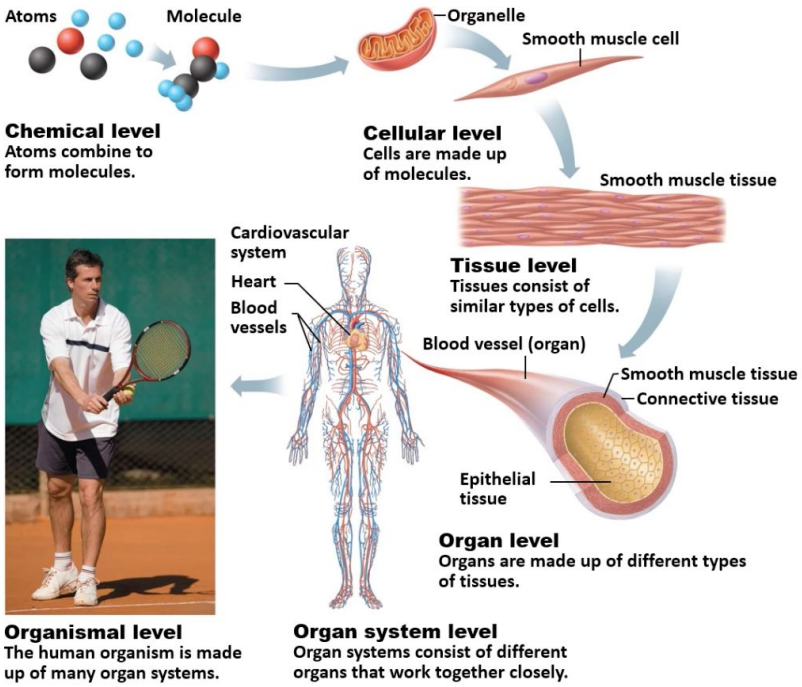
Module 1: Structural Organization of the Human Body

Levels of Organization

Levels of Structural Organization

1. Chemical
    - Atoms and molecules (Ch. 2); and organelles (Ch. 3)
    - Atoms, tiny building blocks of matter, combine to form molecules such as water and proteins.
    - Molecules, in turn, associate in specific ways to form organelles that are the basic components of cells.
2. Cellular
    - Cells (Ch. 3)
    - Cells are the smallest units of living things.
    - All cells share common functions, but individual cells vary widely in size and shape, reflecting their unique functions in the body.
3. Tissue
    - Groups of similar cells (Ch. 4)
    - Tissues are groups of similar cells that have a common function and each tissue type has a characteristic role in the body.
4. Organ
    - Contains two or more types of tissues.
    - Extremely complex functions become possible.
5. Organ System
    - Organs that work closely together to accomplish a common purpose.
6. Organismal
    - All organ systems work cooperatively to promote the well-being of the entire body.

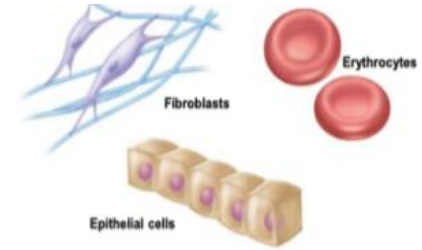
Figure 1.1 Levels of structural organization.



Cells

Cells and Cell Theory

- A cell is the structural and functional unit of life.
- Organismal functions depend on individual and collective cell functions.
- Biochemical activities of cells dictated by their shapes or forms, and specific subcellular structures.
- Continuity of life has a cellular basis.



(a) Cells that connect body parts, form linings, or transport gases

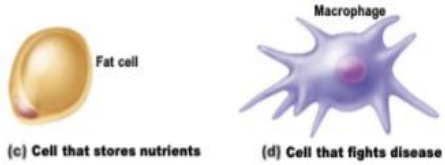
Cell Diversity

- Over 200 different types of human cells.
- Types differ in size, shape, subcellular components, and functions.

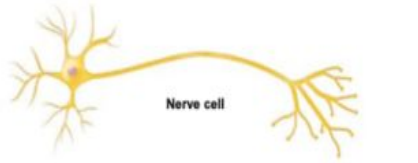
(b) Cells that move organs and body parts

Generalized Cell

- All cells have some common structures and functions.
  Human cells have 3 basic parts:
  1. Plasma membrane = (phospholipid bilayer) flexible outer boundary
  2. Cytoplasm = intracellular fluid containing organelles
  3. Nucleus = control center
- The cell is dynamic…
  - Mitosis
    http://www.youtube.come/watch?v=P7m3WfzgZdI
  - Golgi transport
    http://www.youtube.com/watch?v=souBkm-R5yU
    http://www.youtube.com/watch?v=T3xGlmigIUk
  - Mitochondrial movement
    http://www.youtube.com/watch?v=HpgRGbwu6CM



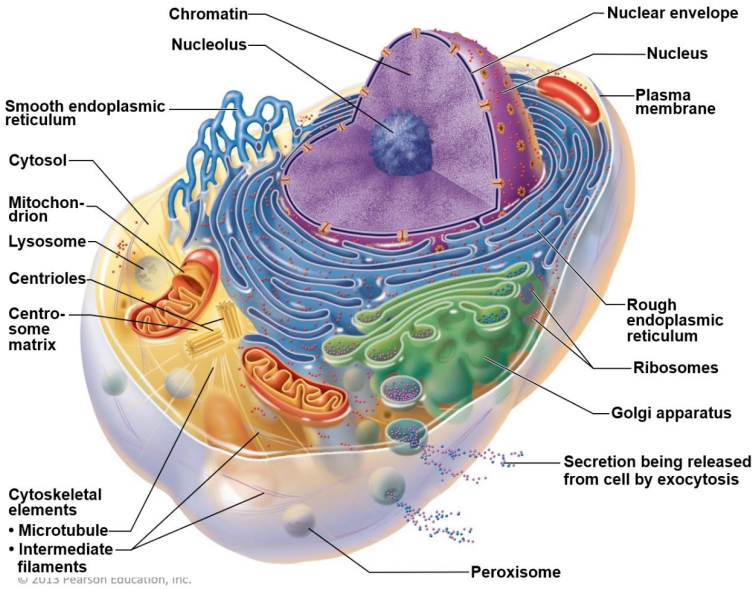
(c) Cell that stores nutrients (d) Cell that fights disease



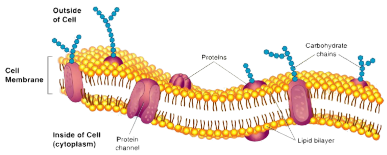
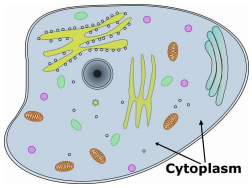
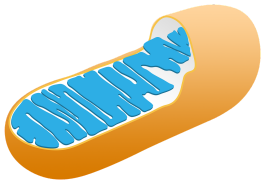
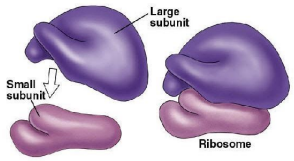
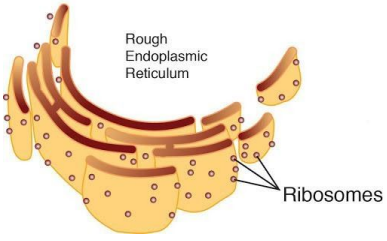
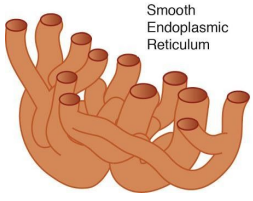
(e) Cell that gathers information and controls body functions

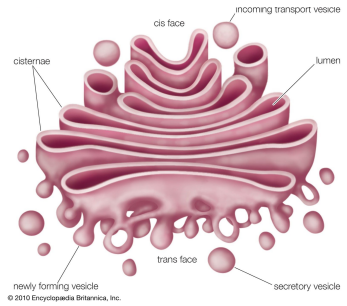
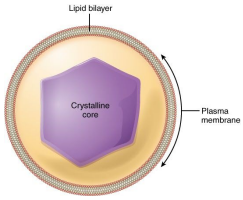
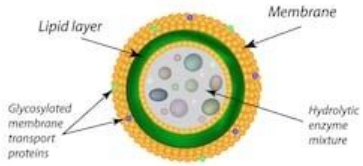
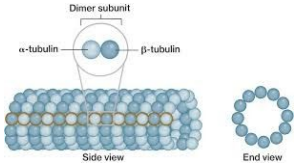
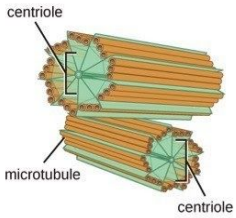
(f) Cell of reproduction

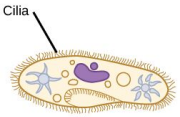
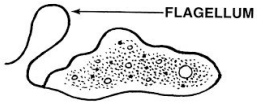
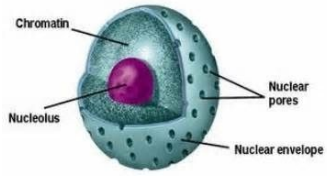
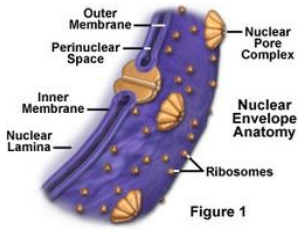
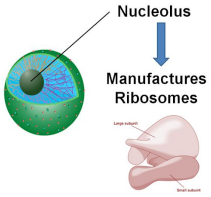
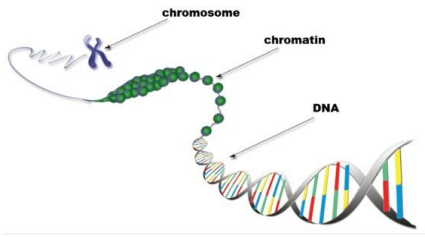
Figure 3.2 Structure of the generalized cell.



Parts of the Cell: Structure and Function

Cell Part	Structure	Function
Plasma Membrane 	- Membrane made of a double layer of lipids (phospholipids and cholesterol) in which proteins are embedded. - Proteins extend entirely through the lipid bilayer or protrude on only 1 face. - Externally facing proteins and some lipids have attached sugar groups.	- Serves as an external cell barrier and allows the transport of some substances into or out of the cell. - Maintains a resting potential that is essential for the functioning of excitable cells. - Externally facing proteins act as receptors (for hormones and neurotransmitters), transport proteins, and in cell-to-cell recognition.
Cytoplasm 	- Cellular region between the nuclear and plasma membranes, consists of fluid cytosol.	- Contains dissolved solutes, organelles (the metabolic machinery of the cytoplasm), and inclusions (storage for nutrients (lipid droplets, glycogen granules, protein crystals, pigment granules), secretory products, wastes, and cell products).
Mitochondria 	- Rodlike, double-membrane structures; inner membranes folded into projections called cristae.	- Site of ATP synthesis; a powerhouse of the cell. - Contains some of the DNA and RNA code necessary for their own function.
Ribosomes 	- Dense particles consisting of 2 subunits, each composed of ribosomal RNA and protein. - Free or attached to the rough endoplasmic reticulum.	- Sites of protein synthesis (mRNA translated to proteins). - Facilitates peptide bond formation between amino acids.
Rough Endoplasmic Reticulum 	- Membranous system enclosing a cavity, the cistern, and coiling through the cytoplasm. - Externally studded with ribosomes.	- Sugar groups are attached to proteins within the cisterns. - Proteins are bound in vesicles for transport to the Golgi apparatus and other sites. - External face synthesizes phospholipids. - Site of protein synthesis, protein modification, targets where proteins are sent in the cell.
Smooth Endoplasmic Reticulum 	- Membranous system of sacs and tubules; free of ribosomes.	- Site of lipid and steroid (cholesterol) synthesis, lipid metabolism, and drug detoxification. - Breakdown of stored glycogen to form free glucose.

Golgi Apparatus 	- A stack of flattened membranes and associated vesicles close to the nucleus.	- Packages, modifies and segregates proteins for secretion from the cell, inclusion in lysosomes, and incorporation into the plasma membrane. - Sorting of subcellular contents within the cell.
Peroxisomes 	- Membranous sacs of catalase and oxidase enzymes.	- The enzymes allow detoxification of a number of toxic substances and the breaking down of hydrogen peroxide (due to catalase, the most important enzyme). - Able to detoxify substances by enzymatic action.
Lysosomes 	- Membranous sacs containing acid hydrolases.	- Sites of intracellular digestion.
Microtubules 	- Cylindrical structures made of tubulin proteins.	- Support the cell and give it shape. - Involved in intracellular and cellular movements. - Form centrioles, cilia, and flagella, if present.
Microfilaments 	- Fine filaments composed of the protein actin. - Polymer.	- Active in muscle cells by allowing the cells to contract, move in non-muscle cells, and other types of intracellular movement. - Help form the cell's cytoskeleton.
Intermediate Filaments 	- Protein fibers; composition varies. - Much more stable and static.	- The stable cytoskeletal elements; resists mechanical forces acting on the cell.
Centrioles 	- Paired cylindrical bodies, each composed of 9 triplets of microtubules.	- Organize a microtubule network during mitosis (cell division) to form the spindle and asters. - Form the bases of cilia and flagella.

Cilia 	- Short cell-surface projections; each cilium composed of 9 pairs of microtubules surrounding a central pair.	- Coordinated movement creates a unidirectional current that propels substances across cell surfaces.
Flagellum 	- Like a cilium, but longer; the only example in humans is the sperm tail.	- Propels the cell.
Microvilli 	- Tubular/finger-like extensions of the plasma membrane; contain a bundle of actin filaments. - On specialized epithelial cells.	- Increase surface area for absorption - They do not move.
Nucleus 	- Largest organelle. - Surrounded by the nuclear envelope; contains genetic material (DNA, chromosomes, chromatin), nucleoli, and fluid nucleoplasm.	- Control center of the cell where genetic information is stored. - Instructions for genetic information are transcribed to mRNA which then provides instructions for protein synthesis in the cytoplasm.
Nuclear Envelope 	- Double-membrane structure pierced by pores. - Outer membrane is continuous with the endoplasmic reticulum. - Surrounds the nucleus.	- Nuclear pores are embedded within this structure which allows the regulation of the passage of substances to and from the nucleus and cytoplasm. - Nuclear pores allow ribosomes, mRNA, and many other large molecules, but not the DNA, to pass out of the nuclear membrane.
Nucleolus 	- Dense spherical (non-membrane bounded) bodies, composed of ribosomal RNA and proteins.	- Site of ribosome subunit manufacture.
Chromatin 	- Granular, threadlike material composed of DNA and histone proteins.	- DNA constitutes the genes.

Tissues

- Individual body cells are specialized.
    - Each type performs specific functions that maintain homeostasis (a division of labour).

What are tissues?

Tissues are groups of cells similar in structure that perform common or related functions.

What does histology refer to?

Histology is the study of tissues.

What are the types of tissues and where can they be found?

There are 4 basic types of tissues:

1. Nervous tissue = control and regulation (internal communication)
   Ex: It can be found in the brain, spinal cord, and nerves.
2. Muscle tissue = contracts to cause movement
   Ex: It can be found in muscles that attach to bones (skeletal), muscles of the heart (cardiac), and muscles of walls of hollow organs (smooth).
3. Epithelial tissue = forms boundaries between different environments, protects, secretes, absorbs, and filters
   Ex: It can be found on the skin surface (epidermis) and the lining of digestive tract organs and other hollow organs.
4. Connective tissue = supports, protects, and binds other tissues together
   Ex: It can be found on bones, tendons, fat, and other padding tissue.

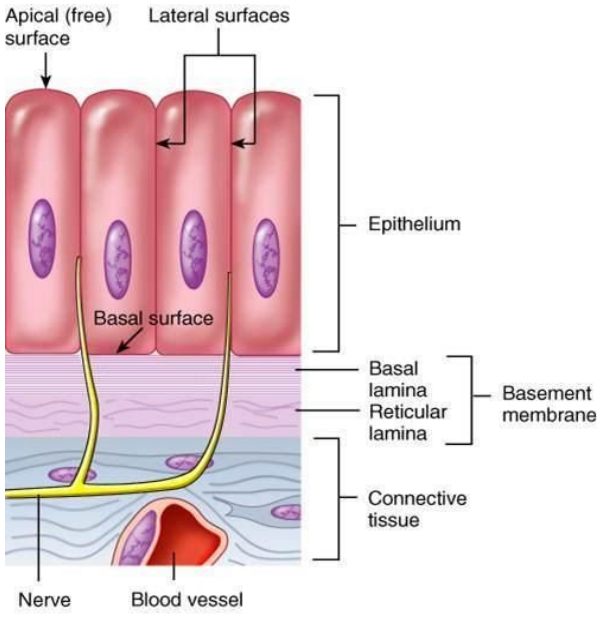
Define Epithelial Tissue and its Functions

What is epithelial tissue and what types are there?

Epithelial tissue is a sheet that covers a body surface or lines a body cavity.

There are 2 types of Epithelial tissue:

1. Covering and lining epithelium (creates boundaries)
2. Glandular epithelium (secretion)



What are the 6 main epithelial functions?

6 epithelial functions:

1. Protection (mechanical, chemical, infection), such as the skin
2. Absorption, such as the GI tract
3. Filtration, such as the kidney
4. Excretion, such as the kidney
5. Secretion, such as the glands
6. Sensory reception, such as the taste buds, olfactory membranes, etc.

7 Special Structural Characteristics of Epithelial Tissue

What are the 7 special structural characteristics of epithelial tissue?

7 special structural characteristics of epithelial tissue:

1. Cellularity = (#)
2. Specialized contacts = tight junctions & desmosomes
   Why?
   It defines polarity and acts as an effective barrier.
3. Polarity = apical and basal surfaces
   - Apical surfaces are often specialized such as having microvilli or cilia.
4. Basal lamina = noncellular, an underlying supportive sheet of primarily glycoproteins
   What are the two functions of a basal lamina?
   The basal lamina acts as a scaffold (platform) and aids with filtration of the epithelium.
5. Supported by connective tissue
   - Basement membrane = basal lamina + underlying reticular connective tissue (collagen fibers from connective tissue).
6. Innervated (nerves go into the epithelial cell layer) but avascular (do not have their own blood supply)
   How nourished?
   By the diffusion of nutrients and oxygen from the blood supply provided by the connective tissue.
7. Regeneration = high regenerative capacity
   - It reflects the nature of their job when it gets rubbed off or damaged.

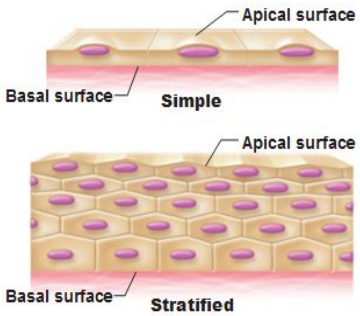
- An important feature of cancerous epithelial cells is the failure to respect the boundary imposed by the basement membrane.

Indicate the 2 Criteria Used to Classify Epithelial Cells

What are the 2 criteria used to classify epithelial tissue?

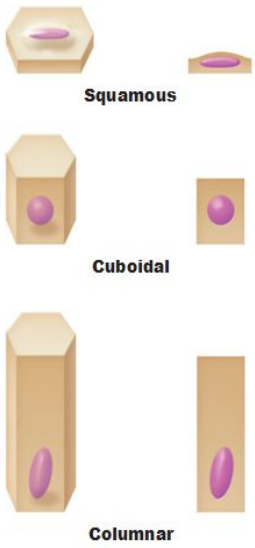
The 2 criteria are:

1. Cell Shape
   - Squamous cells
     - Flattened and scalelike
     - Nucleus is flattened
   - Cuboidal cells
     - Boxlike
     - Nucleus is round
   - Columnar cells
     - Tall; column-shaped
     - Nucleus is elongated
2. Cell Layers
   - ➢ Simple epithelia
     - A single layer of cells
   - ➢ Stratified epithelia
     - Two or more layers of cells
     - When naming, usually name it by the top cell
     - The shape can change in different layers
     - In stratified epithelia, epithelia classified by cell shape in the apical layer



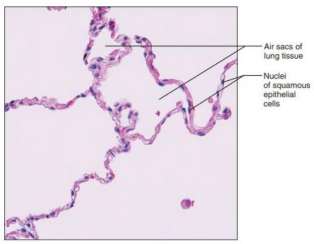
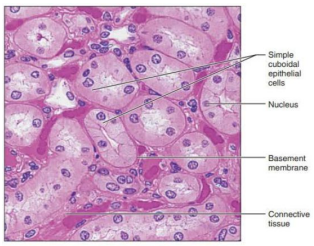
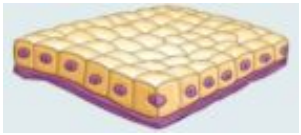
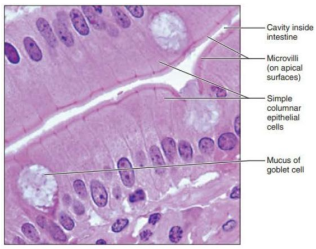
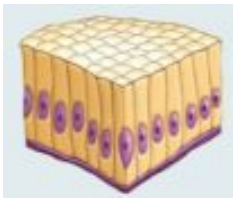
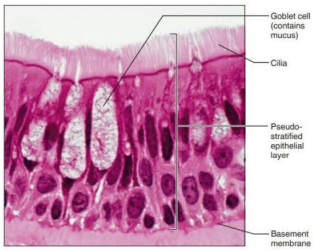
(a) Classification based on number of cell layers

Note that basal cells regenerate; as apical cells slough off, they are replaced by basal cells



(b) Classification based on cell shape

List the 4 Types of Simple Epithelia

Type	Description	Function	Location
Simple Squamous Epithelium  **Photomicrograph:** Simple squamous epithelium forming part of the alveolar (air sac) walls (140×).	- Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia. 	- Allows materials to pass by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosae.	- Kidney glomeruli - Air sacs of lungs **Endothelium:** - Lining of heart - Blood vessels - Lymphatic vessels **Mesothelium:** - Lining of the ventral body cavity (serosae)
Simple Cuboidal Epithelium  **Photomicrograph:** Simple cuboidal epithelium in kidney tubules (430×).	- Single layer of cube-like cells with large, spherical central nuclei. 	- Secretion and absorption.	- Kidney tubules - Ovary surface - Ducts and secretory portions of small glands
Simple Columnar Epithelium  **Photomicrograph:** Simple columnar epithelium of the small intestine mucosa (640×).	- Single layer of tall cells with round/elongated nuclei; some cells have cilia or microvilli; layer may contain mucus-secreting unicellular glands (**goblet cells**). 	- Absorption; secretion of mucus, enzymes and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.	**Nonciliated types:** - Lines most of the digestive tract (stomach to rectum ∴ intestines), gallbladder, and excretory ducts of some glands **Ciliated types:** - Lines small bronchi, uterine tubes, and some regions of the uterus
Pseudostratified Columnar Epithelium  **Photomicrograph:** Pseudostratified ciliated columnar epithelium lining the human trachea (780×).	- Single layer of cells of differing heights; some not reaching the free surface; nuclei seen at different levels; may contain mucus-secreting cells and have cilia. 	- Secrete substances, particularly mucus; propulsion of mucus by ciliary action.	**Nonciliated types:** - In male's sperm-carrying ducts and ducts of large glands **Ciliated types:** - Lines the trachea, most of the respiratory tract

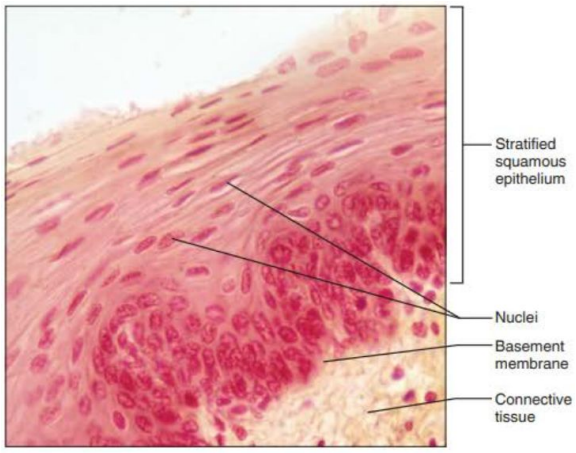
- The position of the nuclei gives the appearance of stratified epithelia.

Stratified Epithelial Tissues

- Two or more cell layers.
- Regenerate from below.
    - Basal cells divide, cells migrate to the surface.
- More durable than simple epithelia.
- Protection is a major role.

Stratified Squamous Epithelium

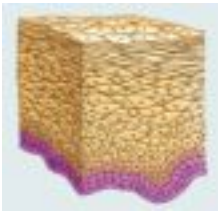
- Most widespread of stratified epithelia.
- Outer surface squamous; deeper layers cuboidal or columnar.
- Located for wear and tear.
- Those farthest from the basal layer (getting nutrients from connective tissue) are less viable.



Photomicrograph: Stratified squamous epithelium lining the esophagus (285×).

Describe the stratified squamous epithelium.

- Thick membrane composed of several cell layers; basal cells are cuboidal or columnar and metabolically active; surface cells are flattened (squamous).
- In the keratinized type, the surface cells are dead and full of keratin; basal cells are active in mitosis and produce the cells of more superficial layers (getting nutrients).



What is its main function?

- Protects underlying tissues in areas subjected to abrasion.

Where would you normally locate stratified squamous epithelium?

- The nonkeratinized type forms the moist linings of the esophagus, mouth, and vagina.
- The keratinized type forms the epidermis of the skin, a dry membrane.

Glandular Epithelia

- A gland is one or more cells that makes and secretes an aqueous fluid called a secretion.

How are they classified?

They are classified by:

1. Site of product release = endocrine or exocrine.
2. A relative number of cells forming the gland unicellular (such as goblet cells) or multicellular.

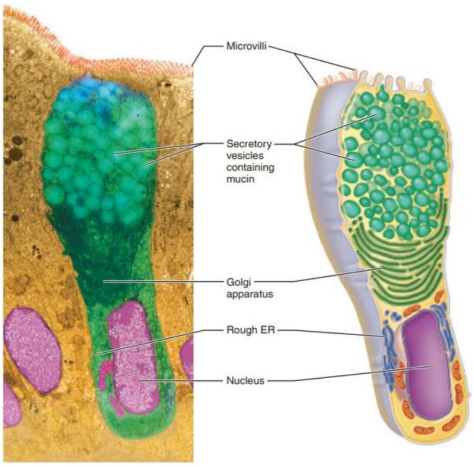
What are endocrine glands and what is their function?

Endocrine glands release products (hormones) directly into the blood; they are ductless.

What are exocrine glands and what is their function?

Exocrine glands release products into ducts (such as mucus, sweat, oil/salivary glands, liver, pancreas).

What are the 2 types of exocrine glands?



The 2 types of exocrine glands are:

1. Unicellular Exocrine Glands
    - No ducts because of only one cell.
    - Really just the goblet and mucus cells (digestive and respiratory tracts).

    Ex: Goblet cell (unicellular exocrine gland) image on the right.
2. Multicellular Exocrine Glands
    - Epithelium-derived duct and secretory cells; surrounded by supportive connective tissue (which brings nutrients to these glands); nerves control their function.
    - Those with unbranched ducts are “simple”, while those with branched ducts are “compound”.

Classification of Multicellular Glands

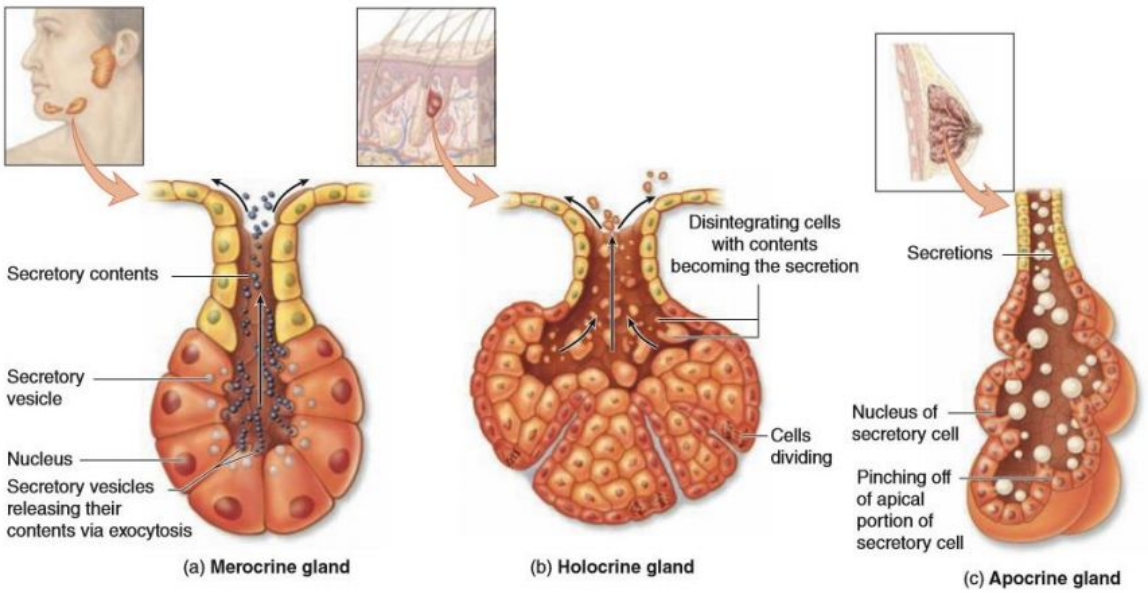
1. Structure
    - Simple glands (unbranched duct)
    - Compound glands (branched duct)
2. Type of Secretion
    - Merocrine = most common, secrete products by exocytosis as produced

      Ex: Pancreas, salivary glands, and most sweat glands.
    - Holocrine = accumulate products within then rupture

      Ex: Only sebaceous glands.
    - Apocrine = accumulated products within then apex pinches off
        - Unclear and controversial if it exists in humans.

Is a mammary gland apocrine or merocrine?

Most of the products in breast milk are made from merocrine secretion. However, we believe that there is an apocrine secretion of the lipids that go into breast milk.



Connective Tissues

5 Major Types	Main Functions
1. Connective Tissue (CT) proper 2. Cartilage 3. Bone 4. Blood 5. Mesenchyme (all CT originate here)	- Binding or support - Protection - Insulation - Storage - Transportation

Describe the Structural Organization of Connective Tissue in General

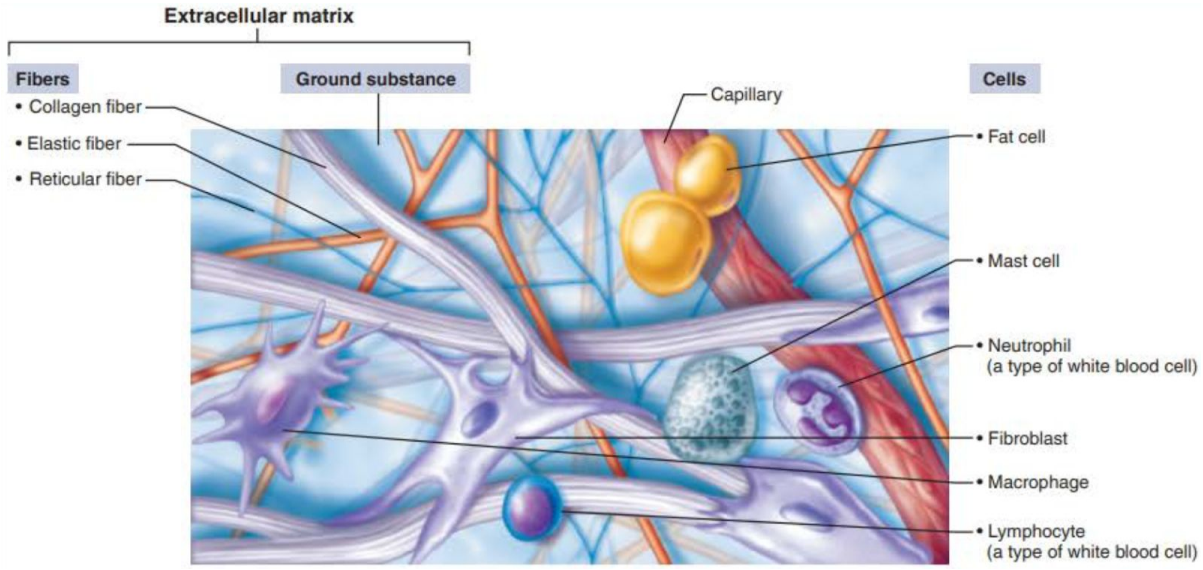
What are the 3 structural elements of connective tissue?

The 3 structural elements of connective tissue are:

1. Ground Substance = a gel-like matrix; interstitial fluid (dissolved within the fluid are various solutes from the circulatory system or wastes) + cell adhesion proteins and proteoglycans: molecular sieve
    - Cell adhesion proteins (fibronectin, laminin) help cells attach to connective tissue elements.
    - Proteoglycans are hybrid; protein with sugar groups attached to them.
        - They form out to be a big array that traps/absorbs fluids (trap water).

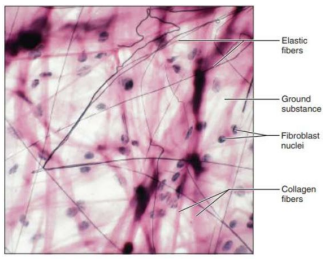
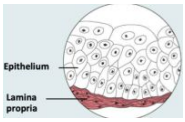
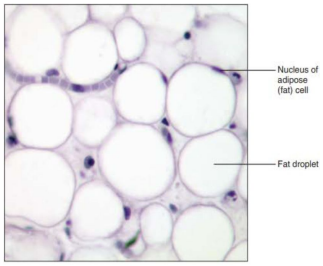
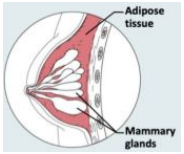
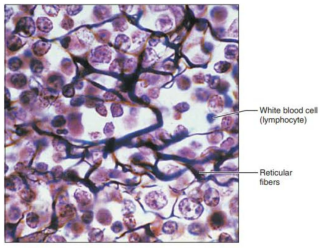
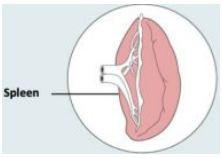
2. Fibers
    - Collagen fibers are high tensile strength formed from protein.
    - Elastic fibers are elastin and have a coiled structure to allow stretching and recoiling.
    - Reticular fibers are thin collagenous proteins that form a fine network to support blood vessels and soft tissue.
3. Cells = immature (“blast”) forms vs. mature (“cyte”) forms
    - “Blasts” are actively dividing/synthesizing cells during growth and repair.
    - “Cystes” primarily provide a level of maintenance.
    - Others include fat cells, immune cells (such as white blood cells, mast cells, and macrophages).

- Connective tissue is a matrix that provides housing for living cells; details vary from tissue to tissue.
    - https://www.youtube.com/watch?v=5g0AT8MDCKU

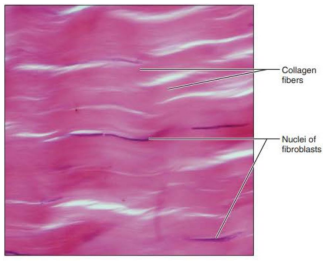
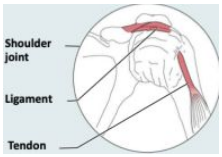


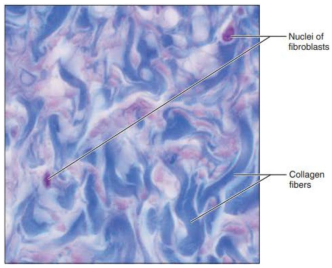
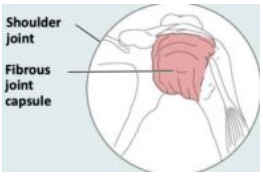
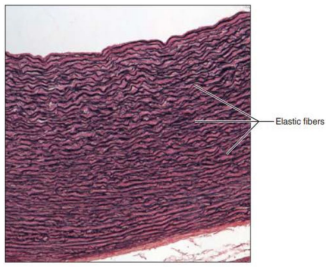
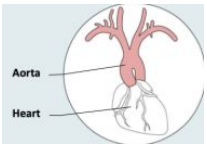
- Areolar connective tissue = a prototype (model) connective tissue

List and Describe the 3 Kinds of Loose Connective Tissue

Type of Loose CT	Description	Function	Location
CT Proper: Loose, Areolar  **Photomicrograph:** Areolar connective tissue, a soft packaging tissue of the body (340×).	- Gel-like matrix with all three fiber types; cells: macrophages, fibroblasts, mast cells, and some white blood cells.	- Wraps and cushions organs; its macrophages phagocytize (ingest) bacteria; mast cells' important role in inflammation; holds and conveys tissue fluid.	- Widely distributed under the epithelia of the body (such as when it forms lamina propria of mucous membranes; packages organs; surrounds capillaries). 
CT Proper: Loose, Adipose  **Photomicrograph:** Adipose tissue from the subcutaneous layer under the skin (350×).	- Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by a large fat droplet.	- Energy storage (food fuel); insulates against heat loss; supports and protects organs.	- Under skin in the subcutaneous tissue - Around kidneys and eyeballs - Within abdomen - In breasts 
CT Proper: Loose, Reticular  **Photomicrograph:** Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350×).	- Network of reticular fibers in typical loose ground substance; reticular cells lie on the network.	- Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, macrophages, and mast cells.	- Lymphoid organs (lymph nodes, bone marrow, and spleen). 

List and Describe the 3 Kinds of Dense Connective Tissue

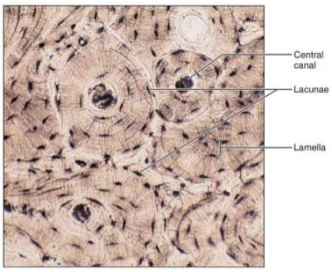
Type of Loose CT	Description	Function	Location
CT Proper: Dense, Regular  **Photomicrograph:** Dense regular connective tissue from a tendon (430×).	- Parallel collagen fibers with very few elastic fibers; the major cell type is fibroblast.	- Attaches muscle to bone (tendons); or bone to bone (ligaments); or muscle to muscle (aponeuroses); withstands tension when pulling force is applied in one direction.	- Tendons (m to b) - Ligaments (b to b) - Aponeuroses (m to m) 

CT Proper: Dense, Irregular  **Photomicrograph:** Dense irregular connective tissue from the fibrous capsule of a joint (430×).	- Irregularly arranged collagen fibers with some elastic fibers; the major cell type is fibroblast.	- Withstands tension exerted in many directions; provides structural strength.	- Fibrous capsules of joints and organs - Dermis of the skin - Submucosa of the digestive tract 
CT Proper: Dense, Elastic  **Photomicrograph:** Elastic connective tissue in the wall of the aorta (250×).	- Dense regular connective tissue containing a high proportion of elastic fibers.	- Allows tissues to recoil after stretching; maintains a pulsatile flow of blood through arteries; aids passive recoil of lungs following inspiration.	- Walls of large arteries - Within certain ligaments associated with the vertebral column - Within the walls of bronchial tubes 

List the Other Remaining Types of Connective Tissue

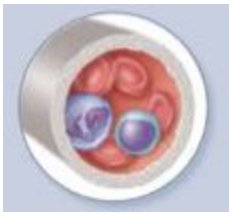
1. Cartilage = features between dense connective tissue and bone: tough, but flexible
    - Avascular, lacks nerve fibers
    - Collagen fibers (which gives it strength and toughness), can have some elastic fibers
    - A ground substance containing proteoglycans which allow it to absorb water and hydrate the tissue; contains lots of the GAGs chondroitin sulfate and hyaluronic acid, also chondronectin (adhesive protein)
    - Up to 80% of H_2O
2. Bone = calcium salts give hardness and strength for support/protection of softer tissues; cavities for fat storage and synthesis of blood cells

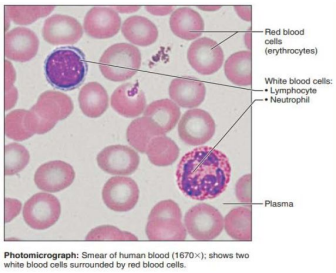
Description	Function	Location
- Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. - Very well vascularized.	- Supports and protects; provides levers for the muscles to act on; stores calcium and other minerals and fat; marrow inside bones is the site for blood cell formation (hematopoiesis).	- Bones 



- Osteoblasts are bone producing cells that can mature into osteocytes.
- Osteocytes are mature bone cells that maintain bone structure and reside in lacunae.
- Osteoclasts are “bone-breakers”.
- Osteons are concentric rings of a bony matrix (lamellae) surrounding central canals containing blood vessels and nerves serving the bone.

3. Blood

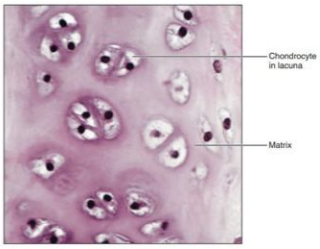
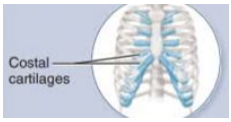
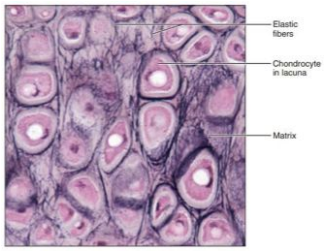
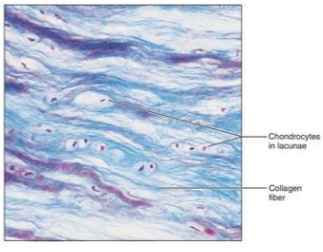
Description	Function	Location
- Red and white blood cells, and platelets in a fluid matrix (plasma).	- Transport respiratory gases (such as oxygen), nutrients, wastes, and other substances.	- Contained within blood vessels. 



Photomicrograph: Smear of human blood (1670×); shows two white blood cells surrounded by red blood cells.

- Classified as connective tissue because it consists of cells surrounded by a nonliving fluid matrix (blood plasma).
- "Fiber" components are soluble protein molecules that are only visible during clotting.

List and Describe the 3 Types of Cartilage

Type of Cartilage	Description	Function	Location
Cartilage: Hyaline 	- Amorphous but firm matrix. - Collagen fibers form an imperceptible network. - Chondroblasts produce the matrix and when it matures (as chondrocytes), it lies in lacunae (spaces in bone matrix).	- Supports and reinforces; serves as a resilient cushion; resists compressive stress.	- Forms most of the embryonic skeleton - Covers the ends of long bones in joint cavities - Forms most costal cartilages of the ribs - Cartilages of the nose, trachea, and larynx 
Cartilage: Elastic 	- Similar to hyaline cartilage, but more elastic fibers in the matrix.	- Maintains the shape of a structure while allowing great flexibility.	- Supports the external ear (pinna) and epiglottis 
Cartilage: Fibrocartilage 	- Matrix similar to, but less firm than that in hyaline cartilage; thick collagen fibers predominate.	- Tensile strength allows it to absorb compressive shock..	- Intervertebral discs - Pubic symphysis - Discs of the knee joint 

List and Describe the 2 Types of Bone Tissue

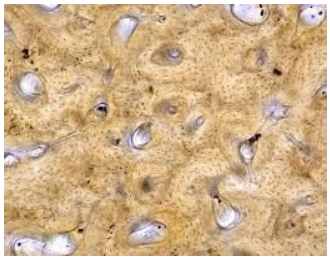
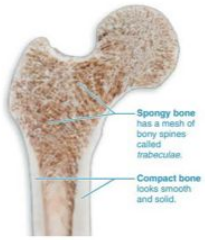
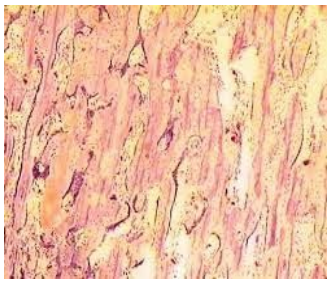
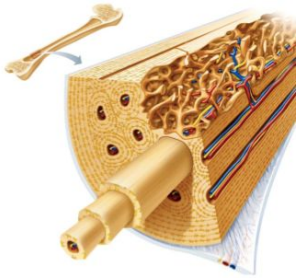
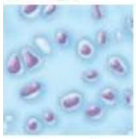
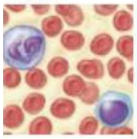
Type of Bone Tissue	Description	Function	Location
Compact Bone 	- External layer of bone. - Looks smooth and solid.	- Surrounds the medullary cavity or bone marrow. - It provides protection and strength to bones. - Compact bone tissue consists of units called osteons or Haversian systems.	- Bones 
Spongy Bone 	- Internal layer of bone. - Also called trabecular bone. - A honeycomb of small needle-like or flat pieces (mesh of bony spines) called trabeculae.	- Reduces the density of bone and allows the ends of long bones to compress as the result of stresses applied to the bone. - Spongy bone is prominent in areas of bones that are not heavily stressed or where stresses arrive from many directions.	- Bones 

Table 4.1 Comparison of Classes of Connective Tissues

TISSUE CLASS AND EXAMPLE	SUBCLASSES	COMPONENTS: CELLS	COMPONENTS: MATRIX	GENERAL FEATURES
Connective Tissue Proper  *Dense regular connective tissue*	1. Loose connective tissue • Areolar • Adipose • Reticular 2. Dense connective tissue • Regular • Irregular • Elastic	Fibroblasts Fibrocytes Defense cells Adipocytes	Gel-like ground substance All three fiber types: collagen, reticular, elastic	Six different types; vary in density and types of fibers Functions as a binding tissue Resists mechanical stress, particularly tension Provides reservoir for water and salts Energy (fat) storage
Cartilage  *Hyaline cartilage*	1. Hyaline cartilage 2. Elastic cartilage 3. Fibrocartilage	Chondroblasts (found in growing cartilage) Chondrocytes	Gel-like ground substance Fibers: collagen, elastic fibers in some	Resists compression because of the large amounts of water held in the matrix Functions to cushion and support body structures
Bone Tissue  *Compact bone*	1. Compact bone 2. Spongy bone (See Chapter 6 for details)	Osteoblasts Osteocytes	Gel-like ground substance calcified with inorganic salts Fibers: collagen	Hard tissue that resists both compression and tension Functions in support
Blood 	(See Chapter 17 for details)	Red blood cells (RBCs) or erythrocytes White blood cells (WBCs) or leukocytes Platelets	Plasma No fibers	A fluid tissue Functions to carry O_2, CO_2, nutrients, wastes, and other substances (such as hormones)