Course Curriculum

MSc. CLINICAL BIOCHEMISTRY
(2/1- year Program)

As per NEP-2020 Scheme

DEPARTMENT OF CLINICAL BIOCHEMISTRY
UNIVERSITY OF KASHMIR
SRINAGAR-190006

About the Course:

MSc. Clinical Biochemistry is a comprehensive postgraduate program designed to provide students with a deep understanding of the clinical aspects of the biochemistry and the underlying biochemical processes involved in human health and diseases. The course covers a wide range of topics, including basic biochemistry, metabolic pathways, cell & molecular biology, immunology, organ system diseases, laboratory diagnostic techniques, and the role of clinical biochemistry in disease management and treatment. Students shall get exposed to the theoritical principles and practical aspects of the advanced laboratory techniques such as chromatography, electrophoresis, and spectrophotometry to analyse biological samples and diagnose conditions like diabetes, cardiovascular diseases, and genetic disorders. In addition to laboratory skills, the program emphasizes on first hand exposure of the students to clinical lab and research settings through internship program. Graduates of the program are well-prepared for careers in clinical laboratories, pharmaceutical and biotechnology industries, research institutions, and healthcare organizations, with opportunities to contribute to advancements in medical diagnostics, therapeutic development, and public health. The course also provides a strong foundation for those interested in higher education or pursuing a career in teaching and academia. A number of the passouts are working as biomedical scientists at reputed institutes across the world, and as faculty members in different medical colleges of the country.

Program Learning Outcomes (PLOs)

PLO1: Develop critical thinking, effective communication, and writing skills, while upholding ethical values, preparing them for careers in research, higher education, or advanced life science fields.

PLO2: Acquire the ability to engage in independent and life-long learning as the technology changes, knowledge grows and their career progresses.

PLO3: Ability to listen to others, help solve disagreements, and work as a team to make shared decisions.

PLO4: Demonstrate empathy towards social concerns and engage in social issues through informed action and volunteering.

PLO5: Acquire in-depth knowledge of biological systems and processes, with the ability to integrate and apply this knowledge across various disciplines of life sciences.

PLO6: Develop insight about the basic fundamental concepts and practices of clinical biochemistry and its processes.

PLO7: Initiate and develop strong research skills to design, conduct, and analyse the experiments, applying current research to solve clinical problems in biomedical sciences.

PLO8: Understand the nature and scope of different applied branches of Clinical biochemistry like human physiology, clinical pathology, clinical genomics and proteomics, medical genetics, etc.

PLO9: Develop strategies to address day-to-day challenges of lifestyle diseases by applying advanced clinical biochemistry approaches for its prevention, diagnosis and management.

PLO10: Demonstrate proficiency in performing biochemical analyses, interpreting clinical test results, and applying diagnostic methods in a clinical laboratory setting.

PLO11: Analyze and perform experimental procedures as per established laboratory standards in the areas of biochemistry, microbiology, molecular biology, immunology, physiology and clinical diagnostics.

Course Structure

NCrf Credit level	Sem-ester	Core papers (Core Course/elective)	Course Code	Type	Course level	Credit	Total Credits	Max Marks			Credit Distribution	Contact Hrs (15wks)
								Int.	Ext.	Total	L:T/P	
6	I	Foundational Biochemistry: Metabolism and associated disorders	MCLBCFB125	Core	400	3	20	21	54	75	3:0	45
		Fundamentals of Molecular Biology and Gene Expression	MCLBCFM125	Core	400	4		28	72	100	4:0	60
		Gastrointestinal and Hepatobiliary organ systems: Physiology and Diseases	MCLBCGH125	DCE	400	2		14	36	50	2:0	30
		Cell Organization, Signalling and associated disorders	MCLBCCO125	Core	400	2		14	36	50	2:0	30
		Enzymes: Structure, Function and Diagnostics	MCLBCES125	Core	400	2		14	36	50	2:0	30
		Techniques in Cell and Molecular Medicine	MCLBCTC125	Core	400	3		21	54	75	3:0	45
		Lab Course-I	MCLBCLC125	Core	400	4		28	72	100	0:4	60
	II	Respiratory and Excretory organ systems: Physiology and Diseases	MCLBCRE225	Core	400	3	20	21	54	75	3:0	45
		Cardio-Vascular system and Drug metabolism	MCLBCCV225	Core	400	2		14	36	50	2:0	30
		Medical Genetics	MCLBCMG225	Core	400	4		21	54	75	3:0	45
		Maternal and Fetal Health: Biochemical Aspects	MCLBCMF225	DCE	400	2		14	36	50	2:0	30
		Clinical Pathology and Haematology	MCLBCCP225	Core	400	2		14	36	50	2:0	30
		Clinical Genomics and Proteomics	MCLBCCG225	DCE	400	3		21	54	75	3:0	45
		Lab course-II	MCLBCLC225	Core	400	4		28	72	100	0:4	60
		Total Credits (1 year)					**40**					
	Exit Option with Post-Graduate Diploma in Clinical Biochemistry on completion of course equal to a minimum of 40 credits OR Entry to One year PG in Clinical Biochemistry with coursework and Research											

NCrf Credit level	Sem-ester	Core papers (Core Course / elective)	Course Code	Type	Course level	Credit	Total Credits	Max Marks			Credit Distribution	Contact Hrs (15 wks)
								Int.	Ext.	Total	L:T/P	
6.5	III	Microbiology and Infectious Diseases	MCLBCMI325	Core	500	3	20	21	54	75	3:0	45
		Endocrine Systems: Physiology and disorders	MCLBCES225	Core	500	3		21	54	75	3:0	45
		Neuromuscular and Skeletal systems: Physiology and Diseases	MCLBCNS325	Core	500	3		21	54	75	3:0	45
		Clinical Immunology	MCLBCCI325	DCE*	500	3		21	54	75	3:0	45
		Advanced Molecular Diagnostics	MCLBCAM325	SEC	500	2		14	36	50	2:0	30
		Laboratory Animal Sciences: Management, Handling and Ethics	MCLBSLA325	SEC	500	2		14	36	50	2:0	30
		Lab Course-III	MCLBCLC325	Core	500	4		28	72	100	0:4	60
	IV	Internship Dissertation and Evaluation	MCLBIID425	Core	500	12	20			300		
		Host Institute Grading	MCLBIHI425	Core	500	2				50		
		Viva-voce and Presentation	MCLBIVP425	Core	500	4				100		
		Automation, Quality Control and Lab Practices/MOOCS**	MCLBSAQ425/ MOOCS	SEC	500	2		14	36	50	2:0	30
		Total Credits (Aggregate)					**80**			**2000**		
Masters in Clinical Biochemistry with Research on Completion of courses equal to a minimum of 80 Credits												

*DCE - Discipline centric course, SEC - Skill enhancement course; **Policy for selection of MOOCS is provided at the end of the syllabus

1st SEMESTER

MCLBCFB125: Foundational Biochemistry: Metabolism and associated disorders

Credits: 3
Max. Marks: 75

Course Learning outcomes: Upon successful completion of this course, students will be able to-

CLO1: *Understand fundamental life processes by exploring the structure, function, and metabolism of carbohydrates and lipids, along with related human disorders.*

CLO2: *Gain insights into the structure, function, and metabolism of amino acids and proteins, as well as the metabolic disorders associated with them.*

CLO3: *Comprehend the structure and function of nucleic acid components and chromatin, along with the processes of nucleic acid biosynthesis, degradation, and related disorders.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	2	2	2	2
CL02	3	3	3	2	3	3	2	2	2	2	2
CLO3	3	3	3	2	3	3	2	2	2	2	2
Average	3	3	3	2	3	3	2	2	2	2	2

Course Content:

Unit-I: Carbohydrates & Lipids - Metabolism & disorders

Structure & function of biomolecules: Carbohydrates and their types, Metabolism of carbohydrates: Bioenergetics, glycolysis, Krebs cycle, Oxidative phosphorylation, ATP synthesis, Synthesis & breakdown of Glycogen, Gluconeogenesis. Structure and functions of Lipids, triacylglycerols, and phospholipids. Saturated and unsaturated fatty acids, Lipid metabolism: Biosynthesis and degradation of fatty acids, cholesterol, Lipoproteins & apolipoproteins. Disorders of carbohydrate & Lipid metabolism - Galactosemia, Glycogen storage disease, Lactose & Fructose intolerance, Dyslipidemia

Unit-II: Amino acids & Proteins - Metabolism & disorders

Amino acids: Structure, Classification, properties and functions; Peptides and polypeptides – peptide and iso-peptide bond, Proteins: properties, primary, secondary, tertiary and quaternary structure; Reverse turns and Ramachandran plot. Protein stabilizing interactions, Supersecondary structures – motifs and Domains; protein folding: Introduction, Levinthal's paradox, folding models and folding funnel hypothesis, Amino acid metabolism: Biosynthesis and degradation of important amino acids and their regulation; Transamination and oxidative deamination, urea cycle; Associated disorders - Lesh Nyhan Syndrome, Niemann Pick's disease.

Unit-III: Nucleic Acids & chromatin- Metabolism & disorders

Structure, properties of purines and pyrimidine bases, nucleosides and nucleotides, Conformation of Nucleic acids (A, B, Z-DNA, tRNA, mRNA), Structure of chromatin & chromosomes, Nucleic Acid metabolism: Regulation of biosynthesis and degradation of purines and pyrimidines, Biosynthesis of ribonucleotides and deoxyribonucleotides, Uric acid overproduction and under excretion; pathology and differential diagnosis of gout, Enzyme disorders of purine metabolism - and Orotic aciduria. Chromosome disorders: aneuploidy (trisomy 21, trisomy 18; trisomy 13, Turner syndrome and Klinefelter syndrome)

Books Recommended:

1. Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (International Edition). Macmillan Learning.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2015). *Biochemistry* (8th ed.). W. H. Freeman and Company.
3. Elliott, W. H., & Elliott, D. C. (2014). *Biochemistry and Molecular Biology* (4th ed.). Oxford University Press.
4. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of Biochemistry: Life at the Molecular Level* (5th ed.). Wiley.
5. Smith, J. L., Hill, R. E., & Lehman, I. R. (2020). *Principles of Biochemistry* (7th ed.). McGraw-Hill Education.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular Biology of the Cell* (6th ed.). Garland Science.
7. Stryer, L., Berg, J. M., & Tymoczko, J. L. (2002). *Biochemistry* (5th ed.). W. H. Freeman and Company.
8. Karp, G. (2018). *Cell and Molecular Biology: Concepts and Experiments* (8th ed.). Wiley.
9. Devlin, T. M. (2010). *Textbook of Biochemistry with Clinical Correlations* (7th ed.). John Wiley & Sons.

MCLBCFM125: Fundamentals of Molecular Biology and Gene Expression

Credits: 4
Max. Marks: 100

Course Learning outcomes: Upon completion of the course, students will be able to-

CLO1: *Know the background and significance of the historical milestones and discoveries leading to the identification of DNA as the genetic material and understand how it is processed and transmitted in living organisms.*

CLO2: *Understand the structure, function, and organization of genes in prokaryotic and eukaryotic systems.*

CLO3: *Understand the process of gene expression at the transcription level, and the underlying regulatory mechanisms in prokaryotes and eukaryotes.*

CLO4: *Learn the mechanism of mRNA translation by ribosomes and regulation of protein synthesis in prokaryotic and eukaryotic cells.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	2	2	2	2
CL02	3	3	3	2	3	3	2	2	2	2	2
CLO3	3	3	3	2	3	3	2	2	2	2	2
CLO4	3	3	3	2	3	3	2	2	2	2	2
Average	3	3	3	2	3	3	2	2	2	2	2

Course Content:

Unit-I: Nature and Propagation of genetic material

History of DNA; Experimental evidences & proof of DNA being the genetic material, DNA replication, Concept of replicon, Overview of bacterial DNA replication, Replication in prokaryotes - Origin, Initiation, elongation & termination of Replication in prokaryotes; Regulation of replication - Role of Ori-C & DNA methylation, Overview of eukaryotic DNA replication; Replication in eukaryotes – Origin, Initiation, elongation & termination of Replication; Telomeres & end replication problem of linear chromosomes. Regulation of replication, Fidelity of replication, DNA mutation types & causes, DNA damage & repair, Xeroderma pigmentosum

Unit-II: Gene structure & organization

Gene as a unit of hereditary, One gene one enzyme hypothesis, Genes code for proteins: historical perspective. Fine structure of gene in prokaryotes, Structure & functions of bacterial promoters, Concept of optimal promoters. Operon concept, Structure and organization of poly-cistronic gene. (Lac & Trp Operons), Fine structure of gene in eukaryotes, Structure and functions of eukaryotic gene promoters (Type I, II & III promoters), interrupted genes, Exons and Introns, Extra chromosomal genes in prokaryotes (Plasmids & types), Extra chromosomal genes in eukaryotes (mitochondrial & chloroplast genomes)

Unit-III: Gene transcription & Regulation

Transcription overview, Transcription factors & machinery. RNA polymerases (Types, structure & functions in eukaryotes & prokaryotes), Formation of initiation complex in prokaryotes, Transcription activators & repressors. Elongation & termination of transcription in prokaryotes. Regulation of polycistronic gene transcription in prokaryotes. Regulation of gene expression (transcription) at Lac & Trp operons. Repression viz attenuation mechanism. Formation of initiation complex in eukaryotes,

Elongation & termination of transcription in eukaryotes. RNA processing, editing, capping, splicing & polyadenylation. Structure & function of different types of RNA

Unit-IV: Protein synthesis & disorders

Protein synthesis and processing: Genetic code, deciphering codon language, Structure & function of prokaryotic & eukaryotic ribosomes, formation of initiation complex in prokaryotes viz eukaryotes, initiation factors and their regulation, elongation and elongation factors in prokaryotes viz eukaryotes, termination; Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, Control of gene expression at translation level: Regulation of prokaryotic and eukaryotic gene expression

Books Recommended:

1. Nelson, D. L., & Cox, M. M. (2004). *Lehninger Principles of Biochemistry* (4th ed.). W. H. Freeman and Company.
2. Elliott, W. H., & Elliott, D. C. (2009). *Biochemistry and Molecular Biology* (4th ed.). Oxford University Press.
3. Devlin, T. M. (2010). *Textbook of Biochemistry with Clinical Correlations* (7th ed.). John Wiley & Sons.
4. Henry, J. B. (1974). *Clinical Chemistry: Principles and Techniques* (2nd ed.). Harper & Row.
5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular Biology of the Cell* (6th ed.). Garland Science.
6. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). Wiley.
7. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2004*). Molecular Biology of the Gene* (5th ed.). Pearson Education.
8. Lewin, B. (2013). *Genes XII*. Jones & Bartlett Learning.
9. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: A Molecular Approach* (6th ed.). Sinauer Associates.
10. Karp, G., & Pruitt, N. L. (2002). *Cell and Molecular Biology: Concepts and Experiments* (4th ed.). Wiley.
11. Weaver, R. F. (2012). *Molecular Biology* (5th ed.). McGraw-Hill Education.
12. Kornberg, A., & Baker, T. A. (2005). *DNA Replication* (2nd ed.). University Science Books.
13. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2004). *Molecular Biology of the Gene* (5th ed.). Pearson Education.
14. Rapley, R., & Whitehouse, D. (Eds.). (2014). *Molecular Biology and Biotechnology* (5th ed.). Royal Society of Chemistry.
15. Lodish, H. (2003). *Molecular Cell Biology* (5th ed.). W. H. Freeman and Company.
16. Brown, T. A. (2000). *Essential Molecular Biology* (Vols. 1 & 2). Oxford University Press.

MCLBCGH125: Gastrointestinal and Hepatobiliary Organ systems: Physiology and Diseases

Credits: 2
Max. Marks: 50

Course Learning outcomes: At the end of this course, the students shall be able to –

CLO1: *Analyze the physiological mechanisms and clinical implications of gastric and pancreatic functions with diagnostic evaluation in disorders such as peptic ulcer and pancreatitis.*

CLO2: *Interpret liver function tests and biochemical markers to assess hepatobiliary disorders, distinguishing between acute and chronic liver diseases through clinical and laboratory data.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	2	2	2	2
CL02	3	3	3	2	3	3	2	2	3	2	2
Average	3	3	3	2	3	3	2	2	2.5	2	2

Course Content:

UNIT I: Physiology and Disorders of Gastrointestinal System

Mechanism of gastric secretion - HCl production, Gastrointestinal hormones - Clinical features and laboratory findings in diseases of the stomach: peptic ulcer, neoplastic disease. Assessment of pancreatic physiology and function, Pancreatic enzymes; Secretin and CCK-PZ tests; Clinical features and laboratory findings in diseases of the pancreas; Acute and chronic pancreatitis; Assessment of intestinal function; Small bowel malabsorption tests; Xylose, Lactose; Clinical features and laboratory findings in: Malabsorption, gluten intolerance, inflammatory bowel disease, Crohn's disease

UNIT II: Physiology and Disorders of Hepatobiliary System

Liver structure and function: brief anatomy; functions of liver, Biochemical indices in hepatobiliary disorders; bilirubin Bile acids, serum enzymes (ALP, AST, GGT, LDH), Serum proteins (immunoglobulins, prothrombin) Serum lipids (lipoprotein X, role of LCAT). Liver function tests (cholangiography). Diseases of hepatobiliary system - acute liver diseases: viral hepatitis, Toxic hepatitis (hepatotoxic drugs); chronic liver diseases - liver cirrhosis

Books Recommended:

1. Longo, D. L., Fauci, A. S., Kasper, D. L., Hauser, S. L., Jameson, J. L., & Loscalzo, J. (2012). *Harrison's Principles of Internal Medicine* (18th ed.). McGraw-Hill Education.
2. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.) John Wiley & Sons.
3. Martini, F. H. (2011). *Fundamentals of Anatomy and Physiology* (9th ed.). Prentice Hall.
4. Marshall, W. J., Bangert, S. K., & Lapsley, M. (2014). *Clinical Biochemistry: Metabolic and Clinical Aspects* (3rd ed.). Elsevier Health Sciences.
5. Tietz, N. W. (1999). *Fundamentals of Clinical Chemistry* (5th ed.). W. B. Saunders Company.
6. Varley, H., Gowenlock, A. H., & Bell, M. (1980). *Practical Clinical Biochemistry* (Vols. 1 & 2, 5th ed.). CBS Publishers & Distributors.
7. Zubay, G. (1998). *Biochemistry* (4th ed.). Wm. C. Brown Publishers.
8. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (1999). *Tietz Textbook of Clinical Chemistry* (3rd ed.). W. B. Saunders Company.
9. *Clinical biochemistry – Metabolic and clinical aspects*, Pearson Professional Ltd
10. Best, C. H., & Taylor, N. B. (1979). *The Physiological Basis of Medical Practice* (12th ed.). Williams & Wilkins.

MCLBCCO125: Cell Organization, Signalling & Associated Disorders

Credits: 2
Max. Marks: 50

Course Learning outcomes: By the end of the course, students will be able to:

CLO1: *Understand the structural and functional organization of cells, including cellular architecture and key biochemical processes, and how these contribute to cell division and regulatory mechanisms.*

CLO2: *Learn how cells communicate through signalling pathways and how problems in these signal-systems can lead to diseases like cancer.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	3	2	1	2
CL02	3	3	3	2	3	3	2	3	2	1	2
Average	3	3	3	2	3	3	2	3	2	1	2

Course Content:

UNIT-I: Cellular structure and cell division

Structure & functional features of prokaryotic and eukaryotic cells. Membrane structure & function, composition of lipid bilayers, membrane transport (diffusion, active transport, ion channels, pumps) intracellular transport & sorting, Cell organelles (Cell wall, Nucleus, Golgi bodies, Endoplasmic reticulum, peroxisomes, plastids), structure & function of cytoskeleton. Cell division: Mitosis & Meiosis, steps of cell cycles, regulation & control of cell division. Cancer & cell cycle: Stages, causes and properties of cancerous cells, virus-induced cancer, oncogenes, tumor suppressor genes, functions of oncogene products, Apoptosis, Diagnosis, prevention and treatment of cancer

UNIT-II: Signal transduction & disorders

Fundamentals of signal transduction. Cell-surface receptor pathways (GPCR pathway, DAG-IP3 pathway, RTK pathway, Non-receptor TK pathway, Receptor Ser/Thr kinase pathway), Signal transduction through intracellular receptors. Signaling pathways that control gene expression. JAK-STAT and MAPK pathway. Hormone response elements, CRE and CREB. Secondary messengers (cAMP, cGMP, NO, Ca^{+2}, IP3, DAG), Steroid hormone receptors, Antibodies to receptors: Ab to insulin receptor, TSH receptor, acetylcholine receptor, G-protein defects: inactivated (pseudo hypo-parathyroidism); activated (cholera); Cancer-causing mutations in receptors

Books Recommended:

1. De Robertis, E. D. P., & De Robertis, E. M. F. Jr. (2004). *Cell and Molecular Biology* (8th ed.). Lippincott Williams & Wilkins.
2. Weinberg, R. A. (2013). *The Biology of Cancer* (2nd ed.). Garland Science.
3. Ruddon, R. W. (2007). *Cancer Biology* (4th ed.). Oxford University Press.
4. McKinnell, R. G., Parchment, R. E., Perantoni, A. O., & Pierce, G. B. (2006). *The Biological Basis of Cancer* (4th ed.). Cambridge University Press.
5. Krauss, G. (2014). *Biochemistry of Signal Transduction and Regulation* (4th ed.). Wiley-VCH.
6. Cantley, L. C., Hunter, T., Sever, R., & Thorner, J. (2009). *Signal Transduction: Principles, Pathways, and Processes*. Cold Spring Harbor Laboratory Press.
7. Finkel, T., & Gutkind, J. S. (2003). *Signal Transduction and Human Disease*. Wiley-Liss.

MCLBCES125: Enzymes: Structure, Function and Diagnostics

Credits: 2
Max. Marks: 50

Course Learning outcomes: By the end of the course, students will be able to:

CLO1: *Understand how enzymes are classified, how they work, how their activity is controlled, and how they react to different conditions like inhibitors or allosteric changes.*

CLO2: *Learn how enzymes are used in diagnosing diseases, including the role of specific enzymes found in the blood and other tissues as indicators of health problems.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	2	2	2	3
CL02	3	3	3	2	3	3	3	3	3	3	3
Average	3	3	3	2	3	3	2.5	2.5	2.5	2.5	3

Course Content:

UNIT I: Enzymes

Classification and nomenclature of enzymes, prosthetic groups, cofactors, Mechanism of enzyme action and properties of enzymes as catalysts. Enzyme kinetics (equilibrium and steady state theory, rate equation and determination of K_m and V_{max}), specific activity, turn over number and catalytic activity, Enzyme regulation; Principles and mechanism of catalysis, Factors affecting rate of enzyme catalyzed reactions, Enzyme inhibition: reversible and irreversible inhibition, Allosteric enzymes: Models of allostery, types and kinetics; Isoenzymes and isozymes

UNIT II: Principles of Diagnostic Enzymology

Diagnostic and prognostic importance of plasma and non-plasma derived enzymes, Source and mechanisms for their abnormal levels, Enzymes as diagnostic markers: Creatine kinase, Lactate dehydrogenase, Transaminases, Alkaline phosphatase, Acid phosphatase, Amylase, Lipase, glutamate dehydrogenase, glucose-6-phosphate dehydrogenase; Clinical features and laboratory findings in disorders of the plasma proteins, acute phase proteins, serum proteins and albumin, serum and urine protein electrophoresis

Books Recommended:

1. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of Biochemistry: Life at the Molecular Level* (5th ed.). Wiley.
2. Price, N. C., & Stevens, L. (1999). *Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins* (3rd ed.). Oxford University Press.
3. Palmer, T. (2007). *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry* (2nd ed.). Woodhead Publishing.
4. Taylor, K. B. (2002). *Enzyme Kinetics and Mechanisms.* Kluwer Academic Publishers.
5. Devlin, T. M. (2010). *Textbook of Biochemistry with Clinical Correlations* (7th ed.). John Wiley & Sons.
6. Cantrow, A., & Trumper, *M. Clinical Biochemistry.*
7. Henry, R. J. (1974). *Clinical Chemistry: Principles and Technics* (2nd ed.). Harper & Row.

MCLBCTC125: Techniques in Cell and Molecular Medicine

Credits: 3
Max. Marks: 75

Course Learning outcomes: At the end of the course, the students will –

CLO1*: Understand the principles, instrumentation, and applications of spectroscopic and centrifugation techniques used in biochemical analysis.*

CLO2*: Apply chromatographic, electrophoretic, and other molecular biology techniques to analyze and separate biomolecules with precision.*

CLO3*: Utilize microscopic and radiological methods for the visualization, quantification, and structural analysis of biological samples in clinical diagnostics and biochemical studies*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	1	2	1	3	1	1	1	3
CL02	3	3	3	1	2	1	3	2	1	2	3
CLO3	3	3	3	1	2	1	3	2	1	2	3
Average	3	3	3	1	2	1	3	2	1	2	3

Course Content:

Unit I: Spectroscopic and Centrifugation techniques

Principle of spectroscopy. Concept of absorptions, transmission, scattering, phosphorescence, fluorescence, luminescence; Principle, instrumentation, working and applications of – UV and visible spectroscopy and spectrofluorimetry; Centrifugation: Basic Principle, sedimentation coefficient and factors affecting sedimentation coefficient; Techniques - Preparative, analytical and ultracentrifuges – principle, instrumentation and applications

Unit II: Chromatography and Biochemical techniques

General principle of chromatography; Principles, instrumentation, working and applications of Size exclusion chromatography, Ion exchange chromatography and affinity chromatography, High Pressure liquid chromatography and Fast protein liquid chromatography; Basic principle, instrumentation and applications of Electrophoresis, Agarose and polyacrylamide gel electrophoresis of Nucleic acids and proteins, Isoelectric focusing and Western blotting

Unit III: Microscopic and Radiological Techniques

Basic principles, instrumentation and applications of microscopy, Optical microscopy – Principles and techniques and their applications and limitations, Individual components of a microscope; Electron Microscopy - Principle of electron microscopes, preparation of samples, Scanning and Transmission electron microscopy; Flow-cytometry – principle and applications; Radioisotope Techniques – Detection and measurement of radioactivity, Radioactivity decay constant, half-life of a radioisotope, Units of radioactivity, Applications of isotopes in research and clinical biochemistry

Books Recommended:

1. Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A., & Weiner, A. M. (1987). *Molecular biology of the gene* (4th ed.). Benjamin/Cummings Publishing.
2. Hartl, D. L., & Jones, E. W. (1998). *Essential genetics* (2nd ed.). Jones & Bartlett Publishers.
3. Watson, J. D., Roberts, J. W., Steitz, J. A., & Weiner, A. M. (2003). *Molecular biology of the gene* (5th ed.). Benjamin/Cummings Publishing.
4. Weaver, R. F. (2012). *Molecular biology* (5th ed.). McGraw-Hill.
5. Glick, B. R., & Pasternak, J. J. (2010). *Molecular biotechnology: Principles and applications of recombinant DNA* (4th ed.). ASM Press.
6. Old, R. W., & Primrose, S. B. (1981). *Principles of gene manipulation* (3rd ed.). Blackwell Scientific Publications.
7. Watson, J. D., Tooze, J., & Kurtz, D. T. (1983). *Recombinant DNA: A short course* (2nd ed.). W.H. Freeman.
8. Freifelder, D. (1987). *Molecular biology* (2nd ed.). Jones & Bartlett Publishers.

MCLBCLC125: Lab Course-I

Credits: 4
Max. Marks: 100

Course Learning outcomes: Upon completion of this Lab course, students will –

CLO1: *Acquire hands-on experience with fundamental biochemical techniques and methods including basic biochemical calculations, concepts of pH and buffers, and carry out essential biochemical methods.*

CL02: *Conduct titrimetric estimation of ascorbic acid and perform chromatographic techniques with some expertise in the enzyme extraction and assays,*

CLO3: *Carry out investigation of enzyme activity under different conditions, and the application of gel electrophoresis for molecular separation.*

CLO4: *acquire a comprehensive understanding of several important biochemical analysis techniques used in research and diagnostics*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	3	1	1	3	3
CL02	3	3	3	3	3	3	3	1	2	3	3
CLO3	3	3	3	3	3	3	3	3	3	3	3
CLO4	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	2	2.25	3	3

List of Practical:

i. Biochemical calculations
ii. Concept of pH and buffers
iii. Quantitative estimation of proteins using Lowry's/Biuret/Bradford's method
iv. Quantitative estimation of glucose
v. Quantitative estimation of cholesterol
vi. Quantitative estimation of DNA/RNA
vii. Absorption and Fluorescence spectra of Nucleic Acids and proteins
viii. Titrimetric estimation of ascorbic acid
ix. TLC and paper chromatography of amino acids and sugars
x. Column chromatography
xi. Extraction and Assay of Enzyme activity
xii. Agarose Gel electrophoresis
xiii. Polyacrylamide gel electrophoresis (PAGE) and SDS- PAGE analysis of proteins
xiv. Use of microscope for unstained and stained preparations
xv. Preparation, staining and examination of blood films
xvi. Manual Blood cell count

Books Recommended:

1. Plummer, D. T. (1987). *An Introduction to Practical Biochemistry* (3rd ed.). McGraw-Hill.
2. Hofmann, A., & Clokie, S. (2018). Wilson and Walker's *Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press.
3. Sadasivam, S., & Manickam, A. (2022). *Biochemical Methods* (4th ed.). New Age International Publishers.
4. Jayaswal, R. P. (2019). *Clinical Biochemistry: Student's Laboratory Manual* (1st ed.). Notion Press.
5. Bisswanger, H. (2011). *Practical Enzymology* (3rd ed.). Wiley-VCH.
6. Carson, S., & Miller, H. B. (2019). *Molecular Biology Techniques: A Classroom Laboratory Manual* (4th ed.). Academic Press.
7. Coico, R., & Sunshine, G. (2015). *Immunology: A Short Course* (8th ed.). Wiley-Blackwell.

SEMESTER – II

MCLBCRE225: Respiratory and Excretory Organ systems: Physiology and Diseases

Credits: 3
Max. Marks: 75

Course Outcomes: By the end of the course, students will learn the:

CLO1: *understanding of regulation of water, electrolytes, and acid-base balance, with a focus on clinical conditions like dehydration, electrolyte imbalances, hypo-hypernatraemia, hyper-hypokalaemia, SIADH etc.*

CLO2: *about the gas diffusion, respiratory diseases investigation, and clinical insights into conditions like COPD, cystic fibrosis, asthma, and pneumonia etc.*

CLO3: *kidney function and disorders, including tests for glomerular and tubular function, and conditions like glomerulonephritis, nephrotic syndrome, and renal failure, applying clinical findings to diagnosis and treatment.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	2	3	3	2	2
CL02	3	3	3	3	3	3	2	3	3	3	2
CLO3	3	3	3	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	2	3	3	2.7	2.3

Course Content:

UNIT I: Electrolyte Regulation and Acid-base balance

Regulation of water and electrolyte balance – Homeostatic control of body fluids, Role of Na^+ and K^+, Na^+/K^+ ATPase pumps – General overview and physiological importance, Role of kidneys and hormones. Clinical features and laboratory findings in - dehydration, overhydration, Hypernatremia, hyponatremia; (SIADH), hypokalemia, hyperkalemia. Acid-Base balance; regulation by kidney and hormones. Acid-base disorders - metabolic, respiratory and mixed acid-base disorders

UNIT II: Respiration - Functional and Clinical Aspects

Physiology of respiratory system, Pulmonary ventilation – pressure changes and factors affecting, Lung volumes and capacities, Diffusion of gases through respiratory membrane; Exchange of Oxygen and Carbon dioxide – external and internal respiration, Oxygen and CO_2 transport, Overall role of transferrin and CO in respiration, Clinical features, Investigation and pathological features of chronic respiratory failure, Chronic obsessive Pulmonary disorder, Cystic fibrosis, asthma and pneumonia

UNIT III: Kidney function – Evaluation and Disorders

Brief anatomy of Nephron, Glomerular filtration, Tubular reabsorption, Tests of kidney function and their Clinical co-relations, tests of glomerular functions and its measurement, Clearance tests, Plasma creatinine, urea, β2-microglobulin. Tubular functions tests. urinalysis; microscopic analysis, Clinical features and laboratory findings in- Glomerulonephritis; acute glomerulonephritis, progressive glomerulonephritis, nephritic syndrome. Nephrotic syndrome, acute renal failure/chronic renal failure, renal calculi

Books Recommended:

1. Marshall, W. J., Bangert, S. K., & Wells, E. S. M. (2008). *Clinical Biochemistry: Metabolic and Clinical Aspects* (3rd ed.). Elsevier Health Sciences.
2. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (2006). *Tietz Fundamentals of Clinical Chemistry* (6th ed.). Saunders Elsevier.
3. Varley, H., Gowenlock, A. H., & Bell, M. (1980). *Practical Clinical Biochemistry* (5th ed., Vols. I & II). CBS Publishers & Distributors.
4. Zubay, G. (1998). *Biochemistry* (4th ed.). Wm. C. Brown Publishers.
5. Best, C. H., & Taylor, N. B. (1981). *The Physiological Basis of Medical Practice* (12th ed.). Williams & Wilkins.
6. Burtis, C. A., Ashwood, E. R., & Border, B. G. (1999). *Tietz Textbook of Clinical Chemistry* (3rd ed.). W.B. Saunders Company.
7. Marshall, W. J., & Bangert, S. K. (2008). *Clinical Biochemistry: Metabolic and Clinical Aspects* (3rd ed.). Pearson Education Ltd.
8. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). John Wiley & Sons.
9. Martini, F. H. (2011). *Fundamentals of Anatomy and Physiology* (9th ed.). Pearson Prentice Hall.
10. Longo, D. L., Fauci, A. S., Kasper, D. L., Hauser, S. L., Jameson, J. L., & Loscalzo, J. (2012). *Harrison's Principles of Internal Medicine* (18th ed.). McGraw-Hill Education.

MCLBCCV225: Cardio-Vascular System and Drug metabolism

Credits: 2
Max. Marks: 50

Course Learning outcomes: By the end of the course, students will be able to-

CLO1: *Understand the structure and function of the heart and blood vessels, how the heart beats, and recognize common heart-related conditions like heart attacks, heart failure, high blood pressure, and clogged arteries.*

CLO2: *Learn how the body processes drugs, how drugs work, and how the digestive system helps absorb them. Students will also explore how a person's genes can affect their response to medications and why this matters in treatment.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	2	3	3	2	2
CL02	3	3	3	3	3	3	2	3	3	2	2
Average	3	3	3	3	3	3	2	3	3	2	2

Course Content:

UNIT I: Cardiovascular system: Physiology and Disorders

Anatomy of heart – location, pericardium, layers and location of heart, Myocardial thickness, Heart valves and blood circulation; Physiology of heart - Conduction system, action potential, contraction mechanism, ECG and its correlation with heart chamber systoles, Cardiac cycle – pressure and volume changes, heart sounds; Cardiac output – different heart volumes and capacities, Heart rate; Myocardial Infarction - troponin, myoglobin and other markers; Congestive heart failure, atherosclerosis, and Hypertension

UNIT II: Mineral and Drug Metabolism

Approaches to pharmacological testing, Use of gastrointestinal tract for drug absorption, T half-life, Drug metabolism, excretion; Pharmacokinetics, pharmacodynamics and pharmacogenetics, Drug metabolism in elderly; Clinical applications of pharmacogenetic testing, Defining pharmacogenetic targets, Examples of clinically relevant pharmacogenetic targets - NAT1 & NAT2.

Books Recommended:

1. Longo, D. L., Fauci, A. S., Kasper, D. L., Hauser, S. L., Jameson, J. L., & Loscalzo, J. (Eds.). (2012). *Harrison's Principles of Internal Medicine* (18th ed.). McGraw-Hill Education.
2. Martini, F. H. (2011). *Fundamentals of Anatomy and Physiology* (9th ed.). Prentice Hall.
3. Marshall, W. J., Bangert, S. K., & Wells, E. S. M. (2008). *Clinical Biochemistry: Metabolic and Clinical Aspects* (3rd ed.). Elsevier Health Sciences.
4. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (1999). *Tietz Textbook of Clinical Chemistry* (3rd ed.). W.B. Saunders Company.
5. Marshall, W. J., & Bangert, S. K. (2008). *Clinical Biochemistry: Metabolic and Clinical Aspects* (3rd ed.). Pearson Professional Ltd.
6. Harvey, R. A., Champe, P. C., Finkel, R., Cubeddu, L. X., & Clarke, M. A. (2008). *Lippincott's Illustrated Reviews: Pharmacology* (4th ed.). Lippincott Williams & Wilkins.

MCLBCMG225: Medical Genetics

Credits: 4
Max. Marks: 100

Course Learning outcomes: At the end of the course, the student should be able to –

CLO1: *Understand and apply key genetic principles, including Mendelian and non-Mendelian inheritance, to analyze autosomal and sex-linked traits.*

CLO2: *Perform pedigree analysis and investigate genetic disorders, including incomplete dominance and mitochondrial inheritance.*

CLO3: *Explore the role of epigenetic regulation and environmental factors in gene expression and disease progression.*

CLO4: *Integrate genetic and epigenetic knowledge to diagnose and manage genetic disorders, chromosomal abnormalities, and multifactorial diseases in clinical practice*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	2	2	3	3	1	2
CL02	3	3	3	3	3	2	2	3	2	1	2
CLO3	3	3	3	3	3	2	2	3	2	2	1
CL04	3	3	3	3	3	2	2	3	3	2	3
Average	3	3	3	3	3	2	2	3	2.5	1.5	2

Course Content:

Unit I: Mendelian Genetics

Introduction to Mendelian inheritance, including the basic concepts of inheritance patterns and gene expression: the laws of dominance, segregation, and independent assortment. Analysis of monohybrid and dihybrid crosses using Punnett squares. Classical inheritance patterns: autosomal dominant, autosomal recessive, X-linked, Y-linked, mitochondrial. Pedigree analysis: construction and clinical interpretation. Consanguinity and implications for recessive inheritance.

Unit II: Non-Mendelian Genetics

Non-Mendelian inheritance patterns: incomplete dominance, codominance, and multiple alleles. Gene interactions: epistasis, pleiotropy, penetrance, expressivity. Genomic imprinting and uniparental disomy, Extranuclear Inheritance: Inheritance of traits controlled by genes in mitochondria and plastids and associated diseases, Gene Linkage: Inheritance of Linked Genes, Crossing over and its role in genetic diversity.

Unit III: Epigenetic Regulation of Gene Expression

Introduction to epigenetic regulation and its impact on gene expression. Mechanisms of epigenetic modifications: DNA methylation, histone modification: Histone methylation, acetylation, phosphorylation, ubiquitylation, ATP-dependent chromatin remodelling, histone chaperones, histone variants and RNA interference. Epigenetics in cellular differentiation and development, including X-inactivation and genomic imprinting. The role of environmental factors (e.g., diet, stress, toxins) in epigenetic changes and gene expression.

Unit IV: Genetic and Epigenetic Basis of Human Diseases

Monogenic (single-gene) disorders: Cystic Fibrosis, Duchenne Muscular Dystrophy, Becker muscular dystrophy, Spinal muscular atrophy, Fragile X syndrome, and Huntington's disease; Chromosomal abnormalities: Down syndrome, Turner syndrome, Klinefelter syndrome. Multifactorial diseases: Diabetes and cancer (Hereditary GI cancers**)**, Epigenetics in Cancer and Neurological Disorders – Alzheimer's, Parkinson's

Books Recommended:

1. Hartl, D. L., & Jones, E. W. (2012). *Genetics: Analysis of genes and genomes* (8th ed.). Jones & Bartlett Learning. ISBN: 978-1-4496-1261-9
2. Strachan, T., & Read, A. P. (2004). *Human molecular genetics* (3rd Ed.). Garland Science. ISBN: 978-0-8153-4102-9
3. Lewis, R. (2021). *Human genetics: Concepts and applications* (13th ed.). McGraw Hill. ISBN: 978-1-260-24089-4
4. Brown, T. A. (2002). *Genomes* (2nd ed.). Wiley-Liss. ISBN: 978-0-471-25046-5NCBI
5. Freeman, S., & Herron, J. C. (2021). *Evolutionary analysis* (5th ed.). Pearson. ISBN: 978-0-1375-2102-9
6. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (1991). *Principles of genetics* (8th ed.). Wiley. ISBN: 978-0-471-53521-8
7. Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A., & Weiner, A. M. (1987). *Molecular biology of the gene* (4th ed.). The Benjamin/Cummings Publishing Company. ISBN: 978-0-8053-1910-2
8. Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., & Killian, D. (2019). *Essentials of genetics* (10th ed.). Pearson. ISBN: 978-0-1355-8878-9

MCLBCMF225: Maternal and Fetal Health: Biochemical Aspects

Credits: 2
Max. Marks: 50

Course Learning outcomes: After the completion of the course, the students will learn –

CLOI: *The assessment of high risk pregnancy via maternal serum screening procedures, biochemical markers and confirmatory tests.*

CLO2: *The congenital and developmental disorders, neonatal infections, and vaccination procedures in neonates.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	3	3	3	3	1
CL02	3	3	3	3	3	3	3	3	3	2	2
Average	3	3	3	3	3	3	3	3	3	2.5	1.5

Course Content:

UNIT I: Assessment and Monitoring of High Risk Pregnancy

Perinatal care, Non-invasive prenatal test (NIPT), Total Maternal serum screen; first trimester Down's syndrome screen, Second & Third trimester screen, [alpha-fetoprotein, hCG, unconjugated estriol), Quadripple screen, Amniotic fluid and Fetal blood examination (acetylcholinesterase and other tests on amniotic fluid), Amniocentesis, Percutaneous Umbilical Cord Blood Sampling, Ectopic pregnancy & Recurrent pregnancy loss: symptoms, risk factors, biochemical diagnosis & management.

UNIT II: Neonatology & Congenital disorders

New Born Screening (NBS) Blood Test, Sweat test for cystic fibrosis, Lecithin Sphingomyelin test for Fetal lung maturity Respiratory distress syndrome, Neonatal Infections. Neural tube defects; Spina bifida, Anencephaly, Encephaloceles (Origin and management), Neonatal anaemia, Rh isoimmunization. Vaccines: History & Types, Vaccination in Newborn babies, WHO recommended immunization schedule, BCG, DPT, OPV & Multivalent vaccine combinations

Books Recommended:

1. Longo, D. L., Fauci, A. S., Kasper, D. L., Hauser, S. L., Jameson, J. L., & Loscalzo, J. (Eds.). (2011). *Harrison's principles of internal medicine* (18th ed.). McGraw-Hill Education. ISBN: 978-0-07-174889-6
2. Paul, V. K., & Bagga, A. (2013). *Ghai essential paediatrics* (8th ed.). CBS Publishers & Distributors. ISBN: 978-81-239-3123-1
3. Martini, F. H. (2014). *Fundamentals of anatomy & physiology* (10th ed.). Pearson Education. ISBN: 978-0-321-92803-2
4. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (Eds.). (2012). *Tietz textbook of clinical chemistry and molecular diagnostics* (5th ed.). Elsevier. ISBN: 978-1-4377-1602-3
5. Hall, J. E. (2015). *Guyton and Hall textbook of medical physiology* (13th ed.). Elsevier. ISBN: 978-1-4557-7005-2PMC
6. Marshall, W. J., Bangert, S. K., & Lapsley, M. (2014). *Clinical chemistry: Metabolic and clinical aspects* (7th ed.). Elsevier. ISBN: 978-0-7020-5181-4
7. Teitz, N. W. (2006). *Fundamentals of clinical chemistry* (6th ed.). W.B. Saunders Company. ISBN: 978-0-7216-0245-1

MCLBCCP225: Clinical Pathology and Hematology

Credits: 2
Max. Marks: 50

Course Learning outcome: At the completion of the course, the students will be able to –

CLO1: *Describe the mechanisms of cellular injury and inflammation, differentiate between acute and chronic inflammatory responses, and explain the role of chemical mediators and immune cells in disease pathology.*

CLO2: *Explain the processes of blood cell formation, identify different types of anaemias and hemoglobinopathies, and interpret laboratory findings related to hematological disorders and hemostasis mechanisms*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	3	3	3	3	2
CL02	3	3	3	3	3	3	3	3	3	3	2
Average	3	3	3	3	3	3	3	3	3	3	2

Course Content:

Unit I: Pathology: Cellular and Inflammatory Responses

History and scope of pathology; General Classification, causes and mechanism of Cell injury, Reversible and irreversible cell injury. apoptosis and sub-cellular responses to cell injury, Cellular responses to growth and differentiation, pathologic calcification. Inflammation: definition and various types of inflammation, Acute and chronic inflammation, morphologic patterns of acute and chronic inflammation, systemic effects of inflammation Chemical mediators of inflammation, vasoactive factors and phagocytosis. Granuloma formation. Role of neutrophils in inflammation

UNIT II: Hematology: Hemopoiesis and Hematologic Disorders

Blood cell formation and Morphology, Regulation of hemopoiesis; Anaemia, definition, pathophysiology, classification and clinical features; Microcytic hypochromic anaemias, Iron deficiency anaemia, Macrocytic anaemia, Pernicious anaemia, Disorders of Haemoglobin - Hemoglobinopathies, Hemostasis – Principle, Types of mechanism –Vascular spasm, platelet plug formation and Coagulation - Intrinsic and extrinsic pathway; Leukaemia and its stages: CML, AML, CLL & ALL; Multiple Myeloma

Books Recommended:

1. Guyton, A. C., & Hall, J. E. (2000). *Textbook of medical physiology* (10th ed.). W.B. Saunders.
2. Gradwohl, R. B. H. (Ed.). (1970). *Clinical laboratory methods and diagnosis* (8th ed.). C.V. Mosby.
3. Braunwald, E., Fauci, A. S., Kasper, D. L., Hauser, S. L., & Longo, D. L. (Eds.). (2001). *Harrison's principles of internal medicine* (15th ed.). McGraw-Hill.
4. Lewis, J. A. (1999). *Illustrated guide to diagnostic tests: Student's version*. Springhouse Corporation.
5. Henry, J. B., Sanford, T., & Davidson, B. (2002). *Clinical diagnosis and management by laboratory methods* (20th ed.). W.B. Saunders.

MCLBCCG225: Clinical Genomics and Proteomics

Credits: 2
Max. Marks: 50

Course Learning outcomes: After the completion of the course, the students will learn –

CLO1: *to analyze and interpret genomic organization, sequencing technologies, and bioinformatics tools to investigate genetic variation, evolutionary relationships, and disease-associated genes in prokaryotic and eukaryotic systems*

CLO2: *The principles and applications of proteomics and emerging omics technologies in biological and translational research*

CLO3: *Various technological approaches for acquiring, managing, and analyzing omics data in systems biology*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	2	2	3	2	3	3	2	3	2
CL02	3	3	2	2	3	2	3	3	2	3	2
CL02	3	3	2	2	3	2	3	3	2	2	3
Average	3	3	2	2	3	2	3	3	2	2.7	2.3

Course Content:

Unit I: Genomics: Genome Organization and Analysis

Prokaryotic and eukaryotic genome organization, Transposable elements, T_m & renaturation kinetics, Repetitive DNA, Satellite and Microsatellite DNA; use in forensics & lineage /pedigree analysis, Human genome features, Human Genome Project (HGP), Sequencing technologies: Bacterial and Yeast artificial chromosomes, Polymerase chain reaction (PCR) & types, RFLP, Sanger sequencing, Shotgun approach; Genomics databases, Homology search - NCBI-BLAST, Sequence alignments, GWAS for disease associated genes

Unit II: Proteomics and Multi-Omics Integration

Introduction to Proteome, Proteomics, metabolomics, proteogenomics and systems biology, Importance of proteomics in clinical and biomedical research, diagnostics, and drug discovery; Protein Extraction and Sample preparation - Extraction of proteins from biological fluids/tissues, Solubilization techniques and removal of interfering substances (lipids, nucleic acids & Salts); Protein pre-fractionation and separation techniques - salt fractionation, with low- and high- abundant proteins by Liquid phase Isoelectric focusing, Machine Learning in proteomics- an introduction

Unit III: Proteomics: Methods and Application

Protein microarray – types, applications and basic workflow; Quantitative Proteomics: Gel-based - 2D gel electrophoresis, Gel-free proteomics - Mass Spectrometry: Separation techniques - Liquid Chromatography (LC-MS/MS), Ionization sources/techniques -MALDI, and ESI; Mass analyzers - ToF, Quadrupole, Ion traps; Label-free proteomics- Advantages and comparison with labelled proteomics, and De Novo Sequencing: De novo peptide sequencing – Introduction, Steps involved, Tools (PEAKS), case study

Recommended Books:

1. Brown, T. A. (2018). *Genomes 4*. Garland Science, Taylor & Francis Group.
2. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
3. Hunt, S., & Livesey, F. J. (2023). *Functional genomics: A practical approach*. Oxford University Press.
4. Lesk, A. M. (2017). *Introduction to genomics* (3rd ed.). Oxford University Press.
5. Richards, J. E., & Hawley, R. S. (2011). *The human genome: A user's guide* (3rd ed.). Elsevier Academic Press.
6. Green, M. R., & Sambrook, J. (2014). *Molecular cloning: A laboratory manual* (4th ed.). Cold Spring Harbor Laboratory Press.
7. Twyman, R. M. (2004). *Principles of proteomics*. Garland Science, Taylor & Francis Group.
8. Liebler, D. C. (2002). *Introduction to proteomics: Tools for the new biology*. Humana Press.

MCLBCLP225: Lab course-II

Credits: 4
Max. Marks: 100

Course Learning Outcomes: After completion of the Lab course, the students will learn -

CLO1: *Clinical sample handling and analysis including collection, preservation, and processing of blood and urine samples, and performing routine clinical analyses to assess physiological and pathological conditions.*

CLO2*: Biochemical estimations and Clinical diagnostics including the estimation of key biochemical parameters in blood and urine and interpret results in the context of clinical diagnostics*

CLO3*: Electrolyte and mineral estimation including evaluation of electrolytes and trace minerals essential for maintaining physiological balance.*

CLO4*: Molecular and Analytical Techniques in Biochemistry so as to investigate the biological samples and utilize bioinformatics tools for sequence analysis.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	3	2	3	3	3
CL02	3	3	3	2	3	3	3	2	3	3	3
CLO3	3	3	3	2	3	3	3	2	3	3	3
CL04	3	3	3	2	3	3	3	2	3	3	3
Average	3	3	3	2	3	3	3	2	3	3	3

List of Practical:

i. Blood collection, sample preservation and processing.
ii. Blood Pressure Measurement and Oxygen Level Assessment
iii. Determination of Bleeding Time and Clotting Time
iv. Determination of RBC, WBC, Platelets, Hematocrit, and PCV
v. Complete Blood Count (CBC) and Erythrocyte Sedimentation Rate (ESR)
vi. Tissue Fixation (Formalin Method) and Paraffin Block Preparation
vii. Urine analysis – Routine and microscopic examination
viii. Estimation of phosphate, urea, creatinine in urine
ix. Estimation of 24-Hour Urinary Protein and Spot Test for Proteinuria
x. Isolation of DNA from animal tissue/ blood samples
xi. Detection of proteins by western blotting
xii. Estimation of serum albumin and determination of albumin/globulin ratio.
xiii. Estimation of serum glucose –fasting, post-prandial and random
xiv. Estimation of serum triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol.
xv. Estimation of serum bilirubin
xvi. Estimation of serum urea and creatinine
xvii. Estimation of alkaline phosphate, ALT and AST and their clinical use

Books Recommended:

1. Varley, H. (1988). *Practical clinical biochemistry* (6th ed.). Heinemann.
2. Godkar, P. B., & Godkar, D. P. (2014). *Textbook of medical laboratory technology* (3rd ed.). Bhalani Publishing House.
3. Boyer, R. (2015). *Modern experimental biochemistry* (3rd ed.). Pearson.
4. Jayaswal, R. (2019). *Clinical biochemistry: Student's laboratory manual*. Notion Press.
5. Bisswanger, H. (2014). *Practical enzymology* (3rd ed.). Wiley-VCH.
6. Weaver, R. F., & Hedrick, P. W. (2019). *Molecular biology techniques: A classroom laboratory manual* (4th ed.). Academic Press.
7. Frances Fischbach Manual of Laboratory and Diagnostic Tests" (10th ed.)
8. Bishop, Fody & Schoeff (2020), *Clinical Chemistry: Techniques, Principles, Correlations*, 7th ed., Wolters Kluwer
9. Strasinger & Di Lorenzo (2014), *Urinalysis and Body Fluids*, 7th ed., F.A. Davis
10. Keohane et al. (2019), Rodak's Hematology: Clinical Principles and Applications, 6th ed., Elsevier.

SEMESTER-III

MCLBCMI325: Microbiology and Infectious Diseases

Credits: 3
Max. Marks: 75

Course Learning outcome: At the completion of the course, the students will be able –

CLO1: *to learn the classification, growth, and control of microorganisms, and assess their significance in human health, industry, and environmental sustainability.*
CLO2: *to identify medically important microbes and describe the mechanisms of infection, transmission, virulence, and antimicrobial resistance, along with strategies for prevention and control.*
CLO3: *to analyze the causes, symptoms, and treatments of common and emerging infectious diseases, with an emphasis on clinical features, pathogenesis, and public health implications.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	2	2	2	1	1	2
CL02	3	3	3	3	3	3	2	2	2	2	2
CL03	3	3	3	3	3	3	2	3	2	3	2
Average	3	3	3	2.7	3	2.7	2	2.3	1.7	2	2

Course Content:

Unit I: Introduction to Microbiology

Introduction to Microbial Systems: Definition and classification of microorganisms, Criteria for classification, Importance of microbiology in human health and the environment. Normal Human Microflora. Microbial Growth: Growth curve, Measurement of microbial growth. Factors affecting microbial growth. Control of Microbial Growth: Sterilization and disinfection techniques. Pure Culture Techniques. Microbial Fermentation: Production of antibiotics, organic acids, and vitamins.

Unit II: Pathogenicity and Host-Pathogen Interactions
Pathogenesis of Infectious Diseases: Mechanisms of infection: adhesion, invasion, and immune evasion. Sources and Routes of Transmission: Different routes of transmission: direct contact, respiratory droplets, vectors, and fomites. Microbial Virulence and Virulence Factors. Toxins: Types of toxins and mode of action. Signs and Symptoms of Infectious Diseases: Clinical manifestations of infections caused by bacteria, viruses, fungi, and parasites.

Unit III: Infectious Diseases and their Management
Bacterial infections: staphylococcal infections, salmonellosis, shigellosis, and clostridial food poisoning – clinical features, pathogenesis, diagnosis, and treatment, System-based infectious diseases: respiratory tract infections, including tuberculosis, pneumococcal pneumonia, seasonal influenza (H1N1 and related variants), COVID-19, and other acute viral respiratory infections; urinary tract infections; and gastrointestinal infections such as cholera, typhoid, and viral gastroenteritis, Antibiotics– mechanisms of action and application. Antibiotic resistance and challenges

Books Recommended:

1. Chess, B. (2018). *Foundations in microbiology* (10th ed.). McGraw-Hill Education.
2. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2017). *Prescott's microbiology* (10th ed.). McGraw-Hill Education.
3. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2020). *Medical microbiology* (9th ed.). Elsevier.
4. Ryan, K. J., & Ray, C. G. (2014). *Sherris medical microbiology* (6th ed.). McGraw-Hill Education.
5. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An introduction* (13th ed.). Pearson.
6. Goering, R., Dockrell, H. M., Zuckerman, M., Roitt, I., Chiodini, P., & Wakelin, D. (2019). *Mims' medical microbiology and immunology* (6th ed.). Elsevier.
7. Todd, P. W., & Tortora, G. J. (2003). *Essential microbiology*. Benjamin Cummings.

MCLBCES225: Endocrine system: Physiology and Disorders

Credits: 3
Max. Marks: 75

Course Learning Outcomes: By the end of the course, students will be able to-

CLO1: *Understand the basics of how endocrine hormones are regulated. Students will also learn about the pituitary hormones, including the effects of too much or too little hormone production.*
CLO2: *Learn about the structure, function, and hormone production of the thyroid, parathyroid, and adrenal glands. The course also covers thyroid problems like hypothyroidism and hyperthyroidism, as well as issues related to the parathyroid and adrenal glands.*
CLO3: *Study the function of pancreatic hormones, how insulin works in the body, and how insulin and glucagon affect metabolism, including their roles in managing carbohydrates and fats.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	2	3	3	2	2
CL02	3	3	3	3	3	3	2	3	3	2	2
CLO3	3	3	3	3	3	3	2	3	3	2	3
Average	3	3	3	3	3	3	2	3	3	2	2.3

Course Content:

UNIT I: Pituitary Gland: Physiology and Disorders

General characters and classification of hormones; Hypothalamus & pituitary gland; Structure, biosynthesis, secretion, transport metabolism, and function of the hormones secreted by pituitary gland, (control mechanism of hypothalamus and pituitary), Hypo- and hyper- secretion of hormones secreted by pituitary, Disorders – Cushing's disease and Cushing's syndrome, Acromegaly, gigantism and Diabetes insipidus

UNIT II: Physiology and Disorders of Thyroid and Adrenal Glands

Thyroid gland: Structure, biosynthesis and function. Hypo-& hyperthyroidism. Regulation of thyroid hormone synthesis. Parathyroid gland and disorders; Adrenal medulla- biosynthesis, metabolism, biological actions and regulation of Epinephrine and nor-epinephrine. Adrenal cortex- synthesis of adrenal cortical steroids, biological actions and transport of cortical steroids. Mechanism of action of adrenal steroid hormones. Disorders – Cretinism, myxedema, Goitre and Grave's disease

UNIT III: Pancreatic Hormones and Metabolic disorders

Pancreatic hormones: structure and biosynthesis of pancreatic hormones, organization of islet cells, synthesis, destruction and mechanism of action of insulin, effect of insulin on carbohydrate and lipid metabolism, Insulin signaling system, insulin deficiency, glucagon chemistry, metabolic effects of glucagon and somatostatin. Disorders – Diabetes Mellitus and Ketoacidosis

Books Recommended:

1. Longo, D. L., Fauci, A. S., Kasper, D. L., Hauser, S. L., Jameson, J. L., & Loscalzo, J. (2012). *Harrison's principles of internal medicine* (18th ed.). McGraw-Hill.
2. Karp, G. (2013). *Cell and molecular biology: Concepts and experiments* (7th ed.). John Wiley & Sons.
3. Martini, F. H. (2011). *Fundamentals of anatomy and physiology* (9th ed.). Prentice Hall.
4. Marshall, W. J., & Bangert, S. K. (2008). *Clinical biochemistry: Metabolic and clinical aspects* (3rd ed.). Elsevier Health Sciences.
5. Tietz, N. W. (1995). *Fundamentals of clinical chemistry* (5th ed.). W.B. Saunders.
6. Varley, H., Gowenlock, A. H., & Bell, M. (1980). *Practical clinical biochemistry* (5th ed., Vols. 1–2). CBS Publishers.
7. Zubay, G. (1998). *Biochemistry* (4th ed.). Wm. C. Brown Publishers.
8. Best, C. H., & Taylor, N. B. (1981). *The physiological basis of medical practice* (12th ed.). Williams & Wilkins.
9. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (1999). *Tietz textbook of clinical chemistry* (3rd ed.). W.B. Saunders.
10. Marshall, W. J., & Bangert, S. K. (1995). *Clinical biochemistry: Metabolic and clinical aspects* (2nd ed.). Pearson Professional Ltd.

MCLBCNS325: Neuromuscular and Skeletal Systems: Physiology and Diseases

Credits: 3
Max. Marks: 75

Course Learning outcomes: At the end of the course completion, the students should be able to –

CLO1: *Describe the structure and function of neurons and mechanisms of nerve impulse conduction and analyze the physiological basis and clinical manifestations of major neurological and psychiatric disorders.*

CLO2: *Describe the ultrastructure and functional characteristics of muscle tissues with the differences in their muscle contraction mechanism.*

CLO3: *Evaluate the structure, formation and growth of bones and joint physiology with an ability to interpret the pathophysiological mechanisms and clinical features of common skeletal system disorders*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	3	3	2	2
CL02	3	3	3	2	3	3	2	3	3	2	2
CLO3	3	3	3	2	3	3	2	3	3	2	2
Average	3	3	3	2	3	3	2	3	3	2	2

Course Content:

UNIT I: **Nervous System: Physiology and Disorders**

Nerve impulse transmission: Structure of neuron, mechanism of nerve impulse conduction along axon, Action Potential; Threshold action potential. Neurotransmitters; Excitory and Inhibitory neurotransmitters, Pre-synaptic and post-synaptic events of neuromuscular junctions, Structure of nervous system; CNS, peripheral nervous system. Disorders of neurotransmission: cholinergic and aminergic systems, Epilepsy, Huntington's disease, Multiple sclerosis**,** Spinal cerebral ataxia

UNIT II: Muscle Tissue: Structure, Function and Diseases

Muscular Tissue – types, functions and characteristic properties, Skeletal muscle tissue – Ultrastructure (connective tissue components, nervous and blood supply, microscopic anatomy and muscle proteins; Molecular mechanism of its contraction and relaxation – sliding filament theory and neuromuscular junction; Muscle metabolism and fatigue, basics of skeletal muscle tension; Smooth muscle - Ultra structure – microscopic anatomy, mechanism of its contraction and relaxation and their control; Mysthenia Gravis and Fibromyalgia - Pathophysiology, clinical features and laboratory findings

UNIT III: Skeletal system: Physiology and Disorders

Bone – functions, structure and histology of bone tissue, Blood and nerve supply of bone, Bone formation in fetus, childhood and adolescence, bone remodeling, factors affecting bone growth and remodeling, Bone turnover and biochemical markers of bone turnover, Role of bone in calcium homeostasis, Joints-Physiology, Types of Joints – fibrous, cartilage and synovial; Synovial fluid and its properties; Pathophysiology, clinical features and laboratory findings of Osteoporosis, osteoarthritis and Rheumatoid Arthritis

Books Recommended:

1. Martini, F. H. (2011). *Fundamentals of Anatomy and Physiology* (9th ed.). Prentice Hall.
2. Marshall, W. J., Bangert, S. K., & Lapsley, M. (2014). *Clinical Biochemistry: Metabolic and Clinical Aspects* (3rd ed.). Elsevier Health Sciences.
3. Tietz, N. W. (1999). *Fundamentals of Clinical Chemistry* (5th ed.). W. B. Saunders Company.
4. Varley, H., Gowenlock, A. H., & Bell, M. (1980). *Practical Clinical Biochemistry* (Vols. 1 & 2, 5th ed.). CBS Publishers & Distributors.
5. Zubay, G. (1998). *Biochemistry* (4th ed.). Wm. C. Brown Publishers.
6. Best, C. H., & Taylor, N. B. (1979). *The Physiological Basis of Medical Practice* (12th ed.). Williams & Wilkins.
7. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (1999). *Tietz Textbook of Clinical Chemistry* (3rd ed.). W. B. Saunders Company.
8. *Clinical biochemistry* – Metabolic and clinical aspects, Pearson Professional Ltd

MCLBCCI225: Clinical Immunology

Credits: 3
Max. Marks: 75

Course Learning outcomes: By the end of the course, students will be able to:

CLO1: *Understand the basics of the immune system, including how it works to protect the body through innate and adaptive immunity, the roles of different immune cells, and how antigens and antibodies interact.*

CLO2: *Learn about the structure and function of antibodies (immunoglobulins), how the body creates a variety of them, and how they can switch between different types.*

CLO3: *Gain a clear understanding of immune-related conditions like autoimmune diseases and allergies, as well as how the immune system responds to infections. The course also covers how the immune system affects organ and bone marrow transplants, including rejection and prevention treatments.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	3	3	2	3	2	2	2
CL02	3	3	3	2	3	3	2	3	2	2	2
CLO3	3	3	3	3	3	3	3	3	2	3	2
Average	3	3	3	2.3	3	3	2.3	3	2	2	2

Course Content:

UNIT I: Introduction to Immunology

Historical perspective, Innate and adaptive Immunity, Cells of immune system (Phagocytic cells, B & T lymphocytes, NK cells and dendritic cells). Humoral and cell mediated immune response. Antigenicity and Immunogenicity. Complement System, Major Histocompatibility Complexes. Antigen processing & presentation, Activation & differentiation of B & T cells.

UNIT II: Immunoglobulin: Structure and Function

Basic structure of immunoglobulins, sequencing studies of immunoglobulins (role of multiple myeloma), structural and functional properties of immunoglobulin classis (IgM, IgD, IgG, IgE, IgA), Antigen-antibody binding, antigenic determinants (isotypic, allotypic and idiotypic determinants), Class switching, clonal deletion, Allelic exclusion, Generation of antibody diversity, gene arrangement and expression of antibody gene.

UNIT III: Autoimmune disorders and Transplantation

Autoimmunity: Definition and its proposed induction mechanism - Organ specific and systemic, autoimmune diseases and their treatment, Hypersensitivity reactions, Immune response during bacterial (TB), Parasitic (malaria), & viral (HIV) infections. Basis of graft rejection - Autograft, isograft and xenograft, specificity and memory of rejection response, role of cell mediated response, transplantation antigens, mechanisms involved in graft rejection, clinical manifestation of graft rejection - hyperacute and chronic rejection, immunosuppressant therapies - General and specific

Books Recommended:

1. Paul, W. E. (Ed.). (2024). *Fundamental immunology* (8th ed.). Lippincott Williams & Wilkins. ISBN: 978-1-9751-4251-3
2. Kuby, J., Kindt, T. J., Osborne, B. A., & Goldsby, R. A. (2007). *Immunology: International edition* (6th ed.). W.H. Freeman and Company. ISBN: 978-0-7167-4947-9
3. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. (2007). *Immunology* (6th ed.). W.H. Freeman and Company. ISBN: 978-0-7167-4947-9
4. Roitt, I. M., Brostoff, J., & Male, D. (2012). *Immunology* (8th ed.). Elsevier Health Sciences. ISBN: 978-0-7020-5028-2
5. Virella, G. (1991). *Introduction to medical immunology*. Marcel Dekker. ISBN: 978-0-8247-8630-3
6. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2023). *Basic immunology: Functions and disorders of the immune system* (7th ed.). Elsevier. ISBN: 978-0-443-10519-7
7. Delves, P.J. et al. (2017). *Roitt's Essential Immunology* (13th ed.). Wiley-Blackwell.
8. Murphy, K. & Weaver, C. (2016). *Janeway's Immunobiology* (9th ed.). Garland Science.
9. Mak, T.W. & Saunders, M.E. (2016). *Primer to the Immune Response* (2nd ed.). Academic Cell.
10. Parham, P. (2021). *The Immune System* (5th ed.). Garland Science.
11. Rich, R.R. et al. (2019). *Clinical Immunology: Principles and Practice* (5th ed.). Elsevier.
12. Janeway, C.A. et al. (2016). *Immunobiology* (9th ed.). Garland Science.

MCLBCAM325: Advanced Molecular Diagnostics

Credits: 2
Max. Marks: 50

Course Learning Outcomes: By the end of the course, students will be able to-

CLO1: *Understand the basics of molecular diagnostics, its application in diseases like HIV, TB, and COVID-19, its comparison to traditional tests, and key ethical and quality considerations in molecular labs.*

CLO2: *Learn key lab techniques—PCR, real-time PCR, DNA chip technology, FISH, and next-generation sequencing—and their clinical applications in molecular diagnostics, including personalized medicine and rare genetic disorders.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	3	3	2	3	3
CL02	3	3	3	3	3	3	3	3	2	3	3
CL03	3	3	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	3	3	3	2	3	3

Course Content:

UNIT I: Molecular Diagnostics: Pathogen detection and Precision medicine

Role of molecular diagnostics in present diagnostic era, Benefits of molecular diagnostics over serological diagnostic tests, Ethical issues related to molecular diagnostics, Quality Assurance in the Molecular Diagnostics Laboratory, Basic techniques used in Molecular diagnostics of HIV, Tuberculosis, cholera, pathogenic *E. Coli and SARS-CoV-2,* Use of molecular diagnostics in Personalized medicine, Application of artificial intelligence in Molecular diagnostics – an introduction

UNIT II: Molecular Diagnostic techniques

Nucleic acid and hybridization: Assays – liquid phase, solid support and Dot-blot hybridization, Southern, northern and western hybridization; Clinical significance and practical application of PCR and its types; FISH and DNA chip technology: Nucleic acid sequence-based amplification, NextGen Sequencing-Principle, overview and application in clinical disorders as in rare genetic disorders, NGS based gene panel tests in Cancer Diagnostics

Books Recommended:

1. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2000). *Molecular cell biology* (4th ed.). W.H. Freeman.
2. Godkar, P. B., & Godkar, D. P. (2014). *Textbook of medical laboratory technology* (3rd ed.). Bhalani Publishing House.
3. Tietz, N. W. (1995). *Textbook of clinical biochemistry* (5th ed.). W.B. Saunders.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular biology of the cell* (4th ed.). Garland Science.
5. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2004). *Molecular biology of the gene* (5th ed.). Benjamin Cummings.
6. Wilson, J., & Hunt, T. (2014). *Molecular biology of the cell: The problems book* (6th ed.). Garland Science.

MCLBSLA325: Laboratory Animal Science: Management, Handling and Ethics

Credits: 2
Max. Marks: 75

Course Learning Outcomes: At the end of the course, the students are expected to-

CLO1: *Understand the basics of laboratory animal science, including the classification, behaviour, breeding techniques, and ethical considerations of using animals in research.*

CLO2: *Learn the proper methods for handling animals, administering drugs, performing surgical procedures, and collecting samples.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	2	3	3	2	1	3	3
CL02	3	3	3	2	2	3	3	3	2	3	3
Average	3	3	3	2	2	3	3	3	1.5	3	3

Course Content:

UNIT I: Principles of Laboratory Animal Management and Ethics

General introduction to laboratory animals. Animal Laboratory- Layout and Demonstration of the animal house facility, Classification and communication with laboratory animals, Normal and abnormal behaviour of the laboratory animals, Methods of safe handling of small animals, Breeding techniques of laboratory animals - Inbreeding and outbreeding, Record keeping and documentation of animal breeding, receipt, distribution of animals, feed and bedding, disposal etc. Animal ethics - Guidelines and regulations for use of animals in research and testing, IAEC - Operational procedures and guidelines

UNIT II: Laboratory Animal Techniques: Handling, Anesthesia, and Procedural Methods

Animal handling and restraining, Routes of drug administration. Sampling techniques, Necropsy procedures and euthanasia, Types of anaesthesia, Drugs used for anaesthesia in surgical operations. List of anaesthetic drugs- dose and its calculation; Handling different types of Laboratory animals- Preparation of beds, Methods of handling of laboratory animals safely and gender identification of different animals, Observing the normal and abnormal behaviour of the animals.

Books Recommended:

1. Bogdanske, J. J., Hubbard-Van Stelle, S., Riley, M. R., & Schiffman, B. (2008). *Laboratory rat procedural techniques*. CRC Press.
2. Attanasio, C., D'Angelo, L., & Corsi, L. (2021). *Practical handbook on the 3Rs in the context of the directive*. Springer.
3. Olsson, A. S., Robinson, P., Pritchett, K., & Sandøe, P. (2010). *Handbook of laboratory animal science* (3rd ed.). CRC Press.
4. Pandey, P., & Raza, W. (2019). *A textbook on laboratory animals: Ethics, guidelines and experimentation*. Discovery Publishing House.
5. *Institute for Laboratory Animal Research* (ILAR). (2011). Guide for the Care and Use of Laboratory Animals (8th ed.). National Academies Press.
6. Pritt, S. & Duffee, N. (2021). *Laboratory Animal Anaesthesia and Analgesia* (5th ed.). CABI
7. Hawk, C.T. & Leary, S.L. (2013). *Formulary for Laboratory Animals* (3rd ed.). Wiley-Blackwell.

MCLBCLC325: Lab Course - III

Credits: 4
Max. Marks: 100

Course Learning Outcome: *At the end of the Lab course, the students will be able to –*

CLO1: *perform sterilization and bacterial culture techniques and apply staining methods for microbial identification.*
CLO2: *carry out manual and automated techniques to evaluate blood parameters, clotting function, and inflammatory markers*
CLO3*: prepare tissue samples for microscopic examination and understand the principles of automated analyzers used in clinical diagnostics.*
CLO4: *isolate DNA, perform gene cloning and amplification, and demonstrate advanced PCR-based techniques used in molecular diagnostics*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	1	3	2	3	3	3	3	3
CL02	3	3	3	1	3	2	3	3	3	3	3
CLO3	3	3	3	1	3	2	3	3	3	3	3
CL04	3	3	3	1	3	2	3	3	3	3	3
Average	3	3	3	1	3	2	3	3	3	3	3

List of Practical:

i. Sterilization Methods
ii. Bacterial Culture Techniques (Solid and Liquid Media)
iii. Gram Staining for Microbial Identification
iv. Isolation of bacterial genomic and Plasmid DNA
v. Cloning and amplification of gene by PCR
vi. Demonstration of the Basic Principles and Operation of Automatic Analyzers
vii. Immunization and monitoring immune response by ELISA
viii. Estimation of T3, T4, and TSH by ELISA/RIA
ix. Separation of mononuclear cells by Ficoll-Hypaque.
x. Estimation of Na^{+}, K^{+} and Cl^{-} (Manual Method)
xi. Estimation of Antinuclear Antibodies (ANA) and C-Reactive Protein (CRP)
xii. Estimation of Ca^{++}, Mg^{++}, P and Fe^{+2}
xiii. Labelling of a sample cages used in the animal facility
xiv. Demonstration of anaesthetics in animal models for experimentation
xv. Blood sample collection methods and routes of drug administration
xvi. Basic surgical procedures for killing of experimental animals and their disposal
xvii. Collection and preservation of different tissues for histopathological study
xviii. Basic procedure for induction of Inflammation and Diabetes (Demonstration)

Books Recommended:

1. Sambrook, J. & Russell, D.W. (2012). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Press.
2. Cappuccino, J.G. & Welsh, C. (2021). *Microbiology: A Laboratory Manual* (12th ed.). Pearson.
3. Murphy, K. & Weaver, C. (2016). *Janeway's Immunobiology* (9th ed.). Garland Science.
4. Plummer, D. T. (1987). *Textbook of practical biochemistry* (3rd ed.). McGraw-Hill.
5. Varley, H. (1988). *Practical clinical biochemistry* (6th ed.). Heinemann Medical Books.
6. Godkar, P. B., & Godkar, D. P. (2014). *Textbook of medical laboratory technology* (3rd ed.). Bhalani Publishing House.
7. Boyer, R. (2000). *Modern experimental biochemistry* (3rd ed.). Benjamin Cummings.
8. Worthley, L. I. G. (1995). *Handbook of emergency laboratory tests*. Churchill Livingstone.
9. Worthley, L. I. G. (1995). *Emergency laboratory tests: A diagnostic guide*. Churchill Livingstone.
10. Jayaswal, R. P. (2019). *Clinical biochemistry: Student's laboratory manual* (1st ed.). Notion Press.
11. Bisswanger, H. (2014). *Practical enzymology* (3rd ed.). Wiley-VCH.
12. Bishop, M.L. et al. (2023). *Clinical Chemistry: Principles, Techniques, and Correlations* (9th ed.). Wolters Kluwer.
13. Kaplan, L.A. & Pesce, A.J. (2021). *Clinical Chemistry: Theory, Analysis, Correlation* (7th ed.).
14. Hau, J. & Schapiro, S.J. (2021). *Handbook of Laboratory Animal Science,* Vol. 1 (4th ed.). CRC Press.
15. Silverman, J. et al. (2021). *The IACUC Handbook* (4th ed.). CRC Press.
16. Bancroft, J.D. & Gamble, M. (2019). *Theory and Practice of Histological Techniques* (8th ed.). Elsevier.
17. Pritt, S. & Duffee, N. (2021). *Laboratory Animal Anaesthesia (5th ed.).* CABI.

SEMESTER IV

INTERNSHIP

The internship present a cross-over point of a student between university and career. The experience acquired during an internship shall influence the students decision & indicate how he/she should structure future studies, explore & decide their own career choice and focus thereon. Students are encouraged to carry their internship program preferably outside the parent department, wherein project work based on research and actual bench work under the guidance of their respective supervisor at the place of internship is carried out. The department facilitates the placement of the students for their internship at institutes of repute across the country. During the program the students are in close touch with their respective teachers in the department. The students are expected to put at least six working hours daily for a minimum period of six months.

Course Learning Outcomes: At the end of the internship, the students will be able-

CLO1: *To plan and conduct research projects in clinical biochemistry, applying theoretical knowledge to practical, real-world diagnostic and research scenarios.*

CLO2: *To analyze research data, identify patterns, and draw scientifically sound conclusions relevant to clinical biochemistry.*

CLO3: *To compile their research findings into a well-organized dissertation, effectively communicating the research process, methodologies, results, and implications of their work.*

CLO4:*To demonstrate professional communication and presentation skills while presenting the scientific data in future research work.*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	3	3	3	3	2	2	3	3
CL02	3	3	3	3	3	3	3	2	2	3	3
CLO3	3	3	3	3	3	3	3	2	2	3	3
CL04	3	3	3	3	3	3	3	2	2	3	3
Average	3	3	3	3	3	3	3	2	2	3	3

The different course components of the internship, with credits details, are as under:

MCLBIID425: Internship Dissertation **Credits: 12**
Max. Marks: 300

At the end of the internship, the completed project / internship work will be compiled by the student in the form of a dissertation, duly certified by the concerned supervisor and will be submitted by the student in the parent department in the form of a hard & soft copy to the department.

Based on the following parameters, the dissertation submitted by the student will be evaluated by the external examiner along with the departmental faculty members.

(i) **Structure and organization** – Includes proper format, coherent flow between different sections, clear heading and subheadings
(ii) **Abstract and Introduction** – Concise and informative abstract, introduction should provide background, rationale and research gap; well-defined research objectives or hypothesis
(iii) **Literature Review** – Comprehensive and up-to-date review of existing literature
(iv) **Methodology** – Clear and detailed description of experimental procedures, instruments used, ethical statements, if applicable
(v) **Results and presentation of Data** – Clear and reasonable presentation of experimental data, figures and tables of good quality with correct labelling, proper statistical analysis

(vi) **Discussion** – Interpretation of results with logical reasoning, comparison with earlier findings, identification of limitations and potential improvements, future perspectives
(vii) **Conclusion** - Concise summary of key findings, Suggestions for future research directions
(viii) **References** – Uniform reference formatting, inclusion of recent and relevant references
(ix) **Overall presentation and formatting** – font consistency, alignment of margins, proper numbering of pages, headings and subheadings, free from grammatical and typographical mistakes

MCLBIHI425: Host-Institute Grading **Credits: 2**
Max. Marks: 50

During the internship, the students will be critically evaluated by the supervisor of the host institute and will be graded by them based on the following assessment format:

Format of Evaluation for Host Institution Grading

Name of the student: **Roll No.:** **Name of Supervisor:** **Name of the Department:** **Name of Host Institute:**			
Project title:			
S. No.	**Evaluation parameter**	**Max. Marks**	**Marks Obtained**
1.	Experimental and data handling/analysis	20	
2.	Punctuality and Attendance	10	
3.	Communication and presentation skills	10	
4.	Research and problem solving ability	05	
5.	Team work	05	
Total		**50**	
Stamp & Signature of the supervisor			

MCLBIVP425: Viva-voce and Presentation **Credits: 4**
Max. Marks: 100

This includes an open presentation wherein the students defend their dissertation work in front of an external examiner (selected from the University-approved panel of examiners) and the departmental faculty members and other students/research scholars. The presentation is followed by viva-voce of the examinee by the external examiner along with the departmental committee members. The overall assessment is based on following parameters:

(i) **Clarity and organization of presentation** – logical flow of content, research objectives, well-structured slides with good visuals, without unnecessary and excessive text
(ii) **Presentation skills** – confidence and clarity in speech, proper time management, reasonable engagement with audience/expert
(iii) **Data presentation and analysis** – proper presentation of data, ability to explain the results along with their significance with logical reasoning and able to provide justification of evidence-based conclusions.
(iv) **Critical thinking and response to questions** – logical response to examiner's/faculty/audience's questions, ability of critical analysis of the research data generated, proper justification of experimental protocols.
(v) **Professionalism** – maintenance of professionalism during presentation, acknowledgement of contributions and references.

MCLBCAQ425: Automation, Quality Control and Lab Practices/MOOCS[**]

Credits: 2
Max. Marks: 50

Note: The students can either take the designated SEC course (Course code: **MCLBCAQ425)** or any other 2-credit MOOC course from approved online platforms[**]

Course Learning outcome: After the completion of the SEC course, the students will learn –

CLO1: *key concepts of laboratory automation, quality control processes, lab management and the importance of maintaining standards like NABL.*

CLO2: *best laboratory practices, focusing on safety protocols, patient preparation, blood collection, specimen handling, transportation, and the use of vacutainers, as well as the importance of Point of Care Testing in clinical environments*

Mapping of Course learning outcomes (CLOs) with Program Learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CL01	3	3	3	2	2	3	3	2	2	3	2
CL02	3	3	3	3	2	3	3	3	3	3	3
Average	3	3	3	2.5	2	3	3	2.5	2.5	3	2.5

Course Content:

Unit I: Automation and Quality Control

Automation – Historical overview, Laboratory information systems, Types of Automation, Individual steps in the analytical processes, Reagent/sample handling and storage, reagent delivery, Chemical reaction phase. Other areas of automation; urine analyzers, hematology cell counters, Quality Assurance & Management: Fundamentals of total quality management, elements of quality assurance program. External quality assessment - Identifying the source of analytical errors; Analytical procedures and quality control, Internal Quality control, QC charts, Quality council of India – NABL – National Board for testing and calibration Laboratories.

Unit II: Best Lab practices

Fundamentals of Lab Safety – PPE protocols, chemical/biological/sharps hazard management, waste disposal guidelines; Patient-centric blood collection - Patient preparation and Blood collection; Specimen integrity management – Specimen types, anticoagulants, prevention of Hemolysis, stability and storing thresholds, use of vacutainers and its advantages, transport of samples; Pre-analytical Error control - prevention of non-analytical errors, controllable and non-controllable variables and transport protocols, POCT – Advantages, limitations and some common POCT devices

Books Recommended:

1. Longo, D. L., Fauci, A. S., Kasper, D. L., Hauser, S. L., Jameson, J. L., & Loscalzo, J. (2012). *Harrison's principles of internal medicine* (18th ed.). McGraw-Hill.
2. Karp, G. (2013). *Cell and molecular biology: Concepts and experiments* (7th ed.). John Wiley & Sons.
3. McCall, R.E. & Tankersley, C.M. (2023). *Phlebotomy Essentials* (8th ed.). Wolters Kluwer.
4. World Health Organization (WHO). (2010). *WHO Guidelines on Drawing Blood: Best Practices in Phlebotomy*. WHO Press.

5. Marshall, W. J., & Bangert, S. K. (2008). *Clinical biochemistry: Metabolic and clinical aspects* (3rd ed.). Elsevier Health Sciences.
6. Lippi, G. & Plebani, M. (2022). *Preanalytical Phase in Laboratory Testing.* Academic Press.
7. Clinical and Laboratory Standards Institute (CLSI). (2022). *GP44-A6: Procedures for Collection of Diagnostic Blood Specimens*. CLSI
8. Varley, H., Gowenlock, A. H., & Bell, M. (1980). *Practical clinical biochemistry* (5th ed., Vols. 1–2). CBS Publishers.
9. Kost, G.J. (2021). *Principles & Practice of Point-of-Care Testing.* Lippincott Williams & Wilkins.
10. Furr, A.K. (2021). *CRC Handbook of Laboratory Safety* (6th ed.). CRC Press.
11. *National Accreditation Board for Testing and Calibration Laboratories* (NABL). (2023). NABL 112: Specific Criteria for Medical Laboratories. NABL India.
12. Hawker, C.D. (2023). *Automation and Artificial Intelligence in the Clinical Laboratory*. AACC Press

****Policy for MOOC Course Selection:**

i. The students can either take the designated SEC course (Course code: **MCLBCAQ425)** or any other 2-credit MOOC course from approved platforms (SWAYAM/NPTEL) of his/her own choice on the recommendation of the faculty/academic counsellor and the credits will be transferred.
ii. The available/suitable online courses (aligned with Clinical Biochemistry) shall be suggested to the students during the third semester and/or at the beginning of the 4th semester. The courses will be approved by the Departmental committee on the basis of their alignment with program learning outcomes of the department.
iii. The academic counsellor of the department shall be responsible to nominate a faculty as mentor for the student rolled in the recommended MOOCS course, who shall support the students for the successful and timely completion of MOOCS course.
iv. The academic counsellor shall ensure that the syllabus and examination pattern for the MOOCS course, chosen by the enrolled student, if any, should be approved by the departmental committee.
v. The respective details of enrolled student, along with the details of respective mentor, shall be communicated to the Controller Examination, University of Kashmir, within one month from the commencement of 4th semester.
vi. For any other requirements and formalities, if missed here, shall adhere to the statutes approved by University of Kashmir for NEP-2020 scheme.