

MICROANATOMY INCLUDING HISTOLOGY & CELL BIOLOGY

COURSE CONTENT

COMPETENCIES

The first year medical student should be able to comprehend ultrastructure of the cell and its function; understand, identify and demonstrate the microanatomical features of basic tissues and components of various systems; able to correlate structure with function; and integrate certain clinical manifestations on microanatomical basis.

MICROSCOPE

Light microscope: parts, magnification, resolution

Electron microscope, difference between LM and EM

Level 2: Microtechniques, H and E staining

Level 3: Polarizing microscope, phase contrast, scanning EM, microtome, histochemistry

CELL BIOLOGY

CELL

Definition, protoplasmic properties

Cytoplasm and nucleus

CYTOMEMBRANES

Unit membrane, fluid mosaic model, functions, exocytosis, endocytosis

Level 2: Specialisations of cell surface, differences between cell membrane and unit membrane

CELL ORGANELLES

Rough Endoplasmic Reticulum

Definition, structure, functions, prominent in protein synthesizing cells

Smooth Endoplasmic Reticulum

Definition, structure, functions, synthesis of steroids

Level 2: Sarcoplasmic reticulum of muscle

Mitochondria

Definition, structure, functions

Level 3: Mitochondrial DNA, mitochondrial myopathy

Golgi apparatus

Definition, structure, functions, sulfation and addition of carbohydrate to protein, lysosome formation, synthesis of cell membrane and glycocalyx

Lysosomes

Definition, structure, functions,

Level 2: Primary and secondary lysosomes, residual bodies, autolysis

Level 3: Lysosomal storage disease – Tay-Sach's disease

Peroxisomes

Definition, structure, functions, production and destruction of H₂O₂

Ribosomes

Definition, structure, functions, monosomes, polysomes, free and bound

CYTOPLASMIC INCLUSIONS

Transitory, may or may not be bound by membranes, stores foods, crystals, pigments - endogenous and exogenous

CYTOSKELETON

Microtubules

Definition, structure, functions

Treadmilling, nucleation site, mitotic spindles, cilia, flagella, centrioles, internal movement of cell organelles

Centriole, Cilia, Flagella – Definition, structure, functions

Level 2: Effect of colchicine and antimetabolic drugs on spindles preventing mitosis

Level 3: Kartagener's syndrome

Microfilaments

Definition, structure, functions

Level 2: Endocytosis, exocytosis, movement of microvilli; Cell mitotic activity, pseudopodial and filopodial processes, cleavage of mitotic cell, actin filaments of muscle

Intermediate filaments

Definition, structure, functions

Level 2: Neurofilaments - nerve fibres; Cytokeratin - tonofilaments, desmosomes; Vimentin - mesenchymal cells; Desmin - muscle cell, Z discs; Nuclear membrane skeleton

NUCLEUS

Definition, structure, nuclear envelope, chromatin, heterochromatin, euchromatin, Barr body, nucleolus, structure - pars chromosa, nucleoplasm

INTERCELLULAR CONTACTS

Without cytological specialization

20 nm gap, glycocalyx, and cations, zipper and, jigsaw interlocking

Specialized cell junctions

Zonula occludens, zonula adherens, macula adherens or desmosome

These constitute junctional complex or terminal bar under LM; Gap junction

CELL MOTILITY

Movement within the cell :

Internal movement of organelles, transport of vesicles, lysosomes, endocytosis, exocytosis, role of microtubules, microfilaments and intermediate filaments, cytoplasmic streaming; Treadmilling of microtubules, movement of centrioles

Movement of the cell :

Mitotic spindles, cleavage of mitotic cell, cell, migratory activity, pseudopodia, filopodial, processes, movement of microvilli, cilia, phagocytosis - macrophages, spermatozoa, myoepithelial cells

Level 2: Effect of colchicine and anticancer drugs on spindle formation

Level 3: Acting of nucleation site, Kartagener's syndrome

GENERAL MICROANATOMY

EPITHELIAL TISSUE

Definition of epithelium

Classification: Simple squamous, cuboidal, columnar; simple columnar ciliated; simple columnar brush bordered; goblet cell; pseudostratified columnar ciliated; stratified squamous non-keratinised & keratinised; stratified columnar; urothelium (transitional); neuroepithelium; gustatory; olfactory; statoacoustic; myoepithelium

Level 2: Nutrition, renewal, innervation; protein/steroid/mucus secreting cells, APUD cells

Level 3: Metaplasia; Cigarette smoking; Vitamin A deficiency; APUDomas

Basement membrane

Surface modifications - Cilia, microvilli, stereocilia; Cell junction and junctional complexes

CONNECTIVE TISSUE

Definition, classification - embryological / adult; Cells, ground substance, fibres - types; Collagen *TS, LS*; Reticulin; Elastic *LS, TS*; Mesenchyme; Mucous CT; Loose areolar; Adipose tissue; Tendon *LS, TS*

Level 2: Ground substances - glycoproteins, glycosaminoglycans ; Functions, growth

Level 3: Scurvy, oedema, inflammation

MUSCULAR TISSUE

Skeletal muscle *TS, LS*; Plain muscle; Cardiac muscle; Intercalated disc, syncytium; Sarcomere, I and A bands, myofibrils, myofilaments; Actin, myosin, troponin, tropomyosin; Sarcoplasmic reticulum, 'T' tubules, triads

Level 2: Innervation, motor end plate, red fibres, white fibres, intermediate fibres

Level 3: Hypertrophy, hyperplasia, rigor mortis, myasthenia gravis

NERVOUS TISSUE

Neurons, types; Neuroglia, types; Myelinated nerve fibre *LS*; Non-myelinated nerve fibre; Peripheral nerve *TS*; Meissner's corpuscle; Paccinian corpuscle; Nodes of Ranvier; Synapses

GLANDS (GLANDULAR SYSTEM)

Classification; Unicellular and multicellular; Exocrine, endocrine, amphicrine; Exocrine - Simple, compound; Apocrine, merocrine, holocrine; Tubular, alveolar, tubuloalveolar, saccular; Serous, mucous, mixed

Level 2: Control of glandular activity

VESSELS

Large sized artery *LS, TS*, Medium sized artery *TS*; Arteriole; Capillary, types; Sinusoid; Medium sized vein *TS*;

Level 2: Diapedesis, blood brain barrier, thermoregulation

Level 3: Atherosclerosis, aneurysm, infarcts, intravascular clotting, angiosarcomas

SCLEROUS / SKELETAL TISSUE

Cartilage

Hyaline (Costal) *section*; Hyaline (Articular) *section*; Fibrous *section*; Elastic *section*; Cellular *section*; Perichondrium, functions

Level 2: Growth – Interstitial, appositional

Level 3: Chondroma, chondrosarcoma

Bone

Compact *section*; Cancellous *section*; Developing bone; Endochondral ossification *section*; Intramembranous ossification; Woven, lamellar bone

Level 2: Support, protection, plasticity, Ca ++ reserve

Level 3: Bone callus, Osteomalacia , Osteoporosis , Osteoma , Osteosarcoma

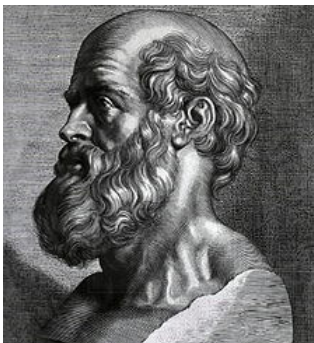
LYMPHOID TISSUE (INCLUDING IMMUNE SYSTEM)

T cells, B cells; Mucosa associated lymphoid tissue (MALT); Humoral immunity, Cell mediated immunity; Lymph node *section*; Thymus *section*; Spleen *section*; Tonsil *section*

Level 2: Blood-thymus barrier, Open and closed circulation in the spleen

Level 3: Organ transplantation, Graft rejection, Autoimmune disease

Hippocrates
(460 BC - 370 BC)



He was a Greek physician, born on the island of Cos.

Regarded as the founder of medicine, he created the art and science of medicine and removed it from the realm of superstition and magic.

The Hippocratic oath, administered to ancient physicians, is still as fresh and practical as it was over two thousand years ago.

SYSTEMIC MICROANATOMY

Basic organization, salient features, identification, draw and label

Level 2: Structure and function correlation, details of individual features

Level 3: Embryological correlation, Electron Microscopy

INTEGUMENTARY SYSTEM

Skin - Types; Epidermis and dermis; Hairless skin *section*; Hairy skin *section*; Melanocytes, Langerhan cells, Merkel's cells; Appendages of skin - types; Hair follicle, sebaceous gland, sweat gland, arrector pili; Nail *TS*, *LS*

Level 2: Renewal of epidermis

Level 3: Psoriasis, vitiligo, albinism, malignant melanoma, acne

RESPIRATORY SYSTEM

Basic organization; Olfactory mucosa; Nasal cavity *section*; Epiglottis; Trachea *TS*; Lung *section*; Bronchus, bronchiole, respiratory bronchiole; alveolar duct, sac, alveoli, pneumocyte type I and II cells

Level 2: Double spirally arranged bronchial smooth muscle

Level 3: Bronchial asthma, immotile cilia syndrome (Kartagener's syndrome), hyaline membrane disease, heart failure cells

ALIMENTARY SYSTEM

Oral tissues

Lip ; Tongue, taste buds ; Papillae; Tooth; Developing tooth; Salivary glands;

Serous demilune, myoepithelial cells

Level 2: Striated duct, ion transport

Alimentary tract

Basic organization - 4 layers; Oesophagus with glands *TS*; Oesophagus without glands *TS*; Stomach - Fundus *TS*; Chief cells, parietal cells;

Stomach - Pylorus *TS*; Small intestine - Duodenum *TS*; Brunner's glands; Small intestine - Jejunum *TS* without Brunner's glands and Peyer's patches; Small intestine - Ileum *TS* with Peyer's patches; Appendix *TS*; Large intestine *TS*

Level 3: Pernicious anaemia, ulcer, gastritis, Hirschsprung's disease or megacolon

Glands

Pancreas *section*: Exocrine: Serous acini, acinar cells, centroacinar cells; Endocrine: islets of Langerhans; Liver *section*; Hepatic lobule, portal lobule, portal acinus; Gall bladder *section*

Level 2: Liver as an endocrine gland

Level 3: Diabetes mellitus, cirrhosis of liver, liver regeneration, chalones

URINARY SYSTEM

Basic organization; Nephron - parts, podocytes, blood supply; Collecting system; Kidney - Cortex, medulla *section*; Ureter *TS*; Urinary bladder *section*; Urethra

Level 2: Juxtaglomerular apparatus

MALE REPRODUCTIVE SYSTEM

Basic organization; Gonads, Tract, Accessory glands; Testis *section*; Epididymis *section*; *TS* of Vas deferens; Prostate *section*; *TS* of Penis; Seminal vesicle

Level 2: Stages of spermatogenesis

Level 3: Immotile sperm syndrome

FEMALE REPRODUCTIVE SYSTEM

Basic organization; Gonads, tracts, accessory glands; Graafian follicle; Ovary - with corpus luteum *section*; Ovary - without corpus luteum *section*; Fallopian tube *TS*; Uterus *TS*; Cervix; Vagina

Level 2: Stages of maturation of ovarian follicle , Phases of menstruation

FEMALE ACCESSORY REPRODUCTIVE SYSTEM

Mammary gland *section*- Active & Inactive; Placenta *section*: Maternal unit, Foetal unit;*TS* of Umbilical cord - Wharton's jelly

Level 2: Colostrum, IgA

ORAL TISSUES

Lip *section*; Tongue, taste buds *section*; Papillae; Tooth *section*; Developing tooth *section*; Salivary glands *section*; Serous demilune, myoepithelial cells

Level 2: Striated duct, ion transport

ENDOCRINE SYSTEM

Basic organizations of cells, blood vessels, hormones

Pituitary *section*; Adenohypophysis, neurohypophysis; Thyroid *section*; Follicular, parafollicular cells; Parathyroid *section*; Chief cells, oxyphil cells;

Suprarenal *section*; Pancreas *section*; Testis *section*; Ovary *section*

Level 2: Hypothalamo-pituitary portal system

Level 3: Pheochromocytoma

NERVOUS SYSTEM

Central

Basic organization; Cerebrum *section*; Cerebellum *section*; Spinal cord *section*; Cervical, thoracic, lumbar, sacral levels

Peripheral

Sensory ganglion *section*; Autonomic ganglion (sympathetic ganglion) *section*; Peripheral nerve *TS*; Receptors: Exteroceptive, proprioceptive, interoceptive

SPECIAL SENSES

Visual: Eyeball, Cornea *section*; Sclerocorneal junction *section*; Canal of Schlemm; Lens *section*; Retina *section*; Optic nerve *LS (entrance), TS*

Level 3: Corneoplasty, eye donation, glaucoma, retinal detachment

Auditory: External ear *TS*, Middle ear; Internal ear; Cochlea *section*; Semicircular canals; Vestibule

(A STUDY OF ALL SECTIONS IN THE PRACTICAL CLASSES IS A MUST)

LECTURES

- Cell Biology - Integrated module (q.v. 108)
- Epithelial tissue
- Connective tissue
- Muscular tissue
- Nervous tissue
- Exocrine glands
- Vessels
- Bone
- Cartilage
- Lymphoid tissue
- Integumentary system
- Respiratory system
- Alimentary system - Oesophagus & stomach
- Alimentary system - Small & large intestine
- Alimentary system - Liver & gall bladder
- Urinary system
- Male reproductive system
- Female reproductive system
- Endocrines
- Nervous system
- Eye I - Lacrimal gland, eyelid, cornea, sclerocorneal junction
- Eye II - Lens, retina, entrance of optic nerve, TS of optic nerve
- Lip, tongue, ear

Marcello Malpighi
(1628-1694)



He was an Italian Anatomist from the city of Bologna.

He was also a physicist and botanist.

Malpighian corpuscles - renal corpuscles

Malpighian corpuscles - lymphoid follicles of spleen

Malpighian layer - basal layer of epidermis of skin

INTEGRATED CELL BIOLOGY MODULE

Learning elements	Specific Learning Objectives Must Know (<i>Nice to know in italics</i>)	Participating departments
Morphology of the cell Light microscopy Electron microscopy	Describe the morphology of cell and its organelles as seen under light and electron microscope	Anatomy
Eukaryotic and prokaryotic cells	Differentiate between eukaryotic and prokaryotic cells	Anatomy
Structure of the cell membrane	Describe the unit membrane and the fluid mosaic model <i>Specify the specialization of cell surface</i>	Anatomy
Cell membrane	Describe transport processes across cell membranes	Physiology
Cell organelles	Describe the structure and elementary ultrastructure of the cell organelles	Anatomy
Functions of organelles	Describe the function of cell organelles	Biochemistry
Sub-cellular organelles	Outline the basic principles of methods used in separation of sub-cellular organelles	Biochemistry
Cytoskeleton; Cell motility	Define cytoskeleton; describe its structure and mention its function	Anatomy
Intercellular contacts	Describe the various types of intercellular contacts and relate their structure to function	Anatomy
Cell cycle; Cell division	Describe the cell cycle and the process of cell division and its clinical correlates	Anatomy / Biochemistry
Defects arising out of abnormal cell division	Explain the defects arising out of abnormal cell division	Anatomy / Biochemistry
Application of cytology in diagnostic: Buccal smear	Discuss the application of cytology to medicine, FNAC, Stem cells and its application	Pathology