

SUBJECT:	GENERAL HISTOLOGY		
CREDITS:	Total: <input type="text" value="4.5"/>	Theory: <input type="text" value="2.5"/>	Practical: <input type="text" value="2"/>

INTRODUCTION AND GENERAL OBJECTIVE

First year General Histology (second semester) requires students to have reached a good level of understanding of Cell Biology and Developmental Biology. The aim of General Histology is to introduce students to the four basic groupings that create tissues. It is essential for students to be given this general information in order to understand the structure and function of organs and systems when studied in the second year. At the end of the year students should be able to describe a histological preparation, indicating which types of tissue can be observed, which cell types are present and what their respective functions are.

This guide focuses on basic tissues and gives a description of the content that students will be expected to learn. Each topic is divided into a series of lessons that cover broadly related areas and can be considered individual teaching units.

SPECIFIC OBJECTIVES

Topic 1

This section should help students to:

- Demonstrate knowledge of the structural and functional characteristics that define a tissue.
- Demonstrate knowledge of the mechanisms of cell differentiation, aggregation, intercellular recognition and communication that lead to the formation of tissues.
- Demonstrate knowledge of mechanisms by which cells adapt to changes in their environment.
- Demonstrate knowledge of the nomenclature of these adaptations that will be widely used in the study of normal and pathological structures.
- Describe the constituent elements of tissues.
- Demonstrate knowledge of the different criteria for the classification of tissues.

Topic 2

This section should help students to:

- Demonstrate knowledge of the structural and functional characteristics of epithelial tissues that distinguish them from basic tissues.
- Demonstrate knowledge of the different types of epithelial tissue and give examples of the parts of the body in which these can be found.
- Demonstrate knowledge of the different functions of each type of epithelial tissue and relate them to the tissue structure.
- Demonstrate knowledge of the specialized functions of different types of epithelial cells and give examples of the different parts of the body in which they can be found.
- Recognize the different types of epithelium in photographs or preparations and, based on the structure identified, predict their function.
- Demonstrate knowledge of the different criteria for the classification of glands.
- Recognize certain glands in diagrams, photographs or preparations and identify the various types of gland.

Topic 3

This section should help students to:

- Name the various structural and functional characteristics that distinguish connective tissue from other basic tissue types.
- Demonstrate knowledge of the functions of connective tissue.
- Demonstrate knowledge of the three fundamental elements that are found in all connective tissue types.
- Demonstrate knowledge of the parts of the cell involved in synthesizing components of the extracellular matrix and how these elements are associated to one another.
- Demonstrate knowledge of the structure and function of the different cell types that are found in connective tissue.
- Compare the different types of connective tissue according to cell types, their disposition and the relation to the size of fibres and the extracellular matrix.
- Relate the composition of the different types of connective tissue and their specific functions.
- Demonstrate knowledge of the parts of the human body in which each type of connective tissue is found and relate these locations to the function of the tissue.
- Recognize the types of connective tissue and their respective cells in a micrograph or preparation and describe their functions.
- Anticipate the potential functional consequences of certain defects in connective tissue.

Topic 4

This section should help students to:

- Relate the different functions of adipose tissue to its structural characteristics.
- Describe adipose tissue as a connective tissue by relating the types and size of cells, fibres and ground substance.
- Demonstrate knowledge of the similarities and differences between the two types of adipose tissue.
- Recognize the types of adipose tissue in a micrograph or preparation of a tissue or organ.

Topic 5

This section should help students to:

- Demonstrate knowledge of the similarities and differences between the three types of cartilage.
- Demonstrate knowledge of the functions of the three types of cartilage and relate these to their functional characteristics and location in the body.
- Demonstrate knowledge of the stages of histogenesis and cartilage growth.
- Relate the ultrastructure of chondrocytes to their functional role in the synthesis and maintenance of the extracellular matrix.
- Recognize the types of cartilaginous tissue in a micrograph or preparation of a tissue or organ and identify their components, for example chondrocytes, the perichondrium, etc.

Topic 6

This section should help students to:

- Describe bone as a connective tissue in terms of cells, fibres and ground substance.
- Compare the different types of bone cells, considering their origin, structure and primary function.
- Demonstrate knowledge of the functions and physical properties of bone tissue and relate them to the specific components of this tissue type.
- Demonstrate knowledge of the different types of bone tissue and their possible location in the body.
- Compare the two types of process of bone tissue formation, in terms of the embryonic origin of this tissue type.
- Explain the structural alterations that are produced in bone remodeling.
- Recognize the types of bone tissue in a micrograph or preparation of a tissue or organ and identify their components, for example the Havers canals, the periosteum, etc.
- Recognize the types of limb and identify their components.

Topic 7

This section should help students to:

- Demonstrate knowledge of the three most important types of muscle tissue, compare them in terms of structure and function, locate them in the human body.

- Demonstrate knowledge of the relations between muscle fascicles, muscle fibres, myofibrils and myofilaments.
- Explain excitation-contraction coupling. The role of T tubules and the sarcoplasmic reticulum in striated muscle.
- Recognize the mechanisms of stimulation, contraction and relaxation of muscle fibres in terms of cell activity.
- Recognize the types of muscle tissue in a micrograph or histological preparation and be able to describe their possible function.

Topic 8

This section should help students to:

- Name the various structural and functional characteristics of nerve tissue that distinguish it from other basic tissue types.
- Demonstrate knowledge of the structure, function and embryonic origin of the different types of cell found in nerve tissue and give examples of where these can be found in the human body.
- Relate the structural and functional characteristics of nerve cells.
- Predict the potential effects of structural deficits on nerve function.
- Describe in detail how neurons receive, propagate and transmit signals.
- Demonstrate knowledge of the subcellular distribution of cellular organelles in neurons and identify the regional differences in dendrites, cell body and axon.
- Demonstrate knowledge of the structure and function of the different types of synapse.
- Demonstrate knowledge of the different support or glial cells.
- Recognize the types of nerve cells a micrograph or histological preparation and be able to identify and be able to identify the prolongations.
- Demonstrate knowledge of cerebral vascularization and its relation to human pathology.
- Demonstrate knowledge of meningeal covers and the creation, drainage and characteristics of cerebrospinal fluid.

PROGRAMME

Topic 1. Concept, formation and classification of tissues.

Lesson 1

1.1. Concept of tissue.

1.2. **Constituent elements of tissue.** Cells. Fibres. Extracellular matrices.

1.3. **Tissue formation.** Cell differentiation. Cell aggregation. Intercellular recognition and communication. Formation of cell communities.

1.4. Adaptation of cells to alterations in their surroundings. Atrophy. Hypertrophy. Hyperplasia. Hypoplasia. Aplasia. Metaplasia. Dysplasia. Neoplasia.

1.5. Cell aging and cell death.

1.6. Classification of tissues.

Topic 2. Epithelial tissues

Lesson 2

2.1. **General characteristics of epithelial tissues.** Diversity. Basal lamina. Renewal. Blood vessels and nerves. Embryonic origin.

2.2. **Classification of epithelia.** Criteria: number of cell layers (simple, stratified, pseudostratified).

Specific types: simple squamous. Simple cuboidal. Simple columnar. Pseudostratified columnar. Stratified (keratinized, non-keratinized). Stratified cuboidal. Stratified columnar. Transitional epithelium.

2.3. **Polarity and specializations of epithelial cells.** Specializations of the apical membrane. Cilia. Flagella. Microvilli. Stereocilia.

Specializations of the lateral membrane: zonula occludens. Zona adherens. Macula adherens (desmosome). Gap junctions.

Specializations of the basal surface: basal lamina: structure and functions. Hemidesmosomes. Transport functions.

Lesson 3

3.1. Definition and classification of glands. Endocrine glands and exocrine glands. Differences between endocrine and exocrine glands.

3.2. Classification of exocrine glands. According to the number of cells: unicellular, multicellular.

According to organization of ducts: simple, compound, straight, convoluted.

According to secretory portion: tubular, acinose, compound tubular acinose.

According to secretion mechanisms: merocrine, apocrine, holocrine.

3.3. Different types of epithelial cells. Epithelial cells specialized for transport. *a)* Ion transport. *b)* Transport by pinocytosis.

Epithelial cells specialized for absorption.

Epithelial cells specialized for secretion: *a)* protein secretors, serous secretion, *b)* peptide secretors (APUD system, paracrine secretion), *c)* steroid secretion.

Contractile epithelial cells (myoepithelial cells).

Neuroeffector epithelial cells (Merkel cells, in taste buds).

Topic 3. Connective tissue

Lesson 4

4.1. General characteristics of connective tissues. *a)* Functions. *b)* Types. *c)* Components. *d)* Extracellular matrix. *e)* Embryonic origin.

4.2. Components of connective tissue. Collagen fibres: synthesis and assembly. Types of collagens. Histological organization and morphological characteristics. Mechanical properties. Localization.

4.3. Reticular fibres.

4.4. Elastic fibres. Synthesis and assembly. Histological appearance. Mechanical properties. Localization.

4.5. Ground substance. Proteoglycans. Glycoproteins. Diffusion of substances.

4.6. Cells. Fixed cells: *a)* fibroblasts, fibrocytes, reticular cells; *b)* adipocytes.

Migratory cells: *a)* mastocytes; *b)* macrophages; *c)* plasma cells.

Other types of connective tissue derived from blood (lymphocytes, neutrophils, monocytes, eosinophils and basophils).

Lesson 5

5.1. Types of connective tissue. Connective tissues: *a)* lax connective tissue; *b)* dense connective tissue; *c)* dense regular connective tissue; *d)* dense irregular connective tissue.

Reticular connective tissue. Elastic connective tissue. Mucous connective tissue (Wharton's jelly). Mesenchyme.

5.2. Functional histology of connective tissue. Functions: *a)* support; *b)* defence (physical and immunological); *c)* repair; *d)* storage; *e)* transport.

Edema. Nutritional factors. Collagen renewal.

Topic 4. Adipose tissue

Lesson 6

6.1. General characteristics of adipose tissues. General organization. Classification of adipose tissue: white adipose tissue, brown adipose tissue.

6.2. White adipose tissue. Differential characteristics. Body distribution. Functional characteristics: *a)* factors that affect lipid uptake; *b)* factors that mobilize lipids. Histogenesis.

6.3. Brown adipose tissue. Differential characteristics. Body distribution. Functional characteristics. Histogenesis.

Topic 5. Cartilaginous tissue

Lesson 7

7.1. General characteristics of cartilage. Composition. Vascularization. Cells.

7.2. The three types of cartilage. Hyaline cartilage: *a)* composition: fibres, ground substance; *b)* organization; *c)* histogenesis; *d)* growth: interstitial, appositional; *e)* repair; *f)* function and localization.

Elastic cartilage: *a)* composition and organization; *b)* histogenesis and growth; *c)* function and localization.

Fibrocartilage: *a)* composition and organization; *b)* histogenesis and growth; *c)* function and localization.

Topic 6. Bone tissue

Lesson 8

8.1. General characteristics of bone. Composition. Functions.

Bone types: *a)* cancellous; *b)* compact; *c)* primary (non lamellar or woven); *d)* secondary (lamellar); *e)* bone as an organ.

8.2. Cells. Osteoprogenitor cells. Osteoblasts. Osteocytes. Osteoclasts. Bone lining cells.

8.3. Bone matrix. Organic components: *a)* collagen fibres; *b)* ground substance.

Inorganic components: hydroxyapatite crystals.

8.4. Organization. Cancellous bone. Compact bone.

8.5. Histogenesis and remodeling. Primary bone. Role of the perichondrium.

Formation of bone: A) intramembranous; B) endochondral: *a)* proliferation of chondrocytes; *b)* hypertrophy; *c)* calcification. Remodelation: *a)* primitive medullary cavity; *b)* formation of secondary bone.

8.6. Microscopic and functional organization of secondary bone tissue: external circumferential systems. Periosteum.

Haversian systems (osteons). *a)* Haversian Canal. *b)* Volkmann's Canals.

Intermediate systems.

Internal circumferential systems. Endosteum.

8.7. Articulations: types and general characteristics.

Synarthrosis: *a)* synostosis; *b)* synchondrosis; *c)* syndesmosis.

Diarthrosis.

Topic 7. Muscle tissue

Lesson 9

9.1. General considerations on muscle tissue. *a)* Terminology. *b)* Specialization for contraction. *c)* Embryonic origin. *d)* Form of muscle fibres. *e)* Organization. *f)* Types of muscle (smooth and striated).

9.2. Skeletal muscle. Histogenesis.

Skeletal muscle fibres. Myofilaments: *a)* thin filaments (G-actin and F-actin, tropomyosin, troponin); *b)* thick filaments (myosin).

Myofibrils. *a)* Longitudinal and transversal sections. *2)* The sarcomer. Z, M, I, A and H lines. Morphological changes relative to the state of contraction.

Sarcoplasmic reticulum.

The sarcolemma and its relation to the extracellular matrix.

9.3. Histochemical types of muscle fibre. Red fibres. White fibres. Intermediate fibres.

9.4. Satellite cells. Skeletal muscle repair.

Lesson 10

10.1. Cardiac muscle. Histogenesis.

Cardiac muscle fibre. *a)* Sarcoplasmic reticulum. *b)* T-tubules. *c)* Intercalary discs: desmosomes, fascia adherens, *gap junction*. *d)* Types of cardiac fibres: ventricular fibres, atrial fibres, conduction fibres.

Cardiac muscle repair.

10.2. Smooth muscle. Histogenesis.

Smooth muscle fibre. a) Myofilaments: thin filaments, thick filaments, dense bodies. b) Sarcoplasmic reticulum. c) Contraction.

10.3. Types of smooth muscle fibre. Visceral smooth muscle. Vascular smooth muscle. Iris smooth muscle.

10.4. Control of smooth muscle contraction.

Topic 8. Nerve tissue

Lesson 11

11.1. General characteristics of nerve tissue. Cell types: a) neurons: structure and function; b) support cells.

Impulse conduction. Synapse. Development of nerve tissue.

11.2. Neurons. Cell body. Dendrites.

Axons: a) the axon hillock; b) initial segment; c) axoplasm and axolemma; d) terminal ramification; e) nerve terminals; f) transport axonal (retrograde and anterograde).

Classification of neurons. a) By arrangement and prolongations: multipolar, bipolar, pseudounipolar, unipolar. b) By shape: pyramidal, stellate, granular, Purkinje. c) By axon length: Golgi type I and Golgi type II. d) By function: motoneurons, sensory neurons, interneurons. e) By the nature of the liberated neurotransmitter: glutamatergic, GABAergic, cholinergic, dopaminergic, adrenergic, peptidergic, purinergic.

11.3. The synapse. Electrical synapses.

Chemical synapses. a) The presynaptic membrane. b) Synaptic cleft. c) The postsynaptic membrane. d) Synaptic transmission.

Excitatory synapses.

Inhibitory synapses.

11.4. The neuromuscular junction. The nerve terminal. The synaptic cleft. The postsynaptic element.

Lesson 12

12.1. Support cells of the central nervous system. Macroglia. a) Astrocytes: protoplasmic. Fibrous. b) Oligodendroglia: myelin. Ranvier's nodes. Saltatory conduction.

Microglia.

Ependymal cells.

12.2. Support cells of the peripheral nervous system. Schwann cells. Satellite cells.

12.3. Vascularization of the human brain. Arterial system. Capillaries. The hematoencephalic barrier. Vascular system. Stroke mechanisms.

12.4. Meninges, ventricles and cerebrospinal fluid. Dura mater, arachnoid mater and pia mater. Meningeal spaces. Choroid plexus. Cerebrospinal fluid. Characterization. Production. Drainage. Cellular composition. Intracranial pressure. Clinical application of the study of cerebrospinal fluid.

LEARNING RESOURCES AND TEACHING METHODOLOGIES

Each topic consists of the theory class and the practical session, which will consist mainly of the recognition of tissues and cells with an optical microscope and subsequent description.

The theory classes are no substitute for personal observation, interpretation and description of microscope preparations in order to gain a better understanding of pathological reports. The faculty therefore provides a practical laboratory equipped with binocular microscopes and monitors connected to the teacher's microscope.

LEARNING REQUIREMENTS

Students must have sufficient preparation in Cell Biology and Developmental Biology to take the course in Histology.