

NIMS UNIVERSITY, JAIPUR



SYLLABUS

**MASTER OF SCIENCE
(MEDICAL LAB TECHNOLOGY)**

Scheme of Teaching for M.Sc. (M.L.T.)**Year - I**

Subject	L	T	P	Internal	External	Total Marks	Duration of Exam. Hrs.
Principles of Biochemistry	5	1	-	40	60	100	3
Enzymes & Metabolism	5	1	-	40	60	100	3
Vitamins, Hormones, General Physiology and Nutrition	5	1	-	40	60	100	-
Principles of Biochemistry Lab	-	-	4	40	60	100	
Enzymes & Metabolism Lab	-	-	4	40	60	100	
Vitamins, Hormones, General Physiology and Nutrition Lab	-	-	4	40	60	100	
Principles of Biochemistry	3	1	-	40	60	100	3
Biological Oxidation & Metabolism	3	1	-	40	60	100	3
Nutrition & General Physiology	3	1	-	40	60	100	3
Molecular Biology	3	1	-	40	60	100	3
Statistics & Laboratory Management	3	1	-	40	60	100	3
Principles of Biochemistry Lab	-	-	5	40	60	100	
Nutrition & General Physiology Lab	-	-	3	40	60	100	
Statistics & Laboratory Management Lab	-	-	3	40	60	100	

Principles of Biochemistry

A. Analytical and Physical Biochemistry

Electrolytes:	Definition, ionization of weak acids, weak bases, pH, Hendersor Hasselbalch equation
Buffer Systems:	Definition, titration curve of weak acids, buffering capacity, physiological buffers.
Law of Mass Action	Keq, activity coefficient
Osmosis:	Definition, osmotic crisis, transportation across membrane by membrane proteins.
Dialysis:	Definition, purification of proteins on basis of solubility, size, charge and binding affinity.
Definitions:	Viscosity, surface tension
Donnan Equilibrium:	Keq, membrane hydrolysis
Free Energy	Protein folding in terms of free energy, changes, useful thermodynamic function for understanding enzymes.
High Energy linkages:	Transport of molecules active and passive, involvement of ATP in biological systems, stages in the extraction of energy from food stuffs, molecular weight determination.

B. General Biochemistry

Enzymes:	Basic concepts, classification, properties
Lipids:	Classifications, properties, types, and common features of biological membranes, fatty acids: key constituents
Proteins and Nucleic Acids:	Classifications, structure, properties, DNA, RNA

Principles & Application of Chromatography

1. Chromatography Definition
2. Types of Chromatography
 - a) Adsorption Chromatography
 - b) Partition Chromatography
 - c) Ion-exchange Chromatography
 - d) Gel Filtration
 - e) Affinity Chromatography
 - f) Paper Chromatography & its applications

- g) Thin Layer Chromatography & its applications
- h) Column Chromatography & its applications
- i) High Performance liquid Chromatography (HPLC) & its application
 - I. Diagnostic application of DNA Probes
 - II. Clinical Significance
 - III. Application of DNA (RNA) Probes
 - IV. Separation & identification of amino acids by Circular Paper Chromatography

Electrophoresis: General Methodology, Definition

1. Factors affecting migration of charged particles
2. Proteins separation by gel Electrophoresis
3. Isoelectric focusing
4. Two Dimensional Electrophoresis
5. Protein purification and Evaluation – total protein, total activity , specific activity, yield, purification level
6. Densitometry
7. Blot Techniques- Southern & Northern Techniques
8. Ultracentrifugation , valuable for separating Biomolecules and determining their masses
9. Fractionation of Serum Proteins by Agarose Gel Electrophoresis
 - a. Fractionation of Lipoproteins by Agarose gel Electrophoresis
 - b. Western Blotting Techniques for Detection of proteins Separated by gel Electrophoresis

Spectrophotometry:

1. Protein Mass determination by Mass Spectrometry
2. Protein purification
3. Protein analysis
4. Protein sequence
5. Immunological techniques for Protein estimation
6. Antibodies to specific protein
7. Enzyme Linked Immuno Sorbent Assay (ELISA)
8. NMR spectroscopy & X- ray crystallography for three dimensional protein structure

Fluorimetry

1. Principles
2. Factors affecting fluorescence
3. Fluorescent markers – visualization of protein in the cell
4. Components of Fluorimeter
5. Advantage of Fluorimeter

Reflectance Photometry

1. Introduction & applications
2. Flame photometry
3. Immunochemical techniques

Immunoassays : Application to Biochemistry

1. Radio Immuno Assay (RIA)
2. Determination of hormones by using Radio Immuno assays (RIA)

3. Use of Radio Labelled Antigens
4. Nonisotopic Immuno Assays
5. Homogeneous Enzyme Immuno Assays
6. Heterogeneous Enzyme Immuno Assays
7. The Indirect ELISA
8. Chemiluminescence & Bioluminescence
9. Microparticle Enzyme Immuno assay (MEIA)
10. Fluorescence Polarization Immuno assay (FPIA)
11. Radio Active Energy attenuation (REA) Assays

Reference Books:

1. Out lines of Biochemistry by Cohn and Stumph
2. Biochemistry by Lubert Stryer
3. Text Book of Medical Laboratory Technology by P.B. Godkar, D.P. Godkar
4. Principles of Biochemistry by Rama Rao

Enzymes & Metabolism

Nature and Classification of Enzymes

- (a) Overview of enzymes
- (b) Nomenclature
- (c) Classification of enzymes

Basic concepts and mechanism of action

- (d) How enzymes work
- (e) Enzyme inhibition assay
- (f) Regulation of enzyme activity
- (g) Properties of enzymes

Kinetics

- (h) Michaelis menten equation
- (i) Factors affecting the reaction velocity

Intermediary metabolism of Carbohydrates, Lipids & Amino Acids

Carbohydrates

- (a) Oxidative phosphorylation
- (b) Glycolysis
- (c) Citric Acid Cycle

Amino Acids

- (d) Urea cycle
- (e) Metabolic breakdown of Essential Amino Acids

Lipids

- (f) Fatty Acid Oxidation
- (g) Fatty Acid hiosynthesis

Reference Books:

1. Principals of Clinical Biochemistry by lippincott
2. Outlines of Biochemistry by cohn and stumph
3. Principles of Biochemistry by Rama Rao
4. Principles of Biochemistry by Lehinger
5. Principles of Clinical Biochemistry by Harper
6. Biochemistry by Lubert Stryer

Vitamins, Hormones, General Physiology and Nutrition

1. Chemistry and functions of Vitamins and Hormones

2. Digestion and Absorption of Food

- Digestion of Carbohydrates
- Digestion of proteins
- Digestion of lipids
- Digestion of nucleic acids
- Absorption of monosaccharide
- Absorption of amino acid, dipeptides and tripeptides
- Absorption of lipids
- Absorption of electrolytes
- Absorption of vitamins
- Absorption of water

3. Blood Clotting

Extrinsic pathway: intrinsic pathway, clot refracts, role of vitamin k in clotting, aspirin and thrombolytic agents, haemostatic control mechanism, anticoagulants, intravascular clotting

4. Respiration:

Lung volume and capacities

Internal and external Respiration

Transport of oxygen and Carbon dioxide

5. Acid base Balance

Action of buffer system-protein buffer system, carbonic acid, Bicarbonate buffer system, phosphate buffer system, kidney excretion of H ion, acid base imbalances, respiratory acidosis, respiratory alkalosis, metabolic acidosis, metabolic alkalosis.

6. Muscle Contraction

Sliding Filament Mechanism

- The contraction cycle
- Excitation-contraction coupling

Reference Books:

1. Principals of Anatomy and Physiology by Tortora Graboswski
2. Text book of Medical Laboratory Technology by P.B. Godkar, D.P. Godkar
3. Text Book of Medical Physiology by Guyton Hall
4. Concise Medical Physiology by Chaudhuri
5. Anatomy and Physiology in Health and Illness by Allison Grant and Anne Waugh

Biological Oxidation and Metabolism

Inter-relationship

1. Metabolic interrelationship between Adipose tissue, Liver & extra Hepatic tissues
2. Clinical importance
3. Key junction Glucose – 6 – Phosphate, Pyruvate & Acetyl-co-A
4. Unique metabolic Profile of various organs

Biological Oxidation

1. Biomedical importance
2. Redox Potential
3. Enzymes involved in Oxidation-Reduction

Bioenergetics

1. Free energy
2. Entropy
3. Laws of thermodynamics

Electron Transport & Oxidative Phosphorylation

1. Components of 'Electron Transport Chain'
2. Respiratory Chain
3. Energy Coupling hypothesis
4. Proton- Gradient Generation
5. Mechanism of ATP Synthesis
6. Uncoupling of Oxidative Phosphorylation

Metabolism of Purine & Pyrimidine

1. Purine Biosynthesis
 - a. Formation of PRPP
 - b. Biosynthesis of Inosine-mono Phosphate
 - c. Purine Nucleotide inter conversion
 - d. Regulation of Purine biosynthesis
2. Pyrimidine Biosynthesis
 - a. Assembling of Pyrimidine Nucleus
 - b. Regulation of Pyrimidiene biosynthesis
3. Salvage Pathway for Purine & Pyrimidine biosynthesis
4. Related disorder

Nutrition and General Physiology

MINERALS AND THEIR ROLE IN NUTRITION

1. Common mineral salts - Source, function and importance
2. Trace mineral salts - Source, function and importance

NUTRITION IN HEALTH AND DISEASE

1. Balanced diet - Regulations of food intake and energy storage.
2. Disorder of nutrition - Malnutrition, Malabsorption, Obesity, Starvation, deficiency diseases

DETOXIFICATION

1. Pathways of metabolism.
2. Drug biotransformation

ANTIBIOTICS

1. Introduction, nomenclature & general characteristics
2. Classification & mechanism of action
3. Antibacterial antibiotics-Penicillin, Tetracyclin, Cephalosporin & Sulphonamides
4. Antifungal antibiotics-Griseofulvin & Nystatin
5. Antiviral antibiotics & Interferons

NITROGEN FIXATION

1. Mechanism of nitrogen fixation.
2. Symbiotic nitrogen fixation.
3. Nosymbiotic nitrogen fixation.
4. Genetic Basis of Nitrogen Fixation

FERMENTATION

1. Types of fermentation.
2. Pathway of fermentation.
3. Anaerobic fermentation.
4. Enzymes as fermentation products.

Molecular Biology

Organization of Genome

1. Structure of Chromosome
2. Lamp brush Chromosome
3. Chromatin Structure
4. Satellite DNA

Structure of Gene

Regulation of Gene Expression

1. Gene Expression by Genetic Recombination
2. Regulation of Gene Expression In Yeast (Eukaryotes)
3. Auto regulation
4. Hormonal Regulation

Genetic Coding

Introduction of Mutation

1. Various types of Mutation
2. Spontaneous Mutation
3. Induced Mutation
4. Applications of Mutation

Linkage, Crossing – Over and Chromosome mapping

Genetic Engineering & the Future

1. Gene Cloning
2. Construction of Gene Libraries
3. Types of Cloning Vectors
 - a. Plasmids
 - b. Bacteriophage
 - c. Cosmids

Statistics & Laboratory Management

Statistics:

1. Meaning, Principle & Importance
2. Collection, classification & Presentation of Data-Graphs, Diagrams & Tables
3. Population & Sample & Sampling Techniques
4. Analysis of Data averages-Mean, Mode & Median
5. Variance & standard Deviation
6. Correlation
7. Additivity of Means & Variance
8. Regression
9. Hypothesis-Meaning, Testing of Hypothesis using t-Test, Chi-square Test & Test for ANOVA

Laboratory Management

1. Organization & Operation of a System for Quality Control
2. Selection & Storage of Chemical Materials & Apparatus
3. Principles of Construction, Selection, Use & care of General Laboratory Apparatus
4. Calibration of Volumetric Apparatus
5. Storage, Handling & disposal of Infected, Radioactive & Dangerous Materials
6. Safety Measures & Emergency Treatments for Accidents

Year - II

Subject	L	T	P	Internal	External	Total Marks	Duration of Exam. Hrs.
Inborn errors of Metabolism	3	1	-	40	60	100	3
Diagnostic Biochemistry	3	1	-	40	60	100	3
Organ Function Tests	3	1	-	40	60	100	3
Clinical Biochemistry	3	1	-	40	60	100	3
Diagnostic Biochemistry Lab	-	-	5	40	60	100	-
Organ Function Tests Lab	-	-	5	40	60	100	-
Clinical Biochemistry Lab	-	-	5	40	60	100	-
Dissertation				100	100	200	

Inborn Errors of Metabolism**A. Inborn errors of Metabolism and General Considerations:**

- a) Definition
- b) Review of Metabolism:
 1. Carbohydrates Metabolism
 2. Protein Metabolism
 3. Lipid Metabolism
 4. Nucleic Acid Metabolism

B. Glycogen Storage Diseases & Galactosuria:

- a) Introduction
- b) Different types of Diseases:
 - Pompe's Disease
 - Cori's Disease
 - McArdle's Disease
 - Andersen's Disease
 - Hers' Disease
 - Tarui's Disease
- c) Galactosuria

C. Intrinsic Disorders of Red Cells, Haemoglobin and Porphyrins Sphingolipidases:

- a) Disorders of Red Cells:
 - Hemolytic Anemia
 - Sickle Cell Anemia
 - Thalassaemia
- b) Disorders of Hemoglobin
 - Haemoglobinuria
 - Other Haemoglobinopathies
- c) Disorders of Porphyrins
 1. Porphria
 2. Introduction
 3. Types of Porphyria
 - Ala Dehydratase Deficient Porphyria
 - Acute Intermittent Porphyria

D. Aminoacidurias:

- a) Definition
- b) Types of Aminoacidurias

- Overflow Aminoacidurias
- Renal Aminoacidurias

E. Gout & Genetic Defects in Urate Metabolism:

- a) Introduction
- b) Types of Gout
 - Primary Gout
 - Secondary Gout
- c) Treatment
- d) X-Linked Disorder

F. Errors in Lipid Metabolism

Diagnostic Biochemistry

A. Enzymes and Isoenzymes and their applications in various disorders:

a) General Introduction to Enzymes:

1. Definition
2. Importance
3. Factors effecting
4. Properties

b) Definition of Isoenzymes

c) Significance of Different Isoenzymes

d) Applications in various disorders:

- Alkaptonuria
- Phenylketonuria
- Xanthinuria

B. Disturbances in Acid-Base Balances:

a) Introduction

b) Factors effecting acid –base balances

c) Metabolic Acidosis

d) Metabolic Alkalosis

e) Respiratory Acidosis

f) Respiratory Alkalosis

C. Lipoproteins & its Disorders:

a) Definition

b) Structure

c) Classification

d) Metabolism

e) Disorders:

1. Hyperlipoproteinemias
2. Hypolipoproteinemias

D. Diabetes and Arthrosclerosis:

a) Diabetes:

- Introduction
- Classification
- Causes
- Management
- Clinical Diagnosis

b) Arthrosclerosis:

- Introduction
- Causes
- Clinical Significance

Organ Function Tests

UNIT I

A) Cardiac Function:

Define-Acute coronary syndrome, angina, coronary artery disease ischemia, myocardial infarction, plaque.

Diagrammatic representation of blood flow through heart and lungs

Events leading to an acute myocardial infarction

Cardiac markers

Methods used to measure cardiac markers.

B) Renal Function:

Macroscopic and microscopic anatomy of renal system

Define- Nephron, glomerular filtration rate, plasma renal flow, hemodialysis, hemostasis, erythropoietin

Functions of renal system

End stage renal disease, acute renal failure, acute nephritic syndrome, nephritic syndrome, pyelonephritis and urinary tract obstruction

UNIT II

C) Liver Function:

Macroscopic and microscopic anatomy of hepatic system

Define- Hepatic lobule, portal triad, jaundice, viral and chronic hepatitis, cirrhosis, cholestasis, cholecystitis.

Major functions of liver

Enzymes synthesized by liver, their functions and clinical significance.

Three specific patterns of liver cell injury, its causes and symptoms

D) Gastric, pancreatic and intestinal function:

Define- Ulcer, cystic fibrosis, steatorrhea

Describe the three phases of digestion

Structure and function of stomach, intestinal tract and pancreas

Function and clinical significance of intrinsic factor

Hormones and enzymes synthesized in the GI tract, their functions and clinical significance

Zollinger-Elison syndrome, gastritis, pancreatitis, pancreatic tumor, lactose intolerance and diabetes mellitus.

UNIT III

E) Thyroid function:

Define – Follicle, colloid, thyroglobulin, reverse T3, goiter, euthyroid, Thyrotropin releasing hormone

Structure and function of thyroid gland

Synthesis, regulation and metabolism of thyroid hormones.

Effects of increased and decreased concentrations of thyroid hormones on TSH levels

Laboratory tests to assess thyroid gland function

Hashimoto's disease, grave's disease, secondary hyperthyroidism and thyroid antibodies

F) Adrenocortical function

Structure and function of adrenal cortex

Synthesis of adrenocortical hormones from cholesterol

Hormones synthesized by each specific zone of the adrenal cortex and their function

Adrenal disorders- Addison's disease, Conn's disease, Cushing's syndrome, congenital adrenal hyperplasia

Laboratory tests to assess adrenocortical function.

Clinical Biochemistry

UNIT I

- a) Biological materials- Methods of estimation, normal range in blood, serum, plasma and Urine of Glucose, Proteins, Urea, Uric acid, Creatinine, Cholesterol
- b) Enzymes- Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : SGOT, SGPT, Alkaline phosphatase, Acid phosphatase, Amylase, CPK
- c) Minerals- Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : Na, K, Ca, Cl, O₂, CO₂, P, Iodine, Nitrogen

UNIT II

- d) Hormones- Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : Androgens, Pregnenolone, estrogens, corticosteroids, catecholamines
- e) Vitamins- Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : Vitamin A, Thiamine, Niacin, Pyridoxine, Ascorbic acid
- f) Others- Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : PBI, Barbiturates, Urobilinogen
- g) Immunological techniques- Equipment, reagents and principles of measurement , Significant molecules that can be detected, sensitivity, sources of error of RIA and ELISA

UNIT III

- h) Automation in the Medical Laboratory
 - Various types of Autoanalyzers
 - Reagents and Kits for Autoanalyzers
 - Validation of the Machine
 - Sources of Error
 - Quality Assurance and Quality Control