University of Rajasthan
Jaipur

SYLLABUS

M.Sc. BIO-CHEMISTRY

(Annual Scheme)

M.A./M.Sc. (Previous) Examination 2021

M.A./M.Sc.(Final) Examination 2022

Raj Jain
Dy. Registrar (Acad.)
University of Rajasthan
JAIPUR

us : M.Sc. Biochemistry

UNIVERSITY OF RAJASTHAN
JAIPUR- 302 004
(TWO YEAR COURSE-ANNUAL SYSTEM)

URSE OUTLINE AND SCHEME OF EXAMINATION FOR

M.Sc. BIOCHEMISTRY

(Previous) Biochemistry

	Title of the Paper	Hours of Exam.	Max. Marks
	Cell Biology and Physiology	3	100
	Chemistry of Biomolecules	3	100
	General Metabolism	3	100
	Enzymology and Bioenergetics	3	100
	Endocrine Biochemistry	3	100
	Biochemical techniques and Computational Methods	3	100
e		12 (Spread up in two days)	200
			800

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COURSE OUTLINE AND SCHEME OF EXAMINATION FOR
M.Sc. BIOCHEMISTRY

M.Sc. (Final) Biochemistry

Paper No.	Title of the Paper	Hours of Exam.	Max. Marks
P-VII	Biochemical genetics and DNA replication	3	100
P-VIII	Protein synthesis and regulation	3	100
P-IX	Microbial Biochemistry and Virology	3	100
P-X	Immunology	3	100
P-XI	Biotechnology	3	100
P-XII	Genetic Engineering	3	100
Lab Course		12 (Spread up in two days)	200
			800

PAPER-I : CELL BIOLOGY AND PHYSIOLOGY

UNIT-I CELL STRUCTURE AND COMPOSITION

Evolution of molecules and cells. Prebiotic origin of organic molecules. Characterization of prokaryotic and eukaryotic cells, mycoplasma, viruses, viroids and virusoids. Structural organization of cells. Development of cell theory and levels for organization in Biology. Dynamic nature of cell constituents and their functions. The nucleus and chromosomes. Relations between nucleus and cytoplasm. Chemistry of nucleus and nucleolus. Localisation of nucleic acid. Chemical nature of the gene and comparision of the genome in bacteria, viruses and eukaryotic cells.

Cell cycle. Events in cell cycle. Synchronized cell division and methods to achieve it. Synthesis of international molecules during cell cycle. Regulation of transition from G1 to S and G2 to M phases of cell cycle. Cytokinesis in plant, animal and bacterial cells. Accelerating and blocking cell division CDC mutants. Cell culture methods. Growth studies on single cells. Measuring growth rates of cells, growth of plants and animal cells in tissue culture. Culture of cancer cells. Unbalanced growth and regulation of growth. Cell death.

UNIT-II WATER ELECTROLYTE AND ACID BASE BALANCE

Water turnover and balance functions of distributions of body water. Water intake and output. Electrolyte balance. Electrolyte composition of body fluids. Osmolarity and osmolality of body fluids, regulation of electrolyte balance. Acid base balance. Maintenance of blood pH, blood buffers, respiratory and renal mechanisms of pH regulation. Disorders of acid-base balance-acidosis and alkolosis.

UNIT-III LIVER AND KIDNEY FUNCTIONS AND THEIR TESTS

Functions of liver, tests based on the secretory, excretory,

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...gation carbohydrates, protein and lipid metabolic functions ...er Formation of urine, physical characteristics, normal and ...normal constitutents of urine. Renal function test.

UNIT-IV BIOMEMBRANES

...mposition and structure of cell membranes, Membrane lipids, ...d bilayers. Membrane proteins–their location and function. ...gar moieties of membranes, Glycoprotenis and glycolipids, ...lecular models of cell membranes and liposomes. Membrane ...dity and membrane fusion. Membrane asymmetry. ...nstitution of functional membranes system from purified ...mponents. The RBC membrane. Glycophorin. Transmembrane ...ers. Cell permeability and transport. Functions of Na^+/K^+ AT... ...se and sodium transport. Transport proteins and carriers. ...compartmentation of cell by membranes.

UNIT-V TRANSPORT MECHANISMS

...sport across cell emmbranes. Permeation at the expense of ...etic energy. Metabolically coupled active transport. Bulk ...sport by endocytosis, phagocytosis, phagotrophy, autotrophy, ...ocytosis and excytosis. Adenyl cyclase, permease and other ...brane bound enzymes. Control of membrane fluidity. Action ...entials of cells. Nature of nerve impulse. Metabolism of nerve ...at rest and in activity. Action potentials in the muscle fibres ...in excitable plant cells. Development, propagation and ...smission of action potential across the synapsis and the ...neuromuscular junctions. Contractility and its chemical basis. ...structural proteins of muscle cells and their organization. The ...sliding mechanism of muscle contraction. Role of calcium ions in ...muscle contraction.

PAPER-II : CHEMISTRY OF BIOMOLECULES

UNIT-I CHEMISTRY OF CARBOHYDRATES

...emistry and classification of carbohydrates. Monosaccharides, ...d saccharides and oligosaccharides. Stability and formation of ...cosidic bond. Configuration and conformation. Polysaccharides. ...rage and structural polysaccharides and Glycosominolycans ...heparin, hyaluronic acid and others) Structural determination of polysaccharides, glycoproteins and glycolipids. Blood group substances. Acid-mucopolysaccharides and proteoglycans.

UNIT-II LIPIDS

The molecular structure and behaviour of lipids. Classification of lipids. Chemistry of fatty acids, triacyl glycerols, waxes, glycerol phospholipids, sphingolipids, glycosphingolipids, cerebrosides, cholesterol. Bile acids and bile salts. Biological role of neutral fats, phospholipids, cholesterol. Structure and biological role of lipoproteins. Liposomes. Structure and functions of prostaglandins, prostancilins, leukotrienes.

UNIT-III PORPHYRINS AND VITAMINS

Structure and functions, porphyrins heme and chlorophyll. Vitamins-Discovery and importance of vitamins. Classification, chemistry. Biological role and deficiency disorders of vitamins.

UNIT-IV CHEMISTRY OF AMINO ACIDS AND PROTEINS, STRUCTURE AND CONFORMATION

Introduction to proteins, chemistry and properties of the amino acids, properties of amino acid side chains, modified and unusual amino acids. Peptides and the peptide bond, stability and formation of the peptide bond. Proteins–structure and classification. Introduction to chemical modification of proteins. Isolation, purification and criteria of proteins. Peptide synthesis–solution and solid phase methods.

Amino acid analysis of proteins. Primary structure, determination of the N and C terminal residues of a protein, sequence determination of a protein. Secondary structure–peptide foldings. peptide mapping. Ramachandran plots. Fibrous proteins–keratins, collagen. Globular proteins–Tertiary structure–Functional diversity. Myoglobin, hemoglobin and Rnase–structural features. Quaternary structure of proteins. Determination of molecular weights and number of sub units in a protein.

UNIT-V NUCLEIC ACIDS-I

Chemistry of Nucleic acids. Structure and properties of purines, pyrimidines, nucleosides and nucleotides. Nomenclature for base derivatives and polynucleotides. Structure of nucleic acids. Ribo and deoxyribonucleic acids. Base composition, helical molecules,

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...ic helical structure (B, A and Z forms). Forces stabilizing ...ic acid structure, elementary treatment of supercoiled. ...duction to t-RNA structure. Physicochemical properties of ...ic acids. Spectral characters, thermal denaturation and ...ring. Action of acid, alkali and enzymes on nucleic acid structure. Fractionation and analysis of nucleic acids. Solution ...ds, chromatography, electrophoresis, centrifugation, blotting techniques and autoradiographic methods. Nucleoproteins. Basic features of eukaryotic chromosomal structure–DNA binding proteins.

PAPER-III: GENERAL METABOLISM

UNIT-I CARBOHYDRATE METABOLISM-I

Glycolysis and fermentation, different forms of fermentation, Pasteur, Crabtree and Warburg effects. Control of glycolysis in muscle. Metabolism of fructose, galactose and mannose. Reaction of TCA cycle, energy yields and central importance of the cycle. Pyruvate dehydrogenase mutienzyme complex and its regulation. Regulation of TCA cycle and its amphibolic nature, Anaprerotic reactions. Glucoenergenesis and its regulation.

UNIT - II CARBOHYDRATE METABOLISM-II

The glyoxylate cycle. Glyoxylate shunt, lactose and sucrose synthesis. ...oprotein synthesis. HMP shunt, Glucoronic acid cycle, Glycogen metabolism and its regulation, Defects in carbohydrate metabolism and its regulation. Glycogen storage diseases, ...emia, galactosuria, lactose intolerance. Regulation of blood glucose and diabetes. Mucppolysaccharide disorders.

UNIT-III LIPID METABOLISM-I

Lipids as energy reserves. Utilization of triacylglycerols in animals. Fat digestion and absorption. Transport of fat to tissues. Lipoproteins. Mobilization of stored fat. Fatty acid oxidation–α, β and W. Energy yields from fatty acid oxidation. Oxidation of unsaturated fatty acids and fatty acids with odd numbered carbon ...ms. Control of fatty acid oxidation, role of cornitine, Ketogenesis.

UNIT-IV LIPID METABOLISM-II

Fatty acid biosynthesis. Elongation of fatty acid chains. Fatty acid desaturation. Control of fatty acid synthesis. Biosynthesis of triacylglycerols. Metabolism of phospholipids and glycolipids. Cholesterol transport and utilization. Biosynthesis of cholesterol and its regulation. Biosynthesis of bile acids. Metabolism of arachidonate, eicosanoids, prostaglandin's thromboxanes and leukotriens. Disorders of lipid metabolism (Ketosis, Niemann-Pick disease, Gaucher's disease, hyper cholesterolemia, hyper and hypolipoproteinemia, fatty liver, obesity and atherosclerosis).

UNIT-V AMINO ACID AND NUCLEOTIDE METABOLISM

Nitrogen metabolism. Nitrogen cycle, biological nitrogen fixation. Utilization of ammonia. Biogenesis of organic nitrogen. General reactions in amino acid metabolism. Role of pyridoxal phosphate. Urea cycle and its regulation. Protein turnover. Metabolism of essential and non-essential amino acids. Genetic disorders of amino acid metabolism. Metabolism of heme. Biogenic amines. Metabolism and role of glutathione tetrahydrofolate cofactors and metabolism of C-1 units. Metabolism of purines and pyrimidines and their regulation. Biosynthesis of deoxyribonucleotides and its regulation. Disorders of nucleotide metabolism-Gout, Lesca-Nyhan syndrome and orotic aciduria. Biological and medical importance of nucleotide analogs.

PAPER-IV : ENZYMOLOGY AND BIOENERGETICS

UNIT-I BIOCATALYSIS

Introduction to enzymology, nomenclature and classification of enzymes, properties of enzymes, enzyme assay and units of activity. Isolation and purification of enzymes. Factors affecting the rate of enzyme catalyzed reactions. Isozymes and zymogens. Enzyme inhibitors. Feed-back inhibition and regression. Allosteric inhibition catalytic RNA.

UNIT-II ENZYME KINETICS

Chemical kinetics, Michaelis-Menten and Briggs-Haldane kinetics. Determination of K_m. Analysis of kinetic data. Importance of

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K_m and V_{max} ccenzymes and their role in metabolism. Reversible reactions.

UNIT- II ENZYMOLOGY

Classification of catalytic mechanisms. Acid-base, covalent, proximity and orientation. Transition state binding and metal ion effects of enzyme catalysis. Metal ion and electrostatic catalysis. Structure and nature of active site. Chemical modification of active site. Mechanism of catalysis of Rnase, lysome, chymotrypsin, trypsin, papain and carboxypeptidase.

UNIT-IV ENZYMOLOGY-II

Coenzymic catalysis. Mechanism of pyridoxal phosphate and thiamine pyrophosphate dependent enzymes. Metabolloenzymes. Brief description of H-II and Scatchard plots. Allosteric regulation of enzyme activity. Models of monod and kashland for allosteric regulation. Regulatory features of aspartate transcarbamylase, glutamine synthetase and ribonucleotide reductase.

UNIT V BIOENERGETICS AND PHOTOSYNTHESIS

Biological oxidations. Free energy changes and high energy compounds. Redox potentials. Biological redox systems. Electron transport chain, components and importance. Substrate level and oxidative phosphorylation. Mechanism of oxidative phosphorylation. Energy change and states of oxidative phosphorylation. ATP generation from carbohydrate and fatty acid oxidation. Cytochrome P450 and microsomal oxidations. Bioluminescence.

Photosynthesis pigments and organelles. Photosynthetic electron transport. Calvin cycle. Quantum efficiency, Regulation of photosynthesis, C3 and C4 plants, HSK pathway, Cyclic and non-cyclic photophosphorylation. Photorespiration. Bacterial and anoxygenic photosynthesis.

PAPER-V : ENDOCRINE BIOCHEMISTRY

UNIT-I ENDOCRINE SYSTEM

Organization of the endocrine system. Biosynthesis, processing and secretion of hormones. Classification of hormones. Disorders of endocrine function. The second messenger concept and

mechanism of hormone action. Hormone receptors. Up and down regulation of receptors. Insulin, glucocorticoid and adrenergic receptors. Super family of steroid and thyroid hormone receptors. Growth factors, chemistry and functions of IGF-I and II NGF, EGF and PDGF.

UNIT-II HYPOPHYSIS, HYPOTHALAMUS AND RELATIONSHIP, PINEAL

Classification, chemistry, functions and regulation of anterior and posterior pituitary hormones. Role of hypothalamus in control and regulation of endocrine orchestra. Hypothalamo-hypophyseal relationship. Chemistry, biosynthesis, regulation and functions of Pineal.

UNIT-III THYROID, PARATHYROID, THYMUS AND OTHER GLANDS

Biosynthesis, regulation chemistry and functions of thyriod hormones. Hormones that regulate Ca^{++} and phosphate metabolism. Parathyroid and calcitrol hormones, calcitonin. Chemistry, biosynthesis, regulation and functions of thymus. Melatonin endocrine role of kidney, Mechanism of erethropoietin, gastrointestinal hormones.

UNIT-IV PANCREAS AND ADRENALS

Chemistry, biosynthesis, regulation and functions of pancreatic hormones. Chemistry, biosynthesis, regulation and functions of hormones of adrenal cortex and medulla.

UNIT-V GONADS AND REPRODUCTION

Chemistry, biosynthesis, regulation and functions of androgens and estrogens. Hormonal and physiological changes in human ménustrual cycle. Placenta as Endocrine Gland. Introduction to oral contraceptives. Gastrointestinal hormones.

PAPER-VI : BIOCHEMICAL TECHNIQUES AND COMPUTATIONAL METHODS

UNIT-I SPECTRO-PHOTOMETRY AND CHROMATOGRAPHY

Concepts of spectroscopy, visible and UV spectroscopy. Laws of photometry. Beer Lambert law. Principles and applications of colorimetry, Fluorimetry, Atomic absorption spectro-photometry

Basic principles and applications of UV, IR, ESR, NMR and mass spectroscopy. Chromatography, Principles and partition, Paper and thin layer chromatography, Ionexchange chromatography, Gel permeation chromatography, GC and HPLC.

UNIT-II METABOLIC TECHNIQUES

Principles of centrifugation. Concepts of RCF. Different types of instruments and rotors. Preparative, differential and density gradient centrifugation. Analytical ultracentrifugation, determination of molecular weights and other applications. The oxygen electrode. Organ perfusion. Use of experimental animals, tissues homogenates and mutant organisms in the study of intermediary metabolism. Stable and radioactive isotopes, Concepts of half life and decay. Use of various isotopes in metabolic studies.

UNIT-III RADIOACTIVITY

Radioactivity, Principles of scintillation counting. GM counters. Applications of isotopes. Isotope dilution technique. Autoradiography. Turnover studies. Precursor-product relationship. Production of radio-labelled biomolecules. Calculations involving isotopes. Radiation hazards and methods for contaminant prevention.

UNIT-IV ELECTROPHORESIS AND MICROSCOPY

Principles of electrophoretic separation. Zonal and continuous electrophoresis. Paper, cellulose acetate/nitrate, gel and capillary electrophoresis. Use of native and denaturating gels. Isoelectric focussing and two dimensional gel electrophoresis. Electroporation. Pulse field gel electrophoresis. Gradient gels. Microscopy : Basics of phase contrast, polarization, fluorescence and electron microscopy. Confocal microscopy. Cell-sorting and FACS.

UNIT-V STATISTICS AND COMPUTER SCIENCE

Statistics, Introduction to statistics. Probability and randomness. Distribution. Normal ploisson and binominal Mean, mode and range. Standard Deviation and error, Regression coefficient and use regression for linear data. Experimental design, sampling. Methods of Data Presentation. Graphs and histograms. Tests of significance, Correlation, coefficient of variation. Student's 'T' and Chi_2 test.

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Elements of computer science, general awareness of development of computers, Mainframe, mines, micro's and super computer systems. CPU and peripherals I/O auxillary storages. Software and programming languages (Machine, assembly and higher level) popular software packages for use in biology. Networking concepts and its use in data search.

LAB COURSE-I

A. BASIC BIOCHEMICAL METHODS

1. Orientation. Units in biochemistry, calibration of volumetric glassware, introduction to biochemical instrumentation. Care and handling of instruments. Colorimetry and spectrophotometry. Verification of Beer-Lambert's law and deviations. Parts of a colorimeter and spectrophotometer. Care and use of cuvettes. Determination of molar extinction coefficients of NAD, NADH, tyrosine, tryptophan, adenine, etc.
2. Determination of absorption spectra of compounds such as proteins and nucleic acids. Preparation of standard solutions. Calibration graphs, methods of plotting data. A typical colorimetric estimation such as Biuret method and proteins. Preparation of buffers. Use of pH meters. Qualitative test for amino acids, carbohydrates and lipids. Estimation of amino acids using the ninhydrin reagent.
3. Dialysis experiments. Ascending and descending paper chromatography. Separation and identification of sugars and amino acids. Paper electrophoresis. Separation of amino acids. Cellulose acetate electrophoresis, Separation of proteins, Polyacrylamide gel electrophoresis.
4. Thin layer chromatography. Separation of lipids, purines, pyrimidines and their quantitation. Ion exchange chromatography. Quantitative separation of amino acids, nucleosides using Dowex 1 and Dowex 50 resins, Gel filtration; Separation of blue dextran and cobalt chloride on Sephadex G25 or similar experiment.

B. CLINICAL BIOCHEMISTRY

1. Determination of hemoglobin content in blood. Osmotic fragility, PCV, ESR, differential counts. Determination of blood-glucose by Hagedorn-Jensen methods by Nelson-Somogyi method and glucose oxidase method. Glycosylated hemoglobins.

... of serum transaminase. Determination of bilirubin and ... Qualitative tests for normal and abnormal urinary ... Determination of urinary creatine and creatinine.

3 ... estimation by Micro-Kjeldahl Method. Total nitrogen ... in humans, balance studies.

4 ... mination of Vitamin 'A' in foods. Estimation of Vitamin 'C' in ... fruits both titrimetric and colorimetric methods. Estimation ... amine in foods by fluorimetry.

LAB COURSE-II

A. ANALYTICAL METHODS

1 Preparation of buffers.

2 Biochemical preparations. Preparations of egg albumin, casein, ... amine, cysteine, ATP glycogen, Preparation of DNP amino ... and separation by TLC and quantitative identification.

3 ... ermination of calcium as calcium oxalate. Determination of ... food stuffs by colorimetry. Use of atomic absorption ... spectrophotometer to determine Na and K in serum. ... Determination of Na and K by flame photometry. Determination ... Mg in biological samples. Methods of cell distruption. Preparation of tissue homogenates using different homogenizers.

... analysis. Determination of lipid content in oil seeds. ... glyceride coimposition by TLC in germinating seeds.

B. CARBOHYDRATE AND LIPID ANALYSIS

1 Isolation of glycogen from liver. End group analysis by periodate oxidation and determination of average chain length of glycogen.

2 Differential analysis of sugars in a mixture. Use of polarimetry for configurational analysis of carbohydrates. Estimation of sucrose.

3 Extraction and adsorption column chromatography of plant pigments. TLC and GC analysis of lipids. Determination of iodine number, saponification and acid value of a fat.

4 Isolation of cholesterol from brain and its estimation. Preparation and analysis of sphingomyelin.

M.Sc. (Final) BIOCHEMISTRY

PAPER-VII : BIOCHEMICAL GENETICS AND DNA REPLICATION

UNIT-I HERIDITY AND GENETIC ANALYSIS

Basic concepts of Mendelian and non-Mendelian inheritance. Importance of meiosis in heridity. Sex linked inheritance. Polygenic and maternal inheritance.

Somatic and germinal cell mutations. Different kinds of mutation (Forward and back, point, frameshift, deletion mutations) Conditional mutants, resistance mutants. Suppressor mutations. Chromosomal mutations. Detection, selection and isolation of mutants. Mutation rates. Mechanism of action of mutagens. Polyploidy. Site directed mutagenesis. Photoreactivation and mechanisms for repair of UV damaged DNA (Post replication and SOS repair).

UNIT-II GENOME ORGANIZATION

Genome organization in procaryotes and eucaryotes. Plasmids, transporons, insertion sequences and retroposons. Mitochondrial and chloroplast DNA. Benzer's fine structures of rII loci. Organization of eucaryotic chromosomes. Histones and non-histone type DNA binding proteins. Nucleosomes and higher order structures. C-value pradox and the significance of introns. Single copy genes, repeating sequences, and tandem gene clusters. r-RNA genes, histone genes and immunoglobulin genes. Selfish DNA.

UNIT-III MUTATIONS, RECOMBINATION AND GENE TRANSFER

Mutations. Different kinds of mutations. Isolation of mutants, phage mutants, host range rapidlysis and temperature sensitive mutants. Mechanism of mutants. Gene transfer mechanisms, transformation, trasduction. (generalized, abortive and specialized). Conjugation $F^+ \times F^-$ Hfr strains. Mechanism of recombinant and cross over. Elements of gene mapping. Mapping by recombination analysis, multiple cross over and interference. Circular chromosome and mapping by conjugation. Tetrad and complement analysis Mapping by transformation and transduction. Map units and cytological maps of eukaryotic chromosomes. Somatic cell genetics.

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