

Histology

I. Introduction

- tissue: group of cells that are closely associated, similar in structure and function, and perform a common or related function.
- four primary tissues: epithelial tissue, connective tissue, muscle tissue, nervous tissue.

II. Epithelial tissue: cell layers are arranged in sheets.

A. General comments: epithelial tissues form the membranes and the glands of the body.

1. Membranes: covering and lining epithelium; sheets of cells that cover external surfaces or line internal surfaces; functions include protection, absorption, filtration, excretion, secretion.
2. Glands: composed of cells mostly specialized for secretion; can be unicellular or multicellular; multicellular glands originally develop as downgrowths of epithelial membranes into underlying connective tissue; secretions can be mucous or aqueous.

B. Distinctive characteristics of epithelial tissue:

1. Cellularity: - cells lie close together, little to no intercellular material.
2. Specialized contacts: - cells fit together to form a continuous sheet; adjacent cells are bound together at many points by lateral contacts.
3. Polarity: - surface specialization (microvilli, cilia); distinctive apical (top) and basal surfaces (bottom).
4. Basement membrane (border between the epithelium and connective tissue below it) present.
5. Innervated but avascular, therefore metabolism depends on diffusion of nutrients from blood vessels in connective tissue below.
6. Regeneration: has a high capacity to regenerate (renew) itself.

C. Classification of epithelium: by number of cell layers present and by shape of the superficial cell layers.

1. Number of cell layers:

- a. Simple epithelium: single layer of cells; important in filtration and absorption.
- b. Stratified epithelium: two or more cell layers; important for protection in high abrasion areas.
- c. Pseudostratified epithelium: - all cells contact basement membrane.

- not all cells reach the surface.
- nuclei at different levels.
- important in secretion and protection.

2. Shape:

- a. Squamous : flattened cells with flattened nuclei.
- b. Cuboidal: cube-like cells with spherical nuclei.
- c. Columnar: column-shaped, rectangular cells with oval nuclei.

D. Types of epithelium:

1. Simple Epithelium:

- a. Simple squamous epithelium: single layer of flattened cells; located in air sacs of lungs, lining inside of blood vessels; function involves permitting easy passage of materials by simple diffusion where protection not critical.
- b. Simple cuboidal epithelium: single layer of cube-like cells; located in kidney tubules, secretory portions of small glands; functions in secretion and absorption.
- c. Simple columnar epithelium: single layer of tall cells; located lining most of the digestive tract (stomach to anus), ciliated variety found lining portions of respiratory tract uterine tubes and regions of uterus.; functions in secretion of mucous and enzymes, and absorption.

2. Stratified epithelium

- a. Stratified squamous epithelium: thick membrane composed of several layers of cells where basal cells are cuboidal or columnar and metabolically active, and surface cells are squamous and often dead; forms top layer of skin, the epidermis; functions in protection.
- b. Stratified cuboidal epithelium: two layers of cube-like cells, ducts of sweat, salivary, mammary glands.
- c. Stratified columnar epithelium: rare; sheet several cell layers thick; basal cell usually cuboidal, and superficial cells elongated.
- d. Transitional epithelium: resembles both stratified squamous or stratified cuboidal depending on the degree of stretch or distension of organ in question; urinary bladder.

III. Glandular epithelium.

- a gland is composed of one or more cells that make and secrete a particular product.
- secretion is an aqueous fluid that contains proteins.

-there are two types based on the route of secretion:

- exocrine glands: more abundant (salivary, and sweat glands).
 - pass secretions to the surface through a duct; thus components include secretory units and ducts.
- endocrine glands: - no connection to the surface.
 - secretions go directly to the blood stream (hormone secretion); thus highly vascularized.
- also classified on basis of type of secretion, mode of secretion, cell numbers making up gland, duct/secretory unit structure

III. Connective tissue - found everywhere in the body; most abundant and widely distributed of primary tissues; amount of connective tissue varies greatly from organ to organ .

A. General comments: subdivided into connective tissue proper, cartilage, bone, and blood; functions in support, protection, insulation, transportation; connective tissue is able to bear weight, withstand tension, and endure trauma.

- common characteristics of all connective tissue:

- common origin, all arise from mesenchyme.
- wide degrees of vascularity: cartilage is avascular, dense connective tissue is poorly vascularized, and areolar (loose connective tissue) is well vascularized.
- CT composed predominantly of ECM; therefore CT is able to bear weight, withstand tension, and endure trauma.

B. Structural elements of connective tissue: in any type of connective tissue there are three types of elements, ground substance, cells, and fibers; the type of connective tissue depends on the type(s) of cell(s) that predominate the tissue, the types of fibers present, and the composition of the ground substance.

1. Ground substance: "everything" between fibers and cells; unstructured material that fills in the space between cells, composed mainly of water, and proteins in solution; produced by cells of connective tissue.

- functions as a medium through which nutrients and other substances can diffuse between the capillaries and cells.

2. Fibers: provide support, made up of groups of fibrous proteins intertwined with one another; produced by cells of connective tissue.

- three major types of fibers, collagen, elastin, reticular fibers; collagen is extremely tough, gives tissue great strength; elastin gives tissue recoil ability, elasticity.

3. Cells : each major type of connective tissue has a fundamental cell type,

each major type of connective tissue has a fundamental cell type that exists in immature ("blast") and mature ("cyte") forms -- fibroblasts in connective tissue proper, chondroblasts in cartilage, osteoblasts in bone.

a. Fundamental cell type

- immature cell: actively mitotic cells, secrete ground substance, produce the extra cellular matrix (ECM).
- mature cell: less active, maintain the ECM.
- can revert to the active state for repair and regeneration of the matrix.

b. Connective tissue is also the home to an assortment of other cells

- white blood cells.
- macrophage.
- plasma cells.
- nutrient storage fat cells.
- mast cells.

C. Types of connective tissue

1. Connective tissue proper

a. Loose connective tissue: cells predominate, separated by mostly ground substance and some fibers.

- loose areolar connective tissue: predominant cell is fibroblast, many collagen fibers; found under epithelia and surrounding organs; wraps and cushions organs.

- adipose tissue: a modified form of loose areolar connective tissue, except cells filled with lipid droplets.

b. Dense connective tissue: fibers predominate over cells, little ground substance.

i. dense regular connective tissue: formed by dense, parallel collagen fibers with very few fibroblasts; withstands tension from one direction; forms ligaments and tendons.

ii. dense irregular connective tissue: formed by dense, irregularly arranged collagen fibers, few fibroblasts or ground substance; withstands tension from many directions; found in dermis of skin.

3. Cartilage: a very resilient tissue, chondroblast is major cell type, found in small cavities throughout a matrix rich in fibers and ground substance (contains a lot of water)

- chondroblast/-cyte produces the matrix in two ways

- Interstitial growth - occurs in the initial phase of cartilage formation
 - growth from within.
- Appositional growth - new matrix elements are secreted onto the superficial face of the cartilage structure.
 - growth from outside.

- there are three types of cartilage that vary mostly in fiber content:

- hyaline cartilage
- elastic cartilage
- fibrocartilage

- note that cartilage is not vascularized.

4. Bone: matrix is similar to that of cartilage; it is more rigid because of the calcium salts deposited into the matrix; bone is well vascularized.

5. Blood - an atypical connective tissue, functions in transport; cells are RBC, WBC, matrix and fibers comprise plasma.

IV. Muscle Tissue

A. General comments: highly cellular, well vascularized and innervated; specialized for movement; cells called muscle fibers.

B. Types of muscle

1. Skeletal muscle: attached to bones, long, cylindrical, multinucleate cells with alternating light and dark bands (striations); voluntary.

2. Smooth muscle: line hollow tubes of body (digestive tract, uterus, blood vessels, parts of respiratory tract); spindly shaped cells, uninucleate; involuntary.

3. Cardiac muscle: walls of heart; long, uninucleate cells, can branch, junctions between cells visible as intercalated disks.

V. Nervous Tissue: makes up the nervous system which controls body functions; cell types present in neural tissue are predominantly supporting (glial) cells and neurons.