

## **MSc Medical Laboratory Technology in clinical chemistry (Faculty of medical sciences)**

1. **Name of the course:** MSc Medical Laboratory Technology in clinical chemistry (Faculty of medical sciences)
2. **Level of the course:** PG degree in Faculty of Medical sciences
3. **Nature of the course:** Full time, Duration : 2 years, Student intake per year : 6
4. **Pattern of the course :** Annual
5. **Eligibility criteria for course entry:** B.Sc.- MLT degree from a recognized at least 50% mark
6. **Admission procedure:** Entrance test/personnel interview
7. **Fees :** Rupees 80, 000/ per year
8. **Course objectives:**

**At the end of the course the candidates must be able to:**

- I. Acquire the knowledge and apply the concepts, theories and principles of laboratory science in their profession.
- II. To bring about an effective change in the laboratory practice and health care delivery system.
- III. Establish collaborative relationship with members of other disciplines.
- IV. Demonstrate interest in continued learning and research for personal and professional advancement.

**9. Course Structure (curriculum): Attached (Annexure 1)**

**10. Institutes /Universities in India offering similar courses:**

- I. Maharshi Dayananda University, Rohtak
- II. VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT.

**11. Career prospects / placement opportunities:**

Academics, R & D Laboratories, Health care set up, corporate organization, Industries & Independent practice

**SCOPE:** This post Graduate programme in Medical Laboratory Technology – Clinical chemistry gives an opportunity for specialized study in the field of Laboratory Technology for training BSc (MLT) students. Candidates who successfully complete MSc (MLT) course may be placed as

- I. Specialized technologists in Biochemistry or supervisors of clinical laboratories in hospitals.
- II. Laboratory technologists /scientists/ consultants in Biomedical and research institutes
- III. Teachers in training institutes of Medical Laboratory Technology

**12. Any Other salient feature that you wish to state:** There are very less number of Universities in India offering MSc MLT in clinical chemistry, which is an upcoming branch. Many corporate laboratories industries and R & D centres are establishing

branches in India in the recent past. There is always increased demand, competition & urge to improve their own quality. Many clinical laboratories now going for NABL accreditation and maintaining quality at low cost is being taken up as a challenge now a days especially in the field of clinical chemistry. Hence there is lots of scope and opportunity for those who are willing to perceive this course

## Annexure 1

### Course Structure (curriculum)

**Faculty for the course:** Course coordinator: Prof. R. Ramesh  
Coordinator: Dr. G. Niranjana

**Faculty:** Prof. Saha S, Prof. Srinivasan A R, Dr. Sathish B M, Dr. Reeta R, Dr. Swetha K

#### **Evaluation pattern:**

- **Examinations**  
Duration of theory examination for all the papers will be three hours each. Practical and viva examinations for MSc (MLT) - clinical chemistry are conducted in two consecutive days.
- **Internal assessment:** Internal Assessment will be based on formative assessment examinations, projects, log books, records, presentation of seminars and journal clubs and work assessment during clinical postings and tutorials. In the case of candidates who fail in the University examination, fresh internal assessment marks can be sent based on their improvement in their performances.
- **Examiners**  
There shall be Four examiners for practical and viva, two internal and two external. External examiner should be a regular teaching faculty of any medical college with either a MD degree or MSc. PhD in Biochemistry/MLT and should be Associate Professor and above. Theory papers will be evaluated by both external and internal examiners.
- **Question paper setters**  
Should be a regular teaching faculty of any medical college with either a MD degree or MSc.PhD in Biochemistry/ MLT.
- **Setting up of Question Paper**  
Each theory paper will be of 3 hours duration with a Maximum of 100 marks. Theory paper in all the subjects will consist of 2 sections -Section A & B. Each section carries 50 marks and shall consist of an essay question with 10 marks, 7 question carrying 4 marks each and 6 questions

carrying 2 marks each. Section A & B will have to be answered in separate answer booklets

**Failed Candidates:** Candidate failing to secure minimum pass (50%) in any paper (Theory or practicals) shall reappear for both theory and practicals.

**References:** Syllabus of MSc MLT form JIPMER, KMC, Manipal, VEER NARMAD SOUTH GUJARAT UNIVERSITY, and SURAT.

• **Suggested books:**

- *Biochemistry by Geoffrey L Zubay, Fourth Edition, 1998*
  - *Fundamentals of Biochemistry by Donald Voet, Judith Voet and Pratt, second edition, 1995*
  - *Biochemistry – Lubert Stryer*
  - *Harper’s Biochemistry by Murray et al. Appleton and Lange Publishers, 27h edition, 2006*
  - *Principles of Biochemistry by Lehninger, Nelson and Cox, fourth edition, W H Freeman and Company, New York, USA, 2005*
  - *Textbook of Biochemistry by West and Todd, Fourth Edition, 1966*
  - *Text book of clinical chemistry - Teitz*
  - *Varley’s Practical Clinical Biochemistry by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition*
  - *Practical Biochemistry – Wilson & Walker*
  - *Clinical chemistry – Marshal*
  - *Clinical Biochemistry Principle and Practice – Praful B Godkar*
  - *Lecture notes on Clinical chemistry – L.G. Whitby*
  - *Clinical Chemistry – Kaplan*
  - *Clinical chemistry in diagnosis and treatment – Philip D Mayne*
  - *Clinical Chemistry – Michael L Bishop*
  - *NMS Biochemistry*
  - *Immunology: Janis Kuby fourth edition, W H Freeman Company, USA (2000)*
  - *Essential Immunology : Ivan Roitt (Blackwell Science Publishers, UK, 1997)*
  - *A Hand Book of Practical Immunology: GP Talwar (Vikas Publishing House, 1983).*
- (Many more under the respective sections)

**Composition of board of studies:**

The board of study members:

**External Members:**

1. Prof. B.D. Toora, HOD, AVMC & RC, Puducherry
2. Dr. Medha, Associate Professor, Dept. Of Biochemistry, JIPMER, Puduchery. Internal members : Prof. Saha S, Prof. Srinivasav A R, Dr. Sathish Babu M, Dr. Reeta R, Dr. Swetha K.

# **SYLLABUS**

## **MSc in Medical Laboratory Technology in clinical chemistry** **(Faculty of medical sciences)**

### **FIRST YEAR (3 PAPERS)**

#### **TOTAL MARKS: 600**

- **PAPER-1:** Biomolecules, Metabolism, Research methodology and biostatistics. (100 marks )
- **PAPER-2:** Enzymology, Biophysical chemistry, Vitamins, minerals and basics of Nutrition, (100 marks)
- **PAPER-3:** Clinical Biochemistry (Part – I) (100marks)
  
- **Practicals: 200 marks**

**Internal Assessment 50 marks (Theory 25 + Practical 25)**

**VIVA 50 marks**

### **SECOND YEAR**

#### **TOTAL MARKS: 600**

#### **Theory**

- **PAPER-1:**Basics of Endocrinology, Clinical Immunology, Cell & Molecular Biology & human genetics (100 marks)
- **PAPER-2:** Medical Laboratory Techniques & instrumentation (100 marks)
- **PAPER-3:** Clinical Biochemistry Part-II (100 marks )
  
- **Practicals: 200 marks**
  
- **VIVA : Dissertation Viva 30 marks + Theory Viva 20 marks ( 50 marks)**  
**Internal Assessment 50 marks (Theory 25 + Practical 25)**

# **COURSE CONTENT**

## **FIRST YEAR**

**PAPER 1:** Biomolecules, Metabolism, Biophysical chemistry and Enzymology. (100 marks)

### **BIOMOLECULES:**

#### ***UNIT 1***

Introduction: Introduction to Biochemistry, water as biological solvent, weak acids and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers.  
Carbohydrates: Classification, structure, occurrence and biological functions.  
Physicochemical properties of monosaccharides.

#### ***UNIT 2***

Lipids: Classification, structure, occurrence and biological functions of lipids. Nomenclature and properties of fatty acids and triglycerides, saponification number, acid number, Reichert-Meissel number, rancidity of fats. Composition and types of lipoproteins. Steroids and carotenoids of biological origin, liposomes.

#### ***UNIT 3***

Amino acids: Nomenclature, classification and chemical structure of amino acids. Physicochemical properties of amino acids with their titration curve, reaction with ninhydrin, amino acids as zwitterions and isoelectric point.  
Proteins: Classification, structure (primary, secondary, tertiary and quaternary; structure of peptide bond, Ramachandran Plot), properties and biological functions of proteins. Protein denaturation & renaturation. Methods to determine amino acid sequence- N- and C-terminal amino acid identification, amino acid sequencing of small peptides and overlapping. Chemical synthesis of polypeptides, salting in and salting out of proteins.

#### ***UNIT 4***

Nucleic acids: Nature of genetic material, properties of DNA in solution, evidence of DNA as genetic material and evidence for semi-conservative nature, Composition of RNA and DNA, generalized structure plan of nucleic acids, nomenclature in structure of nucleic acids, features of DNA double helix, denaturation and annealing of DNA. Structure and roles of different types of DNAs and RNAs. Genetic code, genome.  
Porphyrins: Porphyrin nucleus and classification of porphyrins, important metalloporphyrins occurring in nature, Chemical nature and significance of bile pigments.

### **Suggested Readings:**

1. Lehninger Principles of Biochemistry 4th Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Chemistry of Biomolecules: an Introduction (Paperback) **By** Richard J. Simmonds. Publisher: Royal Society of Chemistry
3. Principles of Biochemistry (Hardcover) **By** Geoffrey Zubay. Publisher: McGraw Hill College.
4. Biochemistry **By** Lubert Stryer. WH Freeman and Co.
5. Biochemistry: The Molecular Basis of Life (Paperback) **By** Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
6. Biochemistry and Molecular biology **By** William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry (Hardcover) 3rd Ed. **By** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) **By** D Voet. John Wiley and Sons.
9. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) **By** Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
10. Principles of Biochemistry (Paperback) **By** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
11. Biochemistry **By** U. S. Satyanarayana
12. Outlines of Biochemistry **By** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

## **METABOLISM**

### ***UNIT 1***

**Introduction:** Concept of metabolism, experimental approaches to study metabolism use of intact organisms, bacterial mutants, tissue slices and radioisotopes. ETC and Oxidative phosphorylation: Sequence of electron carriers, sites of ATP production, inhibitors of ETC, mechanism and regulation of mitochondrial oxidative phosphorylation, ATP synthase, uncouplers of oxidative phosphorylation, transport of reducing potential and ions across mitochondrial membrane, phosphorylation potential, reversed and microsomal electron transfers, generation of superoxides in mitochondria.

### ***UNIT 2***

**Carbohydrate Metabolism:** Reactions and energetics of glycolysis. Alcoholic and lactic fermentations, entry of fructose, mannose and galactose. Reactions and energetics of TCA cycle, gluconeogenesis, glycogenesis and glycogenolysis. Reactions and physiological significance of HMP pathway, regulation of glycolysis and gluconeogenesis, cataplerosis and anaplerosis, biosynthesis of starch and oligosaccharides, regulation of blood glucose. Uronic acid pathway and glyoxylate cycle.

### ***UNIT 3***

**Lipid metabolism:** Transport and mobilization of lipids, oxidation of saturated fatty acids, oxidation of unsaturated and odd-chain fatty acids, role of carnitine

in transport of fatty acid, energetics of -oxidation scheme, metabolism of ketone bodies and its biological significance. Biosynthesis of saturated and unsaturated fatty acids. Biosynthesis of triglycerides, phospholipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism. Metabolism of lipoproteins. Biosynthesis of prostaglandins.

#### **UNIT 4**

**Amino acid metabolism:** General reactions of amino acid metabolism- transamination, deamination and oxidative decarboxylation. Biosynthesis and degradation of amino acids and their regulation. Feedback regulation of amino acid biosynthesis. Urea cycle and its regulation.

#### **UNIT 5**

**Nucleic acid Metabolism:** Sources of atoms in purine and pyrimidine molecules, biosynthesis and degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. Porphyrin Metabolism: Biosynthesis and degradation of porphyrins, production of bile pigments.

#### **Suggested Readings:**

1. Lehninger Principles of Biochemistry 4th Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Principles of Biochemistry (Hardcover) **By** Geoffrey Zubay. Publisher: McGraw Hill College.
3. Harper's Biochemistry (Lange Medical Books) (Paperback) **By** Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
4. Bioenergetics **By** David G. Nicholls and Stuart J. Ferguson. Academic Press.
5. Bioenergetics at a Glance: An Illustrated Introduction (At a Glance) (Paperback) **By** D. A. Harris. Publisher: Wiley Blackwell
6. Bioenergetics: 0 (Paperback) **By** Lars Garby and Poul S. Larsen. Cambridge University Press.
7. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) **By** Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
8. Biochemistry (Hardcover) 3rd Ed. **By** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
9. Biochemistry of Lipids, Lipoproteins and Membranes (4th Ed.) D.E. Vance and J.E. Vance. Pub: Elsevier Science B.V
10. Medical Biochemistry 4th Ed. by NV Bhagavan. Pub: Elsevier India Pvt. Ltd.
11. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) **By** D Voet. John Wiley and Sons.
12. Biochemistry **By** Lubert Stryer. WH Freeman and Co.
13. Principles of Biochemistry (Paperback) **By** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
14. Harper's Biochemistry **By** RK Murray, DK Granner, PA Mayes and VW Rodwell. Appelton and Lange, Stanford.
15. Biochemistry **By** U. S. Satyanarayana
16. Outlines of Biochemistry **By** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

## **Biophysical chemistry**

Cell, the cell organelles, membrane, structure of bio membrane, transport across bio membranes, the fluid mosaic model of bio membranes, surface tension, viscosity, *Donnan* membrane equilibrium, osmosis, diffusion, osmotic pressure, oncotic pressure.

## **Enzymology**

### ***UNIT 1***

Introduction: History, general characteristics, nomenclature, IUB classification, definitions with examples of holoenzyme, apoenzyme, coenzymes, prosthetic groups, cofactors, activators, inhibitors, active site, metalloenzymes, isozymes, monomeric enzymes, oligomeric enzymes and multienzyme complexes. Units of enzyme activity (definition of IU, Katal), specific activity of enzyme, measurement of enzyme activity, enzyme turnover. Ribozymes and abzymes.

Enzyme Catalysis: Role of enzymes in energy of activation, factors of affecting action of enzymes- proximity and orientation, strain and distortion, acid base catalysis and covalent catalysis. Determination of active site. Mechanism of action of chymotrypsin, ribonuclease, carboxypeptidase and lysozyme.

### ***UNIT 2***

Enzyme kinetics: Factors affecting enzyme activity- pH, temperature, time of incubation, enzyme concentration and substrate concentration. Derivation of Michaelis-Menten equation for unisubstrate reaction,  $K_{cat}/K_m$  and its significance, Lineweaver-Burk plot and its limitations; Eadie-Hofstee Plot, Eadie Plot, Hanes plot and Eisenthal-Cornish-Bowden plot. Significance and calculation of energy of activation from Arrhenius plot. Reversible and irreversible inhibition; competitive, non-competitive and uncompetitive inhibitions with determination of  $K_m$  and  $V_{max}$  in presence of reversible inhibitor. Derivation of  $K_i$  and Dixon plot, Kinetics of multisubstrate reactions, introduction to sequential and ping-pong mechanisms and their classifications & double reciprocal plots with examples.

### ***UNIT 3***

Protein-ligand binding, cooperativity phenomenon, Hill and Scatchard plots. Allosteric enzymes: Sigmoidal kinetics and their physiological importance, symmetric and sequential modes for action of allosteric enzymes and their significance.

Immobilization of enzymes: Introduction, classification, various methods of immobilization, kinetics of immobilized enzymes and its significance, applications of immobilized enzymes in analysis of biological materials, food industry and medicine.

### ***UNIT 4***

Enzyme Regulation: Reversible and irreversible covalent modification, feedback inhibition, control of enzyme by products, substrates and adenylate energy charge, monocyclic and multicyclic cascade systems. Enzyme activation, induction and repression.

Coenzymes: Structure and biological functions of NAD, NADP, FAD, FMN, TPP, THF, biotin, Coenzyme Q, ascorbic acid, lipoic acid and PLP.

### **Suggested Readings:**

1. Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins (Paperback) *By* Nicholas C. Price and Lewis Stevens. Oxford University Press.



2. Advances in Enzymology: v. 47 (Hardcover) **By** Alton Meister. John Wiley and Sons Inc.
3. Lehninger Principles of Biochemistry 4th Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
4. Principles of Biochemistry (Hardcover) **By** Geoffrey Zubay. Publisher: McGraw Hill College.
5. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) **By** D Voet. John Wiley and Sons.
6. Basic Biochemical Laboratory Procedures and Computing **By** R. Cecil Jack, Oxford University Press.
6. Enzyme Kinetics: Principles and Methods (Hardcover) **By** Hans Bisswanger. Publisher: Wiley VCH.
7. Enzymatic Reaction Mechanisms (Hardcover) **By** Perry A. Frey and Adrian D. Hegeman. Oxford University Press.
8. Comprehensive Enzyme Kinetics (Hardcover) **By** Vladimir Leskovac. Publisher: Kluwer Academic / Plenum Publishers.
9. Enzyme Kinetics: A Modern Approach (Hardcover) **By** Alejandro G. Marangoni. Publisher: WileyBlackwell.
10. Enzyme Kinetics and Mechanisms (Hardcover) **By** Kenneth B. Taylor. Kluwer Academic Publishers.
11. Nature of Enzymology **By** RL Foster
12. A textbook of enzyme biotechnology **By** Alan Wiseman.
13. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry By Trevor Palmer.
14. Enzymes **By** M Dixon and EC Webb. EC Longmans, London.
15. The chemical kinetics of enzyme action **By** KJ Laidler and PS Bunting. Oxford University Press, London.

**PAPER 2** Vitamins, minerals and basics of Nutrition, research methodology and biostatistics. (100 marks)

### **Vitamins, minerals and basics of Nutrition:**

**Nutrition:** Caloric values of foods, BMR, respiratory quotient, energy requirements, role of carbohydrates, lipids, proteins and amino acids in diet, nitrogen balance, protein energy malnutrition, glycemic index, diet in pregnancy and lactation.

Anemia

**Mineral metabolism:** Metabolism of calcium, phosphorus, magnesium, sodium potassium, chloride, sulphur, iron, copper, iodine, manganese, zinc, molybdenum, cobalt, nickel, chromium, fluorine, selenium.

### **Vitamins**

**Vitamins:** Classification of vitamins.

Chemistry, properties, biological importance and deficiency manifestations of fat soluble vitamins.

Chemistry, properties, biological importance, deficiency manifestations and coenzyme functions of water soluble vitamins.

### **RESEARCH METHODOLOGY**

Basic principles of biostatistics and research methodology, sample size calculation analysis of data, types of studies randomization, clinical trials,

Basic reviewing quantitative and qualitative literature. carry out an appropriate, rigorous review of the literature; and understand the strengths and weaknesses of different methods of identifying, assessing and synthesizing literature.

1. Planning the review: the role of the literature review and specification of the task
2. Identification of relevant literature, both published and unpublished: developing a search strategy and using bibliographic databases.
3. Appraising the literature: methods for assessing the quality of quantitative and qualitative research.
4. Synthesizing the evidence: integration of the evidence using both quantitative and qualitative methods; principles of meta-analysis.
5. Formulating recommendations and writing the review.

## **BIOSTATISTICS**

- 1) Introduction to Biostatistics
- 2) Definition, role of statistics in health science and health care delivery system
- 3) Sampling Population, sample, sampling, reasons for sampling, probability and non-probability sampling
- 4) Methods of probability sampling-simple random, stratified, systematic procedure, merits and demerits. Use of random number table.
- 5) Organization of data
- 6) Frequency table, histogram, frequency polygon, frequency curve, bar diagram, pie chart
- 7) Measures of location Arithmetic mean, median, mode, quartiles and percentiles – definition, computation (for raw data ), merits, demerits and applications.
- 8) Measures of variation: Range, inter –quartile range, variance, standard deviation, coefficient of variation- definition, computation (for raw data), merits, demerits and applications. skewness and kurtosis.
- 9) Basic probability distributions .
- 10) Concept of probability distribution. Normal, Poisson and Binomial distributions, and application. Concept of sampling distributions. Standard error and confidence intervals.
- 11) Tests of significance :
- 12) Basic of testing of hypothesis – Null and alternate hypothesis, type I and type II errors, level of significance and power of the test , p value.
- 13) Tests of significance (parametric) – t – test (paired and unpaired), Chi square test and test of proportion.
- 14) Correlation and Regression :
- 15) Scatter diagram, concept and properties of correlation coefficient, examples (No computation Simple correlation ) Pearson's and spearman's, testing the significance of correlation coefficient. Linear and multiple regressions.

## **PAPER 3: Clinical biochemistry – Part 1**

### ***UNIT 1***

**Disorders of carbohydrate metabolism:** Diabetes mellitus, glycohemoglobins, hypo-glycemias, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases.

**Physiology of lipids/lipoproteins.** Lipidosis. Clinical inter-relationships of lipids (sphingolipidosis and multiple sclerosis), lipoproteins and apolipoproteins. Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders. Inborn errors of metabolism:

a) **Disorders of amino acid metabolism-** Phenylalanemia, homocystinuria, tyrosinemia, MSUD, phenylketonuria, alkaptonuria, albinism and aminoacidurias.

b) **Disorders of nucleic acid metabolism-** Disorders in purine/ pyrimidine metabolism.

### ***UNIT 2***

**Electrolytes, blood gases, respiration and acid-base balance.** Disorders of acid-base balance and their respiratory and renal mechanisms.

**Organ function tests:** Evaluation of organ function tests: Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Clinical importance of bilirubin.

**Diagnostic enzymes:** Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.

## **SECOND YEAR**

**PAPER 1:** Basics of Endocrinology, Clinical Immunology, Cell & Molecular Biology (100 marks)

### **ENDOCRINOLOGY:**

Classification of hormones, mechanism of hormone action, regulation of hormone secretion. Chemistry, metabolism, biological functions and disorders of-

- Hypothalamus & Pituitary hormones
- Thyroid hormones
- Parathyroid hormones
- Pancreatic hormones
- Adrenal hormones
- Gonadal hormones

### **Clinical Immunology**

#### ***UNIT 1***

Introduction to Immune System: Memory, specificity, diversity, innate and acquired immunity, self vs non-self discrimination. Structure and functions of primary and secondary lymphoid organs. Cells Involved in Immune Responses: Phagocytic cells and their

killing mechanisms; T and B lymphocytes; Differentiation of stem cells and idiotypic

variations. Nature of Antigen and Antibody: Antigen vs Immunogen, Haptens; Structure and functions of immunoglobulins; Isotypic, allotypic and idiotypic variations.

### **UNIT 2**

Generation of Diversity in Immune System: Clonal selection theory - concept of antigen specific receptor. Organization and expression of immunoglobulin genes: generation of antibody diversity. T cell receptor diversity. Humoral and Cell Mediated Immune Responses: Kinetics of primary and secondary immune response. Complement activation and its biological consequences. Antigen processing and presentation. Cytokines and costimulatory molecules: Role in immune responses. T and B cell interactions. Major Histocompatibility Complex (MHC) Genes and Products: Role of MHC antigens in immune responses. MHC antigens in transplantation.

### **UNIT 3**

Development, Regulation and Evolution of the Immune System: Measurement of Antigen-Antibody Interaction. Production of polyclonal and monoclonal antibodies: Principles, techniques and applications. Agglutination and precipitation techniques. Radio immunoassay, ELISA, immunofluorescence assays: Fluorescence activated cell sorter (FACS) technique. Tolerance vs Activation of Immune System: Immunotolerance, Immunosuppression, Hypersensitivity (Types I, II, III and IV).

### **UNIT 4**

Immune Responses in Diseases: Immune responses to infectious diseases: viral, bacterial and protozoal. Cancer and immune system. Immunodeficiency disorders. Autoimmunity. Immunization: Active immunization (immunoprophylaxis), Passive immunization (Immunotherapy) and role of vaccines in the prevention of diseases.

#### **Suggested Readings:**

1. Fundamental Immunology (Hardcover) **By** William E. Paul. Publisher: Lippincott Williams and Wilkins.
2. Immunology: International Edition (Paperback) **By** Janis Kuby, Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby. WH Freeman and Co. Ltd.
3. Immunology (Paperback) **By** Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne and Janis Kuby. WH Freeman and Co. Ltd.
4. Immunology (Paperback) **By** Ivan M. Roitt, Jonathan Brostoff and David Male. Publisher: Mosby.
5. Introduction to Medical Immunology **By** Gabriel Virella, Marcel Dekker Inc.
6. Roitt's Essential Immunology **By** Ivan M. Roitt and Peter J. Delves, Blackwell Publishing
7. Understanding Immunology (Cell and Molecular Biology in Action) (Paperback) **By** Peter Wood. Publisher: Prentice hall.
8. Basic Immunology: The Functions of the Immune System (Paperback) **By** Abul K. Abbas and Andrew H. Lichtman. Publisher: Saunders.
9. A Handbook of Practical Immunology, **By** G. P. Talwar, Pub: Vikas Publishing House.
10. Fundamental Immunology (Hardcover) **By** Robert M. Coleman and M.F. Lombard. Publisher: Brown (William C.) Co , U.S.
11. Atlas of Immunology (Hardcover) **By** J.M. Cruse (Author), Robert E. Lewis. CRC Press Inc.
12. Immunology **By** Edwards S Golub. Sinauer Associate, Sunderland.

## **Molecular Biology**

### **UNIT 1:**

Secondary and tertiary Structure of DNA and RNA, Locked nucleic acids, role of locked nucleic acid in therapeutics, siRNA, Micro RNA, Role of micro RNA in gene regulation, Isolation of nucleic acids, Qualitative and quantitative estimation of nucleic acids, Recombinant DNA Technology, Applications of recombinant DNA, Polymerase chain reaction, application of PCR in Diagnostics of pathogens identification, Site directed mutagenesis, RAPD, RFLP & DNA finger printing, DNA Foot Printing, Mobility shift assay, Promoter & Reporter assay, Yeast Two hybrid systems, antisense-RNA technology, chromosomal walking, gene therapy and recombinant vaccines.

### **UNIT 2:**

**Nucleic Acid analysis:** Extraction, purification and analysis of mRNA from eukaryotic cells, methods for synthesis of double strand cDNA, Expression profiling, Transcriptome analysis, RT PCR and Real Time PCR, Rapid DNA sequencing techniques like Sanger's dideoxynucleotide, partial ribonucleotide substitution, Maxam and Gilbert's method, pyrosequencing and single molecule sequencing, Genome, Genome sequencing, DNA Sequence Characterization (Open reading frames, promoters, coding frames)

### **UNIT 3:**

Molecular diagnostics, Viral load monitoring, window period, Role of molecular diagnostics in present diagnostic area, Benefits of molecular diagnostics over serological diagnostics tests, Ethical issues related to molecular diagnostics, role of Molecular diagnostics in Blood banking, Basic techniques used in molecular diagnostics, future of molecular diagnostics,

### **UNIT 4:**

Molecular diagnostic of various viral diseases: HIV type -1, HIV type -II, HPV, Various hepatitis strains, Influenza (H1N1) , sample preparation, various steps required for viral infection analysis and Viral load monitoring, Molecular diagnostics of bacterial infections; Mycobacterium tuberculosis, Shwenella typhus, Pathogenic E Coli, sample preparation and pathogen detection. Prenatal diagnostics of various genetic disorders.

### **Suggested Readings:**

1. Basic Biotechnology (Paperback) **By** Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Introduction to Biotechnology (Paperback) **By** William J. Thieman and Michael A. Palladino. Benjamin Cummings; US Ed edition.
4. Recombinant DNA Principles and Methodologies **By** James Joseph Greene, CRC Press.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA (Paper-back) **By** Bernard J Glick and Jack J Pasternak. Publisher: American Society for Microbiology.
6. Laboratory Techniques in Biochemistry and Molecular Biology; DNA sequencing (Vol 10). **By** J Hindley. Elsevier Biomedical.
7. Methods of DNA and RNA sequencing. **By** Sherman M. Weissman. Pub: Praeger
8. RNA isolation and analysis **By** P. Jones, J Qiu and D. Rickwood. Bios Scientific Publishers.
9. Biotechnology: Expanding Horizons **By** B. D. Singh, Kalyani Publishers.
10. Textbook of Biotechnology **By** PK Gupta, Rastogi Publications.
11. Biotechnology **By** U. Satyanarayana.
12. Molecular diagnostics: for the clinical laboratorian **By** William B. Coleman and Gregory J. Tsongalis. Publisher: Humana Press

13. Fundamentals of molecular diagnostics **By** David E. Bruns, Edward R. Ashwood and Carl A. Burtis
14. Molecular diagnosis of infectious diseases **By** Jochen Decker, Udo Reischl. Publisher: Humana Press

## **PAPER 2:** **Clinical biochemistry- PART 2**

### ***UNIT 1***

Hormonal disturbances: Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology.

Disturbances in thyroid function.

Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia and hyperphosphataemia.

### ***UNIT 2***

Biochemical aspects of hematology: Disorders of erythrocyte metabolism, hemoglobinopathies,

thalassemias thrombosis and anemias. Laboratory tests to measure coagulation and thrombolysis.

Detoxification in the body: enzymes of detoxification, polymorphism in drug metabolizing enzymes. Mechanism of drug action and channels of its excretion, Disorders of vitamins and trace elements.

### ***UNIT 3***

Total quality management in clinical chemistry laboratory, POCT, reference values, Audit in laboratory. NABL accreditation the need and details of ISO 15189.

#### **Suggested Readings:**

1. Textbook of Medical Biochemistry **By** MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Lehninger Principles of Biochemistry 5th Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
3. Davidson's Principles and Practice of Medicine: A Textbook for Students and Doctors (Hardcover) 15th Ed **By** LSP Davidson, J MacLeod and CRW Edwards. Publisher: Churchill Livingstone.
4. Medical Biochemistry (Paperback) **By** John W. Baynes and Marek Dominiczak. Publisher: Mosby.
5. Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3rd Ed **By** Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.
6. Review of Medical Physiology (Lange Basic Science) (Paperback) **By** William F. Ganong. Publisher: McGraw-Hill Medical
7. Harper's Biochemistry (Lange Medical Books) (Paperback) **By** Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
8. Clinical Biochemistry **By** Richard Luxton. Scion Publishing Ltd.
9. Principles of Medical Biochemistry: With STUDENT CONSULT Online Access (Paperback) **By** Gerhard Meisenberg and William H. Simmons. Publisher: Mosby.

**PAPER 3:** Human genetics, Medical Laboratory Techniques & instrumentation (100 marks )

## **Medical Laboratory Techniques**

### ***UNIT 1:***

Analysis of amino acids, Screening tests, quantitative tests, test for specific amino acids, determination of proteins in serum, plasma and CSF. Determination of glucose in body fluids, glucose tolerance test and hypoglycemia determination, analysis of ketone bodies, method of estimation of lactate, pyruvate and glycated hemoglobin in blood. Analytical methods for estimation of triglycerides, high density lipoproteins, low density lipoproteins, apolipoproteins.

### ***UNIT 2:***

Laboratory application of nucleic acid technologies to elucidate, diagnose, monitor disease state and to evaluate non-disease status techniques for the detection of DNA and RNA structures at the molecular level, Basic principles and techniques-nucleic acid biochemistry-Relation to laboratory evaluation of disease and establishing a molecular diagnostic laboratory facilities, equipment, personnel. Clinical testing process, quality assurance, clinical validation and accreditation.

### ***UNIT 3:***

Molecular genetics of hematopoietic neoplasm-lineage probes in the evaluation of hematopoietic neoplasma- Molecular analysis of chromosomal aberrations in leukemias and lymphomas, Molecular diagnosis of genetic diseases. Choice of techniques, choice of applications, special concept unique to molecular genetic disorders, specific disease examples. Application of molecular methods in clinical microbiology.

### ***UNIT 4 :***

DNA analysis; historical aspects advantage of DNA over traditional serology; impact of DNA specimen collection, DNA degradation and environmental damage, quality assurance, standard, databank, legal challenge.

### **Suggested Readings:**

1. Methods in Molecular Biology: Amino Acid Analysis Protocols **By** Catherine Cooper, Nicole Packer and Keith Williams. Publisher: Humana Press
2. Medical Biochemistry [Paperback] **By** John Van Pilsun. Publisher: University of Minnesota Press.
3. Clinical Biochemistry: Metabolic and Clinical Aspects [Paperback] **By** William J. Marshall and Stephen K. Bangert. Publisher: Churchill Livingstone.
4. Clinical Chemistry: Techniques, Principles, Correlations (Bishop, Clinical Chemistry) [Hardcover] **By** Michael L Bishop, Edward P Fody and Larry E Schoeff. Publisher: Lippincott Williams and Wilkins
5. Nucleic Acid Amplification Technologies: Application to Disease Diagnosis [Hardcover] **By** H Olsvik (Editor), S Morse (Editor), O Lee (Editor). Publisher: Eaton Publishing, USA.
6. Chromosomal Alterations: Methods, Results and Importance in Human Health [Hardcover] **By** Gunter Obe and Vijayalaxmi. Publisher: Springer
7. Handbook of Hematologic Pathology (Diagnostic Pathology) [Hardcover] **By** Harold R. Schumacher, Sanford A. Stass and William A. Rock. Publisher: Marcel Dekker Inc.
8. Molecular Diagnosis of Genetic Diseases (Methods in Molecular Medicine) (Methods in Molecular Biology) (v. 1) [Hardcover] **By** Rob Elles. Publisher: Humana Press.
9. Color Atlas and Textbook of Diagnostic Microbiology [Hardcover] **By** Elmer W Koneman, Stephen D Allen, William M Janda, Paul C Schreckenberger and Washington C Winn. Publisher: Lippincott
10. Molecular Diagnostics: Promises and Possibilities [Hardcover] **By** Mousumi Debnath,

### **Genetics in Medicine:**

Haemoglobin and haemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-George syndrome, Klinefelter's syndrome, Turner's syndrome, hermaphroditism, cystic fibrosis, haemophilia, prenatal diagnosis of genetic diseases, application of recombinant DNA technology in medicine – PCR, RFLP, DNA finger printing, therapeutic proteins, transgenic organisms, gene therapy, human genome project.

### **PRACTICAL - FIRST YEAR**

- Laboratory safety : Fire, chemical, radiation ,handling of biological specimens, waste disposal regulations, workplace hazardous.
- Specimen collection, identification, transport, delivery and preservation. Patient preparation for tests.
- Anticoagulants and preservatives
- Regulations and precautions regarding transport of biological specimens
- Preparation of high quality water
- pH determination
- Preparation of buffers and determination of pH
- Measurement of radioactivity
- Practicals related to solvent extraction, Partition coefficient, Dialysis, Concentration, desalting and Ultracentrifugation.
- Calibration of equipments and laboratory wares.
- Familiarization and usage of Colorimetry, spectrophotometry, fluorimetry, flame photometry, atomic absorption spectroscopy, nephelometry, osmometry, chemiluminescence ,ion selective electrodes, flowcytometry.
- Chromatography : - Paper, Thin layer, Gel filtration, Ion exchange, HPLC, GLC,
- Separation of various sugars, amino acids, lipids, drugs toxins etc. Urine aminogram.
- Electrophoresis :- Paper, Agarose gel, Cellulose acetate, PAGE, SDS-PAGE. Separation of serum proteins, lipoproteins, haemoglobin, globin chain and isoenzymes
- Tissue homogenization and cell disruption
- Cell fractionation methods
- Extraction of glycogen and its estimation
- Extraction of protein and its estimation
- Extraction of lipids and estimation of total lipids, glycolipids, phospholipids and cholesterol.
- Determination of saponification number and iodine number from oils
- Estimation of lactic acid and pyruvic acid
- Qualitative analysis of carbohydrate
- Detection of unknown sugars
- Preparation of Buffers and various biochemical reagents, Calculations of Normality and molarity of the reagents, pH estimations, Weighing of reagents, Preparation of distilled water, Autoclaving, cleaning and sterilization of reagents.
- Isolation of lipids from various samples, Biochemical assays for identification of lipids,



separation of lipids using Thin layer chromatography (TLC) and paper chromatography (PC).

- Rf Value calculation of various amino acids using TLC & PC, Biochemical assay for protein estimations (Branford and Lowry method), Electrophoresis : for separation of proteins & nucleic acids & SDS PAGE

### **STATISTICS PRACTICALS**

- Collection and tabulation of data
- Graphical representation of data
- Correlation and regression analysis
- Student's 't' test
- Chi-square test
- ANOVA

## **PRACTICAL - SECOND YEAR**

### **Clinical chemistry: Estimation of the following with Preparation of standard graph**

1. Blood Glucose by GOD-POD method
2. Serum total protein by modified Biuret method & Serum albumin by BCG method
3. Serum total cholesterol
4. HDL cholesterol
5. Serum triglycerides
6. Serum Urea by DAM method
7. Serum Urea by NED Dye method
8. Serum Uric acid by Uricase-POD
9. Serum Uric acid by Phosphotungstate method
10. Serum Creatinine by Jaffe`s method
11. Serum Bilirubin by Malloy & Evelyn method
12. Serum Bilirubin by Jendrassik & Grof method
13. Serum Calcium by OCPC method
14. Serum Phosphorus by Molybdate method
15. Serum Sodium by Trinder methods
16. Serum Potassium by Tetraphenyl boron method
17. Serum Amylase
18. Serum CPK & CPK-MB by CK-NAC by IFCC method
19. ALT by 2-4 DNPH method
20. ALT by IFCC-UV kinetic method
21. AST by 2-4 DNPH method
22. AST by IFCC-UV kinetic method
23. ALP by Kind & King method
24. ALP by pNPP method
25. Colorimetric determination of G6PD
26. Determination of Glycated Hb
27. Determination of Glycated Hb by HPLC method.
28. Estimation of urinary Creatinine, urea, uric acid, ammonia, albumin, protein, calcium,

### **Molecular biology**

- Isolation of DNA and RNA
- Estimation of DNA and RNA
- Agarose gel electrophoresis of DNA
- Blotting techniques

### **Enzyme kinetics**

- Study of factors influencing enzyme reaction.
- Type of inhibition shown by various inhibitors
- Determination of  $K_m$  and  $V_{max}$  of enzyme.
- **Urine qualitative and quantitative analysis.**
- Biochemical analysis of CSF, Amniotic fluid, Peritoneal fluid, Pericardial fluid, Pleural fluid, Synovial fluid, Semen etc
- Estimation of vitamin A,C,E from serum and metabolites of vitamins in urine.
- Analysis of various hormones related to biological functions and disorders of Hypothalamus, Pituitary, Thyroid, Parathyroid, Pancreatic, Adrenal, Gonads etc.
- Estimation of hormone metabolites in urine – 17- ketosteroid, 17- ketogenic steroid, VMA, 5-HIAA, Urinary estriol etc.
- Bleeding disorders – PT, APTT, TT, Fibrinogen

### **IMMUNOLOGY**

- Agglutination reaction, Precipitation reaction, Immunodiffusion, Double diffusion technique, Immuno electrophoresis, Immunofixation, Migration inhibition factor, ELISA, Nephelometric immunoassays, Chemiluminescence immunoassays, Immunofluorescence, Western blotting and identification of blot by ELISA technique  
Preparation of antisera and its standardization
  - ISE, Estimation of Sodium, Potassium, Calcium, chloride, bicarbonate, phosphorus and magnesium in biological fluids.
  - Quality control, interpretation of LJ plots, calibration
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# **SRI BALAJI VIDYAPEETH UNIVERSITY**

Department of Biochemistry, MGMC & RI

MSc MLT in clinical chemistry

## **MODEL QUESTION PAPER**

### **PAPER-1**

(Biomolecules, Metabolism, Biophysical chemistry and Enzymology)

MAX TIME: 3 hrs  
MAX MARKS: 100

#### **INSTRUCTIONS:**

- Write section A & B in separate answer booklets
- Mention the question numbers properly
- Mention your roll number and name correctly
- Answer should be brief and relevant, Illustrate your answers

#### **SECTION A (50 marks)**

1. Explain the metabolism of glycogen in detail. Add a note on hormonal regulation of glycogen metabolism (7+3=10 marks)
2. **Write short notes on: (7 x 4 marks =28 marks)**
  - A] Write the metabolic defect, clinical features and laboratory diagnosis of "Phenylketonuria".
  - B] Explain the "Donnan membrane equilibrium" with any two suitable examples in vivo
  - C] Explain the competitive inhibition of enzyme activity with suitable examples.
  - D] "Mucopolysaccharides" in health and disease
  - E] Explain the types, formation and applications of "LIPOSOMES" in modern medicine
  - F] Mention the causes, clinical feature and laboratory diagnosis of "GOUT"
  - G] Etiology, complications and management of "fatty liver".
3. **Short notes: (6x2=12 marks)**
  - H] Mention the enzyme defect in type 1 glycogen storage disease, what is the reason for hyperuricemia in this case
  - I] Name any two causes for "steatorrhoea".
  - J] What are the different levels of organization of the structure of proteins?
  - K] Mention the sources of NADPH in our body.
  - L] What is suicide inhibition of enzyme activity? Give an example.
  - M] What is "Hill's plot". Mention its application?

#### **SECTION B (50 marks)**

1. Mention the various steps involved in the biosynthesis of cholesterol. Mention ANY three products formed from cholesterol (7+3=10 marks).
2. **Write short notes on: (7 x 4 marks =20 marks)**
  - A] Mention the various steps involved in the beta oxidation of palmitate.
  - B] Reverse cholesterol transport pathway.
  - C] What are "EICOSANOIDS"? Mention ANY TWO examples and their functions.

- D] Illustrate the oxygen dissociation curve (ODC). Mention ANY TWO factors each for shift in *ODC* in to left & right.
- E] Mention ANY Four functions of phospholipids
- F] Describe the formation and the properties of a peptide bond.
- G] Define the “oncotic pressure”. Mention the factors maintain it.

**4. Short notes: (6x2=12 marks)**

- H] Mention the fates of acetyl co A in fed state and in starvation
- I] Mention any TWO inhibitors acetyl co.A caboxylase.
- J] Mention ANY FOUR key enzymes of gluconeogenesis.
- K] Mention ANY TWO causes for orotic aciduria
- L] What is “taurine”? how it is formed. Mention its function.
- M] Explain the covalent modification of enzyme regulation with a suitable example.
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