

**JAWAHARLAL INSTITUTE OF POSTGRADUATE  
MEDICAL EDUCATION & RESEARCH  
(JIPMER)  
PUDUCHERRY**



**MSc MEDICAL BIOCHEMISTRY  
CURRICULUM**

**2021**

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## **JIPMER**

Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER) under Government of India since the year 1956, is one of the leading Medical Institutions of India. Spread over a sprawling 195-acre campus in an urban locale of Puducherry (formerly Pondicherry), JIPMER is 170 kms by road from Chennai.

JIPMER has been declared as an “Institution of National Importance” by an Act of Parliament, JIPMER, Puducherry, Act, 2008. A copy of the Act was Gazette notified on 14-7-2008 to enforce this Act. Prior to this, the Institute was functioning under the administrative control of Directorate General of Health Services, Ministry of Health and Family Welfare, New Delhi. The Institution is now empowered to award Medical Degrees under the clauses 23 & 24 of the said Act. Such Degrees shall be deemed to be included in the schedules to the respective Acts governing Medical Council of India/National Medical Commission, Indian Nursing Council, and Dental Council of India, entitling the holders to the same privileges as those attached to the equivalent awards from the recognized Universities of India.

JIPMER imparts Undergraduate (UG), Postgraduate (PG) and Super Specialty Medical Training through a large hospital complex (JIPMER Hospital) and a Nursing College. Some of the courses offered are MBBS., BSc., MSc., MD., MS, DM., and MCh. Courses. Full-time Ph.D. Programs are available in several disciplines.

### **DEPARTMENT OF BIOCHEMISTRY**

Department of Biochemistry, JIPMER was established in the year 1957. The teaching programs of the department were initiated with following courses: MBBS (1957), BSc [MLT] (1975), MD [Biochemistry] (1965), MSc [Medical Biochemistry] (1965) and Ph.D. [Medical Biochemistry] (1964). Investigations in the clinical biochemistry laboratory were started in 1965. Since its inception, the department has flourished focusing on three core aspects: Teaching, Patient care services and Research. The department has the state-of-the-art clinical chemistry laboratory and equipment available 24 hours for patient care services.

The full time teaching faculty educate and train students of various courses MBBS, MSc, BSc courses and PhD programs. Department of Biochemistry has been in the forefront of research in JIPMER. Several research activities are carried out with both intramural as well as extramural funding. Several research projects funded by ICMR, CSIR, BARC and UGC have been successfully completed in this department. Faculty members are resource persons for various activities at the local, regional, and national level organizations. Faculty and students of Biochemistry have continuously been receiving several awards for their research work and publications in various National and International fora.

## **2. Course details:**

### **2.1 Nomenclature of the course: MSc Medical Biochemistry**

### **2.2 Introduction:**

The specialization in Medical Biochemistry requires an advanced knowledge of anatomy, physiology, biochemistry including metabolism, endocrinology, immunology, cell and molecular biology, nutrition, clinical biochemistry, special laboratory techniques and handling of sophisticated equipment.

### **2.3 Objectives:**

At the end of the course the students will be able to,

1. Describe the normal functions, physiochemical basis and regulatory mechanisms of the various organs and systems of the human body
2. Apply the principles of biochemical process in understanding health and disease processes.
3. Impart the basic knowledge and skill in biochemistry to students through various teaching learning activities.
4. Use, maintain and undertake ordinary repair work of equipment commonly used in a biochemistry laboratory.
5. Perform various biochemical investigations in various bio fluids in assessment of health and disease conditions.
6. Collect relevant information regarding the existing knowledge of biochemistry, in general, and in his/her field of interest by utilizing library and other sources of information.
7. Identify the lacunae in the existing knowledge of biochemistry and design and execute appropriate experiments to investigate a relevant problem.
8. Analyze the results of investigation and draw valid conclusions therefrom.
9. Utilize appropriate bio-statistical knowledge and methods to evaluate the results of investigations.
10. Present the research findings in proper and scientific format in writing or in appropriate scientific forums.
11. To know about the functioning and performance of various automated instruments in the clinical biochemistry laboratory
12. To be competent in handling various techniques and equipment in the research laboratory
13. To be able to establish a modern biochemistry laboratory and to manage the laboratory with organizational skills.

14. Demonstrate his/her understanding of the student's attitudes, feel concern for them and guide them properly.
15. Apply the principles and methods of evaluation in judging the performance of self and students.
16. Improve his/her knowledge, attitude, and skill by self-learning on completion of formal training.
17. Demonstrate understanding of principles of personal management for smooth working with other members in the department

### **3. Regulations:**

#### **3.1 Eligibility:**

A candidate seeking admission should have qualified in a 3-year BSc Degree Examination of a recognized University with Biochemistry as main subject with Biology / Botany / Zoology as ancillary subject OR candidates with BSc Degree in Medical Laboratory Technology from a recognized University.

#### **3.2 Method of Selection:**

Candidates for the MSc (Medical Biochemistry) course will be selected based on merit in the common All India Entrance Examination conducted by the Institute. The syllabus for the entrance examination will be of BSc standard.

#### **3.3 Candidates intake per year:**

Four candidates will be inducted for the course every year. There is no provision for sponsored / nominated candidates.

#### **3.4 Duration of course:**

3 years (Three years). There are no stipendiary provisions during the study period.

#### **3.5 Medium of instruction:**

English

#### **3.6 Vacation**

As per institute guidelines, students will be eligible for 15 days' vacation in summer and 9 days in winter.

#### **3.7 Subject details:**

<b>Year</b>	<b>Paper</b>	<b>Title of the paper</b>
<b>I</b>	Paper I	Anatomy
	Paper II	Physiology
	Paper III	General Biochemistry
<b>II</b>	Paper I	Biophysical chemistry and techniques related to biochemistry
	Paper II	Foods, human nutrition, Vitamins, and dietetics
	Paper III	Bio-organic chemistry and biostatistics
	Paper IV	Enzymes, Minerals, and bioenergetics
<b>III</b>	Paper I	Intermediary metabolism and regulation
	Paper II	Cell and molecular biology
	Paper III	Endocrinology and immunology
	Paper IV	Clinical Biochemistry & Recent Advances in Clinical Biochemistry

### **3.8 Training pattern: Theory, Practical and hands-on work in the Laboratory**

The various teaching and learning experiences described as under shall put the student in an active situation for better learning experiences:

- Participation in undergraduate teaching activities.
- Participation in PG Seminars, Symposia, Case discussions Journal Clubs etc.
- Attendance of lectures
- Small group discussion/Tutorials
- Individual assignments referral work in library
- Maintenance of practical record book of work done by students in practical class.
- Laboratory work - all exercises will be performed independently in various labs of the department.
- Supervision of lab work under guidance for teaching and research activities.
- Participation in laboratory and investigative procedures related to biochemistry in clinical and other disciplines.
- Posting in Clinical Biochemistry and research laboratories in a timely manner in second and third year of the course.

## **SYLLABUS:**

### **I year: Paper 1 – Anatomy**

The students at the end of learning Anatomy during the First year of their course should be able to:

- State the parts and describe the gross anatomy of the various systems of the human body.
- Recognize and state the histological features of the various tissues and organs of the human body.
- Continue to learn the anatomical aspects of the human body and apply the same in health care programs.

### **Theory:**

#### **General Anatomy:**

Introduction – Anatomical terms, position, movements; epithelium – classification, structure & examples; connective tissue – classification and structure; skin – structure, thick and thin skins; cartilage – types, structure, hyaline, elastic, and white fibrocartilage; bones – classification, structure, growth; muscles - classification & structure; glands - classification & structure.

#### **Musculoskeletal system:**

Axial and appendicular skeleton – muscle groups and regions muscles with action.

#### **Cardiovascular and lymphatic system:**

Structure of pericardium, heart & major blood vessels – arteries, veins, and lymphatic system – classification and structure of lymphoid organs – thymus, spleen, lymph node, tonsil, and major lymphatic vessels.

#### **Respiratory system:**

Parts of respiratory system, structure of external nose, paranasal air sinuses, nasal cavity, nasopharynx, larynx, trachea, pleura, lungs & diaphragm.

#### **Gastrointestinal system:**

Parts of gastrointestinal system, salivary glands, oral cavity, pharynx, esophagus, stomach, small intestine, large intestine, liver, gallbladder, extrahepatic biliary apparatus, and pancreas.

#### **Excretory system:**

Parts of excretory system – structure of kidney, ureter, urinary bladder & urethra.

#### **Male and female reproductive systems:**

Structure & parts of male reproductive system, external genitalia, testis, epididymis, vasdeferens, seminal vesicle and prostate. Structure & parts of female reproductive system, uterus, ovary, fallopian tubes, and mammary gland

#### **Endocrine system:**

Location & structure of thyroid, parathyroid, pituitary, adrenal glands.

**Special senses:**

Structure of eyeball, external, middle & internal ear, olfactory mucosa, and papillae of tongue.

**Nervous system:**

Neuron, neuroglia, classification, autonomic nervous system, meninges, parts of brain, cerebrum, cerebellum, basal nuclei, limbic system, thalamus, hypothalamus, spinal cord, circulation of cerebrospinal fluid.

**Practical:**

- Dissection of the human cadaver to learn the anatomy of the organs of various systems listed above.
- Identification of the histological features of various tissues and organs using histology slides stained with hematoxylin and eosin.

**Teaching/Learning activities:**

1. Lectures: 2 hrs./week
2. Practical /Demonstration for gross anatomy: 4 hrs. /week
3. Histology practical: 2 hrs. /week

**Assessment:****Internal assessment:**

A minimum of four periodic assessments (theory and practical) will be conducted. The average of all periodic assessment marks will be taken for calculation of final internal assessment marks.

<b>Internal Assessment</b>	<b>Maximum marks</b>
Theory	20
Practical	10
Record notebook	10
<b>Total</b>	<b>40</b>

**Summative assessment:**

Summative assessment will be held at the end of the year with the following components and distribution of marks

<b>Summative Assessment</b>	<b>Maximum marks</b>
Written examination (3-hour duration)	100
Practical examination	40
Viva-voce examination	20
Internal assessment	40
<b>Total</b>	<b>200</b>



**Written Examination:** One paper of 3 hours duration (100 marks). It consists of ten questions each carrying ten marks.

**Practical examination: (40 marks):**

The practical examination will have the following components:

<b>Practical examination</b>	<b>Maximum marks</b>
Gross anatomy spotters (10 × 2)	20
Histology slides spotters (10 × 2)	20
<b>Total</b>	<b>40</b>

**Viva-voce examination: (20 marks):**

<b>Viva-voce examination</b>	<b>Maximum marks</b>
Station – 1 Dissected parts and organs	10
Station – 2 Osteology	10
<b>Total</b>	<b>20</b>

**Textbooks Recommended (Latest edition):**

**General anatomy:**

Handbook of General Anatomy – B.D. Chaurasia - CBS Publishers

**Systemic Anatomy:**

Textbook of Anatomy – Vishram Singh – Elsevier

B.D. Chaurasia's Human Anatomy – CBS Publishers

Clinical Anatomy – R. Snell

**Histology:**

Di Fiore's Atlas of Histology – Eroschenko – Lippincott Williams & Wilkins

**Dissection:**

Cunningham's Manual of Practical Anatomy – Vol. I, II & III

**Reference textbook:**

Gray's Anatomy: The Anatomical Basis of Clinical Practice – Susan Standring - Elsevier

## **I year: Paper 2 – Physiology**

The students at the end of learning Physiology during the First year of their course should be able to:

- state the functions of various organs and systems of the body
- describe in brief the mechanisms of function of various systems in the body
- apply basic principles of physiology to simple clinical conditions
- know and utilize the knowledge of physiology in organizing simple experiments for biochemical work
- continue to learn the physiological aspects of human body

### **Theory:**

#### **1. General Physiology**

Structure of cell and cell membrane, composition of intracellular and extracellular fluid, transport of substances across cell membrane, resting membrane potential.

#### **2. Body fluid and blood**

Principle of homeostasis, body fluids, composition of blood, plasma proteins, bone marrow, erythrocytes, blood groups, white blood cell, immune mechanism, platelets, haemostasis.

#### **3. Nerve and muscle**

Nerve - Structure of neuron, action potential, conduction of nerve impulse, mechanism of neuromuscular transmission. Muscle - structure of skeletal muscle, mechanism of contraction of skeletal and smooth muscles, properties of skeletal muscle and smooth muscle.

#### **4. Renal Physiology**

Structure of nephron, glomerular filtration, tubular reabsorption and secretion, clearance, water excretion, counter current mechanism, acid-base balance.

#### **5. Endocrine and Reproductive Physiology**

- a) Endocrine pancreas: Functional anatomy of islets, actions of insulin and insulin deficiency, regulation of insulin secretion.
- b) Physiology of bone: Vitamin D and Parathyroid, Calcium metabolism.
- c) Pituitary gland: Anterior pituitary and pituitary hormones, actions of growth hormone, effects of excess and deficiency of growth hormone, Prolactin, Post pituitary hormone - oxytocin and vasopressin.
- d) Adrenal Gland: Adrenal corticoids - actions, effects of excess and deficiency of cortisol, aldosterone. Adrenal medulla - catecholamines- actions, regulation of secretion.

e) Thyroid: Function of thyroid hormones, regulation of thyroid hormone secretion, thyroid dysfunction.

f) Reproductive Physiology: Puberty. Male reproductive system - spermatogenesis, testosterone- actions, regulation of testosterone secretion. Female reproductive system - menstrual cycle, ovarian hormones, control of ovarian functions, pregnancy, lactation - physiology of contraception.

## **6. Cardiovascular system**

Functional anatomy of heart, genesis and spread of cardiac impulse, basic E.C.G., cardiac cycle, heart sound, cardiac output, blood pressure and regulation of blood pressure. Regional circulation - coronary, cerebral, and skeletal muscle circulation.

## **7. Respiratory system**

Functional anatomy, respiratory muscles, mechanics of respiration; lung volumes and capacities, transport of gasses - O<sub>2</sub> dissociation and CO<sub>2</sub> dissociation curves, control of breathing - neural and chemical, hypoxia.

## **8. Gastrointestinal system**

i) Salivary secretion and its regulation.

ii) Regulation of gastric secretion and motility.

iii) Mechanism of secretion, function and regulation of bile and pancreatic secretion.

iv) Intestinal secretion and motility- regulation (including defecation)

## **9. Nervous system**

Synaptic transmission in CNS, Sensory system: Receptors, afferent pathways, Theories of referred pain, mechanism of pain inhibition, Thalamus; Motor system: Muscle spindle and stretch reflex, Corticospinal tract; Cerebellum and basal ganglia; Functions of autonomic nervous system. Functions of hypothalamus and limbic system.

## **10. Special Senses**

Basic physiology of vision, hearing taste and smell

### **Practical:**

Practical shall comprise of

- a) Hematology: Hemoglobin estimation, RBC and WBC count, Differential leucocyte count, Blood group, Bleeding time and Clotting time.
- b) Human: Mosso's ergography, ECG, Stethography, Recording of BP and pulse, Demonstration of Spirometry and AFT.

### Teaching/Learning activities:

The course in Physiology will be covered by:

- i) Lectures – 2 hours per week (60 hours approximately)
- ii) Group discussions/ Tutorials – 1 hour per week (30 hours approximately)
- iii) Demonstrations and Practical – 2 hours per week (60 hours approximately)

**Textbooks and Reference books recommended (Latest edition):**

#### Theory

1. Review of Medical Physiology. Ganong WF. McGraw-Hill Medical Publishers, UK.
2. Textbook of Medical Physiology, Pal GK, Ahuja-Elsevier
3. Textbook of Medical Physiology. Guyton A, Hal JE. Elsevier, India.

#### Practical

1. Textbook of Practical Physiology. Pal GK, Pal P, University Press, India.
2. Ghai's Textbook of Practical Physiology. Jaypee Brothers.

### Assessment:

#### Internal assessment:

A minimum of four periodic assessments (theory and practical) will be conducted. The average of all periodic assessment marks will be taken for calculation of final internal assessment marks.

Internal Assessment	Maximum marks
Theory	20
Practical	10
Record notebook	10
<b>Total</b>	<b>40</b>

#### Summative assessment:

Summative assessment will be held at the end of the year with the following components and distribution of marks

Summative Assessment	Maximum marks
Written examination (3-hour duration)	100
Practical examination	40
Viva-voce examination	20
Internal assessment	40
<b>Total</b>	<b>200</b>

**Written Examination:** One paper of 3 hours duration (100 marks). It consists of ten questions each carrying ten marks.

**Practical examination: (40 marks):**

The practical examination will have the following components:

<b>Practical examination</b>	<b>Maximum marks</b>
Human practical - (Electrocardiogram, Stethography, Recording of blood pressure and pulse, Mosso's ergography)	20
Hematology Practical - (Hemoglobin estimation, RBC count, WBC count, Differential leucocyte count, Blood group, Bleeding time and Clotting time)	10
Cards – 2 problems	10
<b>Total</b>	<b>40</b>

**Viva-voce examination: (20 marks)**

## **I year: Paper 3 – Biochemistry**

The following areas in the subject of Biochemistry shall be the course content in the year I Year. The general idea is that candidate is familiarized and sensitized to the basic concepts of biochemistry as applicable to the human body to enable him to undertake the study of biochemistry in the next two years of this course.

### **General Biochemistry:**

- Chemistry of carbohydrates / lipids / proteins
- Enzyme kinetics, Inhibition and regulation of enzyme activity, Isoenzymes
- Electrophoresis / Chromatography
- Introduction to metabolism

### **Hematological system & Immunological system:**

- Immunoglobulin structure and types, antigen-antibody complex Hemoglobin; Structure and function, Hemoglobinopathies.
- Heme: Synthesis and disorders
- Anemia: Vitamins: B12, folic acid, B6, Iron

### **Locomotor system& Autonomic nervous system:**

- Biological oxidation and ATP synthesis
- Minerals: Calcium, Phosphorus, Magnesium
- Vitamins: Vitamin D and Rickets, Fanconi syndrome

### **Endocrine system:**

- Carbohydrate metabolism, Regulation of blood glucose
- Thyroid function tests, Adrenocortical function tests

### **Respiratory system:**

- General aspects of acid base balance, Respiratory regulation of blood pH and related disorders
- Interpretation of acid base disorders

### **Cardiovascular system:**

- Collagen-structure, disorders of Lipid metabolism, prostaglandins,
- Sulphur containing amino acids,
- Homocysteine metabolism and disorders
- Free radicals and antioxidants

**Gastrointestinal system and Nutrition:**

- Digestion and absorption of carbohydrates, lipids, amino acids
- Metabolism of amino acids (Aromatic AA, glycine, branched chain, polyamine)  
Micronutrients: Vitamins, Minerals
- BMR, SDA, Balanced diet, dietary fibers
- Metabolism of starvation

**Hepatobiliary and Pancreatic function tests:**

- Bilirubin metabolism, Types of jaundice and their biochemical alterations, LFT
- Xenobiotics
- Pancreatic function tests

**Renal System:**

- Excretory function: Formation of ammonia, Detoxification of ammonia, Urea cycle
- Regulatory function: Water and electrolyte balance (Na, K, Cl), Renal regulation of pH
- Renal function test: Tests for glomerular and tubular functions

**Reproductive system:**

- Gonadal function test.
- Prenatal screening test

**Molecular Biology, Cancer biology:**

- Nucleotide chemistry and metabolism, Gout
- Replication, transcription, translation, regulation of gene expression
- Cancer biology
- CSF analysis

**Advances in biochemistry:**

- Radioactivity,
- Human genome project, Genetic engineering
- Biochemistry of AIDS

**Research methodology:**

1. Steps in designing a research protocol
2. Types of research designs (observational/ RCTs/ systematic reviews etc)
3. Sample size calculation
4. Ethics in biomedical research

**Practical:**

- Reactions of carbohydrates, lipids, proteins,
- Reactions and properties of hemoglobin.
- Qualitative analysis of normal and abnormal constituents of urine.
- Principles of colorimetry.
- Estimation of glucose, creatinine, and urea in blood.

**Demonstrations:**

- Electrophoretic and chromatographic techniques ABG analysis and electrolytes
- Oral glucose tolerance tests
- Renal function tests
- Hepatobiliary and pancreatic function tests
- Thyroid function tests

**Teaching/Learning activities:**

- Lectures – 5 hrs/week
- Practical/Demonstration - 2 hrs./week
- Small group discussion/Tutorials - 1 hr./week
- Individual assignments referral work in library - 3 hrs./week.

**Assessment:****Internal assessment:**

A minimum of four periodic assessments (theory and practical) will be conducted. The average of all periodic assessment marks will be taken for calculation of final internal assessment marks.

<b>Internal Assessment</b>	<b>Maximum marks</b>
Theory	20
Practical	10
Record notebook	10
<b>Total</b>	<b>40</b>

**Summative assessment:**

Summative assessment will be held at the end of the year with the following components and distribution of marks

<b>Summative Assessment</b>	<b>Maximum marks</b>
Written examination (3-hour duration)	100
Practical examination	40
Viva-voce examination	20
Internal assessment	40
<b>Total</b>	<b>200</b>



**Written Examination:** One paper of 3 hours duration (100 marks). It consists of ten questions each carrying ten marks each.

**Practical examination: (40 marks):**

The practical examination will have the following components:

<b>Practical examination</b>	<b>Maximum marks</b>
Qualitative exercise	15
Quantitative exercise	15
Spotters	5
Interpretation of charts/graphs	5
<b>Total</b>	<b>40</b>

**Viva-voce examination: (20 marks)**

## II YEAR

### A. Biophysical Chemistry and Techniques related to Biochemistry:

1. Acids, Bases, Buffer system in living body - pH - Henderson Hasselbalch equation, effect of pH on biological processes - Buffer solutions for biological investigations - methods of pH determination, working principles of a pH meter.
2. Osmosis and Osmotic pressure - Osmolarity of body fluids a) Distribution of fluids in body compartments. b) Surface tension and viscosity - their application to human body in relation to normal life and disease processes. c) Colloidal system - preparation - protective action emulsification - colloidal systems of biological importance - their application and role in human body. d) Dialysis, semipermeable membrane, Gibbs-Donnan equilibrium. e) Diffusion and absorption mechanisms - their application to biological systems.
3. Centrifugation techniques - Principles - differential centrifugation - Density gradient centrifugation - ultra centrifuge and its application in biological systems.
4. Chromatographic techniques – Principles and types of chromatographic techniques like column, thin layer, paper, adsorption, partition, gas liquid ion exchange, affinity, high performance - their applications in biological systems.
5. Principles and techniques of photometry and Colorimetry - Laws of light absorption – visible and uv Spectrophotometry - Spectro fluorometry - Flame photometry atomic absorption spectrometry.
6. Principles, instrumentation, techniques and applications of electron spin resonance, Nuclear Magnetic resonance, crystallography Mass spectrometry.
7. Principles of radioactivity, nature, and types - decay rate radioactive decay - units of radioactivity - detection and measurement, of radio activity - radiation hazards and its prevention, applications of radio activity and radio isotopes in biological systems.
8. Electrophoresis - Principles, types, and their applications in biological systems.
9. Rapid DNA sequencing techniques - details of methodologies e.g., plus, and minus dideoxy- nucleotide, Maxam and Gilbert - use of thin gels, resolution etc. interpretation of DNA sequences, Next generation high throughput sequencing.
10. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
11. Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy.
12. Biosensors

## **B. Human Nutrition, Vitamins:**

1. Formulation of balanced diets, nutritional adaptation.
2. Common disorders of nutrition – under-nutrition - over nutrition - protein malnutrition, obesity, food allergy.
3. Diet therapy or formulation of therapeutic diets - purpose and principles of therapeutic diets with special reference to diabetes mellitus, renal disorders, diseases of liver, diseases of heart and circulatory system, obesity and leanness, atherosclerosis, hypertension, anemia, vitamin deficiencies, peptic ulcer, use of exchange lists.

### **Vitamins:**

4. Occurrence, properties, structure, sources, daily requirements, biochemical role, deficiency manifestations and toxic effects of water soluble and lipid soluble vitamins - antivitamins, pseudo vitamins

## **C. Bio-Organic Chemistry and Biostatistics:**

1. Carbohydrates: Occurrence, Chemical properties and Classification Stereo and optical isomerism. Monosaccharides: Structure, mutarotation, general reactions derivatives. Oligosaccharides: Structure and functions Homoglycans: Starch, glycogen, cellulose, insulin, dextrin, structural properties. Heteroglycans: Agar, pectin, alginic acid - structure and properties of mucopolysaccharides cell wall polysaccharides - cell surface carbohydrates.
2. Lipids: Classification, physiochemical properties and structure of fatty acids, waxes, oils, triacylglycerols, phospholipids, glycolipids, sterols, prostaglandins, thromboxanes, leukotrienes, bile acids - separation of lipids by various methods.
3. Heme, porphyrins, cytochromes, and related compounds
4. Proteins: Classification, structure, physiochemical properties and reactions of amino acids, peptides, polypeptides membrane proteins, levels of organisation, synthesis of peptide bonds, peptide unit, denaturation, renaturation, coagulation, flocculation, precipitation methods of
5. estimations, separation techniques, end group analysis-hemoglobins, cytochromes, collagen, immunoglobulins.
6. Nucleic acids and Nucleoproteins: Structure, isolation and functions of nucleosides, nucleotides, nucleoproteins, nucleic acids, DNA, RNA, Denaturation and hybridisation, biologically important nucleotides.
7. Biostatistics: Basic concepts of probability, mean, mode, median, standard deviation, laws of chance, binomial expression, hardy Weinberg law, 't' test, chi square - analysis of variance
8. co-efficient of correlation, Regression, univariate & multivariate analyses, odds ratio, survival analysis, ROC curve, evaluation of a new diagnostic procedure, calculation of sample size.

## **D. Enzymes and Bioenergetics and Minerals**

### **Enzymes:**

1. Reaction rates, collision, and transition state theories - order of reaction, energy of activation, role of enzyme as a catalyst of biochemical reaction and factors influencing enzyme catalysed reactions.
2. Enzyme classification and nomenclature as per IUB enzyme classification of system (rationale, overview, and specific examples).
3. Assay of enzyme activity, units of enzyme activity, fast reactions, stopped flow technique.
4. Determination of the active site of the enzymes and presence of serine, cystine, lysine, histidine, arginine, tryptophan, and tyrosine at the active site.
5. Enzyme-substrate complex formation - concept of ES complex binding sites, active site, stereospecificity - Michaelis - Menten equation - form and derivation of Michaelis Menten equation - Significance of  $V_{max}$  and  $K_m$ -rate equation for bi-substrate reaction.
6. Mechanism of enzyme action - induced fit and lock and key mode mechanism of action of chymotrypsin, lysozyme, carboxypeptidase mechanism of bi-substrate reactions - random, ordered and ping pong mechanisms.
7. Enzyme inhibition - inhibitors - Kinetics of competitive, non-competitive, and uncompetitive inhibition, concepts of reversible irreversible and partially reversible reactions catalyzed by enzyme.
8. Enzyme cofactors - structure and biological functions of a variety of cofactors of enzymes.
9. Immobilized enzymes - immobilized multienzyme systems - effects of charge, pH, ionic strength, hydrophobicity on reaction kinetics.
10. Isoenzymes - chemical modification of enzymes.
11. Enzyme regulation - allosteric, non-co-operative, co-operative, and cumulative regulation of enzyme activity ~ enzyme induction repression - covalent modifications.

### **Bioenergetics:**

12. Laws of thermodynamics and their application in biological systems - free energy change - entropy and enthalpy - thermodynamics of coupled reactions - high energy phosphates – their role in energy capture and transfer - redox potential enzymes involved in biological oxidation
13. components of respiratory chain - phosphorylation at the substrate level and respiratory chain level - inhibitors of biological oxidation - mechanism of energy capture - chemiosmotic theory - uncouplers of oxidative phosphorylation.

### **Minerals:**

14. Mineral metabolism: macro, micronutrients, daily requirements, sources, biochemical functions, regulation of intake, turnover, and metabolism - disorders related to macro and micro mineral nutrients, calcium, phosphorus, iron, copper, zinc, magnesium, chromium, selenium, sodium, and potassium. Trace elements and their disorders

**Practical Exercises:**

- Chromatographic separation of sugars, amino acids, and proteins. (Paper/ TLC)
- Determination of enzyme activity and kinetic properties.
- SDS-PAGE.
- Western blotting.
- Estimation of glucose, fructose, pentose, lactose, in biological samples /food stuffs (Jaggery/Honey/milk)

**Assessment:****Internal assessment, record/logbook, and journal club/seminar presentation:**

A minimum of four notified internal assessment tests (Theory and practical) will be conducted in the second year.

	<b>Maximum marks</b>
Internal assessment (Theory- 120 + Practical - 80)	200
Practical records and Journal club/seminar presentation (50+50)	100

**Second Year summative assessment – Distribution of marks**

	<b>Maximum marks</b>
Theory examination	400
Practical examination	200
Viva-voce examination	100
Internal assessment	200
Practical records/Journal club and seminar presentation	100
<b>Total marks</b>	<b>1000</b>

**Theory examination:**

	<b>Theory papers</b>	<b>Maximum marks</b>
Paper I	Biophysical chemistry and techniques related to biochemistry	100
Paper II	Foods, human nutrition, vitamins, and Dietetics	100
Paper III	Bio-organic chemistry and biostatistics	100
Paper IV	Enzymes and bioenergetics and Minerals	100
	<b>Total marks</b>	<b>400</b>

**Practical and Viva-voce examinations: (Two days)**

<b>Day 1</b>	<b>Maximum marks</b>
Chromatography (paper/TLC)	200
SDS-PAGE	
Estimation of glucose/fructose/lactose/pentose	
Km value and specific activity of enzymes	
<b>Total marks</b>	<b>200</b>

<b>Day 2</b>	<b>Maximum marks</b>
Discussion of results of practical experiments	100
Oral Examination/Viva Voce	
<b>Total marks</b>	<b>100</b>

## **III YEAR**

### **A. Intermediary Metabolism and Regulation**

1. Introduction to methods of studying intermediary metabolism whole organism studies - whole animal, plant studies - perfusion of isolated organ-organ and tissue slice techniques isolated and cultured tissue and cell technique.
2. Intermediary metabolism of carbohydrates - glycolysis, glycogenolysis, glycogenesis, HMP shunt, uronic acid, gluconeogenesis, common metabolic pathway, amino sugars, sialic acids, glycoproteins and proteoglycans, regulation of blood glucose, hormonal control of carbohydrate metabolism.
3. Lipid metabolism: Oxidation of fatty acids, degradation of complex lipids, biosynthesis of fatty acids, essential fatty acids, triacyl glycerol, steroids, phospholipids, prostaglandins, cholesterol, bile acids, lipoproteins, glycolipids - regulation of lipid metabolism.
4. Protein and amino acid metabolism: Degradation of amino acids oxidative and nonoxidative deamination, transamination, decarboxylation, detoxication of ammonia, catabolism of carbon skeletons of amino acids - ketogenic and glucogenic amino acids - nitrogen balance conversion of amino acids to specialised products.
5. Nucleic acid metabolism - Biosynthesis and degradation of purines and pyrimidine ring nucleotides - regulation of biosynthesis and degradation conversion to deoxynucleotides.
6. Metabolism of xenobiotics - detoxication mechanisms in the body biological implications of xenobiotic metabolism.

### **B. Cell and Molecular Biology**

#### **Cell Biology:**

1. Introduction to cell biology - organization levels - cell theory - cell classification and variability.
2. General structure of prokaryotic and eukaryotic cells - mitosis - meiosis - method for studying cells and organelles - freeze fracture technique - specific staining of organelles/marker enzymes - sub cellular fractionation, ultracentrifugation, differential, and density gradient centrifugation - cell cycle.
3. Cell and tissue culture techniques - contact inhibition, cancer, growth inhibitors, cell movement, communication between and within cells.
4. Bio membranes - Structure and functions

5. Host parasite interaction Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.
6. Cell Signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis, and quorum sensing.
7. Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
8. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

### **Molecular Biology:**

1. Nucleic acids as genetic information carriers - experimental evidence e.g. action spectrum, genetic information, Hershey-chase experiment etc.
2. Modes of replication, details of Meselson and Stahl experiment, semi conservative replication.
3. Physical properties of DNA - 5' - 3' direction, size range location, isolation, shear, base composition, base equivalent, gel electrophoresis, secondary structure, base pairing, base stacking, helix~ coil transition, T<sub>m</sub> and relationship to GC content, Tertiary structures.
4. Genetic code - Evidence for a triplet code, properties of the code - sequential, ubiquitous, degenerative, wobble hypothesis, nonsense codon, adapter role of tRNA, amino acyl tRNA synthases, anticodon loop, direction of protein synthesis.
5. Mechanism of translation - A & P sites, N-blocked aa tRNA's – t-Met RNA - initiator codon, shine - Dalgarno consensus sequence (AGGA) Formation of 70S initiation complex - role of initiation factors and GTP, Peptidyl transferase, translocation, role of EF-Tu, EF-Ts, EF-G and GTP - Nonsense codons, role of RF1, RF2 and GTP.
6. Mechanism of transcription-sigma cycle, recognition, binding and initiation sites – TATA /Pribnow box, enhancer, and other regulatory elements - Direction of chain growth - termination rho and palindromes - Regulation of transcription of promoters and repressors - concept of operon.
7. DNA replication - properties of DNA dependent DNA polymerases I, II, III and their role in DNA replication - Discontinuous/continuous synthesis - Okazaki fragments - RNA primers, repairs of DNS polymerase and DNA lipase, role of DNA gyrase, unwinding enzyme, HD protein, polymerase chain reaction.
8. Rates of eukaryotic and prokaryotic protein synthesis, multiple invitation sites, bidirectional replication, bubbler, fidelity of replication excision - repair systems, recombinant repair system, chemical carcinogenesis.



9. DNA dependent RNA polymerase - in vitro assay-physical properties of the enzyme, subunit structure, proof of template directed synthesis.
10. Post transcriptional processing-maturation of rRNA and tRNA-RNA splicing introns and exons - consensus sequence of junction - mechanism of RNA splicing-Poly A tail -5' capping- Non coding sequences etc - Introns and Protein functional domains.
11. Physical properties of RNA-classes of RNA-structure, methods of isolation and fractionation of RNA-primary, secondary, and tertiary structures - DNases, RNases, phosphodiesterase etc.
12. Rapid RNA sequencing techniques - plus and minus, dideoxy nucleotide, Zimmern and Kaesberg, Paettie, Simonesites method et, interpretation of RNA sequences.
13. Satellite DNA - possible functions - C value paradox-mechanical strength, gene library, suppressor mutation, centromeric DNA, split genes.
14. Recombinant DNA technology and its applications, plasmids, cosmids as vehicles, isolation and characterization of DNA and fragmentation with restriction enzymes, ligation to vehicles, introduction of gene by transduction and transfection, selection of clones, DNA cloning-social and moral implications - international guidelines.

## **C. Endocrinology and Immunology**

### **Endocrinology:**

1. Comparison of hormones and trace dietary substances, Endocrine and nerve integration - cell membrane and intracellular receptors for hormones-hormonal inter-relationships. Experimental approaches to endocrinology - Mechanism of hormone action - classification of hormones.
  - a) Hormones of the pituitary and hypothalamus - POMC peptide family.
  - b) Hormones of the thyroid - iodine metabolism - biosynthesis of thyroid hormone structure, activity, metabolism - interaction with other endocrine systems - anti-thyroid drugs.
  - c) Hormones regulating calcium metabolism - parathormone, calcitriol, calcitonin, synthesis, secretion, regulation.
  - d) Hormones of the adrenal cortex-Glucocorticoids, mineralocorticoids, and androgens - their biosynthesis, secretion, transport and metabolism and their metabolic effects.
  - e) Hormones of adrenal medulla-catecholamines and their derivatives - biosynthesis, excretion, storage, regulation, and metabolic effects - functional similarity between catecholamine receptor and visual response system.
  - f) Hormones of the gonads - androgens, estrogens and progestins - structure, biosynthesis secretion, regulation, metabolic effects - transport - menstrual cycle - regulation.

- g) Hormones and endocrinology and pregnancy and lactation - fetoplacental unit.
  - h) Hormones of pancreas - chemistry, biosynthesis, regulation, secretion of insulin, glucagon, somatostatin-effects of insulin and glucagon on carbohydrate, lipid, and protein metabolism, synthetic hypoglycaemic agents.
  - i) Miscellaneous hormones: Hormones of GI tract, kidneys, prostaglandins and their derivatives, hormones of central nervous system, thymus, and pineal gland.
2. Endocrine disorders - Biochemical basis of the disorders related to all the above endocrine system under (2).

### **Immunology:**

1. Introduction to the cells and organs of immunity-memory, specificity, diversity, self vs non- self-discrimination, structure, and functions of primary and secondary – lymphoid organs - cell mediated versus humoral immunity - T and B lymphocytes.
2. Infection: Types, factors influencing infection and harmful microbial products such as exotoxins and endotoxins, leucocidins, hemolysins, fibrinolysins-proof of pathogenicity and course of infection - sources of infectious agents and their carriers - portals of entry.
3. The host response - Natural defense of the body, species, racial, communal, regional, and individual variation - mechanism of natural resistance - the skin, mucus membrane, lysozyme, phagocytes, defenses in blood, lymph, and components of Reticulo-endothelial system.
4. Nature of antigen and antibody: antigen vs immunogen - structure of antibody – constant and variable and hypervariable regions, Fab and Fc, isotype, allotype and idiotype - functions of antibody molecules, classification.
5. Measurement of antigen-antibody interactions: Direct binding assays, agglutination, precipitation, immunodiffusion, immunoelectrophoresis, Elisa, RIA, fluorescence analysis, hybridoma technique.
6. Generation of diversity in the immune response - immune tolerance at birth, in adult and termination of tolerance - instructive, selective, and clonal selection theories - concept of antigen specific receptors, genes encoding antigen - specific receptors on T & B lymphocytes genetic rearrangement - class switch.
7. Antigenicity: Definition - flagellar, somatic, capsular, soluble, heterophilic and auto antigens blood groups and blood group antigens - tissue antigenic determinations.
8. Central role of major histocompatibility complex (MHC) genes and products in immune response - associated MHC functions - allograft, autograft, graft vs host and mixed leukocyte response transplantation and immune response.
9. Complement - complements of classical and alternate pathways hypersensitivity Types I, II, III and IV responses - immune responses to parasites and tumors.
10. Immunodeficiency, auto immunity - Monoclonal cloning and related methodologies.

## **D. Clinical Biochemistry and Recent Advances**

1. Role of biochemistry in diagnosis of diseases.
2. Gastrointestinal tract - Acidity curves, qualitative and quantitative analysis of gastric contents and duodenal contents Pancreatic disorders in relation to exocrine function - malabsorption syndromes - laboratory parameters useful in diagnosing diseases of GI tract.
3. Hepatobiliary system - Hepatobiliary function tests - lab findings and differential diagnosis of jaundice - metabolism of bilirubin - cirrhosis, hepatic coma, hepatitis, gall stones, cholecystitis, and tumors.
4. Excretory system - Renal function tests - Biochemical changes and laboratory findings in acute and chronic renal failure - clearance of tests - urinary calculi, renal hypertension - principles of peritoneal and hemodialysis - urinalysis for normal and abnormal constituents.
5. Disorders of carbohydrates metabolism - Glucose level in normal blood, renal threshold, hyper and hypoglycemia and glycosuria - qualitative tests for sugars in urine - intravenous and other types of glucose tolerance tests - fructose levels in blood lab diagnosis of early and latent diabetes mellitus - diabetic coma, secondary degenerative changes associated with diabetes mellitus - Glycogen storage disorders.
6. Disorders of nitrogen metabolism - Assimilation and excretion of nitrogen with reference to ammonia, urea, uric acid, creatine, creatinine - excretion of nitrogenous waste products - abnormalities of nitrogen metabolism including uremia, porphyria's, porphyrinurias, aminoaciduria - factors affecting nitrogen balance.
7. Disorders of lipid metabolism - Plasma lipoproteins, cholesterol triglycerides and phospholipids in health and diseases, ketosis, fatty liver.
8. Inherited disorders of metabolism: Changes occurring in phenyl ketonuria, alkaptonuria, tyrosinosis, albinism, Hartnup's disease, galactosemia. Tay-Sach's disease, Niemann Pick's disease, Hunter's, and Hunter's syndrome, Lesch-Nyhan syndrome - detection of these anomalies.
9. Clinical Enzymology - Laboratory investigations on serum and urine for constituents (normal & abnormal) of diagnostic and prognostic importance. Plasma specific and non-plasma specific enzymes of diagnostic prognostic importance and their interpretation of amylase, aminotransferase, phosphatases, creatinine kinase, cholinesterase, lactate dehydrogenase, phosphohexose isomerase, lipoprotein lipase.
10. Endocrine system: Laboratory diagnosis and investigations related to disorders of thyroid, pituitary, adrenal cortex, adrenal medulla, testes, ovaries - plasma and urinary assays of hormones related to various endocrinal disorders.
11. Acid base balance - coagulation of blood pH within normal range disturbances in acid base balance - acidosis, alkalosis, mixed disturbances - laboratory parameters - blood gas analysis.
12. Fluid and electrolyte balance - regulation - disturbances of fluid and electrolyte balance - laboratory parameters in the diagnosis and management of fluid and electrolyte disorders - oral rehydration therapy.

13. Lab Management - Method Evaluation: Analytical goals, precision and accuracy, bias, sensitivity and specificity, selection of method and evaluation.
14. Total Quality Management: Fundamental concepts, control of preanalytical, analytical and post analytical variables, internal and external quality control programs, Accreditation programs.
15. Automation: Definition, instrumental concepts, types of analyzers, Trends in automation in Biochemistry laboratory. Laboratory information systems.
16. Recent advances in Medical Biochemistry.

**Practical:**

1. DNA/RNA extraction, PCR
2. Estimation and electrophoretic separation of plasma/serum proteins.
3. Blood sugar and GTT estimation in serum/plasma.
4. Estimation of cholesterol and triacylglycerol in plasma.
5. Estimation of Calcium, electrolytes, pH, and blood gas analysis.
6. Estimation of urea, creatinine, uric acid and NPN reserve and clearance tests.
7. Estimation of bilirubin, and hepato-biliary function tests.
8. Estimation of copper, ceruloplasmin activity, lithium, Iron, iron binding capacity, magnesium in plasma/serum. (demonstration)
9. Thyroid function tests (TSH, T3, T4 assays)
10. Urinalysis for normal and abnormal constituents.
11. Analysis of renal calculi.
12. Estimation of LDH, phosphatases, amino transferases, amylase and CPK in serum.
13. Separation of serum LDH & isoenzymes by polyacrylamide disc gel electrophoresis.
14. CSF analysis for biochemical parameters. (demonstration)
15. Estimation of glycosylated hemoglobin/any other proteins. (demonstration)
16. Evaluation/ validation of a new method in the laboratory.

**Textbooks recommended:** (Latest edition)

1. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stamford, Connecticut.
2. Metabolic control and disease – Ed. Roxenburg and Philip K. Bondy W.B. Saunders -
3. Biochemistry - A case-oriented approach by Montogommoiry - CV Moshy Co.
4. Biochemistry - A functional approach by Mc Gilvery - W.B. Saunders Co.,

5. Principles of Biochemist Vol. I and II by White Handler Smith al - Latest Edition McGraw Hill Publication.
6. Tietz Textbook of Clinical Chemistry. Ed Burtis and Ashwood. W.B. Saunders Company,
7. Metabolic Basis of inherited diseases by Stanbury, Wyngarden et al, W.B. Saunders Co.,
8. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York.
9. Principles of Biochemistry. Ed Lehninger, Nelson, and Cox. CBS publishers and distributors.
10. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin.Wiley-Liss Publishers.
11. Genes XI. Ed Benjamin Lewin. Oxford University Press.
12. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc.
13. Molecular Cloning - A Laboratory Manual. J. Sambrook, E.F.Fritsch and T.Maniatis. Cold Spring Harbor Laboratory Press.
14. Molecular Cell Biology, H. Lodish, A. Berk, S.L.Zipursky, P. Matsudaira, D. Baltimore, J. Darnell.

**Practical books recommended** (Latest edition):

1. A manual of laboratory techniques by National Institute of Nutrition (ICMR) - Hyderabad.
2. Practical Clinical Chemistry by Varyley H.Vol. I and II.
3. Methods in Enzymology - Colowich and N.O. Kaplan Academic Press 11 volumes.
4. Clinical Chemistry - Principles and Techniques by R.J. Henry, Harper, and Row Publishers.
5. Advances in Clinical Biochemistry - Series Edited by Bodansky, Academic Press. Vol. I
6. Standard Methods in Clinical Chemistry - Series Edited by Seliekson, Academic Press.
7. Clinical Biochemistry by E.J. King and IDP Woo Church Hill and Co.
8. Fundamentals of Clinical Chemistry - Edited by Norbert W. Tietz. Pub: W.B. Saunders Company.
9. Practical Clinical Biochemistry (5th Edition) or Vol. I and II Herold Varley et al. Publisher: Arnold - Heinemann
10. Todd Sanford Davidson's Clinical Diagnosis and Management by laboratory methods (17th Edn.) Edited by - John Bernard Henry, MD., Publisher - W. B. Saunders Company.
11. Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge University Press.

**The list is not complete. The candidate is advised to refer to other books related to medicine and allied specialties and also journals related to the various disciplines of medicine to keep himself informed of latest developments in theoretical and practical aspects of Biochemistry.**

### Third Year summative assessment – Distribution of marks

#### Internal assessment, Project work and record/logbook marks:

A minimum of four notified internal assessment tests (Theory and practical) will be conducted in the third year.

	Maximum marks
Internal assessment (Theory- 120 + Practical - 80)	200
Practical records and Journal club/seminar presentation (50+50)	100

#### Summative assessment

	Maximum marks
Theory examination	400
Practical examination	200
Viva-voce examination	50
Internal assessment	200
Practical records and Journal club/seminar presentation	100
Project work`	50
<b>Total marks</b>	<b>1000</b>

#### Theory examination:

	Theory papers	Maximum marks
Paper I	Intermediary metabolism and Regulation	100
Paper II	Cell and molecular biology	100
Paper III	Endocrinology and immunology	100
Paper IV	Clinical Biochemistry & Recent Advances in Clinical Biochemistry	100
	<b>Total marks</b>	<b>400</b>

#### Practical and Viva-voce examinations: (Two days)

Day 1	Maximum marks
Quantitative estimation of biochemical parameters, Abnormal urine analysis, Electrophoresis, Organ function tests, Determination of enzyme activity, Method validation	200
Day 2	
Discussion of results of practical experiments	
Oral Examination/Viva-Voce	50
Project work and viva on project	100

## Regulations of MSc Medical Biochemistry course:

### Attendance:

- Students are required to attend 75% or more of all theory classes held, and 75% or more of practical in each subject to be eligible to appear in the annual examination. Under no condition will a student with less than the prescribed attendance in any subject be allowed to appear in the annual examination of that subject.
- Students with less than 75% attendance in theory and/or practical at the end of any year must start afresh in those subjects by joining the junior batch of students. No extra classes will be arranged to make such students eligible for the annual examinations. The attendance accrued in the previous academic year in those subject(s) will not be transferred. Students will be required to secure 75% attendance afresh in theory and practical/clinical of subjects detained, after joining the junior batch to become eligible to appear in the annual examination.
- The 25% leverage in attendance includes all types of leaves (including leave on medical grounds). For absence because of illness or any medical condition, a duly approved medical leave from Dean (Academic) with medical and fitness certificate issued/verified by authorized JIPMER clinical faculty member is mandatory. Certificate must be submitted before or within 10 days after availing medical leave.
- Attendance cannot be improved upon by attending classes during the gap between the annual regular examination and supplementary examination held within 6 weeks of the former.
- Students who are detained in all the subjects of a year due to lack of attendance should join the classes with junior batch within 7 days of declaration of the eligibility/detention list or when classes commence, whichever is earlier.
- Students who are detained in one or more subject(s) because of lack of attendance but are eligible to appear for annual examination in at least one subject of the year should join classes with junior batch within 7 days of completion of the last final theory/practical examination or when classes start, whichever is earlier. Attendance accrued in the previous academic year will lapse and attendance will be calculated afresh from the date of joining the junior batch.
- A show-cause notice will be issued to students on continuous unauthorized absence without prior permission for two weeks or more. If such absence extends to a period more than one month for any reason, the student is liable for termination from the course. The decision of the competent authority is final.
- There is **no condonation permissible** for shortage of attendance.

## **Internal Assessment (IA):**

A minimum of four notified internal assessments (including model examination) will be held for a subject paper periodically in each year before the final annual examination and the candidate will be examined in theory and practical. Each notified test and the model examination will carry equal weightage for calculation of final internal assessment marks. The internal assessment marks will form 20% of the summative assessment. There is no minimum cut-off percentage of internal assessment mandatory to appear in the annual examination.

## **Project:**

1. Submission of project work is mandatory for the appearing in the final examination. The project work shall be carried out by the candidate under the guidance of a postgraduate teacher in the department. The topics for the project shall be selected within the first year of the course and the final project shall be submitted six months before the final examination. The project work is mainly to orient the candidate towards research methodology. Collaboration works with other departments are encouraged.
2. The project will be reviewed by external faculty and evaluated by the External/Internal Examiners at the time of viva voce examination of the candidate during the final summative exam. 50 marks will be allotted for the quality of work and defending of the project by the candidate.
3. The final project duly approved by the external/ Internal Examiners will be submitted to the Dean's office along with the result. The Dean's office will send the project to the library for record.

## **Examination rules and regulations:**

1. A student needs to pass in all theory paper(s) and practical examination in the I year to progress to the II year.
2. A student who fails in any one or more theory subject(s) and/or practical examination in the first year will reappear in a supplementary examination (to be held within 6 weeks) in the theory and the practical examination of the corresponding subject(s) (2nd attempt). If he/she passes these subjects at this supplementary examination, he/she will continue with the regular batch.
3. In the I year, in case of fail result in any theory subject and/or practical in the 2nd attempt (supplementary examination), the student will study with the next junior year's batch and will have to reappear for I year examination (theory and practical) again the next year (3rd attempt). A student failing in any one or more theory subject(s) and/or practical examination in this attempt will reappear in a supplementary examination in the theory and the practical examination (to be held within 6 weeks) in the subjects (4th attempt).



4. In the II and III years, If the candidate fails to pass in the practical examination, he/she will be required to appear in all the theory papers and the complete practical examination in the supplementary examination. If the candidate passes in the practical examination but fails only in one or two theory papers, he/she will be permitted to appear only for that theory paper(s) in the supplementary exam provided he/she has an aggregate of 50% or above in theory papers. If the candidate passes in the practical examination but fails in three or four theory papers or scores less than 50% aggregate in theory, then he/she will be required to appear in all the theory papers and the practical examination.
5. In case of fail result in any theory subject and/or practical in the 2nd attempt, the student will study with the next junior year's batch and will have to reappear for Year 2/Year 3 examination again the next year (3rd attempt). A student failing in any one or more theory subject(s) and/or practical examination in this attempt will reappear in a supplementary examination (to be held within 6 weeks) in the particular subjects (4th attempt).
6. If a student fails even in the 4th attempt, no further chances will be given, and his/her name will be struck off the rolls of JIPMER.
7. A student needs to complete the entire 3-year course within 6 years from the date of enrollment (twice the duration of the course), beyond which he/she will not be allowed to appear in any examination. Any exception for extenuating reasons (e.g. prolonged illness of the candidate, family problems, natural calamities, etc.) will be made only after approval of the Academic Advisory Committee and Head of the institution.
8. No grace marks will be awarded for either theory or practical examinations, under any circumstances.

### **Pass criteria:**

#### **First year**

For a candidate to pass, he /she should attain the following-

1. A minimum of 40% in each of the theory papers.
2. A minimum of 50% in practical separately.
3. The candidates' overall marks for theory, practical, viva-voce and internal assessments put together should be 50% of the grand total.

#### **Second and Third years**

1. A minimum 40% in each of the theory papers and overall, in theory (all papers put together) should obtain a minimum of 50% marks.
2. A minimum of 50% in practical separately
3. A minimum of 50% of the grand total (theory, practical and internal assessments)

**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY FIRST YEAR EXAMINATION**

**PAPER I - Anatomy**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions with suitable labelled diagrams wherever necessary**

1. Describe the external features of the heart. Add a note on venous drainage of the heart. (7+3)
2. Describe the stomach under- location, parts, relations, and blood supply. (1+2+4+3)
3. Enumerate the parts of Male reproductive system. Describe in detail about gross features and blood supply of testis. (2+8)
4. Draw a neat, labeled diagram of the excretory system. Explain in detail the coverings, and relations of kidneys. (3+7)
5. Describe the parts of a long bone and its blood supply. Add a note on classification of bones. (6+4)
6. Describe in detail the parts, relations of pituitary gland. Add a note on its histological features. (5+5)
7. Describe in detail the tongue under- parts and features, muscles, nerve, and blood supply. (2+3+3+2)
8. Describe cerebellum under the following- location and parts, fissures and lobes, deep cerebellar nuclei. Add a note on its histological features. (10)
9. Enumerate and draw the ventricles of cerebrum. Describe in detail about the lateral ventricle. (3+7)
10. Describe spleen under the following- location, parts and relations, ligaments related and their content, blood supply. (1+5+2+2)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY FIRST YEAR EXAMINATION**

**PAPER II - Physiology**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions with suitable labelled diagrams wherever necessary**

1. With the help of a labelled schematic diagram, explain mechanism of action of  $Na^+-K^+$  pump. List four functions of  $Na^+-K^+$  pump. (6+4)
2. Draw a labelled diagram of neuromuscular junction. Briefly describe the mechanism of neuromuscular transmission. (4+6)
3. List the steps of erythropoiesis. Briefly describe the factors influencing erythropoiesis. (2+8)
4. Define cardiac output. Describe the regulation of cardiac output (2+8)
5. Classify hypoxia and give one example for each. Add a note on hamburger shift (4+6)
6. With the help of a suitable diagram, explain the counter-current mechanism for urine concentration. (10)
7. With the help of a suitable diagram explain mechanism of gastric hydrochloric acid secretion. Add a note on gastric function tests. (6+4)
8. Describe the mechanism of action of insulin and the physiological action of insulin on carbohydrate metabolism. (5+5)
9. List four indicators of ovulation. Describe the ovarian and uterine changes in menstrual cycle. (2+4+4)
10. With the help of a suitable diagram, depict the functional divisions of cerebellum and enumerate the functions of cerebellum. Give a short note on cerebellar function tests. (3+3+4)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY FIRST YEAR EXAMINATION**

**PAPER III - Biochemistry**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**  
**Each question carries TEN marks.**

1. Describe the food sources, daily requirements, biochemical function, and deficiency manifestations of Vitamin A. (2+2+3+3)
2. List the food sources for iron. Discuss factors affecting iron absorption from gut. Add a note on iron deficiency anaemia. (2+4+4)
3. Briefly discuss the indications, procedure, and interpretations of OGTT. (2+3+5)
4. Enumerate the special products of glycine and tyrosine and specify their biological applications. (10)
5. Write short notes on: (5+5)  
a) Features of codon. b) telomerase
6. Describe the steps of Polymerase chain reaction with a suitable diagram and list its applications. (6+4)
7. Enumerate various liver function tests. Add a note on the lab diagnosis of different types of jaundice. (10)
8. Write short notes on: (5+5)  
a) HDL cycle and its importance. b) Phospholipids and its importance
9. Discuss any four factors affecting enzyme activity. Mention two enzymes used in the diagnosis of pancreatic diseases. (8+2)
10. Briefly discuss the causes, clinical features, and treatment of Gout (4+4+2)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY SECOND YEAR EXAMINATION**  
**PAPER I**

**Biophysical chemistry and techniques related to biochemistry**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Describe the following aspects of spectrophotometry: (a) Why the preferred range of measurements is restricted to 0.1 to 0.7? (b) Define molar absorptivity and discuss its significance (c) Define 'spectral band width' and 'natural bandwidth' (d) Assessment of the photometric accuracy of a spectrophotometer. (2+ 2+ 3+ 3)
2. Describe the principle, instrumentation, and applications of mass spectrometry (10)
3. Describe the following with reference to spectrofluorometry: (a) Fluorescence polarization and its applications (b) Relationship between sample concentration and fluorescence intensity (c) Inner filter effect (d) Applications of spectrofluorometry. (2+ 2+ 3+ 3)
4. Describe Gibbs –Donnan equilibrium and its significance in biological system. (10)
5. Discuss the differences between flame photometry and atomic absorption spectrometry with reference to principle, instrumentation, and applications. (10)
6. Describe the following: (5+5)  
(a) Relationship between standard free energy change and equilibrium constant of a biochemical processes (b) Thermodynamic basis for considering ATP as a high energy compound
7. Describe the following: (5+5)  
(a) Criteria for buffers suitable for use in biological research. (b) Henderson – Hasselbalch equation for the ionization of weak acids.
8. (a) Describe the various factors which affect the migration of an analyte during electrophoresis. (b) Describe the principles of the following electrophoretic techniques (i) Isoelectric Focusing (ii) Isotachopheresis (iii) SDS-PAGE (iv) Capillary electrophoresis (2+8)
9. Describe the basic principle of Gel filtration chromatography. Discuss the different types of gel filtration media used and the applications of the technique. (5+5)
10. Explain the following aspects of centrifugation (5+5)  
(a) Sedimentation coefficient (b) Relative centrifugal force

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY SECOND YEAR EXAMINATION**  
**PAPER II**

**Foods, human nutrition, Vitamins, and dietetics**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Write in detail about the sources, daily requirement, absorption, and storage of Vitamin A. (10)
2. Discuss the digestion and absorption of dietary carbohydrates. (10)
3. Write short notes on: (10)  
a. Food fortification b. Probiotics
4. Discuss in detail the assessment of obesity. Explain the dietary recommendations for a man weighing 85 kg (height 160 cm). (10)
5. What are the effects of food processing? Add a note on food preservatives. (10)
6. What is meant by Nitrogen balance? Discuss factors affecting nitrogen balance. (10)
7. Discuss the type of fats and oils that can be consumed by a person to prevent atherosclerosis. Why is PUFA in excess, harmful? (10)
8. Write in brief about: (10)  
a. Lactose intolerance b. Glycemic index
9. What are the various steps to be followed while prescribing a diet for a pregnant woman? (10)
10. What are the causes of deficiency of vitamin B12? What are the manifestations of deficiency and methods of assessment? (10)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY SECOND YEAR EXAMINATION**  
**PAPER III**

**Bio-organic chemistry and biostatistics**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Define Compound lipid. Discuss the structure and applications of any four in detail. (2+8)
2. Describe the structural organization of protein and its significance with suitable diagrams and examples. (5+5)
3. Write short notes on the following: (5+5)  
a) Nucleoproteins b) B-DNA
4. Discuss the secondary structure of RNA in detail with a suitable diagram. Add a note on biologically important nucleotides. (10)
5. Compare the following: (5+5)  
a) Glycoprotein and Proteoglycan b) Thromboxane and Leukotrienes
6. Discuss the biological importance of various prostaglandins in detail. Explain why Eskimos are better protected against cardiovascular diseases. (5+5)
7. Discuss the biological importance of the following: (5+5)  
a) Slow reacting substances of anaphylaxis (SRS-A) b) Amino sugars and Deoxysugars
8. Write short notes on the following: (5+5)  
a) Lipoprotein b) Glycolipid
9. Discuss the structural organization of homopolysaccharides with two examples. (10)
10. Discuss in detail the difference between a case-control and cohort study. (10)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY SECOND YEAR EXAMINATION**  
**PAPER IV**  
**Enzymes, Minerals, and bioenergetics**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Write short notes on:  
a) energy trapping mechanisms b) Q cycle (5+5)
2. Explain the role of enzymes in a) Myocardial Infarction b) Liver disease. (5+5)
3. Write an essay on role of enzymes and isoenzymes in various clinical disorders. (10)
4. Discuss about “standard free energy change of chemical reactions”. (10)
5. What is the normal level of calcium in serum? Discuss the factors maintaining calcium levels. (10)
6. What are allosteric enzymes? Explain allosteric regulation of enzyme activity with suitable examples. (1+9)
7. Describe various types of oxidoreductases with examples. (10)
8. Describe the components of electron transport chain and mention its inhibitors. (10)
9. Using Lineweaver Burk plot explain the differences between competitive and non-competitive enzyme inhibition. Name two competitive inhibitors and its significance. (6+4)
10. Write short notes on:  
a) Enzyme specificity b) Enzyme purification (5+5)

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**MODEL PRACTICAL EXAMINATION**  
**MSc MEDICAL BIOCHEMISTRY SECOND YEAR**

**Total Marks: 200**

1. Estimate the glucose/fructose/lactose/pentose in the given sample (Jaggery/Honey/milk). Prepare standard graph and interpret the result. Interpret your findings. (40)
2. Confirm your findings with chromatography and record your findings. (Paper/ TLC). (Sample A) (50)
3. Carry out SDS – PAGE with the given sample. (60)
4. Estimate the specific activity of urease from horse gram and record your findings. OR Calculate the Km value of urease from horse gram and record your findings. OR Estimate the specific activity of acid phosphatase from potato and record your findings. OR Calculate the Km value of acid phosphatase from potato and record your findings. (Sample C) (50)

		<b>Marks Allocation (Max)</b>	<b>Marks obtained</b>
I	General Biochemistry assay	40	
II	Chromatography (Paper/ TLC)	50	
III	SDS-PAGE	60	
IV	Enzymes (Determination of Km value / Specific activity)	50	
<b>Total (I + II + III+IV)</b>		<b>200</b>	

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Intermediary metabolism and regulation
Cell and molecular biology
Endocrinology and immunology
Clinical Biochemistry & Recent Advances in Clinical Biochemistry

**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY THIRD YEAR EXAMINATION**  
**PAPER I**

**Intermediary metabolism and regulation**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Describe in detail the metabolism in fed state and during starvation. (10)
2. Liver plays a central role in metabolism. Explain. (10)
3. Bile acid synthesis and their role in liver disease. (10)
4. Discuss the metabolism of sulphur containing amino acids and the disorders associated with them. (10)
5. "The fatty acid oxidation is an ideal partner system for gluconeogenesis." Discuss. (10)
6. Explain the biochemical basis of drug resistance. (10)
7. Explain the role of uridine nucleotides in carbohydrate metabolism. (10)
8. Discuss the degradative steps of valine. What is Maple syrup urine disease? (10)
9. Describe the formation and elimination of free radicals in the body. Describe the role of various types of antioxidants in health and disease. (10)
10. Explain the steps in cholesterol synthesis. Add a note on its regulation. (10)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY THIRD YEAR EXAMINATION**

**PAPER II**

**Cell and molecular biology**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Discuss the process of DNA replication and its regulation. How are proof reading and editing done? Add a note on transposons. (10)
2. Problems encountered in the synthesis of a eukaryotic protein in a prokaryotic host by recombinant DNA technology and how they can be solved. (10)
3. Describe the molecular basis of genetic disorders and explain the specific tests used in the diagnosis of genetic diseases. Comment on the major implications of human genome project in the study of health and disease. (10)
4. Discuss in detail the central dogma of molecular biology. (10)
5. Discuss repression and derepression. (10)
6. Explain the role of oncogenes and tumour suppressor genes in carcinogenesis. (10)
7. Apoptosis pathways – mechanisms & role of p53 in apoptosis. (10)
8. Describe in detail the cell signaling pathways. (10)
9. Describe the process of isolation of cell organelles. Give an account of various cell organelles. Add a note on marker enzymes. (10)
10. Describe the molecular organization of bio membranes explaining the following: (10)  
(a) Membrane asymmetry (b) Properties of peripheral and integral membrane proteins with examples.

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY THIRD YEAR EXAMINATION**  
**PAPER III**

**Endocrinology and immunology**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Explain the different mechanisms of hormone action and signal transduction. (10)
2. Describe the molecular basis of actions of insulin. Explain the concept of insulin resistance and its measurement. Add a note on secondary diabetes. (10)
3. Briefly describe the disorders of adrenal cortex and explain in detail the biochemical tests used in the assessment of adrenal cortical dysfunction. (10)
4. Discuss the influence of hormones on adipose tissue. (10)
5. Describe the molecular basis of antibody diversity. (10)
6. Describe the formation, functions and pathophysiology of the hormones which regulate calcium metabolism. (10)
7. Write an essay on major histocompatibility complex (MHC) under the following titles. (10)  
  
(a) Types (b) Structure- Function relationship (c) Functions (d) Pathophysiological importance
8. Types, source, and mechanisms of action of interferons. (10)
9. Immunological synapse. (10)
10. Cancer immunotherapy. (10)

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**MODEL QUESTION PAPER**  
**MSc MEDICAL BIOCHEMISTRY THIRD YEAR EXAMINATION**  
**PAPER IV**

**Clinical Biochemistry & Recent Advances in Clinical Biochemistry**

**Time: 3 hours**

**Max. Marks: 100**

**Answer all the questions.**

**Each question carries TEN marks.**

1. Describe in detail various hemoglobinopathies and the techniques available to diagnose them. (10)
2. Describe the process of atherosclerosis. Write a note on the roles of homocysteine, Lp(a) and oxidized LDL in the genesis of coronary artery disease. (10)
3. Discuss chronic renal failure. What are the metabolic and endocrine disturbances encountered and renal replacement treatment options available? (10)
4. Give an account of the long-term complications of diabetes mellitus. Discuss the biochemical aspects of diabetic emergencies. (10)
5. Give the various liver function tests. Evaluate these tests in the diagnosis of different types of jaundice. What tests could be performed in urine to confirm the diagnosis? (10)
6. Enumerate the thyroid function tests. Comment on the strategy in carrying out thyroid function tests in a suspected case of thyroid dysfunction. Narrate the target proteins whose activities are modulated by thyroid hormones. (10)
7. Describe the molecular basis of human blood groups and its inheritance. (10)
8. Write a note on: (10)  
a) Types of audits in clinical Biochemistry b) Laboratory Information systems
9. Describe the role of Automation in Clinical Biochemistry and Lab management. (10)
10. Enumerate the applications of nanotechnology. What is hybrid technology? (10)

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**DEPARTMENT OF BIOCHEMISTRY**  
**MSc MEDICAL BIOCHEMISTRY FINAL PRACTICAL EXAMINATION**

**Total Marks: 200**

1. Estimate the Cholesterol/ Creatinine/ Urea/ Uric acid/Glucose/ Bilirubin in the given serum sample. Prepare standard graph and interpret the result. (60)
2. Check the abnormal constituents in the given urine sample. Interpret your findings. (30)
3. Carry out Agarose gel electrophoresis with the given sample. (60)
4. Assay the activity of serum ALT/ Alkaline phosphatase/ AST/ Acid phosphatase in the serum sample provided. OR A new kit for glucose estimation is given to you. Analyze and calculate the imprecision and bias for the same. Report whether the kit meets your lab requirements and meets the recommendations provided by CLIA. (50)

		Marks Allocation (Max)	Marks obtained
I	Clinical biochemistry assays	60	
II	Abnormal constituents of urine	30	
III	Electrophoresis (Agarose gel electrophoresis)	60	
IV	Enzymes (Determination of enzyme activity) or Method validation	50	
<b>Total (I + II + III+IV)</b>		<b>200</b>	

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