

**SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH**

**TAMAKA, KOLAR-563 103, KARNATAKA**

**M.B.B.S. Degree Course**

**(Phase-I Biochemistry subject)**

**REVISED CURRICULUM**

**2019-20**

**BIOCHEMISTRY**

**GOALS & OBJECTIVES**

Teaching & Application in the subject of Biochemistry including Medical Physics, Clinical Biochemistry and Molecular Biology

**(i) Goals**

The broad goal of teaching for undergraduate students in Biochemistry is to make them understand the scientific basis of life processes at the molecular level and to orient them towards the application of the knowledge acquired in solving clinical problems. Towards this, the department would facilitate:

1. To enable students understand the scientific basis of life processes at the molecular level and orient them towards the application of knowledge acquired in solving clinical problems.
2. To enable the students to acquire basic practical skills for biochemical investigations in order to support clinical diagnosis of common disorders in the community.
3. To orient the students towards the biochemical basis of common diseases, and
4. To promote research activities for students.

**(ii) Objectives**

**(a) Knowledge**

At the end of the course the student shall be able to:

1. Describe the molecular and functional organization of a cell and its subcellular components

2. Delineate structure, function and inter-relationships of biomolecules and consequences of deviation from normal
3. Summarize the fundamental aspects of enzymology and clinical application wherein regulation of enzymatic activity is altered
4. Describe digestion and assimilation of nutrients and consequences of malnutrition
5. Integrate the various aspects of metabolism and their regulatory pathways
6. Explain the biochemical basis of inherited disorders with their associated sequelae
7. Describe mechanisms involved in maintenance of body fluid and pH homeostasis
8. Outline the molecular mechanisms of gene expression and regulation, the principles of genetic engineering and their application in medicine
9. Summarize the molecular concepts of body defense and their application in medicine;
10. Outline the biochemical basis of environmental health hazards, biochemical basis of cancer and carcinogenesis
11. Familiarize with the principles of various conventional and specialized laboratory investigations and instrumentation analysis and interpretation of a given data
12. Suggest laboratory investigations to support theoretical concepts and clinical diagnosis.

**(b) Skills**

At the end of the course the student shall be able to:

Acquire skills required to consider relevant biochemical investigations for common clinical conditions & its interpretation

**(c) Integration**

Integrate all three preclinical subjects in teaching– learning and evaluation for better understanding of the subject and its correlation.

## COURSE CONTENT AND TEACHING HOURS

### A. TEACHING HOURS

**TOTAL: 250 HOURS**

**Theory:** 160 hours (80 Lectures+40 Small group teaching+40 Case based learning)

**Practical:** 70 hours

**Self-Directed learning (SDL):** 20 hours

**Early clinical exposure (ECE):** 30 hours (12 hrs clinical skills +18 hrs Basic science correlation)

Sl. No.	Teaching learning method	No. of Hours
1	Large group teaching	80
2	Small group teaching (SGT) (Small group discussions SGD/Tutorials/Seminars/Case based learning sessions/Integrated teaching sessions/Practical)	150
3	Self-directed learning (SDL)	20
4	<b>Total</b>	<b>250</b>
5	Early Clinical Exposure	30

### Knowledge

Sl No.	Topics with competency	No. of Teaching Hours	Core	Non-core
1	<p><b>Cell and organelles, Cell membrane, Transport across cell membranes (BI1.1)</b>  <b>Molecular and functional organization of a cell and its subcellular components.</b>  <b>Definition of cell, Difference between prokaryotic and eukaryotic cell</b>                      Composition and functions of cell                      Structure and Functions of different cell organelles such as Cell membrane, Nucleus, Cytoplasm, Mitochondria, Endoplasmic reticulum Ribosomes, Lysosomes, , Golgi apparatus, Peroxisomes                      Describe Plasma membrane structure with composition and function of membranes                      Discuss the Transport across the biological membrane</p> <p>Know Cell Fractionation, and Differential Centrifugation                      Know Marker Enzymes for different cell organelle</p>	03	Y	Y
2	<p><b>Chemistry of Proteins (BI 5.1, BI 5.2)</b>                      General structure of amino acids                      Classification of amino acids with examples                      General properties of amino acids                      Peptide bond formation with characteristic features                      Biologically important peptides with their function                      Classification of proteins                      Physical &amp; chemical properties of Proteins                      Structural organization of proteins: Primary, secondary, tertiary &amp; quaternary structure with forces stabilizing each structure, salient features, examples, significance                      structure-function relationships in relevant areas eg, hemoglobin and                      Methods employed in determining the protein structure                      Denaturation &amp; renaturation of proteins with significance</p>	06	Y	

Sl No.	Topics with competency	No. of Teaching Hours	Core	Non-core
	Non protein amino acids, Non alpha amino acids, D-amino acids			Y
3.	<p><b>Chemistry of Carbohydrates (BI3.1)</b>            Discuss and differentiate monosaccharides, di-saccharides and polysaccharides giving examples of main carbohydrates as energy fuel, structural element and storage in the human body            Definition Carbohydrates &amp; Mention the Biomedical importance of Carbohydrates            Classification of Carbohydrates with suitable examples.            The differences between monosaccharides, di-saccharides and polysaccharides with examples.            Isomerism, stereoisomers, enantiomers, Dia-stereoisomers, D and L isomers, optical isomerism            Mutarotation &amp; the mechanism for Mutarotation.            Chemical properties of carbohydrates such as tautomerisation, enediol formation, osazones formation.            Glycosides with examples &amp; mention their biomedical importance            Polysaccharide &amp; describe Homo &amp; Heteropolysaccharides with examples.            Proteoglycans and Glycoproteins with their Biomedical importance.</p>	05	Y	
4.	<p><b>Chemistry of Lipids (BI4.1, BI11.24)</b>            Definition, Modified Bloor's classification with examples. Biomedical importance of lipids            Fatty acids- Definition, examples and importance of Essential fatty acids, Mono and Polyunsaturated fatty acids, <math>\omega</math>3 and <math>n</math>6 fatty acids, Trans fatty acids.            Triacylglycerol composition and importance            Phospholipids - Types, functions with clinical importance Respiratory distress syndrome            Glycolipids – Types and importance Cholesterol - structure and biological importance            Lipoproteins - Types and functions Amphipathic lipids -            Definition, examples and importance, Liposomes</p>	05	Y	
5	<p><b>Enzymes ((BI2.1, BI2.3, BI2.4, BI2.5, BI2.6, BI2.7)</b>            Enzymes- Definition, General properties, IUBMB Classification. Coenzymes and Cofactors            Mechanism of Enzyme action - Concept of activation energy, transition state, binding energy, active site; Substrate binding to active site, Koshland's Induced fit theory            Factors affecting enzyme activity -Effect of substrate concentration -            Michaelis Menton theory, Km value, Vmax and its significance (derivation not required)            Enzyme specificity            Enzyme inhibition-            Competitive and Noncompetitive inhibition with examples of clinical importance            Suicide inhibition Enzymes as toxins Eg. Snake venom phospholipase Enzyme regulation by            Short term (Covalent modification, Zymogen activation,            Allosteric regulation, Feedback regulation) and long term regulation (Induction and repression)            Clinical Enzymology – Concept of plasma functional and non-functional enzymes            Diagnostic Importance of enzymes – LDH, CK, AST, ALT, ALP, GGT, Amylase,            Lipase, G6PD, Cholinesterase, ACP, 5' nucleotidase            Isoenzymes –Definition, Diagnostic Importance of isoenzymes with examples.            Enzymes as Therapeutic agents            Enzymes used in diagnostic assays Ribozymes</p>	08	Y	
7.	<p><b>Heme metabolism (BI6.11, BI6.12, BI5.2, BI11.17)</b>            Heme –Outline of Synthesis, porphyrias Degradation of Heme, Bilirubin metabolism –            synthesis, transport, conjugation, excretion Jaundice – definition, types, causes, lab diagnosis            Congenital hyperbilirubinemias            Hemoglobin – Adult, fetal and embryonic types Abnormal hemoglobins– carboxy, sulph, metHb.            Hemoglobinopathies            molecular defects, pathophysiological changes in thalassemias and sickle cell anemia</p>	6	Y	
8	<p><b>Extracellular matrix (BI9.1, BI9.2)</b>            Composition of ECM – Proteins (Composition and functions of Collagen, elastin,            fibrillin, fibronectin, laminin) and Proteoglycans.            Involvement of ECM components in health and disease.</p>	4	Y	

Sl No.	Topics with competency	No. of Teaching Hours	Core	Non-core
	Eg. Osteogenesis Imperfecta, Ehler Danlos syndrome etc			
9	<b>Chemistry of Nucleic acids (BI7.1)</b> Primary and secondary structure of DNA Structural forms (polymorphism) of DNA Specificity of the pairing of bases and Chargaff's rule, structure and Functions of RNA Differences between DNA and RNA	4	Y	
10	<b>Acid-Base balance (BI6.7, 6.8)</b> Concept of Acids, Bases and buffers, HH Equation and its application Regulation of pH of blood by buffers, respiratory and renal mechanisms Anion gap and its significance                      Acidosis and alkalosis (metabolic and respiratory) – causes, compensatory mechanisms and lab findings	6	Y	
11	<b>Immunology (BI10.3, BI10.4, BI10.5)</b> Cellular and humoral components of immune system Immunoglobulin -Classes, structure function relationship Innate and adaptive immune responses, self/non self-recognition Role of T-helper cells in immune responses Ig class switching Concept of Immune tolerance and Autoimmunity Antigens and concepts in vaccine development – types of vaccines, immunological basis of vaccine development, recombinant DNA technology in vaccine development.  Phases of vaccine development.	4	Y	Y
12	<b>Vitamins (BI6.5)</b> Definition, difference between water and fat soluble vitamins RDA, Sources, Metabolism, Biochemical functions, Deficiency manifestations, Hypervitaminoses of Fat soluble vitamins (A,D,E,K), Water soluble vitamins Vitamin C, Folic acid, Vitamin B12, Thiamine, riboflavin, Niacin, Pyridoxine, Biotin, Pantothenic acid Antivitamins	12	Y	
13	<b>Minerals (BI6.9, BI6.10)</b> Major elements and trace elements Sources, RDA, absorption and transport, Homeostasis, Functions, Biological reference range, disorders associated with – Calcium, phosphorus, Iron Functions and disorders associated with Copper, Zinc, Selenium, Fluoride, Iodine, Magnesium, Molybdenum.	6	Y	
14	<b>Biological Oxidation (BI6.6)</b> High Energy Compounds – Definition, Classification, biological significance. Transport of reducing equivalents across mitochondria Electron Transport Chain – Organization, components, flow of electrons. Oxidative Phosphorylation – Sites, mechanism (Chemiosmotic theory). Binding change mechanism of ATP synthesis by ATP synthase. Inhibitors of Electron Transport Chain and oxidative phosphorylation. Uncouplers and their significance. Brown adipose tissue metabolism. ATP-ADP cycle. Structure and organization of ATP synthase complex. Mitochondrial myopathies	6	Y	
15	<b>Carbohydrate Metabolism</b> Digestion and absorption Mechanism of absorption Lactose intolerance Glucose transporters Insulin dependent and Insulin independent uptake of glucose by tissues PATHWAYS – Significance, Site, reactions, key steps, energetics, regulation, inhibitors and associated disorders of <ul style="list-style-type: none"> <li>• Glycolysis, Rapaport Leubering cycle and its significance Citric acid cycle, Amphibolic role, Anaplerotic reactions</li> <li>• Gluconeogenesis, Cori's cycle</li> <li>• Glycogenesis, Glycogenolysis, Glycogen storage disorders</li> </ul>	14	Y	

Sl No.	Topics with competency	No. of Teaching Hours	Core	Non-core
	<p>Significance of HMP shunt pathway and uronic acid pathway Glucose-6-Phosphate dehydrogenase deficiency</p> <p>Galactosemia, Essential Fructosuria, Hereditary fructose intolerance</p> <p>Regulation of blood glucose levels in well fed condition and fasting/starvation</p> <ul style="list-style-type: none"> <li>Galactose and Fructose metabolism Details of Pyruvate dehydrogenase (PDH) reaction</li> </ul>			
16	<p><b>Lipid metabolism (BI4.2, BI4.3, BI4.4, BI4.6)</b></p> <p>Digestion and Absorption -Steatorrhea</p> <p>Biosynthesis and breakdown of triacylglycerol</p> <p>PATHWAYS – Significance, Site, reactions, key steps, energetics, regulation, and associated disorders of</p> <ul style="list-style-type: none"> <li>Beta oxidation</li> <li>Fatty acid synthesis-Fatty acid synthase multienzyme complex</li> <li>Ketogenesis, ketolysis</li> <li>Cholesterol biosynthesis upto mevalonate.</li> </ul> <p>Other types of Oxidation of fatty acids and associated disorders</p> <ul style="list-style-type: none"> <li>Lipoprotein metabolism Structure, Composition, Types, Functions, metabolism of Chylomicrons, VLDL, LDL, HDL Formation and functions of bile acids and bile salts Fatty liver and lipotropic factors</li> <li>Hyperlipoproteinemias -Biochemical basis of use of hypolipidemic drugs Prostaglandins – types and biomedical importance</li> </ul> <p>Lipid Storage Disorders</p>	11	Y	Y
17	<p><b>Protein and amino acid metabolism (BI5.3, BI5.4, BI5.5, BI11.17)</b></p> <p>Digestion and absorption and associated disorders</p> <p>Amino acid pool</p> <p>General reactions – Transamination, Transmethylation, Transdeamination, Deamination, Oxidative and nonoxidative and their significance.</p> <p>Biogenic amines</p> <p>Sources and fate of ammonia, Trapping, Transport and Disposal of ammonia, ammonia toxicity</p> <p>Urea cycle and its disorders.</p> <p>Amino acid metabolism</p> <p>Glycine – specialized products and their importance</p> <p>Phenylalanine, Tyrosine – metabolic pathway, synthesis of catecholamines. Pheochromocytoma</p> <p>Other specialised products formed from tyrosine and their importance</p> <p>Tryptophan synthesis of serotonin and melatonin and their importance Carcinoid syndrome</p> <p>Sulphur containing amino acids – functions of cysteine, methionine synthesis of SAM, SAH, Homocysteine</p> <p>Formation of Nitric oxide and its importance</p> <p>Inborn errors of metabolism – enzyme defects, clinical features, laboratory diagnosis and biochemical basis of management of – PKU, Tyrosinosis,</p> <p>Alkaptonuria, Albinism, Homocystinuria, Maple syrup urine disease (MSUD)</p> <p>Important functions/products from histidine, serine, Aspartate, Asparagine, glutamate, glutamine, serine, branched chain amino acids</p> <p>Polyamines Examples and importance</p>	12	Y	
18	<p><b>Metabolism and homeostasis (BI6.1, BI3.8, BI4.5, BI4.7, BI3.10, BI11.17)</b></p> <p>Metabolic processes taking place in specific organs in the body in fed, fasting and exercise states.</p> <p>Metabolic changes during starvation</p> <p>Adipose tissue – Hormones secreted from adipose tissue (adipokines – leptin, adiponectin) their functions and role in hunger and satiety.</p> <p>Diabetes mellitus – types, metabolic changes, complications.</p>	5	Y	

Sl No.	Topics with competency	No. of Teaching Hours	Core	Non-core
	Guidelines for diagnosis of Diabetes mellitus Artificial sweeteners list, use, metabolic effects(briefly) and concerns (to be discussed within context of their use in Diabetes Mellitus). Lipid profile, Dyslipidemia Atherosclerosis-definition, role of lipids in atherogenesis (LDL, Oxidised LDL, Lp(a), Small dense LDL, HDL) Lab tests in Myocardial infarction			
19	<b>Nucleotide metabolism (BI6.2, BI6.3, BI6.4)</b> Salvage pathways of Purine and pyrimidine synthesis Catabolism of Purines, Uric acid and its importance Etiology, manifestations and biochemical basis of clinical manifestations of – Gout, Lesch Nyhan syndrome  SCID, Oroticaciduria Diagnostic importance of Adenosine deaminase	5	Y	Y
20	<b>Nutrition and dietetics (BI8.1, BI8.2, BI8.3, BI8.4, BI8.5, BI11.17, BI11.23, BI11.24)</b> Energy content of food items BMR – Definition, Normal values, Factors affecting and biomedical importance SDA – Definition and significance (Thermogenic effect of food) Nitrogen balance Balanced diet – definition, composition Dietary fibers – definition, examples, importance Glycemic index – definition, calculation, importance Nutritional importance of Carbohydrates, Lipids, Proteins, Vitamins and minerals, commonly used food items including fruits and vegetables. Nutritional indices ,Calculation of calorie requirement Dietary advice for optimal health in childhood and adults, special conditions like diabetes, coronary artery disease, pregnancy. Types, causes and effects of Protein energy malnutrition Obesity – Definition, BMI, types, causes, role of GI peptides and adipokines in obesity, associated health risks (eg., metabolic syndrome)	6	Y	
21	<b>Plasma proteins (BI5.2)</b> Functions and clinical significance of plasma proteins Albumin, $\beta$ and $\gamma$ globulins. Acute phase reactants Positive and Negative (clinical significance) Biological Reference range of serum total protein, albumin, total globulin,C reactive protein Multiple Myeloma	2	Y	
22	<b>Organ function tests (BI6.13, BI6.14, BI6.15, BI11.17)</b> Functions of Liver, Kidney, Thyroid and adrenals. Liver Function Tests: Tests based on Synthetic, Excretory, and Role of enzymes in hepatic dysfunction Renal Function tests – Tests to assess glomerular and tubular functions Thyroid function tests Adrenal function tests	4	Y	
23	<b>Molecular Biology (BI7.1, BI7.2, BI7.3, BI9.3)</b>  Concept of Genomics, proteomics and metabolomics DNA Metabolism Cell cycle DNA replication prokaryotic and eukaryotic replication, requirements, process, inhibitors Telomere, Telomerase and its importance DNA repair mechanisms Diseases associated with DNA repair – Eg. Xeroderma Pigmentosum Mutations, causes, types of mutation, Consequences with examples RNA Metabolism -Transcription process Transcriptional units, promoter regions, RNA polymerases in prokaryotes and eukaryotes Differences between prokaryotic and Eukaryotic transcription Inhibitors of transcription process Post transcriptional modifications of all types of RNA Protein Biosynthesis -Genetic Code and its characteristics Requirements and activation of amino acids Translation in Eukaryotes Inhibitors of Translation	10	Y	

Sl No.	Topics with competency	No. of Teaching Hours	Core	Non-core
	<p>Post translational modifications, Protein folding –Role of Chaperones and Heat shock proteins, Regulation of Gene expression ,Gene, introns, exons, cistron</p> <p>Regulation of gene expression in prokaryotes with illustration of Lac Operon</p> <p>Regulation of gene expression in eukaryotes – Role of enhancers, repressors, DNA regulatory elements, gene amplification, gene rearrangement, RNA processing, RNA editing, mRNA stability. Role of transcriptional activators and co-regulators</p> <p>Alzheimers disease, Prion diseases</p> <p>Protein targeting and sorting with associated disorders Eg, I cell disease Epigenetics</p>			Y
24	<p><b>Molecular biology techniques and Gene therapy (BI7.4)</b></p> <p>Recombinant DNA technology, Hybridoma technology, DNA cloning process and application</p> <p>PCR technique and its application</p> <p>Blotting techniques -Concept, types and application of gene therapy.</p> <p>DNA Polymorphism, SNP, VNTR, RFLP</p> <p>DNA genomic and cDNA libraries -DNA Probes DNA Microarrays</p> <p>Overview of Human Genome Project HGP, Monoclonal antibodies and their application.</p>	3	Y	
25	<p><b>Biochemistry of Cancer (BI10.1, BI10.2)</b></p> <p>Cell cycle, regulation, abnormal cell growth, programmed cell death (apoptosis)</p> <p>Mutagens and carcinogens: Definitions, examples and their actions in carcinogenesis</p> <p>Protooncogenes and their activation, oncogenes, tumour suppressor genes and their role in development of cancer Oncogenic viruses (HPV and cervical cancer)</p> <p>Growth factors and their receptors</p> <p>Tumour markers and their importance in diagnosis and prognosis of cancer</p> <p>Biochemical basis of cancer therapy – alkylating agents, antimetabolites, topoisomerase inhibitors, antibiotics, hormones, receptor blockers, radiotherapy etc</p> <p>Estrogen and progesterone receptors and their clinical importance in breast cancer</p>	4	Y	Y
	<p><b>Endocrinology</b></p> <p>Mechanism of action of Group I and Group II hormones</p> <p>Cell signalling (action of hormones and growth factors)</p>	3	Y	
26	<p><b>Water and electrolyte balance (BI6.7)</b></p> <p>Distribution of water and electrolytes in ICF and ECF Osmolality of ECF</p> <p>Regulation of water and electrolyte balance</p> <p>Disorders of electrolyte imbalance – causes and clinical features of Hyperkalemia, Hypokalemia, Hyponatremia, Hyponatremia, Dehydration</p>	2	Y	
27	<p><b>Free Radicals and Antioxidants (BI7.6, BI7.7)</b></p> <p>Free radicals, Reactive oxygen species (ROS), Reactive nitrogen species (RNS)</p> <p>Damaging effects of ROS on biomolecules, lipid peroxidation</p> <p>Anti-oxidant defence system of our body – enzymes, vitamins, metabolites as antioxidants</p> <p>Role of oxidative stress in atherosclerosis, diabetes mellitus and cancer</p>	2	Y	
28	<p><b>Xenobiotics and Detoxification (BI7.5)</b></p> <p>Xenobiotics and disease caused. Biotransformation</p> <p>Phase –I reactions Oxidation Hydroxylation Cytochrome P450</p> <p>Phase- II reactions Conjugation reactions, Glucuronic acid, Glutathione, Glycine</p>	2	Y	

## Skills

**PRACTICAL: 35X2 = 70 hours**

Part 1: Qualitative Experiments – 9X2=18hrs

Part 2: Quantitative Experiments – 14X2=28hrs



Part 3: Demonstration Experiments – 12X2=24hrs

Sl. No	Type of Experiment	Suggested Teaching learning method Practical tests to be performed	No. of practical classes	Domain/ Level	Assessment method
<b>Part 1: Qualitative Experiments -9 Classes</b>					
1	Analysis of Normal constituents of urine BI11.3, BI11.4	constituents of urine BI11.3, BI11.4 DOAP sessions – Examine Physical properties, Inorganic constituents (Calcium, Phosphorus and Ammonia) and Organic constituents (Urobilinogen, Urea, Uric acid and Creatinine)	3	S/P	Qualitative analysis
2	Analysis of Pathological Constituents of Urine BI11.4, BI11.20	DOAP sessions - Physical examination, chemical tests for Glucose, Ketone Bodies, Blood, Proteins, Bile salts and Bile Pigments Demonstration by using Dip sticks	4	S/P	Qualitative analysis
3	Urine screening tests for Inborn errors of metabolism BI11.5, BI5.5	Newborn screening tests- Interpretation of laboratory reports	1	K/KH	OSPE/Viva
4	Calculate the energy content of food items 11.23	Small group discussion – Calculate	1	K/KH	OSPE/Viva
<b>Part 2: Quantitative Experiments - 14 Classes</b>					
1	Estimation of plasma glucose by Enzymatic method and Glucometer as point of care testing BI11.21, BI3.10	DOAP sessions -Perform and Interpret	2	S/P	Quantitative analysis
2	Estimation of serum and urine creatinine by Jaffe's method, Creatinine clearance BI11.7, BI11.21	DOAP sessions - Perform and Interpret	2	S/P	Quantitative analysis
3	Estimation of blood urea by Urease/ GLDH method BI11.21	DOAP sessions - Perform and Interpret	2	S/P	Quantitative analysis
4	Estimation of Total Protein and Albumin in serum by Biuret and BCG method, A:G ratio BI11.8, BI11.21	DOAP sessions -Perform and Interpret	2	S/P	Quantitative analysis
5	Estimation of Total cholesterol and High density lipoprotein( HDL) cholesterol BI11.9	Practical - Perform and Interpret	1	S/P	Quantitative analysis
6	Estimation of Triacylglycerols BI11.10	Practical - Perform and Interpret	1	S/P	Quantitative analysis
7	Estimation of Calcium and Phosphorous BI11.11	Practical - Perform and Interpret	1	S/P	Quantitative analysis
8	Estimation of Serum Bilirubin BI11.12	Practical - Perform and Interpret	1	S/P	Quantitative analysis
9	Estimation of AST, ALT activity BI11.13	Practical - Perform and Interpret	1	S/P	Quantitative analysis

10	Estimation of ALP activity BI11.14	Practical - Perform and Interpret	1	S/P	Quantitative analysis
<b>Part 3: Demonstrations -12 Classes</b>					
1	Lab safety and Biomedical waste disposal, Commonly used lab equipment, glassware and reagents BI11.1	small group discussion, lab visit	1	K/KH	Viva
2	Preparation of buffers and estimation of pH using pH meter BI11.2, 11.16, 11.19	Demonstration-Observe	1	K/KH	Viva
3	Colorimetry, Spectrophotometry BI11.6, BI11.18,	Demonstration-Observe	1	K/KH	Viva
4	Clinical chemistry autoanalyser and quality control (Internal and External quality control, Precision, Accuracy, QC rules), Biological reference intervals BI11.16, BI11.19	Demonstration-Observe and interpret	1	K/KH	OSPE/ Viva
5	Specimen collection and preanalytical errors in clinical Biochemistry lab	Collection Centre and lab visit	1	K/KH	Viva
6	Serum protein electrophoresis, types and applications BI11.16, BI11.19	Demonstration-Observe and interpret	1	K/KH	OSPE/ Viva
7	Paper chromatography/TLC of amino acids/sugars, types and applications BI11.5, BI5.5, BI11.16, BI11.19	Demonstration-Observe and Interpret	1	K/KH	OSPE/ Viva
8	Analysis of CSF BI11.15	Small group discussion - Interpret	1	K/KH	OSPE/ Viva
9	Estimation of serum electrolytes by ISE BI11.16, BI11.19	Demonstration-Observe and Interpret	1	K/KH	OSPE/ Viva
10	Blood gas analysis using ABG analyser BI11.16, BI11.19	Demonstration-Observe and Interpret	1	K/KH	OSPE/ Viva
11	Principle, procedure and applications of ELISA, protein extraction, Blotting techniques, PAGE BI11.16, BI11.19	Demonstration-Observe	1	K/KH	Viva
12	Principle, procedure and applications of PCR, DNA isolation BI11.16, BI11.19	Demonstration-Observe	1	K/KH	Viva

### **Certifiable Skills**

1. Perform urine analysis to estimate and determine normal and abnormal constituents
2. Demonstrate estimation of glucose in serum.
3. Demonstrate the estimation of serum creatinine and creatinine clearance
4. Demonstrate estimation of urea in serum.
5. Demonstrate estimation of serum proteins, albumin and A:G ratio

### **Early Clinical Exposure – 30 hrs**

#### **Classroom teaching- 18 hours**

1. Orientation to the Clinical Biochemistry Laboratory
2. Application of therapeutic and diagnostic enzymes in the medicine.
3. Biochemical basis of myocardial infarction (dyslipidemia, atherosclerosis, diagnostic tests)
4. Vitamin deficiency disorders
5. Biochemical changes in acid base disorders
6. Inborn Errors of Metabolism

### **Hospital/Lab Setting**

1. Diabetes Mellitus
2. Orientation to Molecular Biology techniques- Visit to cell biology and molecular genomics laboratory
3. Venipuncture
4. Biochemical changes in Chronic Renal Failure

### **TEACHING LEARNING METHODS**

Structured Interactive sessions, Tutorials, Small Group Discussions, Seminars, Projects, Self-Learning modules and e-modules etc.

### **SUGGESTED TOPICS FOR e- LEARNING MODULES**

- a. Mechanism of action of enzymes
- b. Oxygen and CO<sub>2</sub> (Transport of gases by Hemoglobin)
- c. Genetic Mechanisms
  - i. Organization of the Genome
  - ii. Replication
  - iii. Transcription
  - iv. Translation
  - v. Mutations and repair – Inherited diseases of metabolism
  - vi. Recombinant DNA technology

- d. Lipoproteins in Atherosclerosis
- e. Automation in a Clinical Biochemistry laboratory
- f. Principles of Immuno Diagnostic Tests and their interpretation.

### **SCHEME OF EXAMINATION**

Students must secure at least 50% marks of the total marks (combined in theory & practical) assigned for Internal assessment to be declared successful at the final university examination of that subject.

**Scheme for calculation of Internal assessment marks: 80**

<b>Theory (maximum marks)</b>	<b>Marks</b>	<b>Practicals</b>	<b>Marks</b>
Theory written paper	30*	Practical & viva	30**
Formative Assessment (Quiz, PAT, PCT, seminar)	10	Logbook +record	05
		Professionalism	05
<b>Total</b>	<b>40</b>		<b>40</b>

Please note:

\*Prior to submission to the University, the marks for each of the three internal examination theory assessments must be calculated out of 30 marks, regardless of the maximum marks.

\*\*\*Only the final marks out of 40 needs to be submitted to the University, separately for Theory and practical for each internal assessment.

### **Theory : 40 Marks**

Minimum of three internal assessments (IA) will be conducted at the end of each Block with other departments for 100 marks. Average of the Three IA marks is taken into consideration for calculating the final internal assessment marks.

Marks obtained by continuous Assessment tests like Quiz, PAT, PCT, seminar will be considered for theory internal marks

<b>Type of Questions</b>	<b>Number of questions</b>	<b>Marks for each question</b>	<b>Total</b>
MCQ's	20	1	20
Long Essay	2	10	20
Short Essay	6	5	30
Short Answer	10	3	30
<b>Total marks</b>			<b>100</b>

**Note:**

- **The third internal examination is the preliminary examination will be conducted on the lines of the university examination.**
- **Internal assessment will include questions from foundation course, Early Clinical exposure, AITO, AETCOM**
- **20% of the Internal assessment will be by MCQ's**

### **Practical/Viva : 40 Marks**

Three practical assessments will be conducted along with the Theory Internal Assessments. Average of three will be taken. Record maintenance & logbook assessed will be added to practicals. Professionalism will be a separate assessment & marks are considered for practicals.

**Certifiable skills:** will be evaluated as per checklist & certificate of accomplishment is awarded which is mandatory to take-up university exam. (**Annexure I**)

### **University examination**

#### **A. Theory : 200 Marks**

There shall be two theory papers of 100 marks each and duration of each paper will be of 3 hours. The pattern of questions would be of three types.

#### **Note:**

<b>Type of Questions</b>	<b>Number of questions</b>	<b>Marks for each question</b>	<b>Total</b>
Long Essay	2	10	20
Short Essay	10	5	50
Short Answer	10	3	30
<b>Total marks</b>			<b>100</b>

**Distribution of topics for Paper 1 and Paper 2 for University examination  
Topic wise weightage\***

<b>Sl No.</b>	<b>Paper 1 Topics</b>	<b>Weightage</b>
1.	Cell and its subcellular components, Transport mechanism across the cell.	5
2.	Enzyme	13
3.	Vitamins	13
4.	Chemistry of Carbohydrates	6
5.	Metabolism of Carbohydrates	13
6.	Chemistry of Proteins	6
7.	Metabolism of Proteins	13
8.	Nutrition	10
9.	Extracellular Matrix	3
10.	Immunology	6
11.	Intermediary Metabolism and Metabolism in starvation & well fed state	6
12.	Free radicals, Oxidative stress & antioxidants	3
13.	Detoxification	3

<b>Sl No.</b>	<b>Paper II Topics</b>	<b>Weightage</b>
1.	Biological oxidation	6
2.	Chemistry of Lipids	5
3.	Metabolism of Lipids	10
4.	Nucleic Acid chemistry	5
5.	Nucleotide Metabolism	8
6.	Chemistry & metabolism of heme	10
7.	Minerals	10
8.	Acid base balance & disorders	10
9.	Organ function tests	10
10.	Molecular biology	13
11.	Water and electrolyte balance	5
12.	Biochemistry of Cancer	5
13.	Clinical Chemistry	3

\*The topics assigned to the different papers are generally evaluated under those sections. However a strict division of the subject may not be possible and some overlapping of topics is inevitable. Students should be prepared to answer overlapping topics.

## **B. PRACTICAL-80 marks**

Exercise 1: OSPE - 40 Marks

No. of stations- 8

Marks for Each Station: 5

Time for each station: Max 5 min

<b>OSPE stations</b>	<b>Skills tested</b>
1.	Performance
2	Performance
3	Performance
4	Communication Skills
5	Knowledge
6	Knowledge
7	Clinical/ Laboratory interpretation
8	Clinical/ Laboratory interpretation

Exercise 2: Qualitative analysis of Normal or Pathological constituents of Urine - 10 Marks

Exercise 3: Case based Quantitative estimation and interpretation - 20 Marks

Exercise 4: Case charts (2X5) - 10 Marks

## **C. Viva-Voce Examination: 20 Marks**

The viva-voce examination shall carry 20 marks and all examiners will conduct the examination.

Portions of Paper I	10 Marks
Portions of Paper II	10 Marks

## **SCHEME OF MARKS DISTRIBUTION**

<b>Total Marks</b>	<b>380</b>
<b><u>University Examination :</u></b>	
<b>Theory</b>	
Paper – I	100
Paper – II	100
<b><u>University Examination :</u></b>	
<b>Practical</b>	80
<b>Viva voce</b>	20
<b>Internal Assessment</b>	
<b>Theory</b>	40
<b>Practical/viva</b>	40

### Criteria for passing university examination

- The student must **secure at least 40% marks in each of the two theory papers** with **minimum 50% of marks in aggregate** (both papers together) to pass.
- The marks obtained in the viva examination will be added to the practical marks.
- The student **must secure a minimum of 50% of marks in aggregate in the viva and practical examination** (both combined) to pass.
- Students must secure at least 50% marks of the total marks (combined in theory & practical) assigned for Internal assessment to be declared successful at the final university examination of that subject.

**Note:** There shall be **one main examination** in an academic year and a **supplementary** to be held **not later than 90 days** after the declaration of the results of the main examination.

## RECOMMENDED TEXT BOOKS AND REFERENCE BOOKS

### RECOMMENDED BOOKS

Sl. No	Title	Author	Publisher
1	Text book of Biochemistry	Vasudevan.D.M Sreekumari.S.	Jaypee
2	Biochemistry	Sathyanaranana.U Chakrapani.U	Elsevier
3	Principles and applications of biochemistry in medicine Text Book of Biochemistry	Rafi	Path Finder Medical Publishers
	Pankaj naik		
4	Practical manual	In-house	Department of Biochemistry, Sri Devaraj Urs Medical College
5	Practical Manual	SK Gupta	Arya



## REFERENCE BOOKS

Sl. No	Title	Author	Publisher
1	Harper's Biochemistry	Murray.R.K. Granner.D.K Mayes.P.A. Rodwell.V.W	Mc Graw-Hill
2	Illustrated Biochemistry	Champe.P.C Harvey.R.A	J.B.Lippincott Company
3	Principles of Biochemistry	Lehninger	LBS Publishers
4	Biochemistry: A case oriented approach	Montgomery	Mosby
5	Biochemistry with Clinical Correlations	Thomas Devlin	Willy Liss N Y
6	Clinical Chemistry	Bishop.M.L Duben-Engelkirk Fody.E.P	Lippincott Williams and Wilkins

### Annexure I

### Certifiable Skills

<b>Sl. No.</b>	<b>COMPETENCY NUMBER &amp; CERTIFICATIONS</b>	<b>TOPIC</b>
1.	BI11.4	Perform urine analysis to estimate and determine normal Constituents.
2.	BI11.4	Perform urine analysis to estimate and determine abnormal Constituents.
3.	BI11.20	Identify abnormal constituents in urine, interpret the findings and correlate these with pathological states.
4.	BI11.21	Demonstrate estimation of glucose
5.	BI11.21	Demonstrate estimation of urea
6.	BI11.7/ BI11.21	Demonstrate estimation of serum creatinine and creatinine clearance
7.	BI11.8/BI11.21	Demonstrate estimation of serum total proteins, albumin & A:G ratio