by
  - i. Folin Wu and
  - ii. Ortho toluidine methods
- b. Estimation of albumin and A/G ratio in serum.
- c. Estimation of cholesterol by Zak's method
- d. Estimation of protein by Lowry method
- e. Estimation of protein concentration by  $A_{280\text{ nm}}$
- f. Isolation & purification of DNA from onion.

## **2.ENZYME ASSAY**

- a. Assay of activity of alkaline phosphatase in serum.
- b. Assay of activity of acid phosphatase in serum.
- c. Estimation of SGOT and SGPT

## **3.URINE ANALYSIS**

- a. Collection of urine sample.
- b. Qualitative analysis of urine for normal and pathological conditions.

## **4. PREPARATION OF SOLUTIONS**

- Normality, molarity & percentage solution

## **4.HAEMATOLOGY**

- RBC count,,ESR,total and differential WBC count, blood grouping, blood pressure measuring , bleeding time,clotting time.estimation of Hb.

## **5.ELECTROPHORETIC TECHNIQUES**

- Separation of protein by SDS-PAGE and Agarose.

### **PRACTICAL MARKS: 60**

|                                      |      |
|--------------------------------------|------|
| Colorimetric analysis                | - 20 |
| Colorimetric analysis/urine analysis | - 15 |
| Spotters/hematology                  | -15  |
| Record                               | - 10 |

## REFERENCES

1. Harold Varley, (1980). Practical Clinical Biochemistry, Volume I and II. 5th Edition. CBS Publishers. New Delhi.
2. Jayaraman, S. (2003). Laboratory Manual in Biochemistry. 2nd Edition. New Age International (P) Limited. New Delhi.
3. Sadasivam S and Manickam P. (2004) Biochemical Methods. 2nd Edition. New Age International (P) Limited. New Delhi.
4. David, T. Plummer, (1988). An Introduction to Practical Biochemistry. 3rd Edition. Tata McGraw Hill Publishing Company Ltd. New Delhi.
5. Pattabiraman, T.N. (1998). Laboratory Manual in Biochemistry. 3rd Edition. All India Publishers and Distributors. Chennai.

