



SARDAR PATEL UNIVERSITY
University Road P. B. 10
Vallabh Vidhyanagar-388120 (Gujarat)
NAAC accredited with Grade 'A'
(10-01-2023 to 09-01-2028)

Phone: 0692-226808/85; Email: exam_spu@spuvvn.edu; Website: www.spuvvn.edu

The Government of India notified the **National Commission for Allied and Healthcare Professions (NCAHP) Act on March 28, 2021**. As a common regulatory body, the NCAHP Act provides for regulation and maintenance of standards of education and services by Allied and Healthcare Professionals.

Medical Laboratory Sciences (MLS)

Semester II- Medical Biochemistry

Code	COURSE NAME	L/P	C	Hours	IA	ESE	Total
M02MLSMB01	Bioorganic & Biophysical Chemistry	4	4	60	30	70	100
M02MLSMB02	Instrumentation in Biochemistry	4	4	60	30	70	100
M02MLSMB03	Enzymology & Nutrition	4	4	60	30	70	100
M02MLSMB04	Intermediary Metabolism	4	4	60	30	70	100
	Practical						
M02MLSMB05	Bioorganic & Biophysical Chemistry Practical	4	2	60	30	70	100
M02MLSMB06	Instrumentation Practical	4	2	60	30	70	100
M02MLSMB07	Clinical posting	4	2	90	30	70	100
	Total	28	22	450	210	490	700

L: Lecture, T: Tutorial; P: Practical, C: Credit; I: Internal Assessment; ESE: End Semester Examination

Course: Bioorganic & Biophysical Chemistry

Total Credits: 4 (60 hours)

Course Rationale: Students will gain comprehensive understanding of biomolecular structure, function, and physicochemical perspective. This course is designed for postgraduate students to explore the principles underlying biological systems and processes.

Learning Outcomes: At the end of the course students will be able to

1. Describe the structure-function relationships in biomolecules using principles of organic and physical chemistry.
2. Comprehend knowledge of properties of biological fluid
3. Understand biochemical reactions and molecular interactions.

UNIT	M02MLSMB01 Bio-organic & Biophysical Chemistry	C=4 (60hr)
I	Carbohydrates: Definition, Biological importance and Classification of Carbohydrates. Monosaccharides- Classification, Structure and Biological importance of Monosaccharides, Important chemical reactions of Monosaccharides. General Properties in reference to glucose –Structural and Stereo isomerism (Fischer and	10



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	Haworth Projection formulae), Cyclic structure, Epimers, Anomers and Mutarotation. Disaccharides - Structure, Occurrence and Biological importance of Sucrose, Lactose and Maltose. Polysaccharides: Classification , Structure, Occurrence and Biological functions. Homopolysaccharides, Heteropolysaccharides , Carbohydrates in cell membrane	
II	Lipids : Definition, Biological importance and Classification of lipids. Simple Lipids : fats and wax; physical and chemical properties of fats. Identification of fats and oils : Saponification, Acetyl number, Rancidity of fats, Reichert-Meissel number. Compound lipids - Structure and Biological function of phospholipids, Glycolipids and other compound lipids – lipoproteins. Derived lipids - <i>Fatty acids</i> : Structure, Classifications and Properties. <i>Steroid and Sterols</i> - Special reference to cholesterol -Structure, Function and Properties of Cholesterol, Other sterols of biological importance- Bile acids and vitamin D.	10
III	Amino acids and Proteins : Definition, Biological importance of proteins, composition of proteins. Amino Acids : Definition, structure of amino acids, Classification, physicochemical properties and reactions of amino acids, Amino acids as ampholytes, Significance of nonstandard amino acids. Proteins : Classification based on nutritional value, biological importance and solubility. general properties of proteins, colour reactions of proteins (end group analysis); Structural organisation of protein : Primary structure, Peptide linkage-Structure and significance of peptide bond, amino acid sequencing (Sanger's and Edman methods). Secondary structure (helix and pleated sheets Eg.Collagen), Tertiary structure of proteins (Eg. Myoglobin), Quaternary structures of proteins (Eg.Hemoglobin), motifs and domains, Structure-function relation of protein. Denaturation, renaturation, separation techniques	10
IV	Enzymes : Definition, Classification, Mechanism of Action, Models of enzyme – substrate complex formation (lock and key model, induced fit model, substrate strain theory), Enzyme specificity, Factors affecting enzyme activity	4
V	Nucleic Acids and Nucleoproteins : Structure of Purines and Pyrimidines, Structure of Nucleosides and nucleotides; nucleotides and nucleosides of biological importance. Nucleic Acids : Definition, Structure of DNA, RNA and types of RNA. DNA – Watson & Crick Model, A, B and Z forms of DNA. Properties of DNA - buoyant, density, viscosity, chromic effect, T _m , denaturation, renaturation, hybridization and Cot analysis	8
VI	Acids, Bases, Buffers in biological system, pH-Henderson Hassel Balch equation, Acid load in the body, regulation of acid base balance in body.	6



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VII	Fluid and electrolyte balance: Distribution of fluids in body, Water metabolism, factor influencing the distribution of body water, thirst mechanism, Intake and loss of body water, Electrolyte distribution, regulation, and their functions, water/electrolyte balance.	4
VIII	Body fluid properties: Osmosis and osmotic pressure- Osmolality of body fluids, Surface tension and viscosity-their application to the human body in relation to normal life and disease processes, Colloidal system- protective action, emulsification-colloidal systems of biological importance-their application and role in the human body. Diffusion and absorption mechanisms-their application to biological systems.	8
	Total	60

Suggested Readings:

1. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox, W. H. Freeman & Co. (Macmillan). *WH Freeman*; Publication date. 1 January 2017 Biochemistry – Lubert Stryer . *W.H.Freeman & Co Ltd*
2. Harper's Illustrated Biochemistry – Victor W. Rodwell et al., Edition. 31st. *McGraw Hill / Medical*
3. Principles of Physical Biochemistry – van Holde, Johnson, Ho : Pearson Education Limited
4. Essentials of Biophysical Chemistry – R. R. Dasgupta
5. Textbook of Biochemistry for Medical Students – D.M.Vasudevan, Edition. Ninth; *Jaypee Brothers Medicals*; Publication date. 1 January 2019.

Course name: Instrumentation Total Credits 4 (60 hours)

Course Rationale: The students will have an understanding of the principles, instrumentation and applications of various non-analytical and analytical instrumentation in a clinical laboratory.

Learning outcomes: At the end of the course students will be able to

- Understand the fundamental principles behind major analytical and Non analytical instruments in clinical Laboratory
- Operate laboratory instruments with attention to Maintenance and calibration, sensitivity, and reproducibility.
- Evaluate the advantages, limitations, and applications of each technique in a diagnostic lab or research Lab.

UNIT	M02MLSMB02 Instrumentation in Biochemistry	C = 4 (60hr)
I	Non- analytical Instrumentation: Use, Calibration and their maintenance- pipettes and Micropipettes, Weighing balance (Analytical and top loading digital), pH meter, Centrifuges, Water bath, hot plate, magnetic stirrer, thermometer distilled water systems.	4
II	Centrifugation techniques: Definition, Basic principles of sedimentation, instrumentation, application in clinical and research laboratory.	6



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	Types of Centrifugation: Preparative, Analytical centrifugation, Differential centrifugation, Density gradient centrifugation, Ultra centrifuge	
III	Photometry: Definition, basic Principles of photometry, functions, Beer lamberts law, Instrumentation, applications. Laws of light absorption – visible and UV Spectrophotometry Types of Photometric Techniques: Colorimetry, and spectrophotometry, Flame photometry, Fluorimetry, Spectrofluorometry, Atomic absorption spectrometry, Infra-red spectrometry.	8
IV	Chromatography: Definition, basic principles of adsorption and partition, Instrumentation, applications in clinical and research laboratory. Types of chromatographic techniques: Paper (one dimensional & two Dimensional) thin layer, column, affinity, gel filtration (Types of resins, gel and apparatus preparation), ion exchange, gas liquid, HPLC	10
V	Clinical Chemistry analysers: Basic principles, instrumentation, function, significance of these analysers. Types of chemistry analysers – semi –automated and Fully automated	6
VI	Electrophoresis: Definition, Basic Principles of electrophoresis, Instrumentation, applications. Types of electrophoretic techniques- Paper, cellulose acetate, agarose gel, PAGE, capillary, Iso-electric focussing and Two dimensional gel electrophoresis.	10
VII	Advance Instruments: Principles, instrumentation, techniques, and applications of Electron spin resonance, Nuclear Magnetic resonance, crystallography, Mass spectrometry	6
VIII	Immunochemical techniques: Basic concepts, function and significance of these Immunoassay analysers, antigen–antibody binding quantitative methods. Types of assays- sandwich assay, competitive, non-competitive assay. Techniques- ELISA (Enzyme linked immunosorbent assay), FIA, Immunoprecipitation, Turbidometry, Immunofluorescence, Chemiluminescence, Electrochemiluminescence	6
IX	Osmometry : Definition, principle of Osmometry, Instrumentation, applications	4

Suggested Readings:

1. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson & John Walker, . *Cambridge University Press*
2. Instrumental Methods of Analysis – B.K. Sharma, Krishna Prakashan Media (p) Ltd
3. Analytical Biochemistry – David Holme & Hazel Peck, *Prentice Hall*,
4. Introduction to Instrumental Analysis – Robert Braun, . *PharmaMed Press/BSP Books*
5. Clinical Biochemistry: Metabolic and Clinical Aspects – William J. Marshall, Márta Lapsley et al., . *Churchill Livingstone*
6. Principles and techniques of Biochemistry & Molecular Biology – Mahalakshmi & Senthil Kumar, Cambridge Univ. Press



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Course name: Intermediary Metabolism

Total Credits 4 (60 hrs)

Course Rationale: This course provides students with in-depth understanding of metabolic pathways, their interconnections, and the regulatory mechanisms that govern them in various physiological and pathological conditions.

Learning Outcome: At the end of the course, students will be able to

- Explain the biochemical pathways of carbohydrate, lipid, amino acid, and nucleotide metabolism, including their key enzymes and intermediates.
- Describe the integration of metabolic pathways in various tissues.
- Analyze the role of regulatory molecules, cofactors, and hormones in modulating metabolic pathways.

UNIT	M02MLSMB03 Intermediary Metabolism	C=4 (60hr)
I	Metabolism: Bioenergetics, free energy, biological oxidations, electron transport, oxidative phosphorylation.	8
II	Carbohydrate metabolism: Digestion and absorption, Glycolysis, gluconeogenesis, Uronic acid pathway, TCA cycle, HMP pathway, glycogen metabolism, galactose metabolism, fructose metabolism, Regulation of blood glucose. Disorders of carbohydrate metabolism: Diabetes mellitus and its types, glycosuria and its types, Glycated proteins, urinary albumin excretion, Inborn errors of carbohydrate metabolism.	12
III	Amino acid and protein metabolism: Digestion and absorption Transamination, deamination - oxidative deamination and non-oxidative, ammonia transport, urea formation. Metabolism of individual amino acid. Biosynthesis of catecholamines, melanin formation, Nitrogen balance. Disorders of Protein and amino acid metabolism: Inherited disorders associated with urea cycle, proteinuria, proteinemia, Inborn error of amino acid metabolism.	12
IV	Lipid metabolism: Fatty acid synthesis, fatty acid oxidation, ketogenesis. Metabolism of triglycerides, phospholipids, sphingolipids, lipoproteins and cholesterol. Disorders of lipid metabolism: Dyslipidemia, Hyperlipoproteinemia, obesity, fatty liver, lipotropic factors and ketosis, atherosclerosis and coronary heart diseases.	12
V	Purine and Pyrimidine metabolism:	8



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	Biosynthesis of purine and pyrimidine. Degradation of purine and pyrimidine and their Disorders.	
VI	Hemoglobin metabolism: Heme synthesis, formation of hemoglobin, Structure of hemoglobin, Metabolism of bilirubin.	8
	Total	60

Suggested References:

1. Lehninger Principles of Biochemistry – Nelson & Cox, , W. H. Freeman & Co. (Macmillan)
2. Biochemistry – Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, W. H. Freeman / Palgrave Macmillan.
3. Harper's Illustrated Biochemistry – Victor W. Rodwell et al. McGraw Hill Medical
4. Lippincott Illustrated Reviews - Biochemistry, a Wolters Kluwer business
5. Principles of Biochemistry – Voet, Voet & Pratt, Global edition. 5th edition. Wiley.
6. Textbook of Biochemistry for Medical Students – D.M. Vasudevan, Edition. Ninth., Jaypee Brothers Medicals; Publication date. 1 January 2019

Course name: Enzymology and Nutrition

Total Credits 4 (60 hours)

Course Rationale: Students will gain in depth knowledge of mechanistic, regulatory roles of enzymes and the biochemical importance of macro- and micronutrients in health and disease.

Learning Outcome: At the end of the course, students will be able to

- Explain the structure, function, and classification of enzymes.
- Interpret enzyme kinetics, Differentiate types of enzyme inhibition and mechanism of action of enzymes
- Describe the functions, sources, and deficiencies of essential vitamins and minerals.
- Understand the role of nutrition in energy metabolism, growth, immune function, and disease prevention.

UNIT	M02MLSMB04 Enzymology and Nutrition	C=4 (60 hr)
I	Introduction to Enzymes: Nomenclature, Classification and Characteristics of enzymes, Enzyme specificity, Cofactors, Co-enzyme and Prosthetic group, 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.	6
II	Mechanism of Enzyme Action: Nature of active site, identification of functional groups at active site, enzyme substrate complex, Factors responsible for catalytic efficiency of enzymes: Proximity and orientation, Covalent catalysis, Acid base catalysis, Strain and distortion theory, Induced fit hypothesis, Reversible and irreversible covalent modification, feedback inhibition, control of enzyme by products, substrates and adenylate energy charge, monocyclic and multicyclic cascade systems.	6



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III	Enzyme Kinetics: Michaelis Menten equation. Derivation of Michaelis. Menten equation and determination of K_m and V_{max} values, Substrate inhibition and activation, Effect of pH and temperature on rate of enzyme catalyzed reactions, Allosteric enzymes	8
IV	Enzyme inhibition: reversible and irreversible inhibition, Kinetics of competitive, uncompetitive and non-competitive inhibition, Mechanism of enzymic action - general acid base catalysis, covalent catalysis, role of metal ion in enzyme catalysis, Reversible inhibition - competitive, uncompetitive, non-competitive, mixed, substrate and allosteric inhibition, Irreversible inhibition.	6
V	Application of Enzymes: Enzymes as analytical reagents, Immobilized enzymes, Biotechnological applications of enzymes, Application of enzymes in medicine and industry.	4
VI	Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparaginase, streptokinase. Enzymes and isoenzymes in diagnosis, Principles of diagnostic enzymology, clinical significance of alkaline and acid phosphatase, SGOT, SGPT, LDH, CPK, aspartate aminotransferase, alanine aminotransferase, creatine kinase.	6
VII	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, planning of diet in pregnancy and lactation, Renal Failure, cardiovascular Disease, diabetes, obesity, Cancer. Nutritional	4
VIII	Vitamins: Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of fat-soluble and water-soluble vitamins.	8
IX	Minerals: Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of macro and micro minerals	8
X	Nutritional Genomics: Introduction to nutrigenetics and Nutrigenomics, role of genes in metabolism and nutrient utilization, omics technologies in nutrigenomics.	4
	Total	60

Suggested Readings:

1. Fundamentals of Enzymology – Nicholas C. Price & Lewis Stevens, Oxford university press
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry – Trevor Palmer *Horwood Pub*
3. Textbook of Biochemistry with Clinical Correlations – Thomas M. Devlin, Wiley
4. Modern Nutrition in Health and Disease – A. Catherine Ross et al., Wolters Kluwer Health Adis



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Practicals

NO	M02MLSMB05 Bioorganic & Biophysical chemistry Practical	C=2 (60 hr)
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Students will gain practical skills with experimental techniques that are fundamental to understanding the chemical and physical principles governing biomolecular structure, function, and interactions.

1. **Reactions of Carbohydrates** – Molisch, Iodine, Benedict, Modified Barfoed, Osazone, Seliwannof, Foulger, Mucic acid, Bial
2. **Reactions of Proteins** : Precipitation reactions – Acid, Base, Alcohol, Iso-electric, Half & Full saturation, Colour reactions – Biuret, Ninhydrin, Hellers, Aldehyde, Paulis, Sakaguchi, Sulphur, Xanthoproteic, Millons,
3. **Reactions of Lipids** – Solubility Test, saponification test, bromine water test for unsaturated fatty acids, Acrolein test
4. **Reaction of Nucleic acid** – Dische test, Bial Test, Phosphate Test, Quantitative estimation via UV absorption at 260nm or Nano spectrophotometer
5. **Preparation of buffer and determination of pH**
6. Determination of viscosity using Ostwald's viscometer.
7. Demonstration of osmosis and diffusion using semi-permeable membranes.

***Clinical Laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox, W. H. Freeman & Co. (Macmillan). *WH Freeman*; Publication date. 1 January 2017 Biochemistry – Lubert Stryer . *W.H.Freeman & Co Ltd*
2. Harper's Illustrated Biochemistry – Victor W. Rodwell et al., Edition. 31st . *McGraw Hill / Medical* · Principles of Physical Biochemistry – van Holde, Johnson, Ho : Pearson Education Limited
3. Essentials of Biophysical Chemistry – R. R. Dasgupta
4. Textbook of Biochemistry for Medical Students – D.M.Vasudevan , Edition. Ninth; *Jaypee Brothers Medical s*; Publication date. 1 January 2019.

NO.	M02MLSMB06 Instrumentation Practical	C=2 (60 hr)
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Quality practices, and data acquisition of instrumentation which are vital for professional laboratory work.

1. Calibration of micropipettes and glass pipettes
2. Paper Chromatography- One dimensional
3. Paper chromatography - Two dimensional
4. HPLC



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5. Electrophoresis : Gel Electrophoresis and PAGE and Serum protein electrophoresis and Quantification, Osmometer
6. ELISA/FIA

***Clinical Laboratory rotation/observation can be incorporated wherever possible**

	M02MLSMB06 Clinical Posting	C=2 (90 hr)
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Medical Laboratory Sciences (MLS)

SEMESTER III - Medical Biochemistry

Code	COURSE NAME	L/P	C	Hours	IA	ESE	Total
M03MLSMB01	Clinical Biochemistry I	4	4	60	30	70	100
M03MLSMB02	Clinical Biochemistry II	4	4	60	30	70	100
M03MLSMB03	Immunology	4	4	60	30	70	100
M03MLSMB04	Endocrinology & Biochemistry of aging	4	4	60	30	70	100
	Practical						
M03MLSMB05	Clinical Biochemistry I Practical	2	2	60	30	70	100
M03MLSMB06	Clinical Biochemistry II Practical	2	2	60	30	70	100
M03MLSMB07	Immunology Practical	2	2	60	30	70	100
	Total	22	22	420	210	490	700

L: Lecture, T: Tutorial; P: Practical, C: Credit; I: Internal Assessment; ESE: End Semester Examination

Course: Clinical Biochemistry 1 Total Credits : 4 (60 Hours)

Course Rationale: The Course will equip the student with the knowledge of disorders related to the respective metabolisms taking place in the body. The course emphasizes on the understanding of metabolic pathways and biochemical changes associated with various pathological conditions.

Learning Outcomes: At the end of the course, students will be able to

1. Understand the principles of biochemical processes and how they relate to normal and diseased states.
2. Identify and explain the significance of common biochemical markers used in diagnostics and monitoring of disease.
3. Perform key biochemical laboratory techniques and follow proper sample handling procedures

UNIT	M03MLSMB01 Clinical Biochemistry-I	C=4 (60hr)
I	Role of biochemistry in diagnosis of diseases: Use of Biochemical data in clinical medicine: Specific uses of biochemical tests in screening, diagnosis, prognosis and management, Acquisition & Interpretation of biochemical data. Specimen receiving and processing: Types of body fluid specimens received in the lab (Whole blood, Urine, CSF and other fluids) Appropriate specimen collection Factors affecting test results - Preanalytical variables, Preservatives for combined biochemical analysis in urine. Basic concepts: random error, systematic error, analytical range, sensitivity, specificity, detection limit, interferences, recovery, Accuracy, Precision Biological reference intervals	8



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	Benchmarking, continuous Quality improvement Quality indicators (QI): Rejection criteria, Hemolysed rejection rate, TAT (turnaround time), critical value reporting, IQC cv% performance, EQA performance; Importance of QI Selection and evaluation /validation of new methods, Analytical performance criteria: Method comparisons, accuracy, within run-precision; Instrument comparison in laboratory for an assay.	
II	Disorders of carbohydrates metabolism: Glucose level in normal blood, renal threshold Diabetes Mellitus: classification and Pathogenesis of DM, Diabetic ketoacidosis and diabetic coma, secondary degenerative changes associated with diabetes mellitus. Hyper glycemia, Hypoglycaemia, glycosuria and Renal Glycosuria Laboratory diagnosis : Specimen collection, Patient Instructions, storage; principle, estimation, reference range, clinical significance of Plasma glucose (fasting, post prandial, random), Oral Glucose Tolerance Tests, Glucose challenge test, urine Microalbumin, Glycated haemoglobin, qualitative tests for sugars in urine, Ketone bodies, Plasma lactate. Diagnosis of inborn errors of carbohydrate metabolism by qualitative and chromatographic techniques. Self-monitoring of blood glucose and Continuous glucose monitoring (CGM)	10
III	Disorders of lipid metabolism: Plasma triglycerides, Cholesterol, HDL cholesterol, LDL cholesterol levels Familial hypercholesterolemia, hypo and hyper cholesterolemia, Fatty liver, Hyper and hypo lipoproteinemia, hypertriglyceridemia, Dyslipidemia, Atherosclerosis and Myocardial Infarction, ketosis, fatty liver, coronary heart disease. Laboratory diagnosis : Specimen collection, Patient Instructions Principle, estimation, reference range and clinical significance - lipid profile (serum cholesterol, triglycerides, HDL, LDL, HDL:LDL) Diagnosis of inborn errors of lipid metabolism Diagnosis of various disorders by lipoprotein by electrophoresis	10
IV	Disorders of Amino acid and protein metabolism: Overview of plasma proteins and their disorders, multiple myeloma, Paraproteinemia Laboratory diagnosis : Specimen collection, Principle, estimation, reference range and clinical significance of : proteins in blood (albumin, α1-antitrypsin, α1-fetoprotein, C-reactive protein, β2-microglobulin), serum Immunoglobulins; Protein in other body fluids (Urine, CSF, Pleural fluid, Ascitic Fluid) laboratory evaluation of paraproteinemia: Electrophoresis of plasma and urine proteins, quantification for diagnosis of multiple myeloma (M band Quantification) Disorders of nitrogen metabolism: Excretion of nitrogenous waste products, abnormalities of nitrogen metabolism including uremia, Uric aciduria, aminoaciduria Laboratory diagnosis: Principle, estimation, reference range and clinical significance of Ammonia, urea, uric acid, creatinine.	10



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	Diagnosis of inborn errors of Amino acid and protein metabolism by qualitative and quantitative methods	
V	Minerals and Trace Metal disorders : Overview of Mineral and trace metal disorders- Anaemia, Hypercalcemia, Phosphatemia, Wilson disease, etc Laboratory diagnosis: Principle, estimation, reference range and clinical significance: disorders related to iron, calcium, phosphorus, magnesium, copper and zinc	6
VI	Lab diagnosis of porphyrias. Clinical significance and disease correlation Urine qualitative tests (porphyrins, coproporphyrin, uroporphyrin, d-ALA, porphobilinogen, urobilinogen)	2
VII	Clinical Enzymology: Sources of plasma enzymes, diagnostic importance and their interpretation Laboratory evaluation of enzymes- Principle, estimation, reference range, and clinical significance: Amylase, Lipase, aminotransferase, gamma glutamyl transferase, alkaline phosphatase, creatinine kinase, cholinesterase, lactate dehydrogenase, lipoprotein lipase, LDH, Acid phosphatase	6
VIII	Fluid and electrolyte balance disorders: Disorders of fluid and electrolyte balance Laboratory diagnosis Principle, estimation, reference range, and clinical significance Electrolytes (sodium, potassium, chloride, bicarbonate) Acid base balance: Disorders of Acid base balance- Metabolic acidosis, Metabolic alkalosis, Respiratory Acidosis and Respiratory Alkalosis mixed disturbances. Blood gases. Reference intervals for arterial blood gases. Acquisition of arterial blood gas samples. Laboratory diagnosis: laboratory parameters for blood gas analysis: Arterial Blood gas estimation. pCO ₂ , O ₂ and pH.	6
	Total	60

Suggested Readings

1. Harper's Biochemistry, 28th edition, Robert K Murray, Tata McGraw publishers
2. Text book of Medical Biochemistry, MN Chatterjee, Rana Shinde, Jaypee Publishers
3. Varleys practical clinical biochemistry, Alan Gowenlock, CBS publishers
4. Lehinger Principle of Biochemistry, David L Nelson, 7th edition, WH Freeman Publishers
5. Biochemistry, Debajyoti Das, Academic publishers

Course: Clinical Biochemistry II Total Credits: 4 (60 Hours)

Course Rationale: The Course will provide the students with the knowledge of disorders related to the respective organs in the body. The course emphasizes on the understanding of biochemical changes associated with various pathological conditions.

Learning Outcomes:

- **Describe the biochemical basis** of major diseases such as diabetes, renal failure, liver disorders, and cardiovascular diseases.



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- **Interpret clinical laboratory results**, linking biochemical findings with patient conditions.
- **Identify and explain** the significance of common biochemical markers used in diagnostics and monitoring of disease.

UNIT	M03MLSMB02 Clinical Biochemistry-II	C=4 (60hr)
I	Liver Function tests : Overview of Anatomy of liver and its functions Liver diseases: Liver cirrhosis, Hepatitis, liver failure, hepatic coma and Biliary tract diseases- gall stones and cholecystitis Indications and Classification of liver function test: Tests based on abnormalities of bile pigment metabolism, Jaundice and differential diagnosis of Jaundice, Test based on changes in plasma proteins, serum enzyme activities, abnormalities of lipids, abnormalities of Carbohydrate metabolism, detoxification function of liver, excretory capacity of liver, Laboratory analysis of gall stones	6
II	Renal function tests: Overview of anatomy of kidney and its functions Renal diseases: Nephrotic syndrome, Glomerular nephritis, Urolithiasis and nephrolithiasis, renal calculi, renal tubular acidosis, diabetes insipidus, renal hypertension, renal failure Indication and classification of RFT, Test based on glomerular filtration test - Urea, creatinine, Inulin, Cystatin Clearance test, Test based on Renal Plasma flow clearance and tubular filtration Miscellaneous test Routine RFT: serum creatinine, urea, uric acid and proteinuria Early marker of Renal Pathology. - Microalbuminuria, Urine albumin: creatinine ratio Renal handling of electrolytes- Sodium, potassium, Fractional excretion of Sodium (FeNa) Renal calculi Measurement of serum and urine osmolality Urine analysis for normal and abnormal constituents of urine	10
III	Gastric and pancreatic function tests Composition of Gastric juice • Outline of clinical manifestations of gastric, pancreatic and intestinal diseases. • Indications, classification of gastric function test and Pancreas Function test • Qualitative and quantitative analysis of gastric contents and duodenal contents Pancreatic enzymes: Amylases, lipases	4
IV	Cardiac function tests Biochemistry and tissue distribution of cardiac markers. Cardiac enzymes such as CKMB, CK, homocysteine, hsCRP , Cardiac troponins and myoglobin	4
V	Endocrine function Test: Overview of disorders of Hypothalamus, pituitary, thyroid, adrenal cortex, pancreas, placental, testes, ovaries	10



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	Analysis of hormones - T3, T4, TSH, FT3, FT4, anti- TPO, Prolactin, Testosterone, Chorionic gonadotropin (BHCG), FSH, LH, Estradiol, progesterone, Insulin, ACTH, Cortisol. Dexamethasone suppression test	
VI	Tumor markers: Tumor marker and its classification, Potential uses of tumor markers, Marker detection - PSA, β -hCG, AFP, CEA, CA15-3, CA-125.	4
VII	Toxicology testing in Clinical laboratory: Therapeutic drugs and their management (TDM): Therapeutic drugs – Definition, Mechanism of action, Absorption, Distribution, Biotransformation, Excretion and Clinical utility. Overview of specific drugs and analysis of Carbamazepine, Phenobarbital, Phenytoin, Valproic acid, Digoxin, Theophylline, Cyclosporine, Lithium Toxic agents: Source, Routes of entry and the effect of Carbon monoxide, Alcohol, Arsenic, Lead, chromium, mercury, nickel	6
VIII	Paediatric clinical biochemistry • Problems of specimen collection • Biological reference intervals • Heavy metal poisoning in children: Pb, Hg. Overview of Newborn screening - Cystic fibrosis, neonatal TSH, G6PD, PKU and Galactosemia	4
IX	Point-Of-Care-Testing (POCT): Objectives, Biochemical parameter measured by POCT devices, Common POCT devices and Technologies, Requirements, Advantages, Limitation and Challenges	6
X	Automation and AI in Clinical Biochemistry: History of automated analyzers, Types of automation, Total laboratory automation. Objectives of AI integration, Application of AI- Diagnostic support, Data Analysis, Lab workflow optimization, Clinical Decision Support System, Predictive and preventive Healthcare, Challenges and Limitations	6
	Total	60

Suggested Readings

- Harper's Biochemistry, 28th edition, Robert K Murray, Tata McGraw publishers
- Text book of Medical Biochemistry, MN Chatterjee, Rana Shinde, Jaypee Publishers
- Varleys practical clinical biochemistry, Alan Gowenlock, CBS publishers
- Lehinger Principle of Biochemistry, David L Nelson, 7th edition, WH Freeman Publishers
- Biochemistry, Debajyoti Das, Academic publishers



Course: Immunology

Total Credits: 4 (60 Hours)

Course Rationale: A sound knowledge of immunology is required by a Medical Laboratory Science scholar to understand the immune responses which underlie many clinically important states. The in depth theoretical and practical concepts imbibed by the graduate during the course helps in laboratory diagnosis of immune related clinical conditions like hypersensitivity, allergy, immuno pathology etc.

Learning Objective: At the end of the course, students will be able to

- Understand and diagnosis based on immune reactions
- Achieve expertise in immunology techniques.
- Detect and correct errors in techniques

UNIT	M03MLSMB03 Immunology	C=4 (60hr)
I	Overview of the Immune System- Cells, tissues and organs of the immune system	2
II	Types of Immunity: Innate immunity, Anatomical barriers-skin, mucous lining, cilia, saliva, tears etc., Role of T cells , Cellular immunity-neutrophils, macrophages, dendritic cells, natural killer cells • Inflammation-vasodilation, extravasation, oedema, chemokines, integrin, ICAMs, cytokines (defensins, cathelicidins, interferons,etc.) • Acute Phase Response proteins (APR proteins)-C-reactive protein, mannose-binding lectin etc.) • Receptor system-complement receptor, MBL receptor, Toll-like receptor, scavenger receptor etc • Signal transduction pathway eg. TLR signaling • Adaptive Immune system • Antigen- types, Antigen properties contributing immunogenicity-molecular size, chemical composition, genotype, dosage, route of entry etc. • Role of B cells • Immunoglobulins- types, structure, antibody-mediated effector functions-opsonization, complement activation, ADCC (antibody dependent cell mediated cytotoxicity), transcytosis, • Avidity, affinity and cross reactivity • Antigen-antibody interactions: precipitation, agglutination, opsonisation, complement fixation • Immunoglobulin superfamily	12
III	Major Histocompatibility Complex (MHC) molecule class I and class II: Their differences and interactions	6
IV	Hypersensitivity Type I, Type II, Type III and type IV: Allergy, skin tests, transfusion reactions, hemolytic disease of the newborn, Immune Complex diseases, tuberculin test	6
V	Autoimmunity and disorders: SLE, Multiple sclerosis, Rheumatoid arthritis, Myasthenia gravis, Autoimmune Thyroiditis	6



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VI	Immunodeficiency diseases: Primary immunodeficiency: involving lymphoid immune deficiency (B cells, T cells), involving myeloid lineage, Immune complex diseases Secondary immunodeficiency: AIDS	6
VII	Tumor immunology: Tumor antigens, tumor immune surveillance, tumor escape and Tumor Markers	4
VIII	Transplantation and rejection: Role of T cells, Immune recognition in Allograft and Xenograft, pathway of rejection.	6
IX	Vaccination: Principle, types, vaccine development, adjuvants	2
X	Immunological techniques: Precipitation reactions: Immuno-diffusion, immune electrophoresis, Immunoprecipitation Agglutination reactions: Blood group typing, Bacterial agglutination, Agglutination inhibition : Complement fixation ; Neutralisation ; Opsination ; Immunofluorescence ; ELISA ; FIA and RIA ; Western Blotting ; Flow cytometry ; Immunoelectron microscopy	10
	Total	60

Suggested Reading

- Punt, J., Stranford, S., Jones, P., Owen, J.A. – Kuby Immunology, W.H. Freeman
- Parslow, T.G., Stites, D.P., Terr, A.I. – Medical Immunology, McGraw Hill
- Delves, P.J., Martin, S.J., Burton, D.R., Roitt, I.M. – Roitt's Essential Immunology, Wiley-Blackwell
- Kumar, V., Abbas, A.K., Aster, J.C. – Robbins Basic Pathology, Elsevier
- Gangal, S., Sontakke, S. – Text Sontakke, S. – Textbook of Basic andbook of Basic and Clinical Immunology, Universities Press (India) Pvt. Ltd.

Course: Endocrinology and Biochemistry of Aging

Total Credits: 4 (60 Hours)

Course Rationale: This course provides knowledge of endocrine system which plays regulatory role controlling and influencing the functioning of all other systems of the human body. Students will also gain knowledge chronic disease burden, a biochemical understanding of aging processes such as oxidative stress, cellular senescence, and hormonal imbalance.

Learning objectives: At the end of the course, students will be able to

- Describe the structure, synthesis, and regulation of hormones produced by major endocrine glands.
- Apply the knowledge and the associated techniques for diagnosing hormonal disorders.
- Understand molecular theories of aging, including oxidative stress, telomere shortening, mitochondrial dysfunction, and genetic regulation



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UNIT	M03MLSMB04 Endocrinology & Biochemistry of Aging	C=4 (60hr)
I	Introduction to Endocrinology; Neuro-endocrinology, Neuro-immuno endocrinology and their general principles. Types of endocrine glands and classification of hormones based on their chemical nature and function.	10
II	Chemistry, synthesis, mechanism of action, physiological effects, catabolism of the hormones of Hypothalamus and Pituitary gland and their disorders.	10
III	Chemistry, synthesis, mechanism of action, physiological effects, catabolism of Thyroid, Parathyroid (calcium homeostasis hormones). GIT hormones, Pancreatic Hormones and their disorders.	10
IV	Chemistry, synthesis, mechanism of action, physiological effects, Catabolism of the hormones of Adrenal glands, Gonads and their disorders. Extra endocrine hormones- ANP, Erythropoietin, Melatonin, etc	10
V	Introduction to aging: Definition and biological aspects of aging. Theories of Aging - Free radical theory, Mitochondrial theory, Telomere shortening and cellular senescence, Genetic and epigenetic regulation of aging, Immunosenescence and inflammation, and Hormonal theories of aging (endocrine dysregulation)	6
VI	Mechanism of Aging: Cellular mechanism: Cellular senescence, Oxidative stress-imbalance between production of ROS, Telomere shortening, Mitochondrial dysfunction Genetic mechanism: Genetic blue print in determining susceptibility to Alzheimer's, cardio vascular diseases, certain cancers, Genetic variability in life span, Telomere length, Metabolic genetic-insulin sensitivity, metabolic rate, nutrient utilization, metabolic disorders like diabetes, obesity	10
VII	Age associated common disorders-atherosclerosis, neoplasms, cataracts, macular degeneration, neuro degenerative disorders, neuro endocrine disorders, Cancer and aging: biochemical connections	4
	Total	60

Suggested Readings:

- Kronenberg, H., Williams, R. H. (2008) Textbook of endocrinology
- Nussey, S. Whitehead, S. A. (2001) Endocrinology: an integrated approach
- Baulieu, E. E. and Paul A. Kelly, P. A. (1990) Hormones: from molecules to disease
- Jonsen, A. R., Siegler, M. and Winslade, W. J. (2002) Clinical ethics: a practical approach to ethical decisions in clinical medicine
- Christopher Meyers, C. (2007) A practical guide to clinical ethics consulting: expertise, ethos, and power.



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Practicals

No	M03MLSMB05 Clinical Biochemistry I Practicals	C=2 (60hr)
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This course provides a comprehensive understanding of the biochemical basis of health and disease, and the role of biochemical tests in diagnosis. Students will gain practical skills essential for working in diagnostic laboratories in clinical and research lab.

- 1 Estimation of plasma glucose
- 2 Oral Glucose tolerance test
- 3 Glucose challenge test
- 4 Estimation of Glycosylated hemoglobin
- 5 Estimation urine Microalbuminuria
- 6 Qualitative Analysis of urine for sugars and ketone bodies
- 7 Estimation of plasma lactate
- 8 Qualitative Analysis for Fructosuria, galactosemia, pentosuria
- 9 Chromatography for separation of sugars
- 10 Lipid profile- TG, Cholesterol and HDL cholesterol
- 11 Lipoprotein Electrophoresis
- 12 Estimation of serum protein and Albumin
- 13 Serum protein Electrophoresis and quantification of band
- 14 Estimation of C reactive protein
- 15 Qualitative Analysis of Urinary protein
- 16 Estimation of Urea, Uric acid, Blood urea nitrogen, creatinine
- 17 Qualitative methods for Individual aminoacids
- 18 Chromatography Techniques (HPLC)- Aminoaciduria and disorder of Amino acid
- 19 Estimation of Iron, Calcium, phosphorus, Magnesium, Copper and Zinc
- 20 Urine qualitative tests for porphyria
- 21 Estimation of clinically important enzymes – SGOT, SGPT, Alkaline phosphatase, GGT, LDH, Lipase, Amylase, CK
- 22 Electrolyte Estimation
- 23 Arterial blood collection and Analysis of Blood gas
- 24 Westgard rule, LJ Graph data analysis

***Clinical laboratory rotation/observation can be incorporated wherever possible**



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No	M03MLSMB06 Clinical Biochemistry II practicals	C=2 (60hr)
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This course provides a comprehensive understanding of the biochemical basis of health and disease, and the role of biochemical tests in diagnosis. Students will gain practical skills essential for working in diagnostic laboratories in clinical and research lab.

1. Liver function test – Protein, A/G ratio, Total Bilirubin, direct bilirubin, SGOT, SGPT, ALP, GGT.
2. Renal function test – Urea, Uric acid, Creatinine, Microalbuminuria, Urine albumin: creatinine ratio, Analysis of Renal Calculi, Measurement of serum and urine osmolality
3. Urine analysis for normal and abnormal constituents of urine
4. Electrolytes Analysis - Sodium, potassium, Fractional excretion of Sodium (FeNa)
5. Pancreas function Test - Amylase, lipase
6. Cardiac enzymes – creatinine kinase, CK- MB, CAD risk assessment: Homocysteine, Troponin T, CPK, myoglobin
7. Hormone Analysis Thyroid profile- T3, T4, TSH, Fertility profile – LH, FSH, prolactin, estradiol, testosterone, cortisol, insulin
8. Demonstration of Tumor marker

***Clinical laboratory rotation/observation can be incorporated wherever possible**

No	M03MLSMB07 Immunology Practical	C=2 (60hr)
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This course equips students with hands-on skills essential for understanding immune responses, diagnostic techniques, and experimental methods used in immunological research and clinical laboratories.

1. Specimen collection and preparation of reagents and buffers
2. ABO and Rh typing using agglutination
3. Qualitative tests - precipitation, agglutination
4. Double Diffusion
5. Radial Immunodiffusion Assay
6. ELISA
7. Detection of rheumatoid factor
8. Estimation of C-reactive protein (CRP)
9. Separation of Immunoglobulins by Chromatography
10. Demonstration of western blot
11. Demonstration of Immunofluorescence.
12. Demonstration of Flow cytometry

***Clinical laboratory rotation/observation can be incorporated wherever possible**