

***SCHEME OF EXAMINATION  
AND  
SYLLABUS  
(for the Academic Session 2019-2020)***

**B.Sc. (Part-II) Biochemistry**

**Bachelor of Science (B.Sc.)  
Biochemistry**

**Faculty of Science**



**UNIVERSITY OF KOTA**

**MBS Marg, KOTA (Rajasthan)-324 005**

**INDIA**

## **Bachelor of Science**

### **BIOCHEMISTRY** **(Three Year Course)**

#### **B.Sc. BIOCHEMISTRY**

1. The duration of the course will be three years.
2. There will be five theory papers in each year and each theory paper will carry 100 marks..
3. There will be practical examinations in each year & in first-four practical, 2nd year and 3<sup>rd</sup> year-3 practical. Each practical examinations will carry 100 marks each (25% marks in practical examinations will be reserved for internal assessment and viva-voce, respectively). Thus, total marks during the 3 years duration will be 1500 for theory examinations and 1000 for practical examinations.
4. The minimum pass marks for theory and practical examinations will be 45% AGGREGATE & individual 40%.
5. Practical exam duration will be 6 hrs. And Theory exams duration will be 3hrs.
6. For Theory papers of 100 marks, 3 hrs./week will be allotted.
7. For a practical paper of 100 marks, 6 periods will be allotted per week .

**Note:** The paper is divided into 5 independent units. The questions will be set from each unit. The candidates are required to attempt one question from each unit.

### **SCHEME OF EXAMINATION** **B.Sc. (Part-I) Biochemistry Examination**

Number of Paper	Code of Paper	Nomenclature of Paper	Duration of Examination	Max. Marks		
				Int.	Ext.	Total
<b>Theory Papers</b>						
Paper-I	BC-101	Physical Chemistry	3 Hours	--	100	100
Paper-II	BC-102	Organic & Inorganic Chemistry	3 Hours	--	100	100
Paper-III	BC-103	Physics	3 Hours	--	100	100
Paper-IV	BC-104	Mathematics & Statistics	3 Hours	--	100	100
Paper-V	BC-105	Introduction to Biology & Chemistry of Biologically Important Molecules	3 Hours	--	100	100
<b>Practical Papers</b>						
Paper-I	BC-106	Physical Chemistry	6 Hours	25	75	100
Paper-II	BC-107	Organic & Inorganic Chemistry	6 Hours	25	75	100
Paper-III	BC-108	Physics	6 Hours	25	75	100
Paper-IV	BC-109	Introduction to Biology & Chemistry	6 Hours	25	75	100

**SCHEME OF EXAMINATION**  
**B.Sc. (Part-II) Biochemistry Examination**

Number of Paper	Code of Paper	Nomenclature of Paper	Duration of Examination	Max. Marks		
				Int.	Ext.	Total
<b>Theory Papers</b>						
Paper-I	BC-201	Biochemical and Biophysical Techniques	3 Hours	--	100	100
Paper-II	BC-202	Proteins, Enzymes and Coenzymes	3 Hours	--	100	100
Paper-III	BC-203	Human Physiology and Endocrinology	3 Hours	--	100	100
Paper-IV	BC-204	Metabolism of Carbohydrates and Lipids	3 Hours	--	100	100
Paper-V	BC-205	Metabolism of Amino Acids, Nucleotides & Phorphyrins	3 Hours	--	100	100
<b>Practical Papers</b>						
Paper-I	BC-206	Bio-Physical Techniques	6 Hours	25	75	100
Paper-II	BC-207	Bio-chemical Techniques	6 Hours	25	75	100
Paper-III	BC-208	Enzymological Techniques	6 Hours	25	75	100

**SCHEME OF EXAMINATION**  
**B.Sc. (Part-III) Biochemistry Examination**

Number of Paper	Code of Paper	Nomenclature of Paper	Duration of Examination	Max. Marks		
				Int.	Ext.	Total
<b>Theory Papers</b>						
Paper-I	BC-301	Cell Biology	3 Hours	--	100	100
Paper-II	BC-302	Physiology	3 Hours	--	100	100
Paper-III	BC-303	Molecular Biology	3 Hours	--	100	100
Paper-IV	BC-304	Microbial Biochemistry & Immunology	3 Hours	--	100	100
Paper-V	BC-305	Clinical & Nutritional Biochemistry	3 Hours	--	100	100
<b>Practical Papers</b>						
Paper-I	BC-306	Clinical & Nutritional Biochemistry	6 Hours	25	75	100
Paper-II	BC-307	Physiology & Biochemistry	6 Hours	25	75	100
Paper-III	BC-308	Microbial Biochemistry, Immunology & Molecular Biology	6 Hours	25	75	100

## **Bachelor of Science**

### **BIOCHEMISTRY** (Three Year Course)

#### **Syllabus**

#### **B.Sc. (Part-II) Biochemistry**

#### ***Paper-I (BC-201): Biochemical and Biophysical Techniques***

**Duration : 3 Hrs.**

**Max. Marks :100**

**Min. Marks : 36**

Note: This paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit.

#### **Separation techniques:**

##### **Unit-I**

##### **Chromatography**

- |   |                               |
|---|-------------------------------|
| 1. Partition chromatography             | 2. Adsorption chromatography  |
| 3. Ion exchange chromatography          | 4. Thin layer chromatography  |
| 5. Molecular sieve (Gel chromatography) | 6. Hydrophobic chromatography |
| 7. Gas liquid chromatography            | 8. Affinity chromatography    |
| 9. High pressure liquid chromatography  |                               |

##### **Unit-II**

1. Salt and organic solvent fractionation.
2. Dialysis, reverse dialysis, ultra filtration
3. Electrophoresis – free flow, zone (disc, slab-SDS PAGE) and paper electrophoresis.
4. Isoelectric focusing
5. Centrifugation–centrifuge of various types, rotors, boundary, differential, density gradient.

#### **Instrumental methods:**

##### **Unit-III**

1. Spectrophotometry - UV, visible
2. Fluorometry
3. Radioactive counters, GM, liquid scintillation

##### **Unit-IV**

Radioisotopes in Biology, applications and precautions.

##### **Unit-V**

**Microbiology:** Types of media, selective and enrichment media, sterilization, cell counting, cell number, viable & non-viable, Growth, maintenance of cultures, staining procedures, plating, microtomy.

**Microscopy:** Compound, electron, phase contrast, confocal and Preparation of samples.

## ***Paper-II (BC-202): Proteins, Enzymes and Coenzymes***

**Duration : 3 Hrs.**

**Max. Marks :100**

**Min. Marks : 36**

Note: This paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit.

### **Unit-I**

**Peptide Bond:** Nature, identification and conformation. Primary, Secondary, tertiary and quaternary structure of proteins. N and C terminal determination, Ramachandran plot, peptide mapping with respect to myoglobin and hemoglobin.

**Characterization of Proteins:** Physicochemical (molecular weight, molecular size, isoelectric point, viscosity, Svedberg's coefficient), immunologic al and biological characteristics.

### **Unit-II**

**Purification of Protein:** Criteria for homogeneity for peptides and proteins, techniques for sequencing of proteins, Isoelectric point. Solid phase synthesis of proteins :

**Protein folding:** Role of molecular chaperone

**Enzymes:** Historical background and importance of enzymes. chemical nature of enzymes, enzymes as catalysts, Units of enzyme action, Turnover number, Assay of enzymes, Enzyme specificity, Concept of active centres, concept of holoenzyme, co-enzyme, apoenzyme and prosthetic groups.

### **Unit-III**

Enzyme classification and nomenclature.

**Purification of Enzymes:** Criteria of purity (affinity and ion exchange chromatography).

**Kinetics of enzyme catalyzed reactions:** Michaelis-Menten equation,  $V_{max}$ , significance of  $K_m$ , applicability of Michaelis-Menten equation, Methods of determination of  $K_m$  and  $V_{max}$  and their limitations, various factors influencing the rate of enzyme catalyzed reactions.

**Enzyme inhibitions:** Competitive, non -competitive, uncompetitive and mixed inhibitors, reversible and non-reversible inhibitions, suicide in activators.

### **Unit-IV**

Mechanism of enzyme catalysis (acid base and covalent catalysis, proximity effect, induced fit theory, catalysis, due to strain and distortion e.g. lysozyme, chymotrypsin and hexokinase two substrate reactions, general mechanisms (ordered and ping pong).

Chemistry and enzymatic function of water soluble vitamins such as riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid, lipoic acid, and ascorbic acid.

**Regulation of enzyme activity:** (a) Allosteric enzymes, feedback inhibitions, concerted and sequential model, homotropic effect, negative and positive cooperativity e.g. Atcase. (b) Zymogens, isoenzymes, multienzyme complexes. (c) Isoenzymes and their role in metabolism.

### **Unit-V**

Immobilized enzymes and their applications. Applications of enzymes for diagnostic purposes.

## ***Paper-III (BC-203): Human Physiology and Endocrinology***

**Duration : 3 Hrs.**

**Max. Marks :100**

**Min. Marks : 36**

Note: This paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit.

### **Unit-I**

**Introduction to Physiology and Hormones:** Cell signaling and mechanism of hormone action. Receptor families G protein linked receptors. Enzyme linked receptors (self & intracellular). Intracellular receptors. Steroid receptors & super-families. Thyroid hormone receptors. Signal transduction-cAMP, cGMP, Ca<sup>2+</sup>, IPS, DAG G proteins (RAS) Protein kinase (RAF, MAP Calmodulin, Prostaglandin).

**Ca<sup>2+</sup> Homeostasis:** Calcitonin, PTH, Vit. D<sub>3</sub>. Bone turnover and related pathophysiology Osteoporosis, Osteomalacia and Rickets. Pituitary hypophysial axis.

### **Unit-II**

Neuroendocrine Control of GI tract, Secretin and Gastrin family.

**Hepatic Physiology:** Functional anatomy of hepatic lobule, Detoxification, Bile secretion. Related pathophysiology-Obstructive and hemolytic jaundice.

### **Unit-III**

**Glucose Homeostasis-** Glucagon, insulin and glucocorticoid Related pathophysiology.

**Thyroid Hormones** - T<sub>3</sub> & T<sub>4</sub> related pathophysiology - Goitre, Cretinism, Myxedema.

### **Unit-IV**

Renal physiology, Nephron, Nau homeostasis - Aldosterone, Renin, angiotensin system, Kallikrein kinin system, Regulation of water balance, ADH, counter current mechanism, Related pathophysiology - Cushing's, Conn's, Diabetes insipidus

**Physiology of Blood and Cardiovascular System:** Imposition of blood Plasma, RBC Homeostasis, cardiac muscle and action Potential; Blood p assure regulation, blood -H gulation, blood brain barrier, Related patho-physiology, Anemia, thallemia, sickle cell anemia, atherosclerosis, hypertensions, Myocardial inferno, Stress - hormonal control.

### **Unit-V**

Adrenal medullary hormones, Parkinson's disease

**Growth and development** GH, insulin. Growth factors, EGF, NGF, IGF-1 & II.

**Reproduction**-male and female sex hormones, Reproductive cycle, Gestation, lactation and contraception.

## ***Paper-IV (BC-204): Metabolism of Carbohydrates and Lipids***

**Duration : 3 Hrs.**

**Max. Marks :100**

**Min. Marks : 36**

Note: This paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit.

### **Unit-I**

Dynamic state of body constituents, General features of regulation of metabolism. Sources of carbohydrates, Glycolysis, Gluconeogenesis, Enzymatic and hormonal control of glycolysis, and gluconeogenesis. Alcoholic fermentation, Pasteur and Crabtree effect. Futile cycles Metabolism of 2,3 diphosphoglyceric acids.

### **Unit-II**

Tricarboxylic acid cycle, regulation of TCA cycle, Design of TCA cycle and nutritional consequences. Hexose monophosphate shunt and its regulation. Metabolism of glycogen, glycogenolysis and glycogenesis and regulation of glycogen metabolism. Synthesis of sugars in plants, Calvin cycle, Hatchin Slack Cycle

### **Unit-III**

General outlines of lipid metabolism, Digestion and absorption. Enzymatic hydrolysis in intestine. Enzymatic resynthesis in intestine. Packaging into chylomicrons. Uptake of fatty acids from circulating chylomicrons by tissues, role of lipoprotein lipase.

### **Unit-IV**

**Mobilization of Triglycerides:** Hydrolysis of TG to FFA in adipose tissues by hormone sensitive lipase. Resynthesis of TG from FFA in adipose tissues and role of carbohydrate metabolism. Transport of net free fatty acids from adipose tissues as FFA albumin complex and uptake of FFA by tissue.

### **Unit-V**

**Oxidation of Fatty Acids:** Activation of Fatty acids, Entry of long chain fatty acyl CoAs into mitochondrial matrix. Beta-oxidation, Oxidation of unsaturated fatty acids. Beta-oxidation of fatty acids in mitochondria and in peroxisomes. Formation of ketone bodies, Oxidation of ketone bodies, Ketosis, Propionic acid metabolism. Biosynthesis of fatty acids, Biosynthesis of phosphoglyceride, Sphingolipids. Diseases of lipid metabolism, Refsum disease, Respiratory distress syndrome, ganglioside breakdown, fatty livers, Synthesis of cholesterol, bile acids and bile salts, biosynthesis of eicosanoids.

## ***Paper-V (BC-205): Metabolism of Amino Acids, Nucleotides & Phorphyrins***

**Duration : 3 Hrs.**

**Max. Marks :100**

**Min. Marks : 36**

Note: This paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit.

### **Unit-I**

**Amino Acids:** Nitrogen cycle - Protein calorie malnutrition. Outlines of amino acids metabolism. Fixation of nitrogen, mechanisms of reduction of elemental nitrogen, incorporation of ammonia into amino acids, uptake of amino acids by cell. Urea synthesis. Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids.

### **Unit-II**

Metabolism of one-carbon atom groups. Role of pyridoxal phosphate. Precursor functions of amino acids. Synthesis of creatine, creatine phosphate and creatinile. Synthesis of amines -

Spermine, spermidine, epinephrine, nor-epinephrine, Serotonin, GABA, Glutathione. Synthesis of non-essential amino acids, Nitrogen balance.

### Unit-III

Disorders of amino acids metabolism, Phenylketoneuria, Alkaptonuria, Mapiesyruap disease, Parkinson's diseases. Metabolism of purine and pyrimidine nucleotides. Biosynthesis of purine nucleotides, Biosynthesis of IMP, pathway from IMP to AMP and GMP, conversion to triphosphates, regulation of purine, nucleotide biosynthesis, salvage pathways.

### Unit-IV

Biosynthesis of pyrimidine nucleotides. Biosynthesis of UMP, conversion of triphosphate, Regulation of pyrimidine nucleotide synthesis, Biosynthesis of deoxyribonucleotides, biosynthesis and formation of coenzyme nucleotides. Anticancer drugs.

### Unit-V

Degradation of purine and pyrimidine nucleotides. Digestion of nucleic acids, degradation of mononucleotides catabolism of purines, catabolism of pyrimidines. Disorders of purine and pyrimidine biosynthesis - Lesch Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency. Classification, structure and biological function of porphyrins.

## *Chemistry Practical Courses*

### **Paper-I (BC-206): Bio-physical Techniques (Max Marks 100)**

1. Measurement - Criteria of reliability, precision, accuracy, sensitivity, specificity
2. Laboratory rules and safety regulation - First Aid.
3. Principles of Colorimetry
  - i. Verification of Beer's law, estimation of protein and phosphate.
  - ii. Finding out  $X_{max}$ . Relation between O.D. and % transmission. pH, pK, Henderson's equation.
4. Determination of - pH optimum, Temperature optimum,  $K_m$  value,  $V_{max}$  value, Effect of inhibitor (Inorganic phosphate) and measurement of  $K_i$ .

### **Paper-II (BC-207): Bio-chemical Techniques (Max Marks 100)**

1. Preparation of buffer.
2. Separation of Amino acids by paper chromatography.
3. Isolation of phospholipids from liver and their separation on thin layer chromatography (TLC).
4. Separation of hemoglobin and potassium dichromate by gel filtration.
5. Ion exchange chromatography- CM cellulose, DEAE cellulose.
6. SDS poly acrylamide Gel electrophoresis. (SDS-PAGE)

### **Paper-III (BC-208): Enzymological Techniques (Max Marks 100)**

Isolation of enzyme Acid Phosphatase from germinating lentils (moong) using  $(NH_4)_2SO_4$  precipitation and its assay using p-nitrophenyl phosphate and calculation of specific activity.

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