

VIDYASAGAR UNIVERSITY



Post Graduate Syllabus
in
M.Sc. in MEDICAL LABORATORY TECHNOLOGY
(MMLT)
[w.e.f.: 2019-2020]

VIDYASAGAR UNIVERSITY

MISSION

The **Master of Medical Laboratory Technology (MMLT)** course is aimed at training students in the laboratory aspects of medical care with a good scientific foundation. These students will be in a position to competently assist in Clinical Biochemistry, Advance Pathology & Histopathology, Hematology & Blood Transfusion, Applied Microbiology Laboratories and Blood Bank procedures in all types of health care delivery systems along with the basic knowledge and advanced training in latest technologies in laboratories and blood bank, these graduates will play an important role in determining the quality of health care provided.

OBJECTIVES OF THE COURSE

As a nation we have gone ahead in many respects. But there are still areas, which demand attention, care and concern. The area identified by our think-tanks is "global standards in Paramedical education and training. This course will provide trained, qualified, technical personnel in the field of Paramedical Science to support the medical profession. The objectives of the Paramedical Science education programme is to ensure that educational opportunities for development of skills. Candidates, who completed Master of Medical Laboratory Technology (MMLT) course will be able to bring about an effective change in the laboratory practice and health care delivery system, establish collaborative relationship with members of other disciplines; demonstrate interest in continued learning and research for personal and professional advancement.

ELIGIBILITY FOR ADMISSION

1. The students who have passed B.Sc. MLT /BMLT/B.Sc. in Bio Medical Laboratory Science course from institutions affiliated to Vidyasagar University and any other UGC recognised university are eligible for this course.
2. Students completed their graduation with Honours in Zoology, Botany, Physiology, Microbiology, Biochemistry, Nutrition or any other related topic are eligible.
3. Students completed their graduation by 10+2+3 system in Bio Science general is also eligible to take admission in Master of Medical Laboratory Technology (MMLT) course.

JOB PROSPECTS

The Master of Medical Laboratory Technology (MMLT) may be assigned to a specialized area of work in a large medical lab. In small labs, they may perform a variety of tests or all areas of lab work. They can also work as laboratory manager/ consultant/ supervisor, health care administrator, hospital outreach coordinator, laboratory information system analyst/ consultant, educational consultant/ coordinator/ director, health and safety officer etc.

COURSE STRUCTURE
FOR
Master of Medical Laboratory Technology (MMLT)

FIRST SEMESTER

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int. Asst.	End Sem.	Total
1	MLT-101	Human Anatomy & Physiology	3	1		4	10	40	50
2	MLT-102	Haematology & Serology	3	1		4	10	40	50
3	MLT-103	Clinical Biochemistry	3	1		4	10	40	50
4	MLT-104	Advanced Medical Laboratory Techniques	3	1		4	10	40	50
Total Theory						16	200		
PRACTICAL									
5	MLT-195	Physiology & Haematology			4	4		50	50
6	MLT-196	Clinical Biochemistry, Serology & Immunology			4	4		50	50
Total Practical						8	100		
Total of Semester						24	300		

SECOND SEMESTER

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-201	Pathology	3	1		4	10	40	50
2	MLT-202	Diagnostic Molecular Biology & Epidemiology	3	1		4	10	40	50
3	MLT-203	Medical Microbiology	3	1		4	10	40	50
4	MLT-204	Laboratory TQM, Ethics, and Biosafety	3	1		4	10	40	50
Total Theory						16	200		
PRACTICAL									
5	MLT-295	Clinical Pathology			4	4		100	50
6	MLT-296	Microbiology & Molecular Biology			4	4		100	50
Total Practical						8	100		
Total of Semester						24	300		

THIRD SEMESTER

SPECIALITIES

A: CLINICAL BIOCHEMISTRY

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-301	Research Methodology & Biostatistics using Computer Software	3	1		4	10	40	50
2	MLT-302	Immunology	3	1		4	10	40	50
3	MLT-303A	Chemistry of Biomolecule & Clinical Biochemistry	3	1		4	10	40	50
4	MLT-304A	Enzymology and Metabolism	3	1		4	10	40	50
Total Theory						16	200		
PRACTICAL									
5	MLT-395A	Chemistry of Biomolecule & Clinical Biochemistry			4	4		50	50
6	MLT-396A	Enzymology & Molecular Biology			4	4		50	50
Total Practical						8	100		
Total of Semester						24	300		

SPECIALITIES

B: APPLIEDMICROBIOLOGY

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-301	Research Methodology & Biostatistics using Computer Software	3	1		4	10	40	50
2	MLT-302	Immunology	3	1		4	10	40	50
3	MLT-303B	Clinical Bacteriology & Mycology	3	1		4	10	40	50
4	MLT-304B	Clinical Virology & Parasitology	3	1		4	10	40	50
Total Theory						16	200		
PRACTICAL									
5	MLT-395B	Bacteriology & Mycology			4	4		50	50
6	MLT-396B	Virology & Parasitology			4	4		50	50
Total Practical						8	100		
Total of Semester						24	300		

SPECIALITIES

C: HAEMATOLOGY & BLOOD TRANSFUSION

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-301	Research Methodology & Biostatistics using Computer Software	3	1		4	10	40	50
2	MLT-302	Immunology	3	1		4	10	40	50
3	MLT-303C	Haemoglobinopathies - I	3	1		4	10	40	50
4	MLT-304C	Blood Bank Procedures	3	1		4	10	40	50
Total theory						16	200		
PRACTICAL									
5	MLT-395C	Haemoglobinopathies & Serology - I			4	4		50	50
6	MLT-396C	Blood Bank Procedures			4	4		50	50
Total Practical						8	100		
Total of Semester						24	300		

SPECIALITIES

D: ADVANCE PATHOLOGY & HISTOPATHOLOGY

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-301	Research Methodology & Biostatistics using Computer Software	3	1		4	10	40	50
2	MLT-302	Immunology	3	1		4	10	40	50
3	MLT-303D	Histopathology -I	3	1		4	10	40	50
4	MLT-304D	Cytology	3	1		4	10	40	50
Total Theory						16	200		
PRACTICAL									
5	MLT-395D	Histopathology			4	4		50	50
6	MLT-396D	Cytology			4	4		50	50
Total Practical						8	100		
Total of Semester						24	300		

FOURTH SEMESTER

SPECIALITIES

A: CLINICAL BIOCHEMISTRY

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-401	Forensic Science	3	1		4	10	40	50
2	MLT-402A	Diagnostic Biochemistry & Endocrinology	3	1		4	10	40	50
3	MLT-403A	Pharmaceutical Chemistry & Toxicology	3	1		4	10	40	50
Total Theory						12	150		
PRACTICAL									
4	MLT-494A	Diagnostic Biochemistry & Endocrinology			4	4		50	50
5	MLT-495	Research Project in Specialized Area			4	4		50	50
6	MLT-496	Grand Viva			4	4		50	50
Total Practical						12	150		
Total of Semester						24	300		

SPECIALITIES

B: APPLIED MICROBIOLOGY

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-401	Forensic Science	3	1		4	10	40	50
2	MLT-402B	Molecular Microbiology & Genetics	3	1		4	10	40	50
	MLT-403B	Diagnostics and Applied Microbiology	3	1		4	10	40	50
3									
Total Theory						12	150		
PRACTICAL									
4	MLT-494B	Molecular Microbiology			4	4		50	50
5	MLT-495	Research Project in Specialized Area			4	4		50	50
	MLT-496	Grand Viva			4	4		50	50
6									
Total Practical						12	150		
Total of Semester						24	300		

SPECIALITIES

C: HAEMATOLOGY & BLOOD TRANSFUSION

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-401	Forensic Science	3	1		4	10	50	50
2	MLT-402C	Advance Haematology & Immuno Haematology	3	1		4	10	50	50
3	MLT-403C	Haemoglobinopathies -II	3	1		4	10	50	50
Total Theory						12	150		
PRACTICAL									
4	MLT-494C	Haemoglobinopathies & Serology -II			4	4		50	50
5	MLT-495	Research Project in Specialized Area			4	4		50	50
6	MLT-496	Grand Viva			4	4			
Total Practical						12	150		
Total of Semester						24	300		

SPECIALITIES

D: ADVANCE PATHOLOGY & HISTOPATHOLOGY

SL. NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				MARKS		
THEORY			L	T	P	CREDITS	Int Asst.	End Sem	Total
1	MLT-401	Forensic Science	3	1		4	10	40	50
2	MLT-402D	Advance Pathology-I	3	1		4	10	40	50
3	MLT-403D	Advance Pathology-II	3	1		4	10	40	50
Total Theory						12	200		
PRACTICAL									
4	MLT- 494D	Advance Pathology			4	4			
5	MLT-495	Project Work in Specialized Area			4	4		50	50
6	MLT-496	Grand Viva			4	4		50	50
Total Practical						12	100		
Total of Semester						24	300		

INTERNSHIP FOR 6 MONTHS

INTERNSHIP WILL BE DONE IN A REPUTED PUBLIC OR PRIVATE PATHOLOGICAL LABORATORY OR RESEARCH CENTRE AFTER COMPLETION OF 4TH SEMESTER

HUMAN ANATOMY & PHYSIOLOGY

Code: MLT 101

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: To develop knowledge about the human physiology, cell structure and function gross anatomy, and physiology related to the skeletal, muscular and nervous systems to novel technical and/or clinical scenarios.

1. **Human Body an overview:** Directional and regional terms - Cavities and planes, Tissues: Structure, function and locations of epithelial, connective and nerve tissues, Basic of Surface and visceral anatomy.
2. **Skin:** Structure, function and body temperature regulation
3. **Skeletal System:** axial and appendicular skeleton functions, anatomy, histology, Structural and functional classification of joints and movements.
4. **Digestive System:** Gross anatomy, Innervations, gastrointestinal secretions a function
5. **Respiratory system:** Anatomy of respiratory organs and functions, mechanism and regulation of respiration, mechanism of O₂ and CO₂ gases transport, respiratory volumes and capacities.
6. **Circulatory system:** Components of circulatory system, Heart structure, Heart Sound, Circulatory routes (systemic, pulmonary, coronary and portal circulation) and Blood vessels; Blood pressure regulation; Lymphatic system: structure and function.
7. **Endocrine System:** Basic anatomy and physiology of the Pituitary, Thyroid, Parathyroid, Adrenals, Pancreas, Testes and ovary, their hormones, functions and disorders.
8. **Central nervous system:** Brain- structure, location and functions- Spinal Cord: Anatomy, functions, reflex- arc- meninges- Peripheral nervous system – Cranial and spinal nerves- Autonomic nervous system (Physiology and functions) - structure of neuron- synapse- transmission of nerve impulse
9. **Sense Organs:** Basic anatomy and physiology of eye, ear, taste buds, and olfactory sense organs
10. **Muscular system:** Types of muscles, Mechanism of muscle contraction. N-M Junction
11. **Excretory system:** Structure and function of nephron, GFR, Physiology of urine formation. Acid-Base balance
12. **Reproductive System:** Structure and function of testis, ovary and associated glands- Spermatogenesis and Ovulation- hormonal regulation of reproduction. Menstrual cycle and its hormonal regulation

Recommended readings:

1. Derrickson, B.H., 2011. Principles of Anatomy and Physiology, Harper Collins, New York.
2. Sarada, S. and M. Kuty, 1995. Textbook of Physiology, Orient Blackswan, Hyderabad.
3. Tortora, G.J. and Waugh, A. and Grant. A, 2010. Ross and Wilson Anatomy and physiology in health and illness, Elsevier, New Delhi.
4. Costanzo, L.S., 2007, Physiology, Williams and Wilkins, New York.
5. Guyton, A.C. and J.E. Hall, 2010. Textbook of Medical Physiology, Elsevier, New Delhi.
6. Johnson, L.R., 2003. Essential Medical Physiology, Elsevier, New Delhi.
7. Stanfield, C.L., and W.J. Germann, 2010. Principles of Human Physiology, Pearson/Benjamin Cummings, California.

HAEMATOLOGY AND SEROLOGY

Code: MLT 102

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students can correlate hematological findings with those generated in other areas of the clinical laboratory, patient symptoms and clinical history, make appropriate and effective on-the-job professional decisions. They also be able to introduce fundamental and important aspects of the various immunological and serological methods used in laboratory diagnosis of disease, with insight into the basic mechanisms and reactions involved in such methods.

A. HAEMATOLOGY

1. **Haematopoiesis:** Origin, development, function and fate of blood cells.
2. **Erythropoiesis:** Origin, development of RBCs, biosynthesis of Hb, control of Erythropoiesis.
3. **Disorder's of Red blood cells:** Anaemia, definition, Pathophysiology, classification -morphologic and Etiologic classification and clinical features. Investigations in a case of anaemia. Morphologic - Microcytic hypochromic anaemia, macrocytic anaemia. Haemolytic anaemias - Definition, classification, clinical features. Investigations to establish a case of haemolytic anaemia. Tests done –
 - i. Peripheral smear - specific morphologic abnormalities
 - ii. Osmotic fragility test
 - iii. Coomb's test
 - iv. Sickling phenomenon
 - v. Alkali denaturation test
4. **Disorders of White Blood Cells:** Leucocytosis, Leukopenia, Leukaemoid reaction, Myelodysplastic syndrome (MDS). Leukaemias -Definition, Etiology, Clinical features. Classification- [French American British-FAB classification] Lab Investigations Cytochemistry of Acute leukaemias, Chronic myeloid leukaemia -clinical presentation. Investigations. Philadelphia chromosome. Leucocyte Alkaline Phosphatase [LAP score.], Chronic lymphocytic leukaemia
5. **Plasma Cell Disorders:** Classification, Plasma cell myeloma – Definition, Clinical features, Investigations.
6. Special Haematological tests, significance and haemoglobinopathies

B: SEROLOGY: 1. Laboratory procedures in serology 2. Collection, preparation of specimen 3. Application of different types of ELISA 4. Different Serological screening and confirmative test for syphilis (STS). 5. WIDAL test for salmonellatyphi and CRP test, RA test, 6. Serological tests for Lupus erythematosus, helicobacter pylori, tuberculosis and dengue. 7. Serodiagnosis of streptococcal Antistreptolysis O (ASO) test, streptozyme test. 8. Different Serodiagnostic test for AIDS (HIV1 & HIV-2). Serodiagnostic test for Hepatitis 9. ToRCH Panel, Rubella, Toxoplasmosis, Trypanosomiosis, Leishmaniasis. 10. Intradermal hyper sensitively test, Montoux test, Toxoplasmin, Histoplasmin,

Recommended readings

1. Godkar, P.B. and D.B. Godkar, 2006. Medical Laboratory Technology, Bhalani, New Delhi.
2. Hoffman, R., E.J. Benz, S. J.Shattil, B. F. Harvey, J. Cohen, L. E. Silberstein and P. McGlave, 2005. Haematology-Basic principles and practice, Churchillivingstone, Philadelphia.
3. Manoharan, A. and S. Sethuraman, 2003. Essentials of Clinical haematology, Jaypee Brothers, New Delhi.
4. Richard, A., McPherson, M.R. Pincus, 2007. Clinical Diagnosis and management by Laboratory methods, Elsevier, New Delhi.
5. Sood, R., 2006. Medical Laboratory methods and Interpretation, Jaypee, New Delhi.
6. Hoffbrand, A.V. and P. Moses, 2011.Essential Haematology, John Wiley and Sons, Chicester.
7. Mukerjee, K.L. and S. Ghosh, 2010. Medical Laboratory Technology, Volume I, McGraw Hill, New Delhi.

CLINICAL BIOCHEMISTRY

Code: MLT 103

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The student will develop basic knowledge about the biomolecules, their structure and the bonds associated with them, enzyme kinetics and bioenergetics.

1. **Carbohydrate** – Definition, Source, Classification, Functions and Importance, Physiological importance of major type of carbohydrates.
2. **Protein** – Amino acids, Classification, Ramachandran plot, domain, folds and motifs of protein, Function and Importance of major type of proteins: Collagen, Myoglobin, Haemoglobin, Denaturation and renaturation of proteins structure.
3. **Lipids** - Function of major type of lipids. Saturated and Unsaturated type of fatty acids, Essential fatty acids and their importance. Phospholipids and their importance, Triacyl glycerol, Glycolipids, steroids, Eicosanoids, Plasma lipoprotein.
4. **Nucleic acid** – Structure and function of DNA & RNA. Nucleosides and Nucleotides, Genetic code, biologically important nucleotides, Quantification of nucleic acids, Thermal Denaturation
5. **Vitamins** – Fat-soluble and water-soluble vitamins, Daily requirements, Physiological functions and diseases of vitamin deficiency.
6. **Enzymes** – Definition, Classification, Mode of action, Factors affecting enzyme action, Chemical importance of enzyme, Enzyme kinetics, regulation of enzyme activity, activators and inhibitors.
7. **Isotopes** – Isotopes and their role in treatment and diagnosis of diseases.

Recommended readings

1. Chatterje, M.N. and R. Shinde, 2005. Textbook of Medical Biochemistry, Jaypee Brothers, New Delhi.
2. Davidson, S.S., J. MacLeod and C.R.W. Edwards, 1991. Principles and Practice of Medicine, Churchill Livingstone, United Kingdom.
3. Nelson, D.L. and M. M. Cox, 2008. Lehninger Principles of Biochemistry, WH Freeman and Company, New York.
4. Twyman, R.M. 1999, Advanced Molecular Biology, Bios Scientific, UK.
5. Voet, D., Voet, J.G. and C.W. Pratt, 2008. Fundamentals of Biochemistry, John Wiley and Sons, New Delhi.
6. Gaw, A., M.J. Murphy, R.A. Cowan, D.J. O'Reily, M.J. Stewart and J. Shepherd, 2008. Clinical Biochemistry, Elsevier,
7. Malacinski, G.M., 2005. Essentials of Molecular Biology, Jones and Barlett Publishers, New Delhi.

ADVANCED MEDICAL LABORATORY TECHNIQUES

Code: MLT 104

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will expose the modern technologies adopted for confirmation of diagnosis of by using molecular technologies

1. Different types of centrifugation, Ultracentrifugation, Density gradient centrifugation.
2. Sonication and its application.
3. Electrophoresis- Agarose and Poly acrylamide gel electrophoresis.
4. Northern, Southern, and Western Blotting.
5. HPLC technique, types, and application.
6. UV-VIS spectroscopy, IR spectroscopy, and NMR spectroscopy.
7. DNA sequencing method, Sanger sequencing.
8. Microscopy, types, Scanning Electron Microscope, Transmission Electron Microscope, application of Microscope.
9. PCR, RT-PCR, Application. TrueNAT, CBNAAT
10. ELISA reader and Auto-analyzer.
11. ECG, EEG, X-Ray, CT-Scan, MRI, Ultrasonography (USG)

Recommended readings

1. Methods in Molecular Biology: Amino Acid Analysis Protocols By Catherine Cooper, Nicolle Packer and Keith Williams. Publisher: Humana Press

2. Medical Biochemistry [Paperback] By John Van Pilsum. Publisher: University of Minnesota Press.
3. Clinical Biochemistry: Metabolic and Clinical Aspects [Paperback] By William J. Marshall and Stephen K. Bangert. Publisher: Churchill Livingstone.
4. Clinical Chemistry: Techniques, Principles, Correlations (Bishop, Clinical Chemistry) [Hardcover] By Michael L Bishop, Edward P Fody and Larry E Schoeff. Publisher: Lippincott Williams and Wilkins
5. Nucleic Acid Amplification Technologies: Application to Disease Diagnosis [Hardcover] By H Olsvik (Editor), S Morse (Editor), O Lee (Editor). Publisher: Eaton Publishing, USA.
6. Chromosomal Alterations: Methods, Results and Importance in Human Health [Hardcover] By Gunter Obe and Vijayalaxmi. Publisher: Springer
7. Handbook of Hematologic Pathology (Diagnostic Pathology) [Hardcover] By Harold R. Schumacher, Sanford A. Stass and William A. Rock. Publisher: Marcel Dekker Inc.
8. Molecular Diagnosis of Genetic Diseases (Methods in Molecular Medicine) (Methods in Molecular Biology) (v. 1) [Hardcover] By Rob Elles. Publisher: Humana Press.

PHYSIOLOGY AND HAEMATOLOGY LAB

Code: MLT 195

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: They will learn the microscope handling, routine blood test related laboratory examination which will help them to employ in any pathological laboratory.

1. Microscope handling, collection of blood, Blood Pressure, Pulse rate, Respiratory rate, hemocytometer, cell counter, Blood film preparation and it's staining (Leishman Giemsa method).
2. Haemoglobin estimation, Erythrocyte Sedimentation Rate, microhematocrit, macrohematocrit, red cell indices
3. Differential count, Total Red Blood cell count, Total White blood cell count, Platelet count, Eosinophilic count, Reticulocyte count
4. Osmotic fragility, Heinz body preparation, Sick cell preparation, Lupus erythematosus (LE) cell preparation, NESTROF.
5. Quantification of reticulocyte, thrombocyte and erythrocyte count.
6. Determination of Bleeding time and clotting time, Prothombin time (PT).
7. Screening test for sickle cell anaemia and slide identification of thalassemia.

Recommended readings

1. Hoffbrand, A.V. and P.Moses, 2011.Essential Haematology, John Wiley and Sons, Chicester.
2. Mukerjee, K.L. and S. Ghosh, 2010. Medical Laboratory Technology, Volume I, McGraw Hill, New Delhi.
3. Godkar, P.B. and D.B. Godkar, 2006. Medical Laboratory Technology, Bhalani, New Delhi.
4. Hoffman, R., E.J. Benz, S. J. Shattil, B. F. Harvey, J. Cohen, L. E. Silberstein and P. McGlave, 2005. Haematology-Basic principles and practice, Churchillivingstone, Philadelphia.
5. Manoharan, A. and S. Sethuraman, 2003. Essentials of Clinical haematology, Jaypee Brothers, New Delhi

CLINICAL BIOCHEMISTRY, SEROLOGY AND IMMUNOLOGY LAB

Code: MLT 196

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will learn the specimen handling, determine qualitative and quantitative estimation of biomolecules, perform enzyme assay, and common immunological and serological tests..

1. **Biochemistry Laboratory instruments:** (Photometry, Centrifuge, Water bath). Medical laboratory professional - professionalism in biochemistry laboratory. Calibration of pipettes and other volumetric apparatus. General approach to specimen collection, transport and disposal. Anticoagulants

2. **Biochemical Estimation:** Estimation of blood sugar, Glucose tolerance tests (GTT), Glycosylated haemoglobin (HbA1C). Lipid determination of serum lipids – cholesterol, triglycerides and lipoprotein fractionation
3. **Liver Function Tests:** Estimation of Total Protein, Albumin & A/G ratio, Estimation of Bilirubin – total and conjugated. Renal function test: Estimation of NPN substances a) Blood Urea, b) Serum Creatinine. c) Serum Uric acid
4. **Enzymes:** Determination of Alkaline Phosphates, Acid phosphates, SGOT, SGPT, salivary Amylase.
5. **Cardiac markers:** Creatinine phosphokinase, Lactate dehydrogenase (LDH). Inorganic ions – Determination of calcium in serum and urine, serum phosphates, chloride, sodium and potassium.
6. **Serological and Immunological test:** Precipitation, agglutination and coagulation- SRID - Ouchterlony Double diffusion - Immunoelectrophoresis - Estimation of IgG, IgA, IgM - RPR and titer estimation - WIDAL test and titer estimation - ASO test and titer estimation - RA test and CRP test and titer estimation - AIDS test and Hepatitis profile - TORCH panel - Dengue & Lupus erythematosus B - Helicobacter pylori and titer estimation - Mycobacterium tuberculosis - Montoux test.

Recommended readings

1. Lehninger Principles of Biochemistry. 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Chemistry of Biomolecules: an Introduction (Paperback) By Richard J. Simmonds. Publisher: Royal Society of Chemistry
3. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
4. Biochemistry By Lubert Stryer. WH Freeman and Co.
5. Biochemistry: The Molecular Basis of Life (Paperback) By Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
6. Biochemistry and Molecular biology By William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry (Hardcover) 3rd Ed. By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) By D Voet. John Wiley and Sons.
9. Richard, A., McPherson, M.R. Pincus, 2007. Clinical Diagnosis and management by Laboratory methods, Elsevier, New Delhi.
10. Sood, R., 2006. Medical Laboratory Methods and Interpretation, Jaypee, New Delhi.

SECOND SEMESTER

PATHOLOGY

Code: MLT 201

3L+1T=4

CREDIT: 4

FULL MARKS-50

Course Outcome: The student will be able to explain the basic nature of disease processes from the standpoint of causation, epidemiology, natural history, and the structural and functional abnormalities that result. The student will also be able to apply knowledge of pathology's role in the diagnosis, staging, and management of disease.

GENERAL PATHOLOGY

1. Aims and objectives of the study of pathology. Meaning of terms, etiology, pathogenesis and lesions
2. Causes of disease and cell injury – features of cell injury, mechanism of cell injury – hypoxia, free radical injury. Necrosis and gangrene
3. INFLAMMATION- definition, events of acute inflammation, chemical mediator of inflammation, morphological types of acute inflammation, chronic inflammation, difference between acute and chronic inflammation
4. REPAIR –primary healing, secondary healing, factors affecting healing and repair healing of skin, muscle and bone.
5. Fluid and hemodynamic derangements – oedema, hyperemia, Haemorrhage, shock, embolism, thrombosis, infarction
6. NEOPLASIA: characteristic of benign and malignant tumors, grading and staging of malignant tumors, a brief outline of the carcinogenic agents and methods of diagnosis of malignancy and general effects of malignancy on the host
7. Nutritional disorders: deficiency disorders (protein deficiency, vitamin deficiency (A, B, C, D, E) causes, features, a brief outline of the methods of diagnosis.

SYSTEMIC PATHOLOGY

A brief outline of etiology, pathogenesis and general features of disease of the following systems.
(The morphology, microscopic details and details of diagnostic procedures are not required).

1. **Blood Vessels:** Atherosclerosis, thromboangitisobliterance, varicose vein, DVT, thrombophlebitis, lymphoedema
2. **Disease of Heart:** Congestive cardiac failure, ischemic heart disease, rheumatic heart disease, infective heart disease (pericarditis, myocarditis, endocarditis)
3. **Respiratory System:** Pneumonias, Bronchiectasis, Emphysema, Chronic bronchitis, Asthma, Tuberculosis etc.
4. **Joints Disorders:** Arthritis- types and their features.
5. **Bone Disorders:** Osteoporosis, Paget's disease, Osteogenesis Imperfecta, Osteomyelitis, tumors– Osteosarcoma, Chondrosarcoma, Ewing's sarcoma, Multiple myeloma (a brief outline only)
6. **Muscles:** Muscular dystrophy, Myasthenia gravis
7. **Nervous System:** Meningitis, encephalitis, vascular diseases of brain, poliomyelitis, nerve injuries.

CLINICAL PATHOLOGY

1. Collection of urine and stool specimen, types of urine and stool specimen and preservation of urine and stool.
2. Routine examination of urine – physical and Microscopic examination.
3. Chemical test of urine for glucose, protein, Ketone bodies, bilirubin, urobilinogen & blood.
4. Laboratory investigation, Serous fluid and Gastric juice.
5. Collection and processing of CSF and its laboratory investigation.
6. Routine test for stool and occult blood test.
7. Examination of Sputum – routine and special test.
8. Semen Examination – routine and special test.
9. Various methods of detecting HCG level.

Recommended readings

1. Fischbach, F.T. and M. B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams and Wilkins, New York.
2. Godkar, P.B. and D.B. Godkar, 2006. Medical Laboratory Technology, Bhalani, New Delhi.
3. Henry, J.B., 2001. Clinical Diagnosis and Management by Laboratory Methods, W.B. Saunders, Pennsylvania.
4. Mundt, L.A., and K.S. Shanahan, 2011. Textbook of Urinalysis and Body Fluids, Williams and Wilkins, New York.
5. Ochei, J. and A. Kolhatkar, 2000. Medical Laboratory Science, Theory and Practice, McGraw Hill, New Delhi.
6. Mukerjee, K.L. and S. Ghosh, 2010. Medical Laboratory Technology, Volume II, McGraw Hill, New Delhi.

- Sood, R., 2006. Medical Laboratory methods and Interpretation, Jaypee, New Delhi.

DIAGNOSTIC MOLECULAR BIOLOGY & EPIDEMIOLOGY

Code: MLT 202

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will receive elaborate knowledge on central dogma, gene regulation and repair and cancer biology. They will gather knowledge on different molecular biology techniques which help them to better understand the hands-on-training of those techniques.

DIAGNOSTIC MOLECULAR BIOLOGY

- Central dogma:** Replication –Transcription – genetic code - Translation -Regulation of transcription and translation - Post transcriptional (capping, polyadenylation, splicing, intron and exons) and post translational modification. Ageing – malignant transformation of cells and role of oncogenes. Apoptosis -cell regeneration.
- DNA Repair:** DNA damage and repair: photoreactivation, excision – BER and NER, recombination. SOS repair, mismatch, Methyl-directed mismatch repair, very short patch repair, rDNA methylation, transposition
- Molecular diagnostics:** Recombinant DNA Technology, Polymerase chain reaction, application of PCR in diagnosis of pathogens - Site directed mutagenesis - DNA finger printing - DNA Foot Printing – antisense RNA technology - chromosomal walking – inherited genetic disorders in man and gene therapy.
- Cancer biology:** Molecular mechanism of Cancer, cancer markers, tumor markers, apoptosis markers, Immunohistochemistry, TUNEL study, ISEL study, Flowcytometry, Comet study.

EPIDEMIOLOGY

- Fundamentals of Epidemiology:** Tools of Epidemiology: measuring disease Frequency, (Prevalence, incidence, morbidity rates, attack rates etc.), Historical aspects of Epidemiology and evolution, Definition and understanding, Survey methodology including census procedures and Sampling
- Principles of Measurements:** Types of measures, Reliability, Validity, Accuracy, Questionnaire construction, Index construction and scaling, Observe variation, Diagnostic tests, Measurement issues,- Evaluating sources of data.

Recommended readings

- Gaw, A., M.J. Murphy, R.A. Cowan, D.J. O'Reilly, M.J. Stewart and J. Shepherd, 2008. Clinical Biochemistry, Elsevier,
- Malacinski, G.M., 2005. Essentials of Molecular Biology, Jones and Barlett Publishers, New Delhi.
- Chatterje, M.N. and R. Shinde, 2005. Textbook of Medical Biochemistry, Jaypee Brothers, New Delhi.
- Davidson, S.S., J. MacLeod and C.R.W. Edwards, 1991. Principles and Practice of Medicine, Churchill Livingstone, United Kingdom.
- Nelson, D.L. and M. M. Cox, 2008. Lehninger Principles of Biochemistry, WH Freeman and Company New York.
- Twyman, R.M. 1999, Advanced molecular Biology, Bios Scientific, UK.
- Voet, D., Voet, J.G. and C.W. Pratt, 2008. Fundamentals of Biochemistry, John Wiley and Sons, New Delhi

MEDICAL MICROBIOLOGY

Code: MLT 203

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: After learning this course, the students will develop knowledge regarding microbial world-basic physiology and cultivation. Moreover the target is conceptual development about the infectious agents, pathogenic microorganisms, and major infections.

1. Introduction

Definition and scope of Microbiology - History and recent developments, Kochpostulates. Structure of prokaryotes - structure and function of cell wall, plasma membrane, flagella, slime layer, capsule, pili, and sporulation.

2. Medical Bacteriology

Study of Staphylococcus, Neisseria, Listeria, Mycobacterium, Vibrios, Salmonella, Shigella, Escherichia, Klebsiella, Mycoplasma, Rickettsiae, and Spirochaetes.

3. Medical Virology

General Properties of viruses - Detection of viruses and antigens in clinical specimens. Study of Hepatitis, Rabies, Pox, Adeno, Rota and HIV Viruses, Oncogenic viruses, Viral vaccines and their preparation. Bacteriophages - their structure.

4. Medical Mycology

Morphology, Taxonomy, classification of fungi, detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. Yeasts of medical importance- Candida, Mycotoxins, Dimorphic fungi, Opportunistic fungi.

5. Medical parasitology

Introduction to medical Parasitology - Classification, Protozoa - Entamoeba - Plasmodium, Leishmania - Trypanosoma - Giardia Trichomonas - Balantidium. Platyhelminths -- Taenia - Fasciola - Paragonimus - Schistosoma. Nematohelminthes - Ascaris - Ankylostoma - Enterobius - Trichuris - Wuchereria - Dracunculus. Laboratory techniques in Parasitology. Examination of faeces for ova and cysts - Concentration methods. Blood smear examination for Parasites. Cultivation of Protozoan Parasites.

Recommended readings:

1. Alexopoulos, C.J and C. W. Mims, 1993. Introductory Mycology. Wiley Eastern Ltd, New Delhi.
2. Brooks, G.F., S. Morse, K.C. Carroll, J. Butel, 2010. Jawetz, Melnick, and Adelberg's Medical Microbiology, McGraw Hill, New Delhi.
3. Davis, B.D., R. DeBecco., H.N. Eisen and H.S. Ginsburg, 1990. Microbiology, Harper & Row, New. York
4. Dubey, R.C. and D.K. Maheswari, 2005. A text book of Microbiology, S. Chand, New Delhi.
5. Landecker, E.M., 1996. Fundamentals of the Fungi, Prentice Hall International, London.
6. Pelczar, M. J., E. C. S. Chan and N.R. Kreig, 2006. Microbiology, Tata McGraw Hill, New Delhi
7. Powar, C. B and H.F. Dagainawala, 2005. General Microbiology, Vol. I & II, Himalaya Publishing House, Mumbai.
8. Salle, A.J., 2001. Fundamentals & Principles of Bacteriology. McGraw-Hill, New Delhi.

Laboratory TQM, Ethics, and Biosafety

Code: MLT 204

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students acquire knowledge about the quality control of chemical, samples, and laboratory ethics and biosafety.

1. Quality control of product, chemical reagents, good reliable and authentic report, total quality management framework of laboratory.
2. Essential elements in quality assurance programme, internal quality control, control of preanalytical variable, laboratory precision, accuracy and sensitivity validation method.
3. Quality control chart, Cusum chart, Gaussian curve, Westgard rule
4. Internal and External factors for quality control
5. Co-operation and working relationship with other health professionals
6. Confidentiality of patient information and test result
7. Dignity and privacy of patient
8. Responsibility from acquisition of the specimen to the production of data
9. Institutional ethical committee and its role
10. Laboratory ethics of Bio-Safety.
11. Code of good and safe laboratory practice for support staff and responsibilities of the workers regarding Biosafety.
12. ISO rules for laboratory medicine.
13. Set up of a laboratory on the basis of safety priority and Laboratory Biosafety Guidelines.
14. Laboratory Biosafety Level Criteria (BSL-1-4).
15. Handling, transfer and shipment of specimen. Decontamination and disposal. Treatment and disposal technologies for health- care waste.
16. 16. Chemical, electrical, fire and radiation safety. Safety organization
17. General Safety checklist
18. Hazardous properties of instruments and Laboratory chemicals. Laboratory first-aid measures and kit.
19. Safety equipments. Safety signs.

Recommended readings

1. Nelson, D.L. and M. M. Cox, 2008. Lehninger Principles of Biochemistry, WH Freeman and Company New York.
2. Twyman, R.M. 1999, Advanced molecular Biology, Bios Scientific, UK.
3. Voet, D., Voet, J.G. and C.W. Pratt, 2008. Fundamentals of Biochemistry, John Wiley and Sons, New Delhi.
4. Albert B. Bray D and Lewis J Molecular biology of the cells, 2nd edition New York Garland Publications 1989.
5. Kirby L.T DNA fingerprinting; An introduction, New York, W.H. Freeman and Co.1992.
6. De Robertis, E.D.P., and De Robertis, E.M.F. Cell and Molecular Biology (6 Ed), W.B. Saunders College, Philadelphia. 1990.

CLINICAL PATHOLOGY LAB

Code: MLT 295

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will learn the common clinical pathology related experiments.

1. Physical examination of urine
2. Microscopic examination of urine sediment
3. Biochemical estimation of glucose in urine
4. Biochemical estimation of protein and ketone in urine
5. Biochemical estimation of bilirubin (Bile salt and boil pigment), urobilinogen in urine
6. Determination of Urinary hemosiderin
7. Laboratory testing of serous fluid

8. Laboratory testing of synovial fluid, gastric juice and pleural fluid
9. Routine examination of sputum
10. Routine test for stool and occult blood test.
11. Examination of pus from wounds, abscesses, burns and sinuses.
12. Examination of skin exudates from syphilis patient.

Recommended readings

1. Nelson, D.L. and M. M. Cox, 2008. Lehninger Principles of Biochemistry, WH Freeman and Company New York.
2. Twyman, R.M. 1999, Advanced molecular Biology, Bios Scientific, UK.
3. Voet, D., Voet, J.G. and C.W. Pratt, 2008. Fundamentals of Biochemistry, John Wiley and Sons, New Delhi.
4. Albert B. Bray D and Lewis J Molecular biology of the cells, 2nd edition New York Garland Publications 1989.
5. Kirby L.T DNA fingerprinting; An introduction, New York, W.H. Freeman and Co.1992.
6. De Robertis, E.D.P., and De Robertis, E.M.F. Cell and Molecular Biology (6 Ed), W.B. Saunders College, Philadelphia. 1990.

MICROBIOLOGY AND MOLECULAR BIOLOGY LAB

Code: MLT 296

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will gather knowledge on the basic instruments used in microbiological laboratories, bacterial culture, staining, bacterial identification, gel electrophoresis, and modern molecular biology experiments.

1. Demonstration of Autoclave and Hot air oven
2. Cleaning and decontamination of glassware and laboratory waste materials
3. Sterilization techniques
4. Preparation of different types of culture media
5. Cultivation of bacteria and fungi in laboratory
6. Staining of bacteria: Simple staining, Gram staining, and Negative staining.
7. IMViC test
8. Antibiotic sensitivity test of bacteria
9. Isolation of DNA from bacteria and blood sample
10. Agarose gel electrophoresis of DNA
11. Restriction digestion of lambda DNA using Eco R1 and Hind III
12. Polymerase Chain Reaction
13. SDS-PAGE analysis

Recommended readings

1. Cheesebrough, M., 2006. Medical laboratory Manual for tropical Countries, Volume 1 & 2, Cambridge University Press, Cambridge, UK.
2. Collee, J.G., T.J. Mackie, J.E. McCartney, 1996. Practical Medical Microbiology, Churchill Livingstone, USA
3. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.

THIRD SEMESTER

RESEARCH METHODOLOGY & BIOSTATISTICS USING COMPUTER SOFTWARES

Code: MLT 301

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The course will provide the basic understanding and application of statistics as a tool for testing hypothesis and experimental design for research studies. It will encompass the methodology and theory of statistics as applied to problems in the field of life sciences.

RESEARCH METHODOLOGY

1. **Research:** Meaning – Purpose- Types of research-significance of research in social and health sciences - Steps in Research: Identification - selection and formulation of research problem – types and review of literature - Research design- Formulation of hypothesis – preparation of questioner
2. **Sampling Technique:** Sampling theory-Types of sampling-Steps in sampling-Sampling and Non-sampling error-Sample size, Advantages and limitations of sampling.: Primary data: Meaning-Collection-methods- Observation–Interview-questionnaire-Schedule-Pretest-Pilot study –Experimental and case studies- Secondary data: Meaning – Relevance, limitations and cautions
3. **Processing Data:** Checking- Editing-Coding- transcriptions and Tabulation- Data analysis- Meaning and methods- Quantitative and Qualitative analysis. Structuring the Report: Chapter format - Presenting footnotes – abbreviations- bibliography - Documentation-Use and format of appendices- Indexing - Contents-Styles of reporting- Steps in drafting reports-Editing the final draft-Evaluating the final draft. Thesis writing – preparation of manuscript for scientific publications – impact factors

4. **Collection and representation of data:** Tabulation and diagrams – scatter diagram – histogram – bar diagram – frequency curve – frequency polygon – ogives – logarithmic curve – tridimensional graph – pie diagram
5. **Research Proposal:** Contents-Preamble, the problem, objectives, hypothesis to be tested, study, design, setup, measurement procedures, analysis of data, organization of report; Displaying data tables, graphs and charts – preparation of project proposal: Thrust area – funding agencies (National and International) – kinds of research program in India and abroad – career development in laboratory research – principle and method of patenting, Ethics with Plagiarism.

BIOSTATISTICS

1. **Introduction to Biostatistics:** Definition, role of statistics in health science and health care delivery system
2. **Sampling:** Population, sample, sampling, reasons for sampling, probability and non-probability sampling Methods of probability sampling-simple random, stratified, systematic-procedure, merits and demerits Use of random number table.
3. **Measures of location:** Arithmetic mean, median, mode, quartiles and percentiles - definition, computation (for raw data), merits, demerits and applications.
4. **Measures of variation:** Range, inter -quartile range, variance, standard deviation, coefficient of variation-definition, computation (for raw data), merits, demerits and applications
5. **Basic probability distributions and sampling distributions:** Concept of probability distribution. Normal, Poisson and Binomial distributions, parameters and application. Concept of sampling distributions. Standard error and confidence intervals [Skewness and kurtosis].
6. **Tests of significance:** Basic of testing of hypothesis - Null and alternate hypothesis, type I and type II errors, level of significance and power of the test, p value. Tests of significance (parametric) - t - test (paired and unpaired), Chi square test and test of proportion, one way analysis of variance (Anova).
7. **Correlation and Regression:** Scatter diagram, concept and properties of correlation coefficient, examples (No computation Simple correlation) Pearson's and spearman's, & Kendal's rank, Testing the significance of correlation coefficient. Linear and multiple regressions.
8. Biostatistics using computer software like Origin, SPSS, Statistica etc.

Recommended readings

1. Lwanga SK, Cho-Yook Tye (Editors). Teaching Health Statistics, Twenty lessons and seminar outlines, World Health Organization, Geneva
2. Mahajan BK, Methods in Biostatistics for medical students and research workers. 6th Edition, Jaypee Brothers medical Publishers, New Delhi, 1997.
3. Sundr Rao PSS and Richard J. Introduction of Biostatistics; A Manual for students in Health Sciences. Prentic-Hall of India Pvt. Ltd, New Delhi.
4. Bausell, R.B., Yu-Fang Li, Power Analysis for Experimental Research a Practical Guide for the Biological, Medical and Social Sciences, Cambridge University Press, Cambridge.
5. Kuehl, R.O., 2009. Design of Experiments: Statistical Principles of Research Design and Analysis, Belmont, California.
6. Wilcox, R.R., 2010. Fundamentals of Modern Statistical Methods, Springer, New York.

IMMUNOLOGY

Code: MLT 302
3L+1T=4
CREDIT: 4

FULL MARKS-50

Course Outcome: The student can understand the process of disease resistance, concept of immunity and various components & phenomena associated with immunity. They will also acquire knowledge on modern immunological techniques.

1. Immune components and their functions

General concepts of immune system, Innate and adaptive immunity; Structure, properties and functions of the immune cells & organs: T and B -lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophil's, and basophiles. Mast cells and dendritic cells, Thymus and Bone marrow; Lymph nodes, spleen, MALT, GALT and CALT, Toll-like receptors.

2. Chemical aspects of immunology

Antigens - properties (foreignness, molecular size, heterogeneity). Haptens. Antibodies - Structure, function and properties of the antibodies; Different classes and biological activities of antibodies; Antigenic determinants on antibodies (isotype, allotype and idiotype).Antigen-antibody interactions, Hybridoma technology, Monoclonal antibodies. Organization of MHC Structure and cellular distribution of HLA antigens. Components of the complement system, Biological consequence of complement activation and complement deficiencies.

3. Applied Immunology

Hypersensitivity - immediate and delayed type hypersensitivity reactions. Forms of Immunity – nonspecific and specific, Tumor immunology. Immunotherapy of infectious diseases; Types and principles of immunization; vaccinoprophyl axis, vaccinothrapy, serotherapy. Types of grafts, immunologic basis of graft rejection, properties and types of rejection, immunosuppressive therapy.

4. Autoimmunity and Immunodeficiency disorders

Mechanisms of induction of organ specific (Hashimoto's thyroiditis, autoimmune anemias, Good pasture's syndrome, IDDM), and systemic (myasthenia gravis, multiple sclerosis and rheumatoid arthritis) autoimmune diseases.

5. Immunological principles of various reactions and techniques:

Affinity and avidity cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, ELISPOT assay), western blotting, and immunofluorescence.

Recommended readings

20. Coico, R, G. SunShine, 2009. Immunology: A Short Course, John Wiley and Sons, New York.
21. Delves, P.J., S.J. Dennis, R. Burton, I. M. Roitt, 2011. Roitt's Essential Immunology, John Wiley and Sons, New York.
22. Kindt, T.J., R.A. Goldsby, B. A. Osborne, J. Kuby and W.H. Freeman, 2007. Immunology,
23. Peckman, M. and D. Vergain, 1997. Basic and Clinical Immunology, Churchill Livingstone, New York.
24. Playfair, J.H.L, 2001. Immunology at a Glance, Blackwell Scientific Publications, Oxford.
25. Stewart, S, 2001. Immunology, Immunopathology and Immunity, ASM Press Washington W H Freeman and California
26. Owen, J., J. Punt, S. Stranford, 2012. Kuby Immunology, WH Freeman, New York.
27. Paul, W.E., 2008. Fundamental Immunology, William and Wilkins, New York.

CHEMISTRY OF BIOMOLECULE AND CLINICAL BIO CHEMISTRY

Code: MLT 303A
3L+1T=4

FULL MARKS-50

CREDIT: 4

Course Outcome: The students will get knowledge on the chemistry of biomolecules and clinical biochemistry.

CHEMISTRY OF BIOMOLECULE

1. **Bio-membranes:** Chemistry, structure, Transport process across bio-membranes. nucleoproteins, genes, and Chromosomes.
2. **Chemistry of living things:** Structure of cell- animal, bacteria, and virus. Nucleus, organelle, cell-membrane- Structure and functions. Water-a medium for living things. Universal solvent, hydrogen bonds, colligative properties. Preparation of high quality water.
3. **Physical chemistry:** Viscosity, surface tension, osmosis, Donnan membrane equilibrium, dialysis, diffusion, adsorption, partition coefficient- Principles and biochemical applications.
4. **Methodology:** Photometry, spectrophotometry, Atomic absorption spectrophotometry, Chromatography, Biosensors, chemiluminescence, Homogenization, fractional distillation, solvent extraction, liophilization. General concepts regarding laboratory wares and its standardization. Quantities and units: SI units- their advantages and disadvantages
5. **Radioactivity:** radioisotopes, ionizing radiations, measurement of radioactivity, applications of radioisotopes in clinical biochemistry and research, Storage and disposal of radioactive materials.

CLINICAL BIOCHEMISTRY

6. **Automation in the clinical biochemistry:** Precision, reliability, reproducibility and other factors in quality control. Normal values in health and diseases, radio isotopes in diagnosis; Specimen collection and processing (blood, urine and faeces); Storage of specimens; Quality control; Pre-analytical, analytical post analytical variables in quality analysis.
7. **Inherited disorders of metabolism:** Newborn screening: PKU, tyrosinemia, aminoacidurias, organic acidurias, porphyrias. Biochemical monitoring of therapy; prenatal diagnosis of inborn errors of metabolism, amniotic fluid and fetal blood examination; Acetylcholinesterase and other tests on amniotic fluid; chromosomal abnormalities by cytogenetics
8. **Molecular diagnosis of genetic defects:** Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, Hemochromatosis, thalassemias, sickle cell diseases) DNA probes; restriction fragment length polymorphism (RFLP); polymerase chain reaction (PCR); amplification of mRNA. AIDS, Clinical diagnosis. Oncogenic enzymology: acid phosphatase, alkaline phosphatase, lactate dehydrogenase. Body fluid constituents of use in oncology.

Recommended readings

1. Lehninger Principles of Biochemistry 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Chemistry of Biomolecules: an Introduction (Paperback) By Richard J. Simmonds. Publisher: Royal Society of Chemistry
3. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
4. Biochemistry By Lubert Stryer. WH Freeman and Co.
5. Biochemistry: The Molecular Basis of Life (Paperback) By Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
6. Biochemistry and Molecular biology By William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry (Hardcover) 3rd Ed. By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) By D Voet. John Wiley and Sons.

BACTERIOLOGY AND MYCOLOGY

Code: MLT 303B

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will be benefitted by gathering knowledge microbial physiology, drug resistance, and epidemiology of different diseases.

1. Bacterial cell wall synthesis, Growth curve.
2. Culture media-types-preparation-uses.
3. Culturable and unculturable microbes, metagenomics approach.
4. Normal microflora in human body and their beneficial effect.
5. Epidemiology, symptomatology. General description of microbial pathogens, diagnosis, prevention and therapy of - meningitis, tuberculosis, leprosy, urinary tract infection, cholera, ring-worm, syphilis, diphtheria, mycotoxicosis, opportunistic fungal pathogens, and dermatophytes.
6. Toxin- types and effects.
7. Antibiotic resistant microbes – concept and mechanisms. Antibiotic sensitivity test.
8. Hospital acquired pathogens and their prevention.
9. Quorum sensing.

Recommended readings:

1. Alexopoulos, C.J and C. W. Mims, 1993. Introductory Mycology. Wiley Eastern Ltd, New Delhi.
2. Brooks, G.F., S. Morse, K.C. Carroll, J. Butel, 2010. Jawetz, Melnick, and Adelberg's Medical Microbiology, McGraw Hill, New Delhi.
3. Davis, B.D., R. DeBecco., H.N. Eisen and H.S. Ginsburg, 1990. Microbiology, Harper & Row, New York.
4. Dubey, R.C. and D.K. Maheswari, 2005. A text book of Microbiology, S. Chand, New Delhi.
5. Landecker, E.M., 1996. Fundamentals of the Fungi, Prentice Hall International, London.
6. Pelczar, M. J., E. C. S. Chan and N.R. Kreig, 2006. Microbiology, Tata McGraw Hill, New Delhi.
7. Powar, C. B and H.F. Dagainawala, 2005. General Microbiology, Vol. I & II, Himalaya Publishing House, Mumbai.
8. Salle, A.J., 2001. Fundamentals & Principles of Bacteriology. McGraw-Hill, New Delhi.

HAEMOGLOBINOPATHIES -I

Code: MLT 303C

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will learn blood related different complications and their laboratory diagnosis.

1. **Red cells** - Basic aspects of anaemia definition, pathophysiology, classification and clinical features. Investigation of a case of anaemia in general.
2. **Microcytic Hypochromic Anaemias** - Iron deficiency anaemia, Sideroblastic anaemia, Anaemia of chronic infection, Thalassemia, Iron deficiency anaemia - Iron metabolism, causes of iron deficiency, clinical features, laboratory investigations.
3. **Macrocytic Anaemias** - Megaloblastic anaemia - Etiology, clinical features, laboratory investigation. Pernicious anaemia.
4. **Normocytic Normochromic Anaemia** - Anaemia in systemic disorders, Acute blood loss, Renal failure, Liver disorders etc.
5. **Disorders of Haemoglobin** - Structure of Hb and Synthesis, Normal and Abnormal haemoglobins, Haemoglobinopathies
6. **Haemolytic Anaemia** - Definition, pathogenesis, classification, clinical features. Laboratory investigations to establish a case of haemolytic anaemia. Peripheral smear - specific morphologic abnormalities
7. **Special Tests for Anaemia**
 - a. Osmotic fragility test

- b. Sickling test
- c. Ham's test, Sucrose lysis test
- d. Electrophoresis and HPLC methods for HbF, HbA2 estimation, HLA Typing
- e. Tests for G6PD Deficiency,
- 8. **Aplastic anaemia:** Pancytopenia.
- 9. **Polycythaemia:** Classification, Clinical features, Laboratory investigation

Recommended readings:

- 1. Ramzi S. Cotran, Vinay Kumar and Tucker Collins: Robbins Pathologic Basis of Disease (6th Ed.) 2001, Harcourt India Private Ltd., New Delhi.
- 2. Harsh Mohan: Textbook of Pathology (4th Ed.) 2000, Jaypee Brothers Medical Publishers, New Delhi.
- 3. Walter and Israel: General Pathology
- 4. J. R. Anderson: Muir's Textbook of Pathology
- 5. John. D. Bancroft and Alan Stevens: Theory and Practice of Histological Techniques

HISTOPATHOLOGY

Code: MLT 303D

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: To

1. Introduction to histopathology

Definition, Morphology and physiology of cell, laboratory management and planning, sources and types histological specimens, kinds of histological presentations. Recording and labelling, fixation, properties of fixing fluids, classification and composition of fixing fluids. Advantages and disadvantages of secondary fixatives

2. Tissue processing

Processing of histological tissues, Tissue Processor - dehydration and cleaning. Embedding - Water soluble substances, embedding in paraffin nitrocellulose. Technique of processing bone for histological studies. Mounting - Techniques, various mountings. Decalcification of calcified tissue

3. Section Cutting

Equipment for sectioning: Microtome, knife, honing and stropping. Types, care and use of microtome. Techniques and principles of sections cutting – Frozen Section Techniques: Carbon Dioxide Freezing, Cryostat and freezing microtome. Technique for sectioning – Paraffin embedded tissue, Errors in sectioning and remedies. Attaching blocks to carriers

4. Stains & staining technique in histology: Staining – theory, types of staining agent. Preparation of haematoxyline & eosin, special stain preparation, Weigert's iron haematoxyline, trichrome stain, phosphotungstic acid haematoxyline technique (PTAH). Trichomestaining, papanocholou staining. Staining of bone and calcified tissue. Nissl body's Toudine blue, Staining of frozen section by PAS, Sudan –IV, Sudan block B stain, Oil red O stain. Ninhydrine-schif method for aminogroup, Millon reaction for tyrosine, Performic-Alcian Blue for disulphide linkage, Fecelgen nuclear reaction for DNA and Methyl green-Pyronin method for RNA

5. Immunohistochemistry

Immunohistotechnology and Immunofluorescence Histotechnology, Immunofluorescence Cytotechnology, Flow cytometry, Immunopathology of lymphomas, Cell fraction isolation, DNA, RNA quantification, Immunocytochemistry in pathology and Immunocytopathology of routine histopathology, Molecular pathology: In-situ hybridization and TUNEL study.

Recommended readings:

1. Godkar, P.B. and D.B. Godkar, 2006. Medical Laboratory Technology, Bhalani, New Delhi.
2. Ochei, J. and A. Kolhatkar, 2000. Medical Laboratory Science: Theory and Practice, McGraw-Hill, New Delhi.
3. Ross, M.H. and W. Pawlina, 2010. Histology: A Text and Atlas. Williams and Wilkins, New York.
4. Sarada, S. and M. Kuty, 1995. Textbook of Physiology, Orient Blackswan, Hyderabad.

ENZYMOLOGY & METABOLISM

Code: MLT 304A

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will learn metabolism related enzymes and their function, enzyme kinetics.

ENZYMOLOGY

1. Historical perspectives, General Characteristics, nomenclature and IUB enzyme classification (rational, overview and specific examples) introduction to the following terms with examples-Holoenzyme, apoenzyme, cofactors, co enzyme, prosthetic group, metallo enzyme measurement and expression of enzymatic activity, Enzyme assay activity units (I.U. and katal) Enzyme specificity types and theories (Lock and key, induced fit and three points attachment) Riboenzymes and Abzymes. Isolation and purification of enzyme, criteria of homogeneity of enzymes.
2. Factor affecting enzyme activity, enzyme concentration, substrate concentration, pH and temperature. Michaelis-Menten equation, K_{cat} / K_m and its importance, measurement of K_m and V_{max} , Lineweaver-Burk plot and other linear transformation. Enzyme inhibition, types of inhibition-competitive, non-competitive, uncompetitive.
3. Role of cofactor in enzyme catalysis $NAD^+/HADP$, FMN / FAD coenzyme A, TPP, PLP, Lipoic acid, Vitamin B_{12} and tetrahydrofolate. Factors contribute to enzymatic catalysis proximity and orientation, acid base catalysis, covalent catalysis mechanism of action of chymotrypsin and Lysozyme.
4. Control of enzyme activity, feedback inhibition, allosteric control with special reference to aspartate transcarboxylase. Sigmoidal kinetics, concerted and sequential model for action of allosteric enzyme. Reversible and irreversible modification of enzyme.
5. Protein legend interaction. Binding of protein to legend having single binding site and two binding site, cooperatively phenomena and Scattered plot. Clinical significance of CPK, CK MB, LDH, SGOT, SGPT, Cholinesterase amylase, lipase aldolase alkaline and acid phosphate. Control of enzymatic activity feedback inhibition.

METABOLISM

1. **Metabolism of Carbohydrates**-glycolysis-reactions, Metabolism of sugars other than glucose, fructose, galactose, and mannose- energetics and regulation (hormonal, allosteric, and feedback) Gluconeogenesis-reactions and regulation. Cori cycle, glyoxylate pathway, pentose phosphate pathway. Alternative oxidative pathway of glucose. Uronic acid pathway, phosphoketolase pathway.

2. **Metabolism of purine and pyrimidine nucleotides**-biosynthesis and catabolism-inter conversion - uric acid formation, regulation, Heme synthesis and degradation
3. **Hormonal regulation of metabolism**-Role of Insulin, glucagon, epinephrine-intracellular receptor and cell surface receptors signalling: Cyclic AMP-dependent protein kinase; Cyclic GMP-dependent protein kinase; Protein kinase C; Ca^{2+} -calmodulin-dependent protein kinases; AMP-dependent protein kinases. Receptor tyrosine kinases, Regulation of glycogen synthesis, degradation and glucose transport.
4. **Metabolomics**-Introduction to the origin of metabolomics, definition metabolite, metabolome, applications of metabolomics in toxicity assessment, toxicology.
5. **Lipid Metabolism**: Fatty acid oxidation- α , β , ω oxidation. Catabolism of unsaturated fatty acids, formation and utilization of ketone bodies.
6. **Fatty acid biosynthesis**: Regulation, Synthesis and breakdown of triacylglycerols-regulation. Phospholipids and glycolipid metabolism-glycerophospholipids, sphingolipids, sphingoglycolipids.
7. **Cholesterol metabolism**: Cholesterol biosynthesis and regulation. Transport of cholesterol-LDL receptor pathway. Cholesterol catabolism-Synthesis of bile acid. Lipoprotein metabolism-Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL. Arachidonic acid metabolism-leukotrienes and prostaglandins.
8. **Metabolism of proteins and amino acids**: Catabolism of proteins and individual amino acids-regulation.

Recommended readings:

1. Lehninger Principles of Biochemistry 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
3. Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
4. Bioenergetics By David G. Nicholls and Stuart J. Ferguson. Academic Press.
5. Bioenergetics at a Glance: An Illustrated Introduction (At a Glance) (Paperback) By D. A. Harris. Publisher: Wiley Blackwell
6. Bioenergetics: 0 (Paperback) By Lars Garby and Poul S. Larsen. Cambridge University Press.
7. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) By Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
8. Biochemistry (Hardcover) 3rd Ed. By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
9. Biochemistry of Lipids, Lipoproteins and Membranes (4th Ed.) D.E. Vance and J.E. Vance. Pub: Elsevier Science B.V
10. Medical Biochemistry 4th Ed. by NV Bhagavan. Pub: Elsevier India Pvt. Ltd.
11. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) By D Voet. John Wiley and Sons.

VIROLOGY & PARASITOLOGY

Code: MLT 304B
3L+1T=4
CREDIT: 4

FULL MARKS-50

Course Outcome: The students will learn the virology and parasitology related to human diseases and their diagnosis.

VIROLOGY

1. **General morphology and ultra-structure of Viruses:** Capsids- Helical Symmetry, icosahedral symmetry, and complex symmetry.
2. **Bacteriophages:** Classification, Morphology and ultrastructure, One step growth curve (Latent period, eclipse period and burst size). Lytic and lysogenic life cycle.
3. **Systematic Virology-** Parvo viruses, Papova virus, Herpes virus, orthomyxovirus, paramyxovirus, Rubella virus, Arbovirus, Rhabdovirus, Human enteric viruses, Prions, Virusoid.
4. **Life cycles of DNA viruses:** Herpes and SV40.
5. **Life cycle and other details of RNA viruses:** Retroviruses and HIV.
6. **Diagnostic virology-**
 - i. Laboratory diagnosis of viral infections.
 - ii. Collection, Preservation, transportation, Processing, and reporting of various clinical specimens for viral infections.
 - iii. Immune response to viral infections
 - iv. Epidemiology of viral infections, Antiviral agents
 - v. Viral infections in immunocompromised patients.

PARASITOLOGY

1. General Principles of host parasite interactions and definitions of terms in this connection
2. Morphology, life cycle and pathogenesis of the parasites listed below. The students should know the medical importance, laboratory diagnostic methods, drugs used for therapy and Epidemiology.
3. **PROTOZOA**
 - i. Intestinal amoebae.
 - ii. Free living pathogenic amoebae
 - iii. Intestinal and genital flagellates
 - iv. Haemoflagellates
 - v. Ciliates of medical importance
 - vi. Malarial parasite
4. **HELMINTHS**
 - i. Nematodes
 - a. Intestinal
 - b. Tissue
 - ii. Trematodes infection in man.
 - iii. Cestodes infecting man
 - iv. Larval infections in man.

Recommended readings:

1. Alexopoulos, C.J and C. W. Mims, 1993. Introductory Mycology. Wiley Eastern Ltd, New Delhi.
2. Brooks, G.F., S. Morse, K.C. Carroll, J. Butel, 2010. Jawetz, Melnick, and Adelberg's Medical Microbiology, McGraw Hill, New Delhi.
3. Davis, B.D., R. DeBecco., H.N. Eisen and H.S. Ginsburg, 1990. Microbiology, Harper & Row, New. York
4. Dubey, R.C. and D.K. Maheswari, 2005. A text book of Microbiology, S. Chand, New Delhi.
5. Landecker, E.M., 1996. Fundamentals of the Fungi, Prentice Hall International, London.
6. Pelczar, M. J., E. C. S. Chan and N.R. Kreig, 2006. Microbiology, Tata McGraw Hill, New Delhi
7. Powar, C. B and H.F. Dagainawala, 2005. General Microbiology, Vol. I & II, Himalaya Publishing House, Mumbai.
8. Salle, A.J., 2001. Fundamentals & Principles of Bacteriology. McGraw-Hill, New Delhi.

BLOOD BANK PROCEDURES

Code: MLT 304C
3L+1T=4
CREDIT: 4

FULL MARKS-50

Course Outcome: The students will gather knowledge on the theory of blood bank related laboratory experiments, blood transfusion, blood donation and storage which will further help in the absorption of the students in different laboratory.

1. **Blood Grouping**
 - a. Human Blood Group system, ABO Subgroups, Red Cell Antigen, Natural Antibodies
 - b. Rh System, Rh Antigens & Rh Antibodies
 - c. Haemolytic Disease of Newborn & Prevention
 - d. Principal of Blood grouping, antigen-antibody reaction.
 - e. Methods for ABO grouping. Slide & Tube Method, Cell grouping, Serum grouping, Rh grouping by slide & tube method.
 - f. Rouleaux formation, how it interfere with Blood grouping.
 - g. Antiserum used in ABO test procedures, Anti –A, Anti-B Anti- AB Antiserum.
 - h. Inheritance of the Blood groups.
 - i. Medical applications of Blood groups.
2. **Blood Transfusion**
 - a. Principal & Practice of blood Transfusion.
 - b. Guide lines for the use of Blood, Appropriate use of Blood, Quality Assurance.
 - c. Objectives of Quality Assurance in Blood Transfusion services
 - d. Operating procedures for usage, donation & storage of blood, screening of donor,
 - e. Compatibility testing and safety
3. **Blood Donation**
 - a. Blood donor requirements
 - b. Criteria for selection & rejection
 - c. Medical history & personal details
 - d. Self-exclusion.
 - e. Health checks before donating blood.
 - f. Screening for TTI.
4. **Blood Collection**
 - a. Blood collection packs.
 - b. Anticoagulants.
 - c. Techniques of collecting blood from a doctor.
 - d. Instructions given to the donor after blood donation.
5. **Testing Donor Blood**
 - a. Major and minor cross match
 - b. Screening donor's blood for infectious agents - HIV, HCV, HBV, Trepanoma
 - c. Palladium, Plasmodium, HTLV.
 - d. Bacterially contaminated Blood.
6. **Blood Donor Records**
 - a. Blood donation record book.
 - b. Recording results.
 - c. Blood donor card.
7. **Storage & Transport**

- a. Storage of blood.
- b. Changes in blood after storage.
- c. Gas refrigerator.
- d. Lay out of a blood bank refrigerator
- e. Transportation.
8. **Compatibility Testing**
 - a. Purpose
 - b. Single tube compatibility techniques using AHG reagent.
 - c. Emergency compatibility testing.
 - d. Difficulties in cross matching.
 - e. Labelling & Issuing cross- matched blood.
9. **Blood Components**
 - a. Collection of blood components for fractional transfusion.
 - b. Platelets packed Red Cell, Platelet rich Plasma, Platelets concentrate.
 - c. Preparation of concentrated (packed) Red cells.
 - d. Techniques of preparation.
10. **Blood Transfusion Reactions**
 - a. Investigation of a Transfusion reaction.
 - b. Haemolytic transfusion reaction.
 - c. Actions to take when transfusion reaction occurs.

Recommended readings:

1. Ramzi S. Cotran, Vinay Kumar and Tucker Collins: Robbins Pathologic Basis of Disease (6th Ed.) 2001, Harcourt India Private Ltd., New Delhi.
2. Harsh Mohan: Textbook of Pathology (4th Ed.) 2000, Jaypee Brothers Medical Publishers, New Delhi.
3. Walter and Israel: General Pathology
4. J. R. Anderson: Muir's Textbook of Pathology
5. John. D. Bancroft and Alan Stevens: Theory and Practice of Histological Techniques
6. Gradwohl's, 2000. Clinical Laboratory Methods and Diagnosis. (ed) Ales C. Sonnenwirth and Leonard jarret, M.D. B.I. Publications, New Delhi.
7. Richard, R, 1989. Clinical Laboratory Medicine, Medical Publi, Chicago.

CYTOLOGY

Code: MLT 304D

3L+1T=4

CREDIT: 4

FULL MARKS-50

Course Outcome: To

1. History, development and scope of cytology.
2. Cell structure, function, cell cycle, division with recent advances.
3. Cytology of epithelial and connective tissues.
4. Cytopathology Techniques.

- i. Fixation of Cytology specimens various fixatives, pre fixation, coating and spray fixation, advantages and disadvantages.
 - ii. Staining –Routine cytology stain Pap, MGG, H&E advantages and disadvantages.
 - iii. Collection, preparation of gynecological and non-gynecological specimens-exfoliative cytology. Gynecological –vaginal, cervical, endocervical, endometrialNon-gynecological –sputum, bronchial, Body fluids (serous effusions), CSF, urine.
 - iv. Concentration technique in cytology Centrifugation, cyto-centrifugation, membrane filters, cell blocks.
 - v. Liquid based cytology –monolayer preparation.
5. Hormone cytology.
 6. Cancer cytology
 7. Cervical cytology: Normal cells in cervical smear, Inflammatory lesions of the female genital tract –specific and nonspecific inflammation.
 8. Respiratory tract cytology sputum, bronchial materials.
 9. Urinary cytology –urine.
 10. Serous effusions.
 11. CSF.
 12. GIT.
 13. FNAC –Scope, advantages and disadvantages,
 14. Organization of cytology lab.
 15. Cytology laboratory safety.
 16. Quality control measures in cytology.
 17. Automation in cytology –Preparation, staining, Auto screening.

Recommended readings:

1. Cheesbrough, M, 2006, Medical Laboratory Manual for Tropical Countries Vol. I and II, Cambridge University Press; UK
2. Ochei, J. and A. Kolhatkar, 2000. Medical Laboratory Science, Theory and Practice, McGraw Hill, New Delhi.
3. Sood, R., 2006. Medical Laboratory methods and Interpretation, Jaypee, New Delhi.

CHEMISTRY OF BIO MOLECULE AND CLINICAL BIO CHEMISTRY LAB

Code: MLT 395A

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: To get hands on experience on different biochemical experiments related to blood

1. Estimation of blood glucose by Folin Wu Method, Ortho-Toluidine method & God-Pod method using Kit.
2. Estimation of Na⁺, K⁺, and Ca⁺⁺by flame photometer/ electrode analyser/ ELISA / Semi-auto analyser
3. Determination of blood urea (Oxime method) and by kit method.
4. Determination of blood cholesterol by colorimetric method and by kit method.
5. Determination of phospholipids, LDL, VLDL by using kit and, HDL
6. Estimation of T3, T4, TSH by ELISA method.

7. Determination of total protein in serum (Biuret method). Determination of serum albumin/globulin.

Recommended readings:

1. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.
2. Sonnenwirth, A. C. and L. Jarret, 2000. Gradwohl's Clinical laboratory methods and diagnosis. M.D.B.I..
3. De Robertis, E.D.P., and De Robertis, E.M.F., 1996. Cell and Molecular biology, B.I. Waverly Pvt. Ltd, Philadelphia.

BACTERIOLOGY AND MYCOLOGY LAB

Code: MLT 395B

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will learn the culture and identification of different bacteria and fungus.

1. Isolation, characterization and identification of pathogens from clinical samples.
2. Identification of *E. coli*, *P. aeruginosa*, *S. aureus*, *Salmonella* sp. by biochemical tests.
3. Staining of bacteria: Endospore and acid fast staining
4. Antibiotic sensitivity test. Determination of Minimum Inhibitory Concentration (MIC) and MBC of antibiotics.
5. Detection of methicillin resistant *Staphylococci*
6. Cultivation of *Escherichia coli* from urine sample and test the antibiotic sensitivity of the isolates.
7. Common serological tests for the diagnosis of bacterial infections.
8. Identification of pathogenic fungi *Aspergillus niger* and *Candida albicans*.

Recommended readings:

1. Cheesebrough, M., 2006. Medical laboratory Manual for tropical Countries, Volume 1 & 2 Cambridge University Press, Cambridge, UK.
2. Collee, J.G., T.J. Mackie, J.E. McCartney, 1996. Practical Medical Microbiology, Churchill Livingstone, USA
3. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.

HAEMOGLOBINOPATHIES AND SEROLOGY LAB

Code: MLT 395C

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will learn the anaemia related different laboratory experiments. They will also be able to understand the immunological reactions.

1. **Microcytic Hypochromic Anaemia:** Peripheral smear, B.M. Examination, Serum iron. Serum Total iron binding capacity [TIBC] Percent Saturation, Serum Ferritin B. M. Iron Stain.
2. **Macrocytic Anaemia:** Peripheral smear, B.M. Examination, Vit. B12 assay, Folate assay, Schilling Test.

- Haemolytic Work up, Peripheral smear, specific morphologic abnormalities
3. **Special tests:** Sickling test, Kleihauer acid elution test, Alkali denaturation test, Ham's test, Sucrose lysis test, Coomb's test, Electrophoresis - HbF, HbA2 Estimation, Tests for G-6PD deficiency
 4. **Serological tests:** Antibody measurement by Radial immuno-diffusion (RID) technique. Antigen-Antibody reaction testing by precipitating ring. Ouchterlony test. Quantitative assay of Immunoglobins in plasma (IgG and IgM)

Recommended readings:

1. Kanai L. Mukherjee, Medical Laboratory Technology Vol. I. Tata McGrawHill 1996, New Delhi.
2. Gradwohl, Clinical Laboratory-methods and diagnosis, Vol-I
3. Henry, Bernard, J., Sanford, T and Davidson, 2002. Clinical diagnosis and Management by laboratory methods. W. B. Saunders, New York.
4. Gradwohls, 2000. Clinical Laboratory Methods and Diagnosis. (ed) Ales C. Sonnenwirth and Leonard jarret, M.D. B.I. Publications, New Delhi.
5. Richard, R, 1989. Clinical Laboratory Medicine, Medical Publication, Chicago.

HISTOPATHOLOGY LAB

Code: MLT 395D

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: To

1. STAINING

- b. PAS (Periodacid – Schiff) Stain
- c. Argentaffin and argyrophil stains
- d. Amyloid stains
- e. Reticulin Stains
- f. Trichrome stains
- g. Posphotungstic acid hematoxylin stain (PTAH)
- h. Stains for hemosiderin, Melanin, and CA
- i. Stains for neural lipids
- j. Mucin stains
- k. Giemsa Stain
- l. Elastic stain
- m. Myelin stain
- n. Romanowsky stain

2. IMMUNOHISTOCHEMISTRY

- a. Immuno-histotechnology
- b. In-situ hybridization
- c. TUNEL study

3. PHOTOGRAPHY.

- a. Autoradiography
- b. Museum tech
- c. Specimen photography and microphotography

4. MICROSCOPY

- a. General Microscopy
- b. Dark ground microscopy
- c. Immunofluorescence

Recommended readings:

1. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.
2. Sonnenwirth, A. C. and L. Jarret, 2000. Gradwohls' Clinical laboratory methods and diagnosis. M.D.B.I., New Delhi.
3. Godkar, P.B. and B. Godkar, 2003. Medical Laboratory Technology, Bhalani Book Depot, New Delhi.

ENZYMOLOGY AND MOLECULAR BIOLOGY LAB

Code: MLT 396A

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will learn different instruments used in the pathological laboratory. They will also be able to know the enzymology and modern molecular biology techniques.

1. Laboratory instruments- (Photometry, Centrifuge, Water bath). Medical laboratory professional - professionalism in biochemistry laboratory. Calibration of pipettes and other volumetric apparatus. General approach to specimen collection, transport and disposal. Anticoagulants
2. Determination of K_m and V_{max} of enzyme.
3. Estimation of vitamin A, C, E from serum and metabolites of vitamins in urine.
4. Determination of SGOT, SGPT, serum ACP, ALP, LDH, amylase and CPK by using kits and biochemical methods
5. Analysis of hormones related to biological functions.
6. Quantitative estimation of DNA and RNA.
7. Isolation of DNA from blood sample and visualisation in Agarose Gel Electrophoresis.
8. Restriction digestion of DNA by using Eco RI and Hind III.
9. Protein profiling of blood sample by electrophoretic technique
10. Electrophoresis: Native, SDS-PAGE of blood sample.

Recommended readings:

1. Sonnenwirth, A. C. and L. Jarret, 2000. Gradwohls' Clinical laboratory methods and diagnosis. M.D.B.I.
2. De Robertis, E.D.P., and De Robertis, E.M.F., 1996. Cell and Molecular biology, B. Waverly Pvt. Ltd, Philadelphia.

VIROLOGY AND PARASITOLOGY LAB

Code: MLT 396B
4P=4
CREDIT: 4

FULL MARKS-50

Course Outcome: The students can learn to identify the virus and parasites by using ELISA or microscopic methods.

1. VIROLOGY

- a. Diagnostic tests in virology, Animal cell cultures, Media, sterilization, demonstration of cell line.
- b. Viral haemagglutination tests, hemagglutination inhibition tests.
- c. Assays of viruses: physical and chemical methods of assays (protein nucleic acid, radioactivity traces, electron microscopy, plaque method, end point method)
- d. Detection of Measles Virus by ELISA.
- e. Detection of Dengue Virus by ELISA.
- f. Detection of HIV by ELISA.
- g. PCR amplification for detection of virus.

2. PARASITOLOGY

- a. Collection, Presentation & Identification of different disease causing Arthropods (Housefly, Mosquito etc.)
- b. Whole mount preparation of slide of different disease causing arthropods for their detailed anatomical studies.
- c. Identification of different disease causing Helminth and Protozoan parasites.
- d. Identification of different phases of life cycle of arthropods protozoa, helminth, having medical importance for causing disease.
- e. Slide identification of microfilaria, Taeniasolium, ascaris, and deferent stages of malaria.
- f. Examination of stool for OPV (Ova parasite Cyst).

Recommended readings:

1. Cheesebrough, M., 2006. Medical laboratory Manual for tropical Countries, Volume 1 & 2 Cambridge University Press, Cambridge, UK.
2. Collee, J.G., T.J. Mackie, J.E. McCartney, 1996. Practical Medical Microbiology, Churchill Livingstone, USA
3. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.

BLOOD BANK PROCEDURES LAB

Code: MLT 396C
4P=4
CREDIT: 4

FULL MARKS-50

Course Outcome: The students will learn modern blood bank related experiments and also learn the sophisticated techniques to diagnose HIV, HCV, etc.

1. Reagent Preparation of Blood Bank.
2. Determination of Blood groups (forward grouping and reverse grouping)
3. Determination of cross matching by blood group testing techniques, Coomb's test (direct and indirect)
4. Fraction collection from Blood and its storage.
5. Pre-transfusion blood screening.
6. Widal for Typhoid and RPR (Rapid Plasma Regin) Inflammatory Disorders, General inflammatory marks and specific therapeutic bio indicators. CRP (C reactive protein), RA (Rheumatoid Arthritis), ASO (Anti-Streptolysin O)
7. Immunological test for pregnancy, Haemagglutination, Compliment fixation, Precipitation and Immuno-diffusion
8. Basic principles involved in Immunohematology as prior to blood transfusion, Blood collection procedure, Blood grouping (Slide method, tube method), Rh typing, Crossmatching (Major and Minor types), Separation of Blood components, Coombs test.
9. HbsAg, HCV, HIV (ELISA, Western Blot tests), TPHA (Treponema pallidum haemagglutination), malarial parasites.
10. Antiphospholipid Antibody -work up
11. Bone marrow examination - Preparation of B.M. Aspiration and Trepine biopsy smears staining
12. Organisation and quality control in the laboratory.

Recommended readings:

- a. Kanai L. Mukherjee, Medical Laboratory Technology Vol. I. Tata McGraw Hill 1996, New Delhi.
- b. Gradwohl, Clinical Laboratory-methods and diagnosis, Vol-I
- c. Henry., Bernard, J., Sanford, T and Davidson, 2002. Clinical diagnosis and Management by laboratory methods. W. B. Saunders, New York.
- d. Gradwohls, 2000. Clinical Laboratory Methods and Diagnosis. (eds.) Ales C. Sonnenwirth and Leonard Jarret, M.D. B.I. Publications, New Delhi.
- e. Richard, R, 1989. Clinical Laboratory Medicine, Medical Publication, Chicago.

CYTOLOGY LAB

Code: MLT 396D

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: To

1. Preparation of fixatives used in cytology
2. Papanicolaou staining, May GrunwaldGiemsa stain
3. Shorr staining
4. Processing and staining of various fluids for cytological examination
5. Examination of normal and inflammatory cervical smears.
6. Demonstration of normal cytology of respiratory tract, urinary tract, CSF, effusions.
7. Enzyme histochemistry and immunoenzyme techniques
8. Immunohistochemistry and the various immunohistochemical stains in the diagnosis of various-disorders
9. Tissues of special interest – nervous system, Hard tissue, Miscellaneous cells, Endocrine cells
10. Marker study: Cancer marker, Apoptotic marker, Tissue Necrosis marker..

Recommended readings:

1. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.
2. Sonnenwirth, A. C. and L. Jarret, 2000. Gradwohls' Clinical laboratory methods and diagnosis. M.D.B.I., New Delhi.
3. Godkar, P.B. and B. Godkar, 2003. Medical Laboratory Technology, Bhalani Book Depot, New Delhi.

FOURTH SEMESTER

FORENSIC SCIENCE

Code: MLT 401

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will learn forensic science including the uses of modern chromatographic and molecular biology experiments.

1. Forensic Pharmacology:

Pharmacology and its branches, Forensic Pharmacological studies, absorption, distribution, pharmacokinetic, metabolic pathways of common drugs and poisons, Drug toxicity, excretion of drugs and poisons, method of extraction, isolation, identification of metabolites. Metabolites of methanol and ethanol, acetyl salicylate, DDT, Parathion, carbaryl, phenobarbitone, diazepam, amphetamine and heroin metabolite identification by GC-MS and LC-MS.

2. Forensic Toxicology:

Introduction and scope of forensic toxicology. Different types of poisons commonly encountered. Different routes of ingestion, toxicity of poisons. Fate of drug in body. Samples in fatal and non- fatal cases. Packing and preservations of viscera. Extraction and screening of Ethyl alcohol. Determination of alcohol in field by breath analyser

3. Radioactive isotopes and compounds:

Introduction: Nuclear energy and radioactive sources of exposure and contact, acute and chronic effect on the organs of the body methods of detection and measurements handling and disposal of body and tissues containing radioactive material. Medico-legal interpretation

4. DNA Profiling:

Introduction, History of DNA Typing, human genetics- heredity, alleles, mutations and population genetics, molecular biology of DNA, variations, polymorphism, DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, Y- STR. Mitochondrial DNA, evaluation of results, frequency estimate calculations, interpretations, allele frequency determination, match probability- database, quality control, certification and accreditation.

5. Forensic Significance of DNA profiling:

Applications in disputed paternity cases, child swapping, missing person's identity- civil immigration, veterinary, wildlife and agriculture cases, The Combined DNA Index System (CODIS), legal perspectives- legal standards for admissibility of DNA profiling, procedural and ethical concerns, status of development of DNA profiling in India and abroad. New and future technologies: DNA chips, SNPs and limitations of DNA profiling.

Recommended readings:

1. Basu. R., 2004. Fundamentals of Forensic Medicine and Toxicology, Books and Allied, Kolkata.
2. Butler, J. M., 2005. Forensic DNA Typing: Biology, Technology and Genetics of STR Markers, Academic Press, New York.
3. Niesink, R.J.M., 1996. Toxicology - Principle and Application, CRC Press, New York.
4. Norah, R., 2002. An Introduction to Forensic DNA Analysis, CRC Lewis, New York.
5. Paul, T., 1998. Recent Advances in Pharmacology and Toxicology, Churchill Living Stone, London.
6. Sethi, P.D., 2005. Quantitative Analysis of Drugs in Pharmaceutical Formulations, CBS, New Delhi.

DIAGNOSTIC BIOCHEMISTRY AND ENDOCRINOLOGY**Code: MLT 402A****FULL MARKS-50****3L+1T=4****CREDIT: 4**

Course Outcome: The students will learn diagnostic biochemistry and endocrinology at cellular and molecular levels as well as about the disorders of endocrine system.

DIAGNOSTIC BIOCHEMISTRY

1. Liver diseases and diagnostic tests for liver diseases.
2. Pathophysiology of diabetes mellitus and related disorders, diagnostic tests for DM
3. Renal Diseases, tests for diagnosis of renal diseases
4. Pancreatic Function test
5. Intestinal function test
6. Gastric function test
7. Thyroid function test
8. Cardiac function test
9. Feto-Placental function test
10. Acid-base balance and diagnostic test for acid-base disorders
11. CSF analysis
12. Acute phase proteins:- Diagnosis and significance of C-reactive proteins, alpha fetoproteins,
13. ECLIA, Advance ECLIA and CMA technique.
14. Chromatography and HPLC system with application.
15. Pathophysiology of Cancer, Oncogenes, Tumor suppressor genes, Apoptosis. Tumor markers their biochemical and pathological significance, use in management of benign and malignant tumors. Anti-cancer drugs

ENDOCRINOLOGY

1. Techniques followed in hormones assay and different types of standard curve used in immunoassay.
2. Different types of ELISA and steps for antibody coating, enzyme conjugate preparation, second antibody preparation. Testing of hormone by ELISA.
3. Chemiluminescence's assay, Electrochemoluminance, Fluorescence Immunoassay (FIA).
4. Intra-assay and inter-assay co-efficient of hormones assay.
5. Different steps of RIA, Assay of hormone by RIA.
6. Endocrine glands. Information on pituitary- gonadal axis, feedback system, function, pathophysiology (male and female). Information on pituitary-thyroid axis, feedback system, function, goiter and goitrogens – its pathophysiology. Information on pituitary-adrenocortical axis feedback system: Pathophysiology. Information on pancreatic-hormones, regulation, function, disorders.
7. Dynamic Test on pituitary gonadal activities, thyroid activities, adrenal activities, pancreatic activities.
8. Hormonal disorders in diabetes mellitus- its types- symptoms, cause, management.
9. Diabetes insipidus- cause, symptoms and management.
10. Hypertension- Cause, symptoms and management. Obesity - Cause, symptoms and management.
11. Hypogonadism - Cause, symptoms and management. Sterility- Hypertension- Cause, symptoms and management.
12. Goiter - Cause, symptoms and management. Adrenocortical syndromes- Cause, symptoms and management. Growth hormone diseases.

Recommended readings:

1. Fundamental Immunology (Hardcover) By William E. Paul. Publisher: Lippincott Williams and Wilkins.
2. Immunology: International Edition (Paperback) By Janis Kuby, Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby. WH Freeman and Co. Ltd.
3. Immunology (Paperback) By Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne and Janis Kuby. WH Freeman and Co. Ltd.
4. Immunology (Paperback) By Ivan M. Roitt, Jonathan Brostoff and David Male. Publisher: Mosby.
5. Introduction to Medical Immunology By Gabriel Virella, Marcel Dekker Inc.
6. Roitt's Essential Immunology By Ivan M. Roitt and Peter J. Delves, Blackwell Publishing
7. Understanding Immunology (Cell and Molecular Biology in Action) (Paperback) By Peter Wood. Publisher: Prentice hall.
8. Basic Immunology: The Functions of the Immune System (Paperback) By Abul K. Abbas and Andrew H. Lichtman. Publisher: Saunders.

MOLECULAR MICROBIOLOGY & GENETICS

Code: MLT 402B

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students get knowledge central dogma, plasmids, and bioinformatics for applying them into laboratory.

1. Bacterial genome, plasmid, F plasmid, Hfr strains, R plasmid, bacteria in genetic engineering.
2. Conjugation
3. Transformation
4. Transduction- general & specialized
5. DNA replication, transcription and translation. Post transcriptional (capping, polyadenylation, splicing, intron and exons) and post translational modification.
6. Mutagenesis, mutations & mutants- biochemical basis of mutations, Genetic mechanism of drug resistance. Spontaneous & induced mutations, isolations of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants.
7. Regulation & expression of gene activity lac Operons and trp Operons.
8. Viral genome, types and their symmetry.
9. Basic idea of Bioinformatics, databases, BLAST, Types of BLAST, FASTA
10. Data retrieval tools
11. Prediction of function of unknown genes.

Recommended readings:

1. Medical Microbiology, David green Wood, Slack Pentherer
2. Mackie & Macartney practical medical Microbiology - Colle. Fraser, Marmion, Simmons
3. Text Book of Microbiology: Ananthanarayanan & Jayaram Paniker
4. Medical Laboratory Manual for Tropical Countries Vol-2 Monica Cheesbrough.
5. De Robertis, E.D.P., and De Robertis, E.M.F., 1996. Cell and Molecular biology, B.I. Waverly Pvt. Ltd, Philadelphia.

ADVANCE HAEMATOLOGY & IMMUNO HAEMATOLOGY

Code: MLT 402C

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will get knowledge advance haematology & immuno haematology.

1. Coagulation disorders and basics of their work up
2. Thrombotic disorders and basics of testing

3. Automated cell counters and coagulation analysers – principles
4. Manual Haemoglobin and Counts
5. Peripheral smear –Preparation and Interpretation
6. Manual tests of coagulation, factor assays
7. Basic Genetics and immunology
8. ABO and Rh blood group systems
9. Other major blood group systems – clinical significance
10. Compatibility testing, clinical significance
11. Donor Screening
12. Blood bags, Anticoagulant and preservative solutions
13. Blood Components – preparation, Quality control
14. Apheresis
15. Infectious disease screening
16. Transfusion reactions, Haemolytic Disease of the New born
17. Choice of blood in specific clinical scenarios – HDN, Multiply transfused etc.
18. Basics of HLA typing and anti HLA antibody detection.

Recommended readings:

1. Kanai L. Mukherjee, Medical Laboratory Technology Vol. I. Tata McGrawHill 1996, New Delhi.
2. Henry, Bernard, J., Sanford, T and Davidson, 2002. Clinical diagnosis and Management by laboratory methods, W.B. Saunders, New York.
3. Gradwohl, Vol-I, 2000. Clinical Laboratory Methods and Diagnosis. (ed) Ales C. Sonnenwirth and Leonard jarret, M.D. B.I. Publications, New Delhi.
4. Richard, R, 1989. Clinical Laboratory Medicine, Medical Publication, Chicago.

ADVANCE PATHOLOGY I

Code: MLT 402D

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The student will be able to apply knowledge of pathology's role in the diagnosis, staging, and management of disease

1. URINE

- a. Microscopical examination of urine, collection of urine and its preservation, Colour, cloudiness, specific gravity, reaction, pH
- b. Different methods for detection, importance and its interpretation of –Protein, Sugar, Bile pigment, Bile salt, Urobilinogen, ketone bodies, Bence - Johnes proteins & Blood
- c. Examination and identification of sediment for: various cells, crystals, casts, parasites
- d. Concentration methods for examination identification of urine sediment for: Gonococci, Trichomonas vaginalis, monilia.
- e. Pregnancy test-Production of HCG, HCG level at various stages of pregnancy, pregnancy test, Different types of pregnancy test such as Gravindex test & card test. Method of urine collection, Compare their advantage, disadvantages & accuracy.

2. FAECES

- a. Examination of motion sample for: colour, mucous, consistency, ova, Amoeba, cyst, Parasites, Pus cells, RBCs & crystals.

- b. Detection of occult blood in stool, measurement of faecal urobilinogen & faecal fat, their importance interpretations.
3. **SPUTUM**
 - a. Method for the collection, examination of sputum for AFB, sputum in disease conditions.
4. **SEMEN**
 - a. Methods of collection, Macroscopic and microscopic examination of semen, Motility, count, other findings.
 - b. Staining and morphological studies of spermatozoa, importance & interpretation in each step of investigation in case of infertility.
5. **CSF**
 - a. Collection, transport, preservation, examination and interpretation total and differential count, staining methods, CSF in disease.
6. **OTHER BODY FLUIDS**
 - a. Examination of Pleural fluid, pericardial fluid, Synovial fluid

Recommended readings:

1. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.
2. Sonnenwirth, A. C. and L. Jarret, 2000. Gradwohl's Clinical laboratory methods and diagnosis. M.D.B.I., New Delhi.
3. Godkar, P.B. and B. Godkar, 2003. Medical Laboratory Technology, Bhalani Book Depot, New Delhi.
4. Marks, V., T. Cantor, D. Mesko, R. Pullman and G. Nosalova, 2003. Differential Diagnosis in Lab Medicine, Springer, India.
5. Ochei, J. and A. Kolhatkar, 2000. Medical Laboratory Science, Theory and Practice, McGraw Hill, New Delhi.
6. WHO laboratory manual for the processing of human semen, 2010, Geneva.

PHARMACEUTICAL CHEMISTRY AND TOXICOLOGY

Code: MLT 403A

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will learn pharmaceutical chemistry, drug designing, and their toxicological studies.

PHARMACEUTICAL CHEMISTRY & TOXICOLOGY

1. **Drug:** Classification and nomenclature, some medicinally important inorganic and organic compounds and (any four with structure) and their biological role. Chemical structure and pharmacological activity: effects of some functional group- unsaturation, chain length, isomerism, halogens, amino group, nitro and nitrite compounds, nitrite acidic groups, aldehyde and ketone group, hydroxyl group, alkyls. etc. Pharmaceutical aids: organic pharmaceutical aids preservatives, stabilizing and suspending agents, ointment bases and related agents and solvents.
2. **Drug designing and screening:** Physiological properties evolved in the design and preparation of dosage forms-hydrogen ions concentration, pH and buffers-colloidal state, membrane phenomena, osmosis, adsorption, surface tension, viscosity, ionization constants, chelation-importance of chelation in medicine, design of antibacterial and antifungal agents. Biological testing of drugs: testing drugs in-vitro enzyme inhibition, receptor studies, safety and efficacy, microbiological testing, screening and testing by NMR, testing

drugs in vivo: test systems drug potency, therapeutic ratio. Use of cell lines and animal models. Placebo controlled studies. Safety evaluations, followed by efficacy studies.

3. **Pharmacokinetic analysis:** Bioavailability of drugs-role of bioenhancers. Entry routes for drugs, factors that affect drug distribution, drug metabolism, renal excretion of drug. Drug clearance: renal clearance, plasma clearance. Drug absorption and elimination.
4. **Fundamentals of Toxicology and dose-Response Relationships:** Introduction Biomarkers Criteria of Toxicity New Technologies Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response Hormesis; Hazard and Risk Assessment Duration and Frequency of Exposure and Effect
5. **Toxicity testing:** Test protocol, Genetic toxicity testing & Mutagenesis assay: *In vitro* test systems: bacterial mutation tests-Reversion test, Ames test, Fluctuation test, and Eukaryotic mutation test. *In vivo* test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules & genotoxicity, Tissue specific toxicity
6. **Toxic Responses to Foreign Compounds:** Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, physiological and Biochemical effects, Developmental Toxicology-Teratogenesis, Immunotoxicity Genetic Toxicity, Chemical Carcinogenesis.
7. **Toxicology Analysis:** Action, detection and quantification of common drugs in therapy and toxic agents. Digoxin, lithium, salicylates, paracetamol, barbiturates, alcohol, morphine derivatives, amphetamines, lead, iron, mercury, carbon monoxide, organophosphates, carbamates and cyanide.

Recommended readings

1. Niesink, R.J.M., 1996. Toxicology - Principle and Application, CRC Press, New York.
2. Norah, R., 2002. An Introduction to Forensic DNA Analysis, CRC Lewis, New York.
3. Paul, T., 1998. Recent Advances in Pharmacology and Toxicology, Churchill Living Stone, London.
4. Sethi, P.D., 2005. Quantitative Analysis of Drugs in Pharmaceutical Formulations, CBS, New Delhi.

DIAGNOSTICS AND APPLIED MICROBIOLOGY

Code: MLT 403B

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will get knowledge about the hospital infection and molecular diagnosis methods.

1. **NOSOCOMIAL INFECTIONS**
 - a. Epidemiological aspects of control infections and diseases
 - b. Typing methods in Bacteriology
 - c. Hospital acquired infections
 - d. Surgical and trauma related infections
 - e. Microbial bio – film -prevention, control and removal
 - f. Emerging infectious diseases
2. **PUBLIC HEALTH MICROBIOLOGY**
 - a. Microbiology of air
 - b. Bacteriology of water
 - c. Microbiology of milk and milk products
 - d. Milk born infections
 - e. Bacteriology of food and food borne diseases

- f. Vaccines for infectious diseases
- g. Molecular diagnostic methods in microbiology
- h. Automation in diagnostic microbiology
- i. Genetically modified microorganisms

3. MOLECULAR DIAGNOSTIC METHODS

Molecular diagnostic techniques relevant to medical microbiology. PCR and its modifications including nested PCR, Multiplex PCR. Special emphasis to Real-time PCR. Principles of recombinant DNA technology.

Clinical diagnosis serological techniques for identification of bacteria: TMV Bacteriophages. HIV. SV 40, Orthomyxo & Paramyxovirus.

Recommended readings:

1. Monica Cheesebrough, 1987. Medical Laboratory Manual for Tropical Countries, Vol 1 & 2, Butterworth.
2. Collect, J.C., Duguid, J.P., Fraser, A.C., Marimon. B.P., Mackie and McCartney, 1996. Practical Medical Microbiology, Churchill Livingstone, U.S.A.
3. Gunesekaran, P, 1996. Laboratory Manual in Microbiology, New Age international, India.
4. Fischbach, F.T., Dunning, M.B, 2002. A Manual of Laboratory and Diagnostic Tests. Lippincott Williams and Wilkins, Baltimore.

HAEMOGLOBINOPATHIES II

Code: MLT 403C

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will learn the blood components related disorders and their laboratory investigations.

1. **Leucocyte disorders:** Leukaemoid reaction - type of leukaemoid and diagnosis. Myelodysplastic syndrome [MDS] Definition, Clinical features, peripheral smear and Bone marrow findings.
2. **Leukaemias:** Definition, classification -French- American-British [FAB], WHO- classification of acute leukaemias, Diagnostic criteria, Cytochemical staining and Immunophenotyping, Chronic Leukaemias; classification, Diagnostic criteria.
3. **Myeloproliferative disorders** - classification, Clinical features, and laboratory investigations. Chronic myeloid leukaemia in detail.
4. **Lymphoproliferative disorders** - Chronic lymphocytic leukaemia in detail.
5. **Plasma cell disorders** - classification. Plasma cell myeloma - definition. Clinical features, laboratory investigations.
6. **Haemorrhagic disorders:** Definition: Pathogenesis, clinical features, Classification: Vascular disorders, platelet disorders, Coagulation disorders Fibrinolysis.
7. **Platelet disorders:** Quantitative - Thrombocytopenia - Idiopathic Thrombocytopenic purpura (ITP) Classification, clinical features, diagnosis and B.M. findings in ITP, Qualitative platelet disorders.
8. **Thrombocytosis:** Definition, Etiology, Lab Investigations
9. **Coagulation disorders:** Inherited -Haemophilia A and B von Will brand's disease Acquired: Vit. K deficiency, Liver disease, DIC Investigation of Haemorrhagic disorders. Tests of vascular and platelet function - Bleeding time, Clot retraction, Platelet count. Platelet aggregation studies. Bone marrow examination.
10. **Tests for coagulation disorders:** Screening tests- First line tests -Prothrombin time (PT) Activated partial thromboplastin, Time (APTT) Thrombin time (TT), Second line tests - Mixing experiments, Coagulation factory assay, Urea solubility tests for Factor XIII, Factor VIII inhibitor study. Fibrinogen assay, Disseminated intravascular coagulation- Definition, Pathogenesis, laboratory investigations
11. **Thrombotic disorders:** Classification - Inherited and Acquired.
Clinical features, Investigation of thrombotic disorders:

Tests:

- i. Protein C
- ii. Protein S,
- iii. AT-III
- iv. Factor V leiden

Recommended readings:

1. Kanai L. Mukherjee, Medical Laboratory Technology Vol. I. Tata McGraw Hill 1996, New Delhi.
2. Gradwohl, Clinical Laboratory-methods and diagnosis, Vol-I
3. Henry, Bernard, J., Sanford, T and Davidson, 2002. Clinical Diagnosis and Management by Laboratory Methods. W.B. Saunders, New York.
4. Grad Wohls, 2000. Clinical Laboratory Methods and Diagnosis. (ed) Ales C. Sonnenwirth and Leonard Jarret, M.D. B.I. Publications, New Delhi.
5. Richard, R, 1989. Clinical Laboratory Medicine, Medical Publication, Chicago.

ADVANCE PATHOLOGY II

Code: MLT 403D

FULL MARKS-50

3L+1T=4

CREDIT: 4

Course Outcome: The students will learn cell cycle, apoptosis, sex-linked disorders, cancer and etc.

UNIT-I

- a. Apoptosis and sub cellular responses to cell injury, necrosis
- b. Acute and chronic inflammation, morphologic patterns of acute and chronic inflammation, systemic effects of inflammation
- c. Cytokines and their functions
- d. Intracellular accumulation, gangrene – pathology and classification, pathogenesis and classification of edema, reticulocyte structure
- e. Pathogenesis of thrombosis, embolism, infarction and shock

UNIT-II

- a. Control of normal growth, cell cycle illustration and the regulation of cell division, labile cells, stable cells, permanent cells, molecular events in cell growth (autocrine signalling, paracrine signaling, endocrine signaling), cell surface receptors, signal transduction systems and transcription factors.
- b. Growth inhibition, growth factors, extra cellular matrix and cell matrix interactions, collagen, elastin, fibrillin and elastic fibres, adhesive glycoproteins and integrins, matricellular proteins, proteoglycans and hyaluronidase.
- c. Fibrosis, tissue modelling, wound healing, healing by first and second intention
- d. Haemo dynamic disorders – hemostasis and thrombosis.

UNIT-III

- a. Genetics (molecular basis of human diseases, production of human biologically active agents, gene therapy, disease diagnosis, mutations, mendelian disorders, autosomal dominant disorders, autosomal recessive disorders and X linked disorders)

- b. Disorders with multifactorial inheritance, normal karyotype, fluorescence *in-situ* hybridization, cytogenetic disorders involving sex chromosomes.
- c. Diagnosis of genetic diseases. Direct gene diagnosis, indirect gene diagnosis, linkage analysis.

UNIT-IV

- a. Neoplasia, Nomenclature, characteristics of benign and malignant neoplasms
- b. Molecular basis of cancer, oncogenes and cancer, protein products of oncogenes
- c. Suppressor genes, protein products of tumor suppressor genes.
- d. Molecules that regulate nuclear transcription and cell cycle, *Rb* gene, *P⁵³* gene, *BRCA-1* and *BRCA-2* gene, molecules that regulate signal transduction, cell surface receptors, other tumor suppressor genes.
- e. Genes that regulate apoptosis and DNA repair, Telomeres and cancer, molecular growth, Kinetics of tumor cell growth and angiogenesis.

Recommended readings:

1. Gaw, A., M.J. Murphy, R.A. Cowan, D.J. O'Reilly, M.J. Stewart and J. Shepherd, 2008. Clinical Biochemistry, Elsevier,
2. Malacinski, G.M., 2005. Essentials of Molecular Biology, Jones and Bartlett Publishers, New Delhi.
3. Chatterje, M.N. and R. Shinde, 2005. Textbook of Medical Biochemistry, Jaypee Brothers, New Delhi.
4. Davidson, S.S., J. MacLeod and C.R.W. Edwards, 1991. Principles and Practice of Medicine, Churchill Livingstone, United Kingdom.
5. Nelson, D.L. and M. M. Cox, 2008. Lehninger Principles of Biochemistry, WH Freeman and Company New York.
6. Twyman, R.M. 1999, Advanced molecular Biology, Bios Scientific, UK.
7. Voet, D., Voet, J.G. and C.W. Pratt, 2008. Fundamentals of Biochemistry, John Wiley and Sons, New Delhi.
8. Albert B. Bray D and Lewis J Molecular biology of the cells, 2nd edition New York Garland Publications 1989.
9. Kirby L.T DNA fingerprinting; An introduction, New York, W.H. Freeman and Co. 1992.
10. De Robertis, E.D.P., and De Robertis, E.M.F. Cell and Molecular Biology (6 Ed), W.B. Saunders College, Philadelphia. 1990.

DIAGNOSTIC BIOCHEMISTRY AND ENDOCRINOLOGY LAB

Code: MLT 494A

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will get knowledge on the hormone assay by using ELISA and other modern instruments.

1. Instrument used in hormone assay
2. Programme in ELISA reader for hormone assay
3. Intra assay & Inter assay variation & cross reaction in hormone assay
4. Standard curve plotting
5. Assay of FSH, TSH, LH, GH, Insulin and C-peptide in ELISA

6. Assay of Testosterone, E2, Progesterone in ELISA reader
7. Programming in Gamma counter for hormone
8. Standard curve in Gamma counter
9. Hormone assay in Gamma counter
10. Interpretation of results of LH, FSH, testosterone, estradiol and PRL from same serum sample (As per sex)
11. Interpretation of results of TSH and T3 / T4 from same serum sample
12. Quantification of blood iodine for the assessment of thyroid
13. Interpretation of results of insulin and C-peptide from same serum sample
14. Interpretation of results of ACTH and cortisol from same serum sample
15. Assessment of obesity by the estimation of lipid profile
16. Assessment of hypertension by the estimation of cholesterol
17. Evaluation of autoimmune disorder in relation to pathophysiology of endocrine gland

Recommended readings:

1. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.
2. Sonnenwirth, A. C. and L. Jarret, 2000. Gradwohl's Clinical laboratory methods and diagnosis. M.D.B.I..
3. De Robertis, E.D.P., and De Robertis, E.M.F., 1996. Cell and Molecular biology, B.I. Waverly Pvt. Ltd, Philadelphia.

MOLECULAR MICROBIOLOGY LAB

Code: MLT 494B

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will get knowledge on the modern molecular microbiology techniques and bioinformatics analysis.

1. Gene as a unit of mutation and recombination.
2. Mutagenesis, mutations, and mutants-biochemical basis of mutations, genetic mechanism of drug resistance, spontaneous and induced mutations, mutagenesis, reversion, suppression, genetic analysis of mutants.
3. Transformation- competence cells, regulations, general process
4. Transduction- general and specialized
5. Recombination Mechanism: Introduction and models, Transposable elements
6. Regulation and expression of gene activity of lac operon
7. Plasmid, Hfr strains
8. Basic idea of Bioinformatics. BLAST, FASTA
9. Alignment by using CLUSTAL.
10. Construction of phylogenetic tree based on the 16S rRNA gene.

Recommended readings:

1. Albert B. Bray D and Lewis J Molecular biology of the cells, 2nd edition New York Garland Publications 1989.
2. Kirby L.T DNA fingerprinting; An introduction, New York, W.H. Freeman and Co.1992.
3. De Robertis, E.D.P., and De Robertis, E.M.F. Cell and Molecular Biology (6 Ed), W.B. Saunders College, Philadelphia. 1990.

HAEMOGLOBINOPATHIES AND SEROLOGY LAB II

Code: MLT 494C

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: To

1. Leukaemias

- a. Myeloperoxidase
- b. Periodic Acid Phosphatase [PAS]
- c. Sudan Black
- d. Esterase, Non specific esterase
- e. Leucocyte alkaline Phosphatase

2. Immuno Cytochemical Staining

- a. Plasma cell Disorders: Serum Protein Electrophoresis, Urine Electrophoresis

3. Investigation of Haemorrhagic disorders

- a. Test of vascular and platelet function - Bleeding time, Clot retraction, Platelet count.
- b. Platelet aggregation studies. Bone marrow examination.
- c. Tests for coagulation disorders:
- d. Screening tests - First line tests- Prothrombin time (PT) Activated partial thromboplastin
- e. Time (APTT) Thrombin time (TT) INR.
- f. Second line tests - Mixing experiments.
- g. Coagulation factor assay
- h. Urea solubility tests for Factor XIII
- i. Factor VIII inhibitor study
- j. Fibrinogen assay

4. Thrombotic Work-up Tests:

- a. Protein C
- b. Protein S
- c. AT-III
- d. Factor V leiden

5. Serological test: Different Serodiagnostic test for AIDS (HIV1 & HIV-2). Serodiagnostic test for Hepatitis, ToRCH Panel, Rubella, Toxoplasmosis, Leishmaniasis, Montoux test, Toxoplasmin, Histoplasmin

Recommended readings:

1. Kanai L. Mukherjee, Medical Laboratory Technology Vol. I. Tata McGraw Hill 1996, New Delhi.
2. Grad Wohl, Clinical Laboratory-methods and diagnosis, Vol-I
3. Henry, Bernard, J., Sanford, T and Davidson, 2002. Clinical diagnosis and Management by laboratory methods. W.B. Saunders, New York.
4. Gradwohls, 2000. Clinical Laboratory Methods and Diagnosis. (eds) Ales C. Sonnenwirth and Leonard Jarret, M.D. B.I. Publications, New Delhi.
5. Richard, R, 1989. Clinical Laboratory Medicine, Medical Publication, Chicago.

ADVANCE PATHOLOGY LAB

Code: MLT 494D

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will get knowledge on the routine pathology experiments.

1. Haemoglobin electrophoresis
2. Blood cell cytochemistry-Peroxidase, PAS, LAP, Esterase
3. Perl's stain

4. Osmotic fragility and mechanical fragility test
5. LE cell demonstration
6. Clot retraction test, fibrinolysis test
7. Ham's test
8. Serum electrophoresis of myeloma proteins.
9. Familiarisation of automation in Haematology
10. **Urine analysis:**
 - a. Reducing sugar-Benedict test, protein -Heat and acetic acid test, and sulfosalicylic acid method, Ketone bodies-Rothera's test, Bile pigment (Fouchet method), bile salt (Hay's test), Urobilinogen- Ehrlich aldehyde test and Bence Jones protein test, Renal clearance test-urea, creatine, Test for mucin. Test for Drugs of Abuse - Methadone, metha - Amphetamine, Benzodiazepine, Cocaine, Morphine, Cannabinoids and Phenobarbitone.
 - b. Microscopic examination; Identification of casts and crystals and blood cells -RBC, WBC, smear for gram staining and urine culture
11. **Stool Examination:** Collection of faecal specimen, preservation, physical examination; volume, colour, odour and appearance. Identification of crystals, meat fibers, fat globules and blood cells. Chemical examination; reducing sugar, occult blood test, Demonstration of fat in stool, detection of steatorrhea
12. Semen analysis
13. Examination of CSF
14. Examination of body fluids
15. Examination of sputum
16. **Techniques for Intestinal Parasites:** Identification of Parasites in wet mounts, Concentration methods, direct centrifuge floatation method and ether extraction method for ova and cysts. Culture especially for enriched group of organisms.

Recommended readings:

1. Practicals Biochemistry – Plummer
2. Practical Biochemistry – Harold Varley
3. Tools in Biochemistry – Cooper
4. Lynch's Medical Lab Technology – Stanley S. Raphael
5. Gradwohl clinical laboratory methods & diagnosis
6. Manual of clinical laboratory methods-Copeland. E. Hopier
7. Medical laboratory methods-Dr. Ramniksood
8. Clinical laboratory methods-Beuer.
9. Introduction to Medical laboratory technology-Baker
10. Clinical pathology and bacteriology-Sachdev

RESEARCH PROJECT IN SPECIALIZED AREA

Code: MLT 495

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will get acquaintance with a research environment, impart knowledge to write a thesis, acquire knowledge how to .write a manuscript / thesis.

At this academic Level, the Project is of some great significance in the testing of a candidate's virtuosity in Health Administration and judges his or her ability to independently take charge of Project/System development. All candidates are required to get the synopsis of the Project approved from the Society. The Project is to be taken up only after obtaining the approval of the Society.

Authenticity of the Project Work

It should be an original work, of real life value and not copied from existing material from any source and certificate to the effect will be provided with Project duly countersigned by the Supervisor/Guide.

How to submit Final Project

The student will submit his/her Project Report in the prescribed format along with the requisite fee. The Project Report should include:

- a. Two Hardcopy of Project Report.
- b. Softcopy of Project Report.
- c. The Project Report may be about 100 pages

The following suggested guidelines may be followed in preparing the Final Project Report:

1. Good quality white executive bond paper A4 size should be used for typing and duplication. Care should be taken to avoid smudging while duplicating the copies.
2. Page specification (written paper and source code)

Left margin	1.2 inch.
Right margin	1.0 inch.
Top margin	1.0 inch.
Bottom margin	1.0 inch.
3. Page numbers – all text pages as well as program source code listing should be numbered at the bottom centre of the pages.

Guidelines for submission of Project Report

a) Supervisor/Guide for Final Project

A supervisor/Guide should be a person of eminence in the area in which the student has chosen the Project, all help including the nomination of the supervisor/guide will be rendered by the institute concerned. The Candidate should ensure that the facilities are available in the organization (where the Project is taken up) and also the same are extended to them. The guide of Final Project would be a person having Ph D/ MD with 5 years of experience in the field of Hospital Operation and Management.

b) Format of Final Project

1. Project Cover page in the prescribed format
2. Acknowledgement from the Organization where the Candidate has undergone training or the Organization where the Candidate has made the Project.
3. Project Completion Certificate duly signed by the Project Guide/ Principal and Head of the Department
4. Approved copy of the Project synopsis, along with the copy of the synopsis approval letter.
5. Main report should contain:
 - a) Objective & scope of the Project.
 - b) Theoretical background
 - c) Definition of problem
 - d) Formulation of research Hypothesis
 - e) System planning (PERT Chart)
 - f) Methodology adopted

- g) Results and Statistical analysis
 - h) Discussion
 - i) Summary and Conclusion
 - k) References or Bibliography.
- 6. List of abbreviations, figures, tables
 - 7. Reference
 - Bibliography
 - Website
 - 8. Soft Copy of the Project on CD/DVD

GRAND VIVA

Code: MLT 496

FULL MARKS-50

4P=4

CREDIT: 4

Course Outcome: The students will acquire overall knowledge on the subject and experienced how to face an interview board.

It is a common Compulsory Paper for all Final Semester Students. Grand Viva will be conducted from first semester to fourth semester papers by a Board of Examiners to be decided by the Board of Studies. Board of Examiners will consist of all the internal teachers and three external teachers chosen from different specialization areas.