

LPUNEST (Ph.D.) Syllabus

Ph.D. in Medical Laboratory Science

UNIT I — Clinical Biochemistry

Biomolecules and their interactions: Structure and function of carbohydrates, proteins, lipids, nucleic acids, vitamins and minerals; energetics and regulation of glycolysis, Krebs cycle, HMP shunt, glycogenesis and glycogenolysis; transamination and deamination; urea cycle; fatty-acid synthesis and oxidation; de novo and salvage synthesis and metabolism of purines and pyrimidines; role of vitamins and minerals; diseases and inborn errors associated with biomolecule metabolism; enzymes and enzyme kinetics.

Organ function tests: Liver function tests, kidney function tests, pancreatic function tests, thyroid function tests and cardiac function tests.

Cell signalling: Endocrine system and hormones; hormone receptors; cell-surface receptors; cellular signalling and signal-transduction pathways; G-protein-coupled receptors; receptor tyrosine kinases; G proteins; Ras and Rho family signalling; primary and secondary messengers.

UNIT II — Haematology and Haemostasis

Haematopoiesis: Stem cells and regulation of haematopoiesis; erythropoiesis, granulopoiesis and thrombopoiesis; structure, function and metabolism of blood cells; haemoglobin synthesis and degradation; iron metabolism.

Red-cell disorders: Classification, pathophysiology and laboratory diagnosis of anaemias; iron-deficiency, megaloblastic, haemolytic and aplastic anaemias; haemoglobinopathies and thalassaemias; red-cell membrane and enzyme defects.

White-cell disorders: Reactive leucocyte disorders; acute and chronic leukaemias; myeloproliferative neoplasms; myelodysplastic syndromes; lymphomas and plasma-cell disorders.

Haemostasis: Platelet physiology and function; coagulation pathways and factors; fibrinolytic system; inherited and acquired bleeding disorders; thrombosis and thrombophilia.

Haematological techniques: Automated blood-cell analysis; peripheral blood-film examination; reticulocyte count; ESR; haemoglobin estimation and haemoglobin electrophoresis/HPLC; bone-marrow aspiration and examination; cytochemistry; PT, aPTT, thrombin time, fibrinogen and D-dimer assays; coagulation-factor assays; flow cytometry and immunophenotyping.

UNIT III — Clinical Microbiology and Immunology

General microbiology: Nutritional requirements and nutritional types of microorganisms; culture media and their types; growth curve; continuous culture and synchronous growth; influence of environmental factors on growth; aerobic and anaerobic cultures.

Sterilisation, disinfection and biosafety: Physical and chemical agents of sterilisation and disinfection; minimum inhibitory concentration (MIC); minimum bactericidal concentration (MBC); testing of disinfectants and biosafety in the microbiology laboratory.

Medical microbiology: Mode of infection, pathogenesis and laboratory diagnosis of medically important bacterial, fungal and viral diseases, including aspergillosis, candidiasis, cryptococcosis, pneumocystosis; *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Clostridium* spp., *Escherichia coli*, *Pseudomonas aeruginosa*, *Mycobacterium tuberculosis*; HIV, hepatitis A and B, influenza, dengue and coronavirus infections.

UNIT IV — Histopathology and Cytopathology

General pathology: Cellular adaptations; cell injury; necrosis and apoptosis; acute and chronic inflammation; tissue repair and wound healing; haemodynamic disorders; immunopathology; neoplasia, carcinogenesis, invasion and metastasis.

Histopathology: Principles of histopathological examination; collection and fixation of tissues; fixatives; decalcification; tissue processing; dehydration, clearing, impregnation and embedding; microtomy; cryostat and frozen sections.

Staining techniques: Principles and applications of haematoxylin and eosin staining; special stains for carbohydrates, connective tissue, lipids, pigments, minerals, amyloid and microorganisms; histochemistry and enzyme histochemistry.

Cytopathology: Exfoliative cytology; cervical cytology; body-fluid cytology; fine-needle aspiration cytology and cell-block preparation.

Advanced techniques: Immunohistochemistry and immunocytochemistry; antigen retrieval; antibody selection and controls; in-situ hybridisation; FISH; molecular pathology and molecular biomarkers; digital pathology and principles of image analysis.

UNIT V — Molecular Biology and Recombinant DNA Technology

Immunology: Innate and adaptive immunity; cells and organs of the immune system; antigens, antigenicity and immunogenicity; B- and T-cell epitopes; structure and function of

antibodies; antibody diversity; monoclonal antibodies and antibody engineering; antigen-antibody interactions; MHC molecules; antigen processing and presentation; B- and T-cell receptors and activation; cytokines; humoral and cell-mediated immunity; complement; Toll-like receptors; inflammation; hypersensitivity; immune tolerance and autoimmunity; congenital and acquired immunodeficiencies; immune responses to bacterial, parasitic and viral infections; vaccines.

UNIT VI — Analytical and Advanced Laboratory Techniques

Biochemical analytical techniques: Chemical and enzymatic methods of carbohydrate analysis; separation and identification of carbohydrates, lipids and amino-acid mixtures; principles and methods of protein separation and purification.

Chromatographic techniques: Gel filtration, ion-exchange and affinity chromatography; HPLC, HPTLC and FPLC.

Electrophoretic techniques: Agarose gel electrophoresis, SDS-PAGE and isoelectric focusing.

Spectroscopic techniques: UV-Visible spectroscopy, fluorescence spectroscopy, circular dichroism, FTIR and NMR spectroscopy.

Microscopic techniques: Light, phase-contrast, fluorescence, confocal, electron and super-resolution microscopy.

Other advanced techniques: Centrifugation; immunoprecipitation and protein-protein interaction studies; X-ray diffraction/crystallography; surface plasmon resonance; radioactivity and radioisotopes; detection and measurement of radioactivity and Cerenkov counting. These consolidate the analytical-technique content of both original syllabi without repeating the common methods.