

Chapter 4: Tissue Level of Organization

- Tissue - a group of similar cells that have similar origin in an embryo and function to perform specific activity, e.g. skin tissue or liver.
- Tissues form multi-cellular orgs.
- Histology - the science that deals with the study of tissues.

I. Four Types of Tissue: (see tissue classification handout)

1. Epithelial – “protection” ; body surface, lines body cavities (i.e. membranes), and lines blood vessels, and forms glands.
2. Connective – “support”; insulates, protects the body, and binds(holds) organs together; has large amount of matrix.
3. Muscular – “movement”; responsible for movement.
4. Nervous – “control”; initiates, transmits and interprets nerve impulses; sends electrical info.

* All four tissue categories originate (differentiate) from *embryonic tissue*.

II. Cell Junctions: “the glue that holds the cells together” to form tissues (see page 109).

- Adjacent cells can fit together in a tongue & groove fashion
- Special membrane junctions (proteins) that form connections between cells; 3 types:
 - a. Tight junctions – “a zip-loc bag seal”; prevents leakage between cells, e.g. skin.
 - b. Desmosomes – “spot welds”; reinforcement & strength between cells; e.g. muscle & skin.
 - c. Gap Junctions – “ a communication tube” ions pass between cells; e.g. heart tissue.

III. Epithelial Tissues - 2 categories:

1. Covering and Lining - forms membranes that line body cavities such as the abdominal cavity, or the pleural cavity (pleural membrane). Also, the skin is considered a covering.
2. Glandular epithelium - secreting portion of glands; eg. sweat glands or hormone glands like adrenal glands.

A. Functions of Epitheilia:

- a) protection
- b) absorption
- c) filtration
- d) excretion
- e) secretion
- f) sensory reception

B. Six Special Characteristics of Epithelium:

1. Cellularity - closely packed cells; very little ECF between the cells.
2. Specialized Contacts - have *Tight Junctions* and *Desmosomes*; points of attachment between cell membranes, so that cells are arranged in continuous sheets (single or multi-layered).
3. Polarity – all epithelia has a free surface exposed to the body exterior or a cavity. Free surfaces (*apical region*) may be smooth, but some may have surface features such as *cilia*, or *villi* and their *microvilli*. *Villi* are finger-like projections that increase the surface area of the cell. These are found on the surface of intestine cells where the rate of diffusion of nutrients is increased by more surface area.
4. Supported by connective tissue – epithelial sheets are attached to underlying connective tissue by Basement Membranes made of collagen (protein) that helps epi. to resist tearing & stretching.
5. Avascular but innervated – *avascular* tissue ie. w/ out blood vessels, but supplied by nerve fibers.
6. Regeneration – has a high rate of cell division and rapid replacement of damaged cells.

IV. Classification of Epithelium [Coverings and Linings]:

Classified (named) by:

- A) number of layers of cells
- B) the shape of cells.

A. Arrangement of layers- depends on location and function

1. Simple - cells arranged in single layers.

Function: absorption & filtration where there is minimal wear & tear

2. Stratified - cells are stacked.

Function: high degree of wear and tear.

3. Pseudo-stratified “false layers” - only one layer of cells. Some don't reach the surface. Has a multi-layered appearance.

Function: Some secrete mucus or contain cilia that move foreign particles for elimination.

B. Cell Shape – 4 different shapes.

1. Squamous - flattened, "scale-like" (a mosaic-like)
2. Cuboidal - cube shaped / hexagonal
3. Columnar - tall & cylindrical or rectangular
4. Transitional - cells that are a combo. of shapes depending on location, ie. usually where there is distension or expansion of the body, eg. skin, uterus

C. Classification of covering & lining (cell layers and shape)

1. Simple: a. Squamous b. Cuboidal c. Columnar
2. Stratified: a. Squamous b. Cuboidal c. Columnar d. Transitional
3. Pseudostatified: a. Columnar (ciliated or unciliated)

D. Simple Epithelial:

1. *Simple Squamous*: little wear & tear
 - Highly adapted to diffusion, osmosis & filtration
 - Lines air sacs of the lungs and parts of kidney (filters the blood)
 - Forms walls of capillaries - "endothelium"
2. *Simple Cuboidal*: secretion and absorption
 - Performs functions involving secretion and absorption
 - Covers surface of ovaries, & kidney tubules
3. *Simple Columnar*:
 - Involved in absorption & secretion as well.
 - Can be modified 3 ways depending on location:
 - a. Have microvilli on surface of cell membrane (microscopic projections that increase surface area for absorption)
eg. the small intestine.
 - b. Can be Goblet Cells that secrete mucus to reduce friction between food and walls of the GI tract.
 - c. Can have cilia on the surface of cells. Found in upper respiratory tract, fallopian tubes & sinuses cavities.

E. Stratified Epithelium: - w/stands considerable wear & tear

- name depends on the shape of the surface cells
1. *Stratified Squamous* – 2 types:
 - A. nonkeratinized - usually wet surfaces; lining of mouth & vagina.
 - B. keratinized - forms a tough layer of protein in these cells "waterproofs" the skin
 2. *Stratified Cuboidal* - relatively rare.
 - found in sweat glands, pharynx
 - mainly for protection
 3. *Stratified Columnar* - relatively uncommon
 - lining of male urethra, mammary glands
 - protection & secretion

4. *Transitional Epi* - subjected to wear and tear

- subjected to wear and tear such as in the bladder; lines the bladder
- prevents rupture of bladder & ureters

F. Pseudo-stratified Columnar Epi (one layer of cells)

- give a multi-layered impression
- can contain cilia & goblet cells
- Upper respiratory tract, and lines large excretory ducts

V. Glandular Epithelium:

Gland - one cell or a group of cells that secrete substances.

2 types of glands:

- 1) Exocrine gland - secrete subs. into ducts(tubes) that empty onto free surfaces. eg. mucus, oils, perspiration.
- 2) Endocrine - secrete subs. into the blood. eg. hormones.

VI. Connective Tissue: *blood, cartilage, bone, fat, tendon & ligament*

General Info. on Connective Tissues:

- all is differentiated (derived) from *mesenchyme tissue* which is embryonic tissue
- most abundant tissue in the body
- binds and supports other tissues
- they don't occur on free surfaces like epi.
- highly vascular w/ rich blood supply; except for cartilage
- storage of reserve energy (adipose tissue)
- cells are widely scattered w/ much ECF (matrix)
- contain protein fibers in matrix which provide strength & support
- protein fibers are secreted by *fibrocytes* derived from *fibroblasts (to bud)*

* Marfan Syndrome - genetic disorder that results in abnormalities of connective tissues.

Five Common Characteristics of Connective Tissue:

1. all are derived from *mesenchyme tissue* which is embryonic tissue.
2. cells are widely scattered w/ much ECF (matrix)
3. contain protein fibers in matrix which provide strength & support
4. have protein fibers are secreted by *fibrocytes*
5. binds and supports other tissues; the infrastructure of soft organ, egs. liver & spleen

A. Adult Connective Tissue:

Connective Tissue Proper, or "regular C.T": *areolar, adipose, reticular, dense & elastic*

1. Areolar or Loose - "loose" arrangement of fibers.
 - found in subcutaneous layer (superficial fascia) of the skin.
 - It forms the Basement Membrane
 - contains protein fibers. (collagen, elastin)
 - contains immune response cells which phagocytize debris. ie. "defense cells"
2. Adipose - "adipocytes" fat storage cells.
 - major energy storage cells
 - found in subcutaneous layer of the skin
 - acts as an insulator of heat & shock absorber (absorbs "blows")
 - Liposuction- "lipectomy" removal of unwanted fat tissue.
3. Reticular - "web-like" fibers
 - forms the supporting framework for many soft organs.
eg. liver & spleen
4. Dense - closely packed protein fibers.
 - major component of tendon(M to B), and
 - ligaments(B to B)

* Carbon fiber implants are sewn into torn ligaments or tendons to reinforce and provide scaffolding around bone or muscle to which collagen fibers can grow.

5. Elastic - branching, elastic fibers
 - can stretch and snap back into place
 - found in vocal cords and lungs

B. Special Types of Connective Tissue: *cartilage, bone, & blood*

1. Cartilage - 3 types: *hyaline, fibrocartilage & elastic.*
 - has no blood vessels or nerves
 - can endure more stress than other tissues
 - densely packed protein fibers consisting of elastin & collagen in the matrix (ECF)

* Chondrocytes - mature cartilage cells which secrete the matrix material during development.

- a. *Hyaline cartilage* - "gristle", bluish-white and "glassy" appearance.
 - most abundant cartilage in body
 - helps to form nose, joints, larynx & trachea
 - helps to absorb and reduce shock between joints (found on the heads of bone)

- b. *Fibrocartilage* - found in intervertebral discs, and the symphysis pubis of the pelvis
- c. *Elastic cartilage* - provides strength and elasticity
 - found in outer ear

2. Osseous - bone tissue

- cartilage, joints, & osseous tissue make-up skeletal system.
- supports soft tissue.

*2 sub-types of bone tissue: *Compact & Spongy*

a. *Compact(Dense)* – arranged in concentric rings.

b. *Spongy(Cancellous)* – has “lattice work”

Discussion of Compact Bone:

- mature bone cells are called "osteocytes" which are found in lacunae
- cells contain mineral salts such as calcium phosphate, calcium carbonate(responsible for hardness), and collagenous fibers (responsible for flexibility)

Basic Unit of Compact Bone: “the osteon” or “Haversian System” which contains:

- a. lamellae - concentric rings.
- b. lacunae “little lake” - small spaces between the lamellae that contain osteocytes.
- c. canaliculi “little canal” - radiating canals perpendicular to lamellae. Provide routes for nutrients to reach the osteocytes and wastes can be removed.
- d. central(Haversian) canal - contains blood vessels and nerves.

3. Vascular Tissue - liquid connective tissue, ie. “blood”

- protein fiber’s characteristic of connective tissue are present during “blood clotting”.
- contains plasma, cells, and other substances:

Plasma - is a yellow-colored liquid made up of water and dissolved gases, nutrients, hormones, enzymes and ions.

* Cells found in blood:

- a. erythrocytes(RB'S) - carry O₂ to cells, and carry CO₂ away from the cells.
- b. leucocytes(WB'S) - involved in phagocytosis and immunity reactions.

VII. Membranes that Line Body Cavities: a combination of epithelial tissue and connective tissue.

4 types of membranes that line body cavities:

- a. mucus membrane - lines cavities that open directly to the exterior of the body. They secrete mucus to prevent cavities from drying out.
- b. serous membrane - lines body cavities that do not open directly to the exterior, and covers organs w/in the cavity, eg. lungs & heart
- c. cutaneous membrane - the skin
- d. synovial membrane - found in joints; different than tissues a thru c above in that it is not made up of epithelial tissue.

- secrete synovial fluid which lubricates the cartilage on the ends of bones

VIII. Muscle Tissue:

- highly specialized fibers(cells) for active generation of force for contraction
- provides motion(all muscle) and posture (skeletal muscle)

3 types of muscle: *skeletal, cardiac, & smooth*

a. *skeletal muscle* - attached to bones.

- striated - the fibers(cells) contain light and dark bands; “stripped”
- voluntary control
- multinucleated (many nuclei per cell)

b. *cardiac muscle* - forms bulk of heart walls.

- striated - the fibers(cells) contain light and dark bands; “stripped”
- involuntary control
- mononucleated – one nuclei per cell
- have *Intercalated discs* – reinforce the cell to cell connection (tissue reinforcement)
- have *Gap Junctions* – communication tubes that allow for cell to cell communication, ie. electrical info. from one cell’s cytoplasm (ICF) to another cell’s ICF.

c. *smooth muscle* - found in walls of hollow internal structures like blood vessels, stomach & (GI tract).

- nonstriated
- usually involuntary
- mononucleated

IX. Nervous Tissue: “the wiring”

2 types of nerve tissue: *Neuron & Neuroglial*

1) Neuron – “nerve cell” - receives and transmits stimuli to other nerve cells, muscles or glands

*neurons contains 4 main structures:

a. cell body b. dendrites c. axon d. axon terminals

2) Neuroglia cells - protect and support neurons (gray matter)