

**UNIVERSITY OF HEALTH  
SCIENCES LAHORE**

A



**M.Phil Medical  
Laboratory Sciences  
Two Years Degree  
Programme**

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M.Phil (MLSc.)

**Curriculum**

*Department of Allied Health Sciences*



***COURSE CONTENTS***

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## ***INTRODUCTION***

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MPhil in Medical Laboratory Sciences is a program designed for graduates in Medical Laboratory Technology to acquire more advanced and specialized training in different specialties of a diagnostic clinical laboratory. Medical Laboratory Technologists are professionals who have the technical expertise necessary to perform a wide variety of routine and specialized tests on patient specimens to help the physician in the diagnosis and treatment of disease. These professionals practice in hospital laboratories, private medical laboratories, public health laboratories, government laboratories, research and educational institutions.

### **AIM**

This program aims to provide student with expert practical training and instructions in different specialties of medical laboratory sciences.

### **MISSION**

It is the mission of the MPhil in Medical Laboratory Sciences program at the department of Allied Health Sciences, to help students develop specialized knowledge, skill, attitude and clinical judgment required for competency as medical laboratory technologists and laboratory scientists in different fields of laboratory medicine. The program strives to prepare graduates who, using the newest methodologies, state of the art automated analyzers, critical thinking and task management, provide valid, accurate and precise test results used in the detection, diagnosis and treatment of the diseases.

This course does not merely aim to impart scientific knowledge but will also provide students with opportunities to develop a variety of persona qualities and transferable skills, such as self- assurance, communication skills, writing skills, and the ability to make objective judgments.

### **OBJECTIVES**

- To provide advanced and specific training to students in different specialties of laboratory medicine
- To provide the students a capacity to recognize the clinical significance of the test they perform, and evaluate the reliability of the results by obtaining satisfactory quality control results



- To enable students to report results accurately using verbal and written means, recognizing the necessity to draw attention to abnormal values
- To train students in the operation of laboratory instruments and able to recognize failures and take appropriate actions
- To train the students in biomedical research methodology, search for biomedical science literature, interpretation of research data and in the written and oral presentation of scientific research.

**ELIGIBILITY FOR ADMISSION**

BSc (Hons) Medical Laboratory Technology

MSc Medical Technology



**COURSE STRUCTURE:**

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In the academic requirements for the MPhil degree shall comprise course work and a thesis based on research.

The duration of the course would be two years full time. The distribution of the courses of study in the two years would be as follows:

**First Year**

**Major Subjects:** Candidate shall select one of following as his/her area of specialization at the time of admission:

- Chemical Pathology
- Cytotechnology
- Hematotechnology
- Histotechnology
- Immunology
- Microbiology
- Molecular Pathology & Cytogenetics

**Minor Subject:**

“Laboratory Management and Research Methodology” shall be compulsory for all students as a minor subject during their first year of study.

**Second Year**

During the second year of study, the student shall select one of the following as a second minor subject

- Chemical Pathology
- Cytotechnology
- Forensic Sciences
- Histotechnology
- Immunology
- Microbiology
- Molecular Pathology & Cytogenetics
- Transfusion Medicine

**Research Thesis:**

The student shall select a topic of thesis which will be recommended by the supervisor by the end of 1<sup>st</sup> academic year of studies for approval of the Advanced Studies & Research Board.



**ASSESSMENT**

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**Major Course:**

MCOs Papers	150 Marks	3 Hours
SEQs Papers	150 Marks	3 Hours
Viva voce& Practical Examination	100 Marks	

**Total = 400 marks****1st Minor Course:**

1st Minor	100 Marks	2 Hours
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**2nd Minor (Elective) Course:**

2nd Minor	100 Marks	2 Hours
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**Thesis:** Thesis Examination = 200 Marks

The degree of MPhil would be conferred on successful completion of course and defense of research thesis.



# *Curriculum*



# ***Chemical Pathology Major***





**General Laboratory Techniques and Procedures**

- Basic concepts in Laboratory Medicine and Ethics
- Laboratory hazards, Types of hazards, Identification of hazards,
- Safety Program, Safety Equipment, Safety Inspections, Safety Plans
- Chemicals used in lab and General Laboratory Equipment.
- Type of Glassware, Pippets, Uses and cleaning
- Units of Measurement
- Reagent Grade Water
- Basic laboratory calculations
- Waste disposal
- Waste disposal regulations

**Specimen Collection and Processing**

- Patient preparation for tests
- Phlebotomy techniques and guidelines
- Collection of samples
  - Blood
  - Urine
  - Feces
- body fluids and their preservation
- transport of samples
- anticoagulants
- preservatives
- problems associated with lipemic, hemolytic and icteric samples
- handling of body fluids
- Collection of sample from neonates

**Analytical Techniques and Instrumentation****Centrifugation**

- Principle of Centrifugation
- Types of centrifuges
- Merits and demerits of different types of centrifuges



- Calibration of different parts of centrifuge
- Maintenance of centrifuge
- Application of different types of centrifuges in clinical lab.

### **Balances**

- Principle of weighing
- Types of Balances
- Characteristics of an ideal balance
- Maintenance and applications of balances.

### **Spectrophotometry**

- Principle of spectrophotometry
- Application of spectrophotometer
- Types of spectrophotometers
- Calibration of different parts of spectrophotometer
- Maintenance and troubleshooting of spectrophotometer.

### **Atomic Absorption Spectrophotometry**

- Principle and parts of Instrument
- Applications and Maintenance
- Troubleshooting
- Difference between atomic absorption and flame emission, spectrophotometer.

### **Flame Emission Spectrophotometry**

- Principle
- parts of Instrument
- Merits and Demerits

### **Electrolyte analyzer**

### **Fluorometry, Nephelometry and Turbidimetry**

- Principle
- Applications

### **Electrophoresis**

- Principle
- parts of Instrument
- Types
- Applications



**Chromatography**

- Basic Concepts
- Principle
- Mechanisms of separation
- Types
- Application

**Mass Spectrometry**

- Basic Concepts and definitions
- Application

**Immunochemical Techniques**

- Types of Immunoassays
- ELISA

**PCR**

- Procedure
- Uses
- Types
- Method.

**Automation in the Clinical Laboratory**

- Need of automation
- Merits and Demerits of automation
- Automation at different steps of Sample Processing
- Types of automation

**Quality Assurance and Lab Management**

- Basic Concepts and Definitions
- Internal and External Quality Control Program
- Pre-analytical, Analytical and Post-analytical Errors
- Westgard rules and their application
- Identifying sources of Analytical Errors
- The role of statistics in analytical work
- Sources of variation in analytical work
- Selection of Analytical Methods
- Basic concept of Lab Management



- Human Resource Management

**Reference Values**

- Basic Concepts
- clinical significance
- Application
- Critical values, their importance and need for immediate action.
- Observing and drawing attention to abnormal results

**Proteins**

- Names of Plasma Proteins
- Methods of determination of Proteins in
  - Serum
  - CSF
  - Urine
- Principles of the methods
- Interferences and interpretation
- Significance of urinary proteins
- Serum protein electrophoresis

**Clinical Enzymology**

- Basic Concepts and Definitions
- Method of measurement of different enzymes in serum
- Factors effecting enzyme measurements

**Interpretation of following enzymes**

**Liver enzymes**

- Aspartate aminotransferase
- Alanine
- Aminotransferase
- Alkaline phosphatase

**Cardiac and Skeletal Enzymes**

- Creatine kinase
- lactate dehydrogenase
- Isoenzymes of creatine kinase
- Isoenzymes of lactate dehydrogenase



- Aldolase

**Biliary Tract Enzymes**

- 5-nucleotidase
- Gamma glutamyl transferase

**Digestive Enzymes of Pancreatic Origin**

- Amylase
- Lipase
- Trypsin
- Chymotrypsin

**Carbohydrates**

- Definition and causes of hyperglycemia
- Definition of Diabetes Mellitus
- Criteria for diagnosing Diabetes Mellitus
- Sample collection and processing for blood glucose determination
- Methods for determination of blood glucose
- Method interferences and interpretation
- Reference intervals
- Self monitoring of the blood glucose
- Definition of glycosuria
- Methods of determination of urinary glucose
- Names of ketone bodies
- Methods for determination of ketone bodies in
  - serum
  - urine
- Names of different glycosylated proteins
- Methods of determination of glycosylated proteins
- Definition of hypoglycemia
- Lab diagnosis of hypoglycemia

**Lipids, Lipoproteins, and Apolipoproteins**

- Definition
- Sample collection for lipid profile
- Methods of determination of lipids, lipoproteins and apolipoproteins



- Sources of variation in lipid and lipoprotein measurement
- Reference intervals

**Electrolytes and Blood Gases**

- Methods for determination of electrolytes
- Method interferences
- Determination of plasma and Urine Osmolality
- Sweat Testing
- Principle of methods for determination of Blood Gases and pH

**Liver Function**

- Biochemical Functions of the Liver
- Lab Diagnosis and Interpretation of Liver function Tests
- Methods of determination of serum bilirubin
- Methods of determination of liver enzymes, Method interferences

**Cardiac Markers**

- Names of different cardiac markers
- principle of methods for determination of cardiac markers
- Lab diagnosis of Myocardial Infarction

**Renal Function and Nitrogen Metabolites**

- Renal Function Tests
- principles of methods for determination
  - Serum
  - Creatinine
  - Urea
  - Uric acid
- Method interferences and interpretation
- 24-hour urine collection
- Methods for determination of creatinine clearance
- Detailed Biochemical Analysis of Urine

**Gastric, Pancreatic, and Intestinal Function**

- Basic Anatomy, Physiology and Definitions
- Gastrointestinal Hormones
- Enzymes of the Gastrointestinal



- Tests Measuring the Exocrine Function of the Pancreas
- Pancreatic and Intestinal Diseases
- Reference Value & Principles of Analysis

**Mineral and Bone Metabolism**

- Principle of methods for determination of
  - Calcium
  - Phosphate
  - Magnesium
- Names of the hormones Regulating Mineral Metabolism
- Reference Value & Principles of Analysis

**General Endocrine Function**

- Actions of Hormones
- Regulation of Hormone Secretion
- Biorhythms
- Hormone Receptors
- Principles of different techniques of hormone measurement

**Pituitary Function Tests**

- Tests used to evaluate pituitary functions

**Thyroid Function Tests**

- Definition, causes of Hyperthyroidism
- lab diagnosis of Hyperthyroidism
- Definition, causes of Hypothyroidism
- lab diagnosis of Hypothyroidism
- Principles of methods for determination of
  - T<sub>3</sub>
  - T<sub>4</sub>
  - TSH and their interpretation

**Parathyroid Gland**

- Principles of methods for determination of PTH and interpretation

**Adrenal Gland**

- Adrenocortical Steroids
- Names of hormones of the Adrenal Cortex



- Names of hormones of the Adrenal Medulla
- Principles of methods for determination of Adrenal hormones
- Methods for determination of Catecholamines and Metabolites

**Lab Diagnosis of Male and Female Infertility**

- Tests to diagnose male and female infertility and their interpretation

**Inborn Errors of Metabolism**

- Names of inborn errors of metabolism
- Lab diagnosis of common inborn errors of metabolism

**Tumor Markers**

- Introduction and classification of Tumor Markers
- Clinical Applications of Tumor Markers
- Tests for the determination of tumor markers

**Therapeutic Drug Monitoring**

- Basic Concepts and Definitions

**Clinical Toxicology**

- Basic Concepts, Screening Procedures for Detection of Drugs

**Trace Elements**

- Basic Concepts and Definitions
- Methods for determination of Trace Elements

**Porphyrias**





# ***Cytotechnology Major***



**Techniques In Cytology****Introduction**

- Fixation
- General comments on fixation
- Fixation methods
- Air drying for selected cells samples
- Other considerations
- Papanicolaou staining methods
- Staining procedures based on the Papanicolaou method
- The nuclear stain: haemateixylin
- Counter stains: orange G and EA
- Automated versus manual staining procedures
- Environmentally friendly staining procedure
- On-site quick staining procedure
- Helpful hints when staining with the Papanicolaou staining
- Troubleshooting the Papanicolaou staining method
- Cross-contamination method to avoid floaters
- Cover slipping
- Automated cover slipping
- Liquid mounting media
- Destaining and restaining slides
- Collecting and processing nongynaecological cell samples
- Body cavity fluids
- Cerebrospinal fluid
- Genitourinary tract specimens and other watery samples
- Respiratory tract specimens and other mucoid samples
- Staining body fluids
- Infection control
- Other factors related to cytopreparation



**Light optical microscopy**

- Image formation
- Koehler illumination

**Virtual microscopy**

**Virtual slide acquisition**

- Equipment for slide acquisition
- Acquisition speed
- Virtual slide quality
- Focus planes
- Applications

**Automation in cervical cytology**

- Historical attempts at Automation
- The rationale of automation
- Cytology automation: accuracy and productivity
- Currently available automation platforms
  - i. Liquid – based preparation
  - ii. Automated screening devices
- Laboratory process issue associated with the use of automated devices
  - i. Reporting issues
  - ii. Issues with specimens that can not be successfully processed
  - iii. Stain used in automated system
  - iv. Training required for initiation of automated system
  - v. Laboratory workflow issues
- Cost-effective of liquid- based preparation and automated screening devices

**Immunocytochemistry**

- Immunocytology techniques
  - i. The specimen
- Interpretation and limitations of ICC
- Effusion Cytology
- Mesothelial Markers ( they need to be done very briefly no details are required)
  - Calretinin
  - HBME-1



- CK- 5/6
- NON Mesothelial (adenocarcinoma) MarkersMOC-31
    - BG-8
    - Ber-EP4
    - Monoclonal CEA
    - TAG-72.3
    - CD15
  - Site –Specific Markers
    - Thyroid transcription factor-1
    - Estrogen receptor
    - CdX2
  - Breast Cytology
    - E-cadhearin and p120 catenin, ER, PR HER2NEU
  - Immunocytochemistry for targeted therapies
    - CD117
    - Her2/Neu
    - EGFR
  - Gynecological cytology
    - P16
    - ProEx C
    - In Situ hybridisation Assays for Detection of High risk HPV
  - Ovarian Cytology
    - Malignant Melanoma
    - Ki67
    - c-met
  - Lymphoid Tissue (lymphomas)
    - CD3
    - CD20
    - CD15
    - CD45



**Molecular Techniques**

- Molecular Techniques in cytopathology
  - i. Fluorescence in Situ hybridisation
  - ii. Polymerase chain reaction
  - iii. Microsatellite analysis
  - iv. Laser microdissection
  - v. Promoter methylation analysis
  - vi. Hybrid capture system
- Applications in cytology
  - Improved diagnosis and classification of cancers
- Molecular analysis of therapeutic targets
  - i. HER2, TOP2A, and ESRI in breast cancer
  - ii. EGFR analysis in non small cell lung cancer
- Human Papillomaviruses
  - i. Classification of Human Papillomaviruses
  - ii. High – risk and low- risk HPV types
  - iii. Traditional DNA techniques used for HPV techniques
  - iv. Noval HPV assays of the third millennium
  - v. Detection of HPV by molecular techniques
  - vi. Comparing PCR with the HC2 assay
  - vii. FISH in gynaecological cytology
  - viii. Clinical value of and controversies in HPV testing

**Basic Structure and Function of Mammalian Cells**

- i. Nucleus
- ii. Contents of the Nucleus
- iii. Nuclear Morphology
- iv. Haematoxylin
- v. Nucleoli
- vi. Nuclear Envelope and Nuclear Shape
- vii. Cytoplasm and Plasmalemma
- viii. Cytoplasmic Stain
- ix. Endoplasmic Reticulum



- x. Golgi Apparatus
- xi. Mitochondria
- xii. Lysosomes
- xiii. Cytoskeleton, Centrosome
- xiv. Cell Membrane, Receptors, and Signal Transduction
- xv. Cell Junctions
- xvi. Cell Growth and Division

### **The Molecular Basis of Neoplasia**

- i. Principles of Malignant Transformation
- ii. Cancer-related Genes
- iii. The Major Pathways of Carcinogenesis
- iv. Carcinogenesis induced by Papillomavirus Infections
- v. Basic Structure of the Virus and Its Genome
- vi. Epidemiology of HPV Infections
- vii. The Role of the HR-HPV E6 and E7 Genes
- viii. Progression of HPV-Infected Epithelial Cells to Invasive Cancer Cells

### **Basic Cytogenetics and the Role of Genetics in Cancer Development**

- Basic Knowledge of Cytogenetics
  - i. Cell Cycle
  - ii. The Interphase
  - iii. The Mitosis
  - iv. The Meiosis
  - v. The Chromosome Structure
- Methodology
  - i. The Karyotyping
  - ii. Fluorescent in Situ Hybridization
  - iii. Comparative Genomic Hybridization (CGH)
- Acquired Chromosomal Aberrations in Cancer
  - i. Introduction
  - ii. Lymphomas



- iii. Sarcomas
- iv. Thyroid Carcinomas

➤ Clinical Applications of Conventional Cytogenetics and Fish in Cytology

- i. Introduction
- ii. FISH Strategy
- iii. Application

**Cytologic Screening Program**

- i. Principles of screening
- ii. Cervical Cancer and Screening
- iii. Cervical Cancer Incidence and Mortality Worldwide
- iv. Efficacy of Screening
- v. Design of Screening Programs
- vi. Features of Successful Screening Programs
- vii. Limitations of Screening Programs
- viii. The Role of Laboratory in Screening Programs
- ix. Early Detection of Cancer in Other Sites
- x. New Developments in Cytological Screening
- xi. Liquid-Based Cytology (LBC)
- xii. Automated Cytology

**Diagnostic Quality Assurance in Cytopathology**

- i. Quality Assurance Measures
  - ii. Laboratory Directors
  - iii. Cytotechnologists
  - iv. Physical Laboratory Facilities
  - v. Safety Precautions
  - vi. Equipment
  - vii. Specimen Collection
  - viii. Preparation, Fixation, and Staining Procedures
  - ix. Laboratory Records, Logs, and
- Internal Quality Assurance Mechanisms
- Rapid Re-evaluation



- Computer-Assisted Quality Assurance Mechanisms
- External Quality Assurance Mechanisms

### **Evaluation of the Sample in Smears and Liquid-Based Preparations**

- Cervicovaginal Cytology
  - i. Specimen Type
  - ii. Patient Identification
  - iii. Clinical Information
  - iv. Microscopic Evaluation
- Nongynecological Cytology
  - i. Specimen Type
  - ii. Specimen Cross-Contamination
  - iii. Specimen Mishandling

### **Diagnostic cytology**

- The Bethesda system for reporting cervical cytology
- The Bethesda system: Historical perspective
- The 2001 Bethesda system
- Report format
- Specimen adequacy
- General categorization
- Interpretation /result
- Automated review
- Interobserver reproducibility in cervical cytology
- The Bethesda system for reporting anal – rectal cytology

### **Microbiology, Inflammation and Viral Infections**

- Vaginal microbiology
- Infection of the female genital tract
- Bacterial infections
- Viral infections
- Chlamydial infection
- Fungal infection
- Parasitic infection





**Systemic Cytopathology**

**Benign Proliferative Reactions, Intraepithelial Neoplasia, and Invasive Cancer of the Uterine Cervix**

- The normal uterine cervix
- Benign proliferative reactions
- Squamous intraepithelial neoplasia
- Papanicolaou classification
- Dysplasia
- Cervical intraepithelial neoplasia
- Invasive cancer of the uterine cervix
- Microinvasive carcinoma
- Invasive cervical carcinoma
- Efficacy of cervical cytology in the detection of cervical abnormalities
- Liquid –based cervical cytology
- Screening programs of cervical cytology
- Observer variability
- Quality control

**Glandular Lesions of the Uterine Cervix**

- Endocervical canal normal histology and cytology
- Endocervical adenocarcinoma in Situ
- Endocervical adenocarcinoma
- Atypical glandular cells

**Endometrial Lesions, Unusual Tumours and Extrauterine Cancer**

- Overview of Endometrial carcinoma
- Types I and II Endometrial adenocarcinoma
- Normal appearing endometrial cells and gestational changes
- The detection of endometrial abnormalities

**Vulva, Vagina, and Anus**

**Vulva**

- Sample collection methods



- Histology
- Infectious and inflammatory diseases & cancer

**Vagina**

- Sample collection methods
- Histology
- Infectious and inflammatory diseases & cancer

**Anus**

- Histology
- Squamous cell carcinoma and anal intraepithelial neoplasia
- Anorectal cytology

**Peritoneal Washings and Ovary**

- Peritoneal Washings
- Sampling techniques
- Specimens
- Cytology
- Ancillary techniques
- Diagnostic accuracy
- Ovary
- Sampling techniques
- Basic histology
- Ancillary techniques
- Diagnostic accuracy

**Respiratory Tract**

- Sampling and cytopreparatory techniques
- Sputum
- Bronchoscopy
- Fine needle aspiration
- Cytology of normal and benign components
- Cytology of respiratory infections
- Viral infections
- Bacterial infections



- Fungal infections
- Parasitic infections
- Pathology of lung cancer
- Cytology of lung cancer
- Diagnostic accuracy

**Alimentary Tract (Esophagus, Stomach, Small Intestine, Colon, Rectum, Biliary Tract)**

- Specimen collection and preparation
- Overview of gastrointestinal epithelial reparative atypia
- Stomach
- Normal histology
- Overview of gastritis
- Helicobacter – associated gastritis
- Duodenum
- Normal histology and cytology
- Adenocarcinoma
- Malignant lymphoma

**Urinary Tract**

- Screening for bladder cancer
- Examination of symptomatic patients
- Sample techniques
- Sample collection
- Bladder washing
- Aspirates washing ,brushing and cell blocks of ureters and renal pelvis
- Sample preparation
- Tumours of the urinary tract (cytology)
- Papillary tumors (cytology)
- Urothelial dysplasia and carcinoma in situ
- Invasive nonpapillary urothelial carcinoma
- Squamous cell carcinoma
- Adenocarcinoma



- Irradiation changes
- Morphometry
- Fish and immunocyto test
- Telomerase

**Central nervous system**

- Preparatory methods
- Cerebrospinal fluid
- FNA biopsy
- Normal cerebrospinal fluid and histology
- Infectious fluid
- Demyelinating diseases
- Neoplasia
- Leukemia
- Lymphoma
- Diagnostic accuracy in cerebrospinal fluid
- Needle aspirates of intracranial lesions
- Diagnostic accuracy of Needle aspiration

**Eye**

- Sampling and cytopreparatory techniques
- Scraping
- Fine –needle aspiration
- Intraocular washing
- Special techniques
- To detect Chlamydia organism
- To detect viral cytopathic effect
- Eyelids
- Conjunctiva and cornea
- Orbit
- Eye
- Diagnostic accuracy



**Cytology of Soft Tissue, Bone, and Skin**

- Morphologic approach to soft tissue lesions
- Grade
- Lipoma & Liposarcoma

**Bone Lesions**

**Cartilage Tumors**

- Chondrosarcoma
- Osteomyelitis

**Osteogenic Tumors (cytology of)**

- Osteosarcoma

**Hematopoietic Tumors**

- Giant Cell Tumors
- Adamantinoma

**Skin**

**Techniques**

**Pleural, Peritoneal, and Pericardial Effusions**

**Sampling Technique**

- Collecting Serous Effusions
- Gross Appearance of Serous Effusions

**Cytopreparatory Technique**

- Preliminary Steps
- Wet-Film Technique
- Permanent Smears
- Cell Block Technique
- Usefulness of Stained Wet Films
- Usefulness of Cell-Block Preparations

**The Serous Cavities**

**Types of Effusions**

- Transudates and Exudates

**Normal Cells**

- Range of Normal Cells
- Mesothelial Cells



- Cytology
- “Atypical” and “Reactive” Mesothelial Cells
- Mesothelial Cells in Wet Films
- Cell-Block Preparations
- Mesothelial Cells in Peritoneal Washings and Culdocentesis Specimens
- Diagnostic Pitfalls

**Red Blood Cells**

- Cytology

**Neutrophil Leukocytes**

- Cytology

**Eosinophilic Leukocytes**

- Eosinophilic Pleural Effusion
- Eosinophilic Peritoneal Effusion
- Eosinophilic Pericardial Effusion
- Cytology

**Basophil Leukocytes and Mast Cells**

- Cytology

**Histiocytes (Macrophages)**

- Cytology

**Lymphoid Cells**

- Cytology
- Megakaryocytes

**Detached Ciliary Tufts**

- Cytology

**Non-neoplastic Effusions**

- Cytology
- Necrotic Background Material

**Systemic Lupus Erythematosus**

- Cytology
- Tart Cells
- Tuberculosis
- Hepatic Cirrhosis



- Parasitic, Protozoal, Fungal, and Viral Infections

**Neoplastic Effusions**

- General
- Identification of Neoplastic Cells
- Differential Diagnosis of Types of Neoplasms and Determination of Primary Sites of Neoplasms

**Adenocarcinoma**

- Cell Clusters
- Vacuolation of Adenocarcinoma Cells

**Squamous Cell Carcinoma**

- Cytology of

**Small-Cell Anaplastic Carcinoma**

- Cytology of
- Urothelial Carcinoma
- Melanoma

**Mesothelioma**

- Cytology of
- Morphologic Variants

**Special Techniques**

- Electron Microscopy
- Histochemistry
- Immunocytochemistry

**Reporting of Results and Statistics**

- Reporting
- Reliability of Positive and Negative Reports

**Fine-Needle Aspiration Biopsy Techniques**

- History of Aspiration Biopsy
- Clinical Skills Required

**The needle Aspiration Method**

- Training and Planning
- Basic Equipment
- Ancillary Equipment and Special Procedures



**Aspiration Technique**

- Performing the Aspiration
- Smear Preparation
- Fixatives and Stains
- Ancillary Techniques and Applications
- Organization of the Aspiration Biopsy Service
- Complications of Fine Needle Aspiration Biopsy
- Equipment

**Staining techniques**

- 1 Papanicolaou Stain
- 2 Rapid Papanicolaou Stain<sup>46</sup>
- 3 Diff-Quik Stain Set
- 4 Modified May-Grunwald-Giemsa Stain
- 5 Hematoxylin-Eosin Stain

**Other Techniques**

- Cell Block Preparation
- Preparation of Cytospins for Tumor Markers<sup>60</sup>
- Saponization
- Supravital Stain
- Immunostaining of Cytospins Using the Autostainer

**Salivary Glands and Some Head and Neck Lesions**

**Salivary Glands**

- Introduction
- Technique used in Cytology of salivary glands
- Diagnosis Accuracies

**Thyroid**

- The Thyroid Nodule
- FNA Technique
- Slide Preparation
- Diagnostic Categories
- Normal Thyroid





**Hyperplasia cytology & technique used**

- Toxic Diffuse Hyperplasia (Graves' Disease)
- Hurthle Cell Neoplasm (Oncocytic Neoplasm) cytology
- Papillary Carcinoma
- Medullary Carcinoma
- Poorly Differentiated Thyroid Carcinoma
- Complications
- Ancillary Techniques
- Accuracy
- Management of the Thyroid Nodule

**Lymph Nodes: Cytomorphology and Flow Cytometry**

**Techniques**

- Collection and Cytologic Preparation

**Normal Lymph Node: Structure and Immunophenotypes**

- Histology
- Cytology

**Non-neoplastic Lymphadenopathy**

- Viral Infections
- Granulomatous Lymphadenitis

**The Classification of the Lymphoid Neoplasms**

- Practical Guideline for the Cytopathologist
- Non-Hodgkin's Lymphoma
- Hodgkin's Lymphoma

**Challenges and Diagnostic Pitfalls in Lymph Node Cytology**

**Breast**

- Limitations of FNA of the Breast
- Role of FNA in the Era of CNB
- Accuracy, False-Negative and False-Positive Rates, and the Triple Test

**Technique**

- Cell Block Preparation
- Liquid-based Cytology
- Complications of FNA of the Breast



**Kidney**

**Tumors of The Kidney (FNA)**

**Benign Renal Tumors (FNA)**

**Benign Epithelial Tumors**

- Oncocytoma
- Renal Adenoma
- Metanephric Adenoma

**Malignant Epithelial Tumors**

**Genetics and Molecular Biology**

- Hereditary Kidney Cancer
- Classification of Renal Tumors
- Clear Cell (Conventional) Renal Cell Carcinoma
- Chromophobe Cell Renal Carcinoma
- Papillary Renal Cell Carcinoma

**Liver and Pancreas**

**Normal Liver**

- Histology
- Cytology
- Hydatid Cyst of Cytology
- Clonorchiasis of Cytology
- Amebic Abscess Of Cytology
- Pyogenic Abscess of Cytology
- Granulomas of Cytology
- Viral Hepatitis of Cytology
- Alcoholic Hepatitis Of Cytology
- Cholestasis Of Cytology

**Focal Nodular Hyperplasia**

- Liver Cell Adenoma

**Effects of Therapy on Cytologic Specimens**

- Introduction

**Radiation Biology**

Acute Radiation Changes



- Chronic Radiation Changes
- Urinary Bladder
- Cytology
- Prostate
- Cytology
- Uterine Cervix
- Evaluation of Allograft Transplant Rejection and Immunosuppressive Toxicity
- Fine-Needle Aspiration of Renal Allograft
- Urine Cytology of Renal Allograft
- Thyroid-suppressive Therapy
- Carbimazole
- Cytology
- Radioactive Iodine
- Thermal Injury

**Recommended Book:**

- **Cytology** (Third Edition)  
**Diagnostic Principles and Clinical Correlated**  
*Edmund S. Cibas, MD, and Barbara S. Ducatman, MD*
- **Basics of pathology & diseases**  
**A.H nagi**



# ***Hematotechnology Major***



**Introduction to Haematology**

- Review of vascular system and Blood constituents

**Anatomy of Bone marrow and haematopoiesis**

- Blood formation in the body (Intra-uterine and extra-uterine)
- Factors governing haematopoiesis
- Stages of normal cell maturation

**Safe methods of securing blood for analysis****Laboratory safety**

- Safe handling of specimens
- Risk of communicable diseases such as HCV & HBV
- Exposure to reagents having toxic or carcinogenic nature

**Quality control in Haematology and blood bank**

- Internal quality control measures
- External quality assessment

**Quality Assurance**

- Preanalytical, Analytical and Postanalytical Components
- Proficiency Testing
- Establishment of Quality Control Limits
- Interpretation of Quality Control Charts
- Bulls Testing Algorithm
- Monitoring QC with Patient Specimens
- Detection of abnormal Test Results And Delta Checks

**Anticoagulants for haematology tests**

- Chemical anticoagulants
- Preparation and use of important anticoagulants
- Anticoagulation in blood banking

**Estimation of Haemoglobin Concentration****Manual methods**

- Cyanmethaemoglobin (HiCN) method
- Preparation of Calibration curves



- Acid haematin and alkaline haematin method Oxyhaemoglobin method

**Automated methods**

- Other methods of haemoglobinometry

**Enumeration of Erythrocytes (RBCs)**

- General Principles of RBC count.
- Methods for estimation
- The hemocytometer, red cell pipette and diluting fluids
- Normal Values in different age groups.
- Automation of RBCs

**Haematocrit**

- Definition and principle of test procedures: Methods for estimation
- Correlation of hemoglobin, haematocrit, and erythrocyte count.

**Erythrocyte Sedimentation Rate**

- Principle and kinds of test procedures
- Normal values.
- Significance of abnormal Values.

**The Red Cell indices.**

- Mean Corpuscular Volume (MCV)
- Mean Corpuscular Haemoglobin (MCH)
- Mean Corpuscular Haemoglobin Concentration (MCHC)

**Preparation of Blood Smears.**

- Preparation, drying & staining of smears
- Types of Stains & methods for preparation
- Criteria for good smear
- Variation in haemoglobin content and staining properties

**Examination of stained smears:**

- Define differential count.
- Observation of erythrocytes
- Number of Platelets estimated.
- Tabulation of Leukocytes.
- Classification of leukocytes and normal ranges

**Reticulocyte Count:**

- Normal values for adults and infants.
- Means of demonstrating reticulocytes, principle of the staining reaction:  
Interpretation of findings & sources of error
- Preparation of stain

**Lab Diagnosis of Anaemias**

- Introduction to anaemias
- Tests for Iron deficiency anaemia
- Tests for megaloblastic anaemia
- Tests for aplastic anaemia

**Tests for hemolytic anaemia**

- Congenital
- Acquired

**Investigations for Membranopathies**

- Introduction
- Osmotic fragility test
- Sucrose lysis test
- Ham's test

**Investigations for Enzymopathies**

- Glucose –6-Phosphate dehydrogenase deficiency
- Pyruvate Kinase Deficiency

**Investigation of Abnormal Hemoglobins and Thalassaemia**

- Hb Electrophoresis
- Estimation of Hb F
- Demonstration of Heinz Bodies
- Tests for Hb S
- Demonstration of Hb H
- Tests for Unstable Hb

**Paroxysmal Nocturnal Hemoglobinuria .**

- Etiology and Pathogenesis
- Laboratory findings

**Acute Leukemia**

- Acute Lymphoblastic Leukemia



- Classification
- Lab Diagnosis
- Acute Myeloid Leukemia
- Classification
- Lab Diagnosis

**Myeloproliferative disorders**

**Chronic Myeloid Leukemia**

- Introduction
- Lab Investigations
- Diagnostic Criteria
- Differentiation from Leukemoid Reaction

**Polycythemia Vera**

- Introduction
- Classification
- Lab Investigations
- Diagnostic Criteria

**Essential Thrombocythemia**

- Introduction
- Lab Investigations
- Diagnostic Criteria

**Myelofibrosis**

- Introduction
- Lab Investigations
- Diagnostic Criteria

**Lymphoid Neoplasia**

- Chronic Lymphocytic Leukemia
- Introduction
- Lab Diagnosis
- Clinical Staging

**Introduction to Hodgkin and Non-Hodgkin Lymphomas**

- Classification
- Lab Diagnosis





**Myelodysplastic syndromes**

- Introduction
- Classification
- Lab Diagnosis

**Plasma cell dyscrasias**

- Introduction
- Multiple Myeloma & Lab Diagnosis
- Waldenstromes Macroglobulinemia
- Lab Diagnosis
- Light chain & heavy chain disease

**Tests to evaluate the Haematostatic status**

- Hess test
- Bleeding time by Duke's and Ivy's method
- Whole blood clotting time
- Prothrombin time (PT)
- Partial thrombolastin time (PTTK)
- Thrombin time
- Mixing studies
- Measurement of FDP & D-dimers
- Measurement of Fibrinogen
- Factor Assays

**Platelet Function studies**

- Aggregation patterns by ADP, Collagen, Adrenaline, Restocitin and Arachidonic acid

**Thrombophilia**

- Causes
- Lab Investigations

**Tests for non-malignant diseases of white cells**

- Tests for Infectious mononucleosis
- Monospot test
- Paul bunnell test



## **Bone Marrow Aspiration**

- Equipment required for the process
- Preparation of smears
- Processing & staining of bone marrow smears

## **Special stains in Haematology:**

- Sudan Black B
- MPO
- PAS
- Non-Specific Esterase
- Specific Esterase
- NAP Staining
- Acid Phosphatase
- Perl's stain

## **Bone Marrow Examination**

### **Bone marrow Aspiration**

- Procedure
- Staining of bone marrow smears
- Examination of Aspirated Bone Marrow smear
- Differential cell counts and Myelogram

### **Bone marrow Trephine biopsy**

- Bone marrow trephine needles
- Preservation of biopsy

## **Immunophenotyping**

- Instrumentation
- Sample Requirements
- Sample Processing
- Role in ALL, AML, CLL, Non-Hodgkin Lymphomas.

## **Introduction to Molecular Techniques**

- BCR-ABL RT-PCR
- Southern Blot Analysis in Lymphoproliferative Disorders
- FISH



# ***Histotechnology Major***



**Introduction And Theory Of The Light Microscope**

- Nature of light, Concepts of Wavelength and Phase. Perception of color and brightness. Refraction, formation of images. Simple and Compound microscope.

**Lenses of The Microscope:**

- Merits and Demerits of achromatic and apochromatic objectives. Immersion objectives. Specification of objective magnification, focal length, tube length, resolution, numerical aperture etc. Calculation of the resolution and magnification. Eye pieces, magnification of eye pieces use of eye piece micrometer. Condensers, correct use of condenser and the iris diaphragm.

**Microscope Illumination:**

- Use of illuminators. Alignment of illuminator with the microscope. Setting up koehele illumination setting up dark field illumination.

**Care and Cleaning of the Microscope:**

- Care of the mechanical parts. Care of the Optical parts. Techniques of cleaning the optical components.

**Introduction to common Histological Techniques:**

- Examination of fresh material. Supravital staining. Examination of fixed material.

**Fixation:**

- The purpose of fixation, common fixative used for the histological techniques.

**Tissue processing**

- Principles of Tissue processing
- Dehydration : Types with advantages and disadvantages
- Clearing: Types with advantages and disadvantages
- Impregnation : Types with advantages and disadvantages
- Schedule of manual and automated tissue processing with maintenance of processing machine.

**The Paraffin method of embedding and Sectioning of Tissue:**

- Advantages and disadvantages of the paraffin method. Paraffin block making. Fixing paraffin section to slides.



**Microtomy**

- Principles of Microtomy
- Types of microtome's and their uses
- Rocking microtome , Rotary Microtome, Sledge Microtome, Freezing Microtome, Cryostat, Ultra microtome

**Paraffin Sectioning :** Requirement and procedure

**Care of Microtome and Microtome Knives:**

- Grinding and stooping of microtome knives. Cleaning and lubrication of the microtome.

**The Frozen Section Techniques:**

- Theory of Frozen section techniques. Advantages and disadvantages of freezing method. Common techniques of freezing tissues. Cutting sections with a freezing microtome.

**Stains:**

- Object of staining. Classification of stains. Acids and basic dyes. Basophilic and acidophilic tissue components.

**Routine Hematoxylin-Eosin Staining Of Paraffin Sections:**

- Types of Hematoxylin-eosin staining
- The procedure of Hematoxylin-eosin staining and mounting sections.
- Progressive Hematoxylin-eosin staining, Regressive Hematoxylin-eosin staining
- The relation of various steps in this procedure.

**Special Staining Techniques**

**Stains for Connective Tissue Elements:**

- Mallory's connective tissue stain
- Aldehyde fuchsin stain for elastic fibers
- Aldehyde ducluxin stain for elastic fibers
- Toluidine blue staining of mast cells.

**Stains for Nervous Tissues:**

- Nissl Stain. Stains for myelin.

**Histochemical demonstration of lipids:**

- Choice of fixative. Choice of sectioning Technique. Sudan Black B, Oil Red O Stain. Staining for frozen section.



**Histochemical demonstration of glycogen:**

- Choice of fixative and sectioning Best's Carmine staining for paraffin sections.

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**The PAS Technique:**

- The Schiff reaction. Significance of the Schiff reaction. Procedure of the PAS staining.

**Stains for amyloid**

- Congo red
- Crystal violet for amyloid

**Stains for myelin**

- Luxol fast blue for myelin
- Nissel Stain for myelin

**Stain for iron**

- Perls Prussian blue stain for iron

**Stain for reticulin fiber**

- Retuculin methods for reticulin fiber

**Stain for AFB**

- Ziehl-Nelson stain for AFB

**Tumor Marker and Immunohistochemistry**

- Types of different tumor markers and their role in diagnosis. The background theory of IHC procedures. Immunohistochemistry techniques and introduction to various steps in this procedure. Quality control of the Immunohistochemistry procedures.

**Electron Microscopy**

- Brie history and basic concepts of Electron microscopy. Transmission and scanning Electron microscopy. The use of E/M in diagnosis and research.

**Autopsy Techniques**

- Procedure and stages of Autopsy techniques.

**Immunoperoxidase Procedures**

- General introduction of Immunoperoxidase. Merit of Immunoperoxidase staining and Quality assurance

**Immunoflorescent techniques**



- Principle and theory of immunoflorescent techniques. Role of this technique in research and diagnosis.

## **Special Gross Anatomical Techniques**

### **Preserving and mounting gross anatomical specimen:**

- Preservative fluids. Mounting specimens in fluid media. Mountings specimens in plastics.

## **Elementary Histology**

### **Tissues of the Body:**

- Concept of the tissues, organs and systems built out of cells as anatomical and functional units. The four basic types of tissues. Specialized morphological and functional characteristics of Epithelial Tissue, Connective Tissue, Muscular Tissue, Nervous Tissue.

## **Elementary Anatomy.**

- The purpose of this part of the course is to familiarize the student with the gross component parts of the various systems of human body. Reference is made to comparative anatomy of common laboratory animals.

### **Introduction to Gross Anatomy:**

- General organization of the body.
- Division into systems.
- Descriptive terms used in gross anatomy.
- Skeletal system:Subdivision, recognition of individual bones.
- Vascular system:Identification of gross components; heart and recognition of its chambers; recognition of the major arteries and veins.
- Respiratory system:Recognition of larynx, trachea, main bronchi, Main pulmonary vessels and lobes of the lungs.
- Digestive system:Parts of the G.I.T; liver, spleen, pancreas their recognition and locations.
- Genito-urinary system:Parts of the male and female reproductive and urinary systems their recognition and location.
- Nervous system: Gross components:Brain: Cerebrum, Brain stem, Spinal Cord, cerebellum.Nerves: Cranial, Spinal.



- Endocrine system: Location of the various endocrine glands and their recognition. *Not more than four MCQs and one SEQ will be from Elementary anatomy in the Morbid Anatomy & Histopathology paper*

### Recommended Books

- **Theory and Practice of Histological Techniques**  
John D. Bancroft, Marilyn Gamble
- **Clinical Pathology Interpretation**  
A.H Nagi
- **Atlas of Histology With Functional Correlations**  
Victor P. Eroschenko





# ***Immunology Major***



**Basic Immunology****Innate Immunity and Inflammation****Components of the non-specific immune system**

- Mechanical barriers
- Chemical and biochemical barriers
- Biology of NK cells, Polymorphonuclear phagocytes, macrophages, and other major cellular components in the innate immunity
- Phagocytosis
- Opsonization
- Receptors and molecules: Cytokines, Pathogen recognition; Toll like receptors, Fc receptor
- Complement system and pathways
- Self and non-self antigens
- Molecular and cellular mechanisms involved in inflammation

**Specific Acquired Immunity****Immunoglobulins (Ig)**

- B-Cell maturation, activation, differentiation and memory
- The B-cell receptor
- Phases of humoral immune response
- Basic structure of antibodies
- Antibody binding site (CDRs)
- Antibody-mediated effector functions
- Antibody classes and biological functions
- Serological analysis of antibodies : **Isotype, Allotype, Idiotype**
- Antibody diversity
- Ab gene and repertoires
- Antibody class switching
- Ab Affinity Maturation
- B cell responses
- Primary and secondary immune response



**The lymphoid system**

- Haemopoietic stem cells, growth factors, lymphoid progenitors
- T cell development, activation and differentiation
- Clonal selection theory
- T-Cell antigen receptor (TCR)
- T-cells subpopulation (T helper/Cytotoxic cells)
- Antigen presenting cells/ Dendritic cells
- How the Immune System recognises self and non-self:
- Structure and function of MHC molecules
- MHC genes
- Antigens recognition: T-dependent and T-independent antigens
- Antigen processing and presentation pathways
- Endogenous Antigen: The cytosolic pathway
- Exogenous Ags: The endocytic pathway
- Cell-cell communication in the immune system
- Cross presentation
- HLA/ MHC restriction
- Mixed lymphocyte reaction (MLR)
- Molecular basis of immune recognition: Regulation and structure of genes and proteins that function in specific immune recognition
- The Role of Toll-Like Receptors in the Immune System
- Regulatory T lymphocytes

**Medical Immunology**

- Infections and immunopathology
- Hypersensitivity reactions
- Transplantation
- Autoimmunity
- Immunodeficiency
- Tumor Immunology
- Clinical Uses of Hematopoietic Stem Cells



**Advanced Practical Immunology/ Application of Immunology in Diagnostic and Research**

**Practical Immunology**

- Production of Chimeric and Hybrid Monoclonal Antibodies
- Antibody Engineering (Chimeric, hybrid, humanized)
- Antibody Labelling (Enzymes, Fluorochromes, Radioactive elements)
- Coating of microwells with Ab
- Coating of Ab to particles (RBCs, latex etc)
- Coating of Ag to particles
- Development Of immunodiagnostic kits
- Monoclonal antibodies, applications in biomedical research, clinical diagnosis and treatment
- Role of the Major Histocompatibility Complex in Mate Choice
- Methods of vaccine production (Bacterial Superantigens DNA vaccines / Recombinant Vector Vaccines)
- Animal Models in Immunology
- Types and use of Mice in Immunological Research (knock-out, Transgenic mice etc.)
- Evaluation of Complement function
- Evaluation of cellular immunity
- Evaluation of Humoral immunity
- HLA Typing
- Allergy Diagnosis
- Immunophenotyping of leukemias and lymphomas
- Immunopharmacology (use of cytokines, cells, antibodies as treatment options)

**Immunological Techniques**

- Quality control in diagnostic immunology
- Agglutination
- ELISA



- RIA
- Immunoélectrophorèses/ SDS-PAGE
- Western blotting/Immune blot
- Complement; hemolytic assay (CH50)
- Chemiluminescence
- Immunofluorescence techniques
- Immuno electromicroscopy
- Immunochemistry
- Flowcytometry
- Tissue culture techniques
- Introduction to advance molecular techniques (RNAi, microarray etc)



***Laboratory  
Management  
&  
Research  
Methodology***



### Laboratory Management Sciences

- Introduction to Health Facility, Management & Standards of Laboratory Practice
- Laboratory Infrastructure & Resources
- Quality Laboratory Management Systems
- Laboratory Safety
- Laboratory Commodity Management
- Laboratory Management of Information Systems
- Systemic approach to specimen Management & Processes
- Systemic approach to Laboratory processes
- Support Supervision
- Data Interpretation & its Commutation
- Effective administration of Laboratory Services
- Defining Standards of performance
- Budget Processing
- Document control through complaints
- Control of Records, Internal Audits & Management Review

### Research Methodology

- Types of measurement
- Types of variables Dependent / Independent
- Development of Research Questions
- Development of Research Hypothesis
- Type of Experimental Design
- Concepts of Parametric & Non parametric Statistics
- Probability and Significance
- Standard Deviation
- Confidence Limits
- T-Test
- F-Test
- Analysis of Variance



- Chi Square
- Linear & Other Regression
- Difference Plots
- Sensitivity
- Specificity
- Predictive Values
- Odds Ratio
- Assessing the Efficiencies of a Test
- Cluster Discriminant function & trend analysis
- Multiples of Median (MOM)

### **Communication Skills**

- Definition, Elements, Process, Purpose, Qualities & Barriers
- Oral Communication: Public Speaking, Persuasion, Interviews, Committee Meetings, & Tutorial Discussion
- Listening Skills: Efficient Listening, Barrier
- Writing Skills: Essay, Correspondence, Reports, Summary
- Reading Skills: Efficiently Reading, Barriers, Skimming, Scanning & Steady Reading
- Visual Communication: Chalkboard, transparencies, Stencils, Slides
- Public Communication: Public Relations, advertising
- Source of Information: Questionnaires, Library, Observation, Experiments.





# ***Microbiology Major***



**MICROBIOLOGY MAJOR**

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- Nature of Microorganisms
- Classification of Microbes
- Prokaryotes & Eukaryotes
- Bacterial Anatomy
- Bacterial Physiology
- Sterilization & Disinfection
- Bacterial Genetics
- Immunology/Serology
- Antimicrobial Sensitivity Testing Techniques

**Bacteriology**

- Staphylococci
- Streptococci & Pneumococci
- Neisseria
- Corynebacterium & Lactobacillus
- Mycobacteria: Myco. tuberculosis, Myco. leprae
- Actinomyces & Nocardia
- Clostridia
- Genus: Bacillus
- Enterobacteriaceae
- Vibrionaceae & Pseudomonas
- Pasteurella group: Yersinia: Pasteurella: Francisella
- Brucella
- Haemophilus
- Bordetella
- Spirochaetes
- Treponema: Borrelia: Leptospira
- Chlamydia
- Mycoplasma
- Misc. Bacteria: Listeria, Erysepalothrix, Bacteroides, Bartonella
- Rickettsiae



**Parasitology**

- Introduction to Parasites
- Intestinal Protozoa
- Helminthes
- Blood & Tissue Parasites
- Nematodes
- Cestodes

**Microbiological Techniques**

- Microscopy
- Staining Methods
- Culture Media & their preparation
- Methods for Anaerobic Culture
- Common Culture Methods
- Serological Techniques
- Collection, Transport & Processing of Microbiological Specimens
- Biochemical Testing of Microorganisms
- Microbiological Examination of Water, Milk & Food Specimens

**Immunological Techniques**

- Antigens
- Antibodies
- Various Ag , Ab reactions & their clinical applications
- Agglutination
- Precipitation
- ELISA
- RIA
- Complement fixation
- Immunoflourscence

**Virology**

- General Introduction of Viruses
- Serological Diagnosis of viruses
- Herpes Viruses
- Hepatitis C Virus



- Hepatitis B Virus
- Hepatitis A Virus
- Rota Virus
- HIV Virus
- Rubella

**Mycology**

- Introduction to Fungi
- Basic Morphology of Fungi
- Moulds: Dermatophytes
- Yeasts
- Dimorphic Fungi
- Miscellaneous Fungal Infection
- Mycetoma: Aspergillosis: Mycotoxins



***Molecular Pathology***  
**&**  
***Cytogenetics***  
***Major***



**Nucleic Acid**

- DNA structure
- DNA replication
- RNA structure and types
- RNA transcription and Gene expression
- RNA processing
- Translation and Post-translational processing
- Organization of Human Genome
- Genetic code
- DNA variations and Mutations

**Mode of Inheritance**

- Mendelian Mode of Inheritance
- Complications of the basic mendelian pattern
- Multifactorial mode of inheritance
- Pedigree construction
- Hardy Weinberg Equation and Factors affecting the gene frequencies

**Volume/Weight measurement**

- Volume measurement
- Weight measurement

**Concentration measurement**

- Spectrophotometry
  - i. Principles of spectrophotometry
  - ii. Component of spectrophotometer
  - iii. Understanding results
  - iv. Trouble shooting
- Quantification of Nucleic acid
- Quantification of Proteins
- Gel based quantification of Proteins and Nucleic acid

**Equipping and Establishing a PCR Laboratory**



**Reagent Preparation**

- Accuracy of weighing and Pipetting
- Use of calibrated pH meter
- Avoiding contamination of reagents
- Making buffer solutions

**Extraction and concentration of Nucleic Acid**

- DNA Extraction from Blood
- DNA Extraction from Tissue
- DNA Extraction from Saliva
- Extraction of DNA from Microdissected Archival Tissues
- DNA Extraction from Plasma and Serum
- DNA Extraction from Fungi, Yeast, and Bacteria
- Extraction of Ancient DNA
- RNA Extraction from Blood
- RNA Extraction from Frozen Tissue
- RNA Extraction from Tissue Sections
- Dual DNA/RNA Extraction
- Isolation of RNA Viruses from Biological Materials

**Electrophoresis**

- Agarose gel electrophoresis
- SDS-Polyacrylamide Gel electrophoresis (SDS-Page)
- Staining protein gels
- Digital electrophoresis analysis
- Other electrophoresis techniques

**Nucleic Acid Hybridization:**

- Principles of Hybridization
- Southern blotting
- Northern blotting
- Immunoblotting/Dot and Slot Blotting o
- Labeling DNA and preparing probes
- Microarray based hybridization



- FISH & ISH
- Other techniques of blotting

**Polymerase Chain Reaction**

- Basics of PCR/Principles of PCR
- Thermal Cycler machine
- Primer Designing
- Reagent preparation
  - i. dNTP stock
  - ii. PCR reaction buffer
  - iii. Primer dilution
- Optimization of PCR cycling condition
- Different PCR techniques & Applications
- Contamination control and Trouble shooting

**Real Time PCR**

- Principles of RT PCR
- RNA isolation
- cDNA generation
- Primer designing
- Probes designing
- Fluorescent dyes for monitoring real time amplification
- Nested RT-PCR
- Real time PCR analysis & quantification
- Applications of RT PCR

**DNA Sequencing**

- DNA sequencing by Dideoxy (Sanger) Method
- DNA sequencing by Chemical (Maxam-Gilbert) Method
- Denaturing Gel Electrophoresis for Sequencing
- Next Generation Sequencing
- Emerging Sequencing Techniques

**DNA Libraries**

**Enzymatic Manipulation of DNA and RNA/Restriction Fragment Length**

**Polymorphism**





**Genetic Mapping of Mendelian Characters**

**Mapping Genes Conferring Susceptibility to Complex Diseases**

**Association Studies and Linkage disequilibrium**

**Identifying Human Disease Genes and Susceptibility Factors**

- Positional Cloning
- Candidate Gene Approach
- Positional Independent Routes to Identifying Disease Genes
- Genome wide Association studies
- Emerging Molecular techniques

**Cancer Genetics**

- Oncogenes
- Proto-oncogenes
- Cell cycle dysregulation in Cancer
- Fusion genes
- Molecular Markers of Angiogenesis and tumorigenesis
- Molecular technique used in cancer diagnosis

**Single Nucleotide Polymorphism analysis**

**Restriction Length polymorphism analysis**

**Current and Emerging Techniques for Diagnostic Mutation Detection**

**Molecular diagnosis of infectious and parasitic diseases**

**Pre-natal and Pre-implantation Genetic Diagnosis**

**Chromotography**

**CYTOGENETICS**

- Introduction to Cytogenetics and the objectives of a clinical Cytogenetics services.
- Chromosome structure and functions
- ISCN(International System for Human Cytogenetic Nomenclature) of G-banded chromosomes
- Preparation of Human Tissues for Cytogenetics studies:



- i. Peripheral blood cell culture and harvesting techniques
  - ii. Bone Marrow cell culture and harvesting techniques
  - iii. Solid organs cell culture and harvesting techniques
  - iv. Amniotic Fluid and Chorionic villi sample culturing techniques
- Chromosome slide making techniques
  - G-banding of Chromosomes
  - Other banding techniques
  - Molecular Cytogenetics
    - i. Fluorescence in Situ Hybridization principles and techniques
    - ii. Principles of Comparative Genome Hybridization
    - iii. Principles of Microarray technique
  - Use of database and Computer Assisted Analysis/Image Reproduction
  - Trouble shooting and laboratory management



# ***Chemical Pathology Minor***



**Specimen Collection and Processing**

- Patient preparation for tests
- Phlebotomy techniques and guidelines
- Collection of samples
  - Blood
  - Urine
  - Faeces
- body fluids and preservation
- transport of samples
- Anticoagulants
- Preservatives
- Problems associated with lipemic
- Hemolytic and icteric samples

**Quality Assurance and Lab Management**

- Basic Concepts and Definitions
- Internal and External Quality Control Program
- Pre-analytical, Analytical and Post-analytical Errors
- Westgard rules
- Identifying sources of Analytical Errors
- The role of statistics in analytical work
- Sources of variation in analytical work
- Selection of Analytical Methods
- Basic concept of Lab Management
- Human Resource Management

**Reference Values**

- Basic Concepts
- Clinical significance
- Application
- Critical values drawing attention to abnormal results



**Proteins**

- Names of Plasma Proteins
- Methods of determination of Proteins in
  - Serum
  - CSF
  - Urine
- Principles of the methods
- Interferences and interpretation
- Significance of urinary proteins
- Serum protein electrophoresis

**Clinical Enzymology**

- Basic Concepts and Definitions
- Method of measurement of different enzymes in serum
- Factors effecting enzyme measurements
- Interpretation of following enzymes

**Liver enzymes**

- Aspartate aminotransferase
- Alanine aminotransferase
- Alkaline phosphatase

**Cardiac and Skeletal Enzymes**

- Creatine kinase
- lactate dehydrogenase
- Isoenzymes of creatine kinase
- Isoenzymes of lactate dehydrogenase
- Aldolase

**Biliary Tract Enzymes**

- 5-nucleotidase
- Gamma glutamyl transferase

**Digestive Enzymes of Pancreatic Origin**

- Amylase
- Lipase
- Trypsin



- Chymotrypsin

**Carbohydrates**

- Definition and causes of hyperglycemia
- Definition of Diabetes Mellitus
- Criteria for diagnosing Diabetes Mellitus
- sample collection and processing for blood glucose determination
- Methods for determination of blood glucose
- Method interferences and interpretation
- Reference intervals
- Self- monitoring of the blood glucose
- Definition of glycosuria
- Methods of determination of urinary glucose
- Names of ketone bodies
- Methods for determination of ketone bodies in
  - serum
  - urine
- Names of different glycated proteins
- Methods of determination of glycated proteins
- Definition of hypoglycemia
- Lab diagnosis of hypoglycemia

**Lipids, Lipoproteins, and Apolipoproteins**

- Definition
- Sample collection for lipid profile
- Methods of determination of lipids
- Lipoproteins
- Apo-lipoproteins
- Sources of variation in lipid and lipoprotein measurement
- Reference intervals

**Electrolytes and Blood Gases**

- Methods for determination of electrolytes
- Method interferences
- Determination of plasma and Urine Osmolality



- Sweat Testing
- Principle of methods for determination of Blood Gases and pH

**Liver Function**

- Biochemical Functions of the Liver
- Interpretation of Liver function Tests
- Methods of determination of serum bilirubin
- Methods of determination of liver enzymes
- Method interferences

**Cardiac Markers**

- Names of different cardiac markers
- principle of methods for determination of cardiac markers
- Lab diagnosis of Myocardial Infarction

**Renal Function and Nitrogen Metabolites**

- Renal Function Tests
- principles of methods for determination of serum
  - Creatinine
  - Urea
  - Uric acid
- Method interferences and interpretation
- 24-hour urine collection, Methods for determination of creatinine clearance
- Detailed Biochemical Analysis of Urine

**Gastric, Pancreatic, and Intestinal Function**

- Basic Anatomy, Physiology and Definitions
- Gastrointestinal Hormones
- Enzymes of the Gastrointestinal
- Tests Measuring the Exocrine Function of the Pancreas
- Pancreatic and Intestinal Diseases
- Reference Value & Principles of Analysis

**Mineral and Bone Metabolism**

- Principle of methods for determination of
  - Calcium
  - Phosphate



- Magnesium
- Names of the hormones Regulating Mineral Metabolism
- Reference Value & Principles of Analysis

### **General Endocrine Function**

- Actions of Hormones
- Regulation of Hormone Secretion
- Biorhythms
- Hormone Receptors
- Principles of different techniques of hormone measurement

### **Pituitary Function Tests**

- Tests used to evaluate pituitary functions

### **Thyroid Function Tests**

- Definition, causes and lab diagnosis of Hyperthyroidism
- Definition, causes and lab diagnosis of Hypothyroidism
- Principles of methods for determination of T<sub>3</sub>, T<sub>4</sub>, TSH and their interpretation

### **Parathyroid Gland**

- Principles of methods for determination of PTH and interpretation

### **Adrenal Gland**

- Adrenocortical Steroids
- Names of hormones of the Adrenal Cortex
- Names of hormones of the Adrenal Medulla
- Principles of methods for determination of Adrenal hormones
- Methods for determination of Catecholamines and Metabolites

### **Lab Diagnosis of Male and Female Infertility**

- Tests to diagnose male and female infertility and their interpretation

### **Inborn Errors of Metabolism**

- Names of inborn errors of metabolism
- Lab diagnosis of common inborn errors of metabolism

### **Tumor Markers**

- Introduction and classification of Tumor Markers
- Clinical Applications of Tumor Markers
- Tests for the determination of tumor markers





# ***Cytotechnology Minor***



**Techniques In Cytotechnology****Light optical microscopy**

- Image formation
- Koehler illumination

**Virtual microscopy****Virtual slide acquisition**

- Equipment for slide acquisition
- Acquisition speed
- Virtual slide quality
- Focus planes
- Applications

**Automation in cervical cytology**

- Historical attempts at Automation
- The rationale of automation
- Cytology automation: accuracy and productivity
- Currently available automation platforms
  - iii. Liquid – based preparation
  - iv. Automated screening devices

**Immunocytochemistry**

- Immunocytology techniques
  - ii. The specimen
- Interpretation and limitations of ICC
- Effusion Cytology

**Molecular Techniques**

- Molecular Techniques in cytopathology
  - vii. Fluorescence in Situ hybridisation
  - viii. Polymerase chain reaction
  - ix. Microsatellite analysis
  - x. Laser microdissection
  - xi. Promoter methylation analysis



xii. Hybrid capture system

➤ Applications in cytology

Improved diagnosis and classification of cancer

**Basic Structure and Function of Mammalian Cells**

**The Molecular Basis of Neoplasia**

ix. Principles of Malignant Transformation

x. Cancer-related Genes

xi. The Major Pathways of Carcinogenesis

**Basic Cytogenetics and the Role of Genetics in Cancer Development**

➤ Methodology

iv. The Karyotyping

v. Fluorescent in Situ Hybridization

vi. Comparative Genomic Hybridization (CGH)

➤ Acquired Chromosomal Aberrations in Cancer

v. Introduction

vi. Lymphomas

vii. Sarcomas

viii. Thyroid Carcinomas

➤ Clinical Applications of Conventional Cytogenetics and Fish in Cytology

iv. Introduction

v. FISH Strategy

vi. Application

**Cytologic Screening Program**

xiii. Principles of screening

xiv. Cervical Cancer and Screening

xv. Cervical Cancer Incidence and Mortality Worldwide

xvi. Efficacy of Screening

xvii. Design of Screening Programs

xviii. Features of Successful Screening Programs

xix. Limitations of Screening Programs

xx. The Role of Laboratory in Screening Programs

xxi. Early Detection of Cancer in Other Sites



- xxii. New Developments in Cytological Screening
- xxiii. Liquid-Based Cytology (LBC)
- xxiv. Automated Cytology

#### **Diagnostic Quality Assurance in Cytopathology**

- x. Quality Assurance Measures
- xi. Laboratory Directors
- xii. Cytotechnologists
- xiii. Preparation, Fixation, and Staining Procedures
- xiv. Laboratory Records, Logs, and
  - Internal Quality Assurance Mechanisms
    - Rapid Re-evaluation
  - Computer-Assisted Quality Assurance Mechanisms
  - External Quality Assurance Mechanisms

#### **Evaluation of the Sample in Smears and Liquid-Based Preparations**

- Cervicovaginal Cytology
  - v. Specimen Type
  - vi. Patient Identification
  - vii. Clinical Information
- viii. Microscopic Evaluation
  - Nongynecological Cytology
- iv. Specimen Type
  - v. Specimen Cross-Contamination
  - vi. Specimen Mishandling

#### **Diagnostic cytology**

- The Bethesda system for reporting cervical cytology
- The Bethesda system: Historical perspective
- The 2001 Bethesda system
- Report format
- Specimen adequacy
- General categorization
- Interpretation /result
- Automated review



- Interobserver reproducibility in cervical cytology
- The Bethesda system for reporting anal – rectal cytology

### **Microbiology, Inflammation and Viral Infections**

- Vaginal microbiology
- Infection of the female genital tract
- Bacterial infections
- Viral infections
- Chlamydial infection
- Fungal infection
- Parasitic infection

### **Systemic Cytopathology**

#### **Benign Proliferative Reactions, Intraepithelial Neoplasia, and Invasive Cancer of the Uterine Cervix**

- The normal uterine cervix
- Benign proliferative reactions
- Squamous intraepithelial neoplasia
- Papanicolaou classification
- Dysplasia
- Cervical intraepithelial neoplasia
- Invasive cancer of the uterine cervix
- Microinvasive carcinoma
- Invasive cervical carcinoma
- Efficacy of cervical cytology in the detection of cervical abnormalities

#### **Glandular Lesions of the Uterine Cervix**

- Endocervical canal normal histology and cytology
- Endocervical adenocarcinoma in Situ
- Endocervical adenocarcinoma
- Atypical glandular cells

#### **Peritoneal Washings and Ovary**

- Peritoneal Washings
- Sampling techniques
- Specimens



- Cytology

**Respiratory Tract**

- Sampling and cytopreparatory techniques
- Sputum
- Bronchoscopy
- Fine needle aspiration
- Cytology of normal and benign components
- Cytology of respiratory infections
- Diagnostic accuracy

**Urinary Tract**

- Screening for bladder cancer
- Examination of symptomatic patients
- Sample techniques
- Sample collection
- Bladder washing
- Aspirates washing, brushing and cell blocks of ureters and renal pelvis
- Sample preparation

**Central nervous system**

- Preparatory methods
- Cerebrospinal fluid
- FNA biopsy
- Normal cerebrospinal fluid and histology
- Infectious fluid

**Cytology of Soft Tissue, Bone, and Skin**

- Morphologic approach to soft tissue lesions
- Grade
- Lipoma & Liposarcoma

**Bone Lesions**

**Cartilage Tumors**

**Osteogenic Tumors (cytology of)**

**Hematopoietic Tumors**



**Skin**

Techniques

**Pleural , Peritoneal, and Pericardial Effusions**

**Sampling Technique**

- Collecting Serous Effusions
- Gross Appearance of Serous Effusions

**Cytopreparatory Technique**

- Preliminary Steps
- Wet-Film Technique
- Permanent Smears
- Cell Block Technique
- Usefulness of Stained Wet Films
- Usefulness of Cell-Block Preparations

**The Serous Cavities**

**Types of Effusions**

- Transudates and Exudates

**Normal Cells**

- Range of Normal Cells
- Mesothelial Cells

**Red Blood Cells**

**Neutrophil Leukocytes**

**Eosinophilic Leukocytes**

- Eosinophilic Pleural Effusion
- Eosinophilic Peritoneal Effusion
- Eosinophilic Pericardial Effusion

**Basophil Leukocytes and Mast Cells**

**Histiocytes (Macrophages)**

**Lymphoid Cells**

- Megakaryocytes

**Detached Ciliary Tufts**

**Non-neoplastic Effusions**

**Systemic Lupus Erythematosus**



**Neoplastic Effusions**

- General
- Identification of Neoplastic Cells
- Differential Diagnosis of Types of Neoplasms and Determination of Primary Sites of Neoplasms

**Adenocarcinoma**

- Cell Clusters
- Vacuolation of Adenocarcinoma Cells

**Squamous Cell Carcinoma**

**Small-Cell Anaplastic Carcinoma**

- Urothelial Carcinoma
- Melanoma

**Mesothelioma**

- Morphologic Variants

**Special Techniques**

- Electron Microscopy
- Histochemistry
- Immunocytochemistry

**Reporting of Results and Statistics**

- Reporting
- Reliability of Positive and Negative Reports

**Fine-Needle Aspiration Biopsy Techniques**

- History of Aspiration Biopsy
- Clinical Skills Required

**The needle Aspiration Method**

**Aspiration Technique**

**Staining techniques**

- Papanicolaou Stain
- Rapid Papanicolaou Stain<sup>46</sup>
- Diff-Quik Stain Set

**Other Techniques**

- Cell Block Preparation





- Preparation of Cytospins for Tumor Markers<sup>60</sup>
- Saponization
- Supravital Stain
- Immunostaining of Cytospins Using the Autostainer

### **Thyroid**

- The Thyroid Nodule
- FNA Technique

### **Lymph Nodes: Cytomorphology and Flow Cytometry**

#### **Techniques**

- Collection and Cytologic Preparation

#### **Normal Lymph Node: Structure and Immunophenotypes**

- Histology
- Cytology

#### **Non-neoplastic Lymphadenopathy**

- Viral Infections
- Granulomatous Lymphadenitis

#### **The Classification of the Lymphoid Neoplasms**

#### **Challenges and Diagnostic Pitfalls in Lymph Node Cytology**

### **Breast**

- Limitations of FNA of the Breast
- Role of FNA in the Era of CNB
- Accuracy, False-Negative and False-Positive Rates, and the Triple Test

#### **Technique**

- Cell Block Preparation
- Liquid-based Cytology
- Complications of FNA of the Breast

#### **Recommended Book:**

- **Cytology** (Third Edition)  
**Diagnostic Principles and Clinical Correlated**  
*Edmund S. Cibas, MD, and Barbara S. Ducatman, MD*
- **Basics of pathology & diseases**  
**A.H Nagi**



# ***Forensic Sciences Minor***



**Course Objectives:**

- This course will provide an introduction to forensic science, the history and overview of disciplines. Students will be introduced to the theory, concepts, and practices used in the analysis of biological and physical evidence, analysis of drugs, forms of trace evidence, document examination, and identification of biological fluids, personal identification, and chain of custody procedures, the forensic laboratory, and fundamentals of crime scene investigations. Guest lectures and visits to forensic laboratories will be arranged to cover selected topics.

**Introduction to Forensic Sciences:**

- Forensic Pathology
- Crime Scene Evaluation
- Forensic Toxicology
- Forensic Odontology
- Forensic Biology.
- Basic Chemistry
- Forensic Physics
- Firearms and Ballistics
- Fingerprints
- The development of forensic science Laboratory;
- Physical science
- Biology
- Firearms analysis
- Document analysis
- Photographic analysis
- Methods used to compare copiers, Printers and fax machines

**Forensic Biology & Serology:**

- Serology; using blood type
- Biological Evidence and its type
- Blood testing and typing



- Analyzing blood stains and stain patterns; locating, collecting and preserving blood evidence
- Semen analysis in rape and other sexually related crimes
- The structural components of DNA; base pairing, replication
- Polymerase chain reaction
- DNA Fingerprinting.
- Blood-type and DNA
- Technological advances in DNA analysis

### **Crime Scene Investigation:**

- Processing and photographing a crime scene
- Types of evidence, collecting, cataloging and preserving evidence
- Instruments comprising the crime scene kit
- How investigators process, secure, isolate and record crime scene evidence using a Variety of sophisticated techniques
- Understanding the role of Medical examiner, Odontologist, anthropologist, Radiologist

### **Forensic Toxicology & Chemistry:**

- Basics of Organic Chemistry
- The psychological and physical factors contributing to drug dependence
- Characteristics of opiates, hallucinogens, depressants, stimulants, anabolic steroids and the so called “club drugs”
- Drug identification testing procedures
- Collecting and preserving drug evidence
- Measuring alcohol in the blood system
- Interpretative conclusions reached as a result of drug tests.

### **Introductory Forensic Pathology:**

- Death investigations
- Distinguishing the cause of death
- The role of pathologists
- Estimating time of death based on stages of decomposition
- Identifying homicide victims



**Practical's:**

- Techniques and instruments for examining organic evidence;
- theories and principles of chromatography
- spectrophotometry and mass spectrometry
- measurement and analysis tool
- explosives and poisons evidence
- how to determine the elemental composition of materials
- Using the compound, comparison, stereoscopic, polarizing and scanning electron microscopes;
- comparative analysis of microscopic evidence
- identifying and analyzing hair
- fiber and paint particles
- Extraction of DNA from various Sources
- Polymerase chain Reaction
- DNA genotyping/ Sequencing

**Recommended Book:**

1. Fundamentals of Forensic Science, Second Edition by Max M. Houck and Jay A. Siegel
2. Forensic DNA Typing, Second Edition: Biology, Technology, and Genetics of STR Markers by John M. Butler
3. CSI: Crime Scene Investigation: The Burning Season by Jeff Mariotte



# ***Histotechnology Minor***



**Special Gross Anatomical Techniques****Preserving and mounting gross anatomical specimen:**

- Preservative fluids. Mounting specimens in fluid media. Mountings specimens in plastics.

**Elementary Histology****Tissues of the Body:**

- Concept of the tissues, organs and systems built out of cells as anatomical and functional units. The four basic types of tissues. Specialized morphological and functional characteristics of Epithelial Tissue, Connective Tissue, Muscular Tissue, Nervous Tissue.

**Elementary Anatomy.**

- The purpose of this part of the course is to familiarize the student with the gross component parts of the various systems of human body. Reference is made to comparative anatomy of common laboratory animals.

**Introduction And Theory Of The Light Microscope**

- Nature of light, Concepts of Wavelength and Phase. Perception of color and brightness. Refraction, formation of images. Simple and Compound microscope.

**Lenses of The Microscope:**

- Merits and Demerits of achromatic and apochromatic objectives. Immersion objectives. Specification of objective magnification, focal length, tube length, resolution, numerical aperture etc. Calculation of the resolution and magnification. Eye pieces, magnification of eye pieces use of eye piece micrometer. Condensers, correct use of condenser and the iris diaphragm.

**Microscope Illumination:**

- Use of illuminators. Alignment of illuminator with the microscope. Setting up koeheler illumination setting up dark field illumination.

**Care and Cleaning of the Microscope:**

- Care of the mechanical parts. Care of the Optical parts. Techniques of cleaning the optical components.

**Introduction to common Histological Techniques:**

- Examination of fresh material. Supravital staining. Examination of fixed material.

**Fixation:**

- The purpose of fixation, common fixative used for the histological techniques.

### **Tissue processing**

- Principles of Tissue processing
- Dehydration : Types with advantages and disadvantages
- Clearing: Types with advantages and disadvantages
- Impregnation : Types with advantages and disadvantages
- Schedule of manual and automated tissue processing with maintenance of processing machine.

### **The Paraffin method of embedding and Sectioning of Tissue:**

- Advantages and disadvantages of the paraffin method. Paraffin block making. Fixing paraffin section to slides.

### **Microtomy**

- Principles of Microtomy
- Types of microtome's and their uses
- Rocking microtome , Rotary Microtome, Sledge Microtome, Freezing Microtome, Cryostat, Ultra microtome

### **Paraffin Sectioning :** Requirement and procedure

### **Care of Microtome and Microtome Knives:**

- Grinding and stooping of microtome knives. Cleaning and lubrication of the microtome.

### **The Frozen Section Techniques:**

- Theory of Frozen section techniques. Advantages and disadvantages of freezing method. Common techniques of freezing tissues. Cutting sections with a freezing microtome.

### **Stains:**

- Object of staining. Classification of stains. Acids and basic dyes. Basophilic and acidophilic tissue components.

### **Routine Hematoxylin-Eosin Staining Of Paraffin Sections:**

- Types of Hematoxylin-eosin stains
- Preparation of Hematoxylin-eosin stain
- The procedure of Hematoxylin-eosin staining and mounting sections.
- Progressive Hematoxylin-eosin staining, Regressive Hematoxylin-eosin staining
- The relation of various steps in this procedure.

### **Special Staining Techniques**





**Stains for Connective Tissue Elements:**

- Mallory's connective tissue stain
- Aldehyde fuchsin stain for elastic fibers
- Aldehyde fuchsin stain for elastic fibers
- Toluidine blue staining of mast cells.

**Histochemical demonstration of lipids:**

- Choice of fixative. Choice of sectioning Technique. Sudan Black B, Oil Red O Stain. Staining for frozen section.

**Histochemical demonstration of glycogen:**

- Choice of fixative and sectioning Best's Carmine staining for paraffin sections.

**The PAS Technique:**

- The Schiff reaction. Significance of the Schiff reaction. Procedure of the PAS staining.

**Stains for amyloid**

- Congo red
- Crystal violet for amyloid

**Stains for myelin**

- Luxol fast blue for myelin
- Nissel Stain for myelin

**Stain for iron**

- Perls Prussian blue stain for iron

**Stain for reticulin fiber**

- Reticulin methods for reticulin fiber

**Stain for AFB**

- Ziehl-Nelson stain for AFB
- Kinyoun (Cold Method) Method
- AFB Auramine-Rhodamine - Fluorescent Method

**Stain for melanin**

- Masson Fontana Staining

**Tumor Marker and Immunohistochemistry**



- Types of different tumor markers and their role in diagnosis. The background theory of IHC procedures. Immunohistochemistry techniques and introduction to various steps in this procedure. Quality control of the Immunohistochemistry procedures.

### **Electron Microscopy**

- Brief history and basic concepts of Electron microscopy. Transmission and scanning Electron microscopy. The use of E/M in diagnosis and research.

### **Autopsy Techniques**

- Procedure and stages of Autopsy techniques and sampling technique.

### **Immunoperoxidase Procedures**

- General introduction of Immunoperoxidase. Merit of Immunoperoxidase staining and Quality assurance

### **Immunoflorescent techniques**

- Principle and theory of immunoflorescent techniques. Role of this technique in research and diagnosis.

### **Recommended Books**

- **Theory and Practice of Histological Techniques**  
John D. Bancroft, Marilyn Gamble
- **Clinical Pathology Interpretation**  
A.H Nagi
- **Atlas of Histology With Functional Correlations**  
Victor P. Eroschenko



# ***Immunology Minor***



**Basic Immunology****Innate Immunity and Inflammation****Components of the non-specific immune system**

- Mechanical barriers
- Chemical and biochemical barriers
- Cellular Components (NK cells, Polymorphonuclear phagocytes, macrophages)
- Complement system and pathways
- Molecular and cellular mechanisms involved in inflammation

**Specific Acquired Immunity****Immunoglobulins (Ig)**

- B-Cell maturation, activation, differentiation and memory
- Basic structure of antibodies
- Antibody-mediated effector functions
- Antibody classes and biological functions
- B cell responses
- Primary and secondary immune response

**The lymphoid system**

- Haemopoietic stem cells, growth factors, lymphoid progenitors
- T cell development, activation and differentiation
- T-cells subpopulation (T helper/Cytotoxic cells)
- Antigen presenting cells/ Dendritic cells
- Structure and function of MHC molecules
- Antigens recognition: T-dependent and T-independent antigens
- Antigen processing and presentation pathways
- HLA/ MHC restriction
- Mixed lymphocyte reaction (MLR)
- Regulatory T lymphocytes

**Medical Immunology**

- Tumor immunology
- Hypersensitivity reactions



- Transplantation
- Autoimmunity
- Immunodeficiency
- Immunization

**Advanced Practical Immunology/ Application of Immunology in Diagnostic and Research**

**Practical Immunology**

- Monoclonal antibodies, applications in biomedical research, clinical diagnosis and treatment
- HLA Typing

**Immunological Techniques**

- Quality control in diagnostic immunology
- Agglutination
- Precipitation: Immunoélectrophorèses/ SDS-PAGE
- ELISA
- RIA
- Immunofluorescence techniques
- Western blot
- PCR
- Flowcytometry



***Molecular Pathology  
& Cytogenetics  
Minor***



### **Nucleic Acid**

- DNA structure
- DNA replication
- RNA structure and types
- RNA transcription and Gene expression
- RNA processing
- Translation and Post-translational processing
- Organization of Human Genome
- Genetic code
- DNA variations and Mutations

### **Mode of Inheritance**

- Mendelian Mode of Inheritance
- Complications of the basic mendelian pattern
- Multifactorial mode of inheritance
- Pedigree construction
- Hardy Weinberg Equation and Factors affecting the gene frequencies

### **Volume/Weight measurement**

- Volume measurement
- Weight measurement

### **Concentration measurement**

- Spectrophotometry
  - v. Principles of spectrophotometry
  - vi. Component of spectrophotometer
  - vii. Understanding results
  - viii. Trouble shooting
- Quantification of Nucleic acid
- Quantification of Proteins
- Gel based quantification of Proteins and Nucleic acid

### **Equipping and Establishing a PCR Laboratory**



## **Reagent Preparation**

- Accuracy of weighing and Pipetting
- Use of calibrated pH meter
- Avoiding contamination of reagents
- Making buffer solutions

## **Extraction and concentration of Nucleic Acid**

- DNA Extraction from Blood
- DNA Extraction from Tissue
- DNA Extraction from Saliva
- Extraction of DNA from Microdissected Archival Tissues
- DNA Extraction from Plasma and Serum
- DNA Extraction from Fungi, Yeast, and Bacteria
- Extraction of Ancient DNA
- RNA Extraction from Blood
- RNA Extraction from Frozen Tissue
- RNA Extraction from Tissue Sections
- Dual DNA/RNA Extraction
- Isolation of RNA Viruses from Biological Materials

## **Electrophoresis**

- Agarose gel electrophoresis
- SDS-Polyacrylamide Gel electrophoresis (SDS-Page)
- Staining protein gels
- Digital electrophoresis analysis
- Other electrophoresis techniques

## **Polymerase Chain Reaction**

- Basics of PCR/Principles of PCR
- Thermal Cycler machine
- Primer Designing
- Reagent preparation
  - iv. dNTP stock
  - v. PCR reaction buffer





vi. Primer dilution

- Optimization of PCR cycling condition
- Different PCR techniques & Applications
- Contamination control and Trouble shooting

### **Real Time PCR**

- Principles of RT PCR
- RNA isolation
- cDNA generation
- Primer designing
- Probes designing
- Fluorescent dyes for monitoring real time amplification
- Nested RT-PCR
- Real time PCR analysis & quantification
- Applications of RT PCR

### **DNA Sequencing**

- DNA sequencing by Dideoxy (Sanger) Method
- DNA sequencing by Chemical (Maxam-Gilbert) Method
- Denaturing Gel Electrophoresis for Sequencing
- Next Generation Sequencing
- Emerging Sequencing Techniques

### **DNA Libraries**

- Genomic DNA Libraries
- CDNA Libraries

### **Enzymatic Manipulation of DNA and RNA/Restriction Fragment Length Polymorphism**

### **Genetic Mapping of Mendelian Characters**

### **Cancer Genetics**

- Oncogenes
- Proto-oncogenes
- Cell cycle dysregulation in Cancer
- Fusion genes
- Molecular Markers of Angiogenesis and tumorigenesis
- Molecular technique used in cancer diagnosis



## Single Nucleotide Polymorphism analysis

## Restriction Length polymorphism analysis

## Current and Emerging Techniques for Diagnostic Mutation Detection

## Pre-natal and Pre-implantation Genetic Diagnosis

### CYTOGENETICS

- Introduction to Cytogenetics and the objectives of a clinical Cytogenetics services.
- Chromosome structure and functions
- ISCN(International System for Human Cytogenetic Nomenclature) of G-banded chromosomes
- Preparation of Human Tissues for Cytogenetics studies:
  - v. Peripheral blood cell culture and harvesting techniques
  - vi. Bone Marrow cell culture and harvesting techniques
  - vii. Solid organs cell culture and harvesting techniques
  - viii. Amniotic Fluid and Chorionic villi sample culturing techniques
- Chromosome slide making techniques
- G-banding of Chromosomes
- Other banding techniques
- Molecular Cytogenetics
  - iv. Fluorescence in Situ Hybridization principles and techniques
  - v. Principles of Comparative Genome Hybridization
  - vi. Principles of Microarray technique
- Use of database and Computer Assisted Analysis/Image Reproduction
- Trouble shooting and laboratory management



# ***Transfusion Medicine Minor***



**Requirement of a standard blood bank**

- Area
- Staff
- Equipment
- Reagents

**Donors**

- Donor selection criteria
- Collection techniques
- Adverse reactions

**Processing**

- Labeling
- Storage of blood
- Screening for Transfusion transmitted disease

**Storage**

- Anticoagulants/preservatives
- Storage/refrigeration requirements
- Transportation
- Properties of stored products

**Blood Components**

- Red blood cells
- Fresh frozen plasma
- Cryoprecipitated AHF
- Platelets
- Plasma
- Leukocyte-reduced components
- Red blood cells deglycerolized
- Apheresis products
- Whole blood
- Washed red blood cells
- Gamma irradiated components



- Hematopoietic progenitors

**Autologous Donors**

**Quality Assurance**

- Blood samples
- Reagents
- Test procedures

**Blood Group Systems**

**Genetics**

- Basic
- Molecular
- Inheritance of blood groups

**Chemistry, Antigens**

- ABO
- Lewis
- Rh
- MNS
- P, Globoside
- Ii
- Kell
- Kidd
- Duffy
- Lutheran
- Other
- Antigens of high incidence
- Antigens of low incidence
- HLA
- Platelet specific
- Granulocyte specific

**Immunology**

**Immunoglobulins**

- Classes and subclasses
- Structure



- Biologic and physiochemical

**Antigen-Antibody Interactions**

- Principles
- Testing
- Principles
- Methods

**Complement**

- Classical and alternative pathway mechanisms
- Biologic properties

**Serologic and Molecular Testing**

**Routine Tests**

- Blood grouping tests
- Compatibility tests
- Antibody detection
- Crossmatch
- Antibody identification/clinical significance
- Antiglobulin testing
- Direct and indirect

**Reagents**

- Antiglobulin sera
- Blood grouping sera
- Reagent red cells

**Application of Special Tests and Reagents**

- Enzymes
- Enhancement media
- Lectins
- Adsorptions
- Elutions
- Titrations
- Solid phase
- Column agglutination test
- Microtechniques



**Adverse Effects of Transfusion**

- RBC/platelet destruction
  - Physiology
  - Detection (serologic, biochemical, clinical)
- Leukocyte/plasma protein reactions
- Nonimmunologic reactions
- Disease transmission
- Graft vs. host disease

**Investigations of Haemolytic Transfusion reactions**

