

Tissues

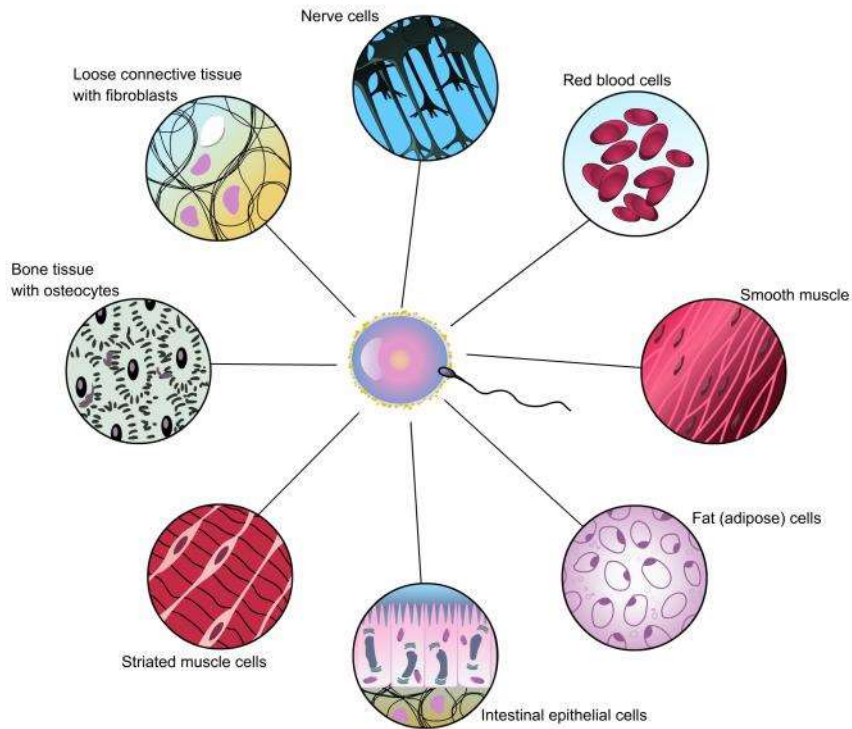
Biology 260

M. Iyengar

Body Tissues

- All humans start out as a single, fertilized egg that divides endlessly

– Cells specialize for particular functions.



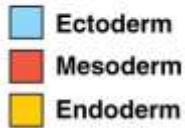
– Division of labor in the body with all functions benefiting the whole organism

Developmental Aspects of Tissues



16-day-old embryo
(dorsal surface view)

- **Embryo** = sperm + egg
→ Cell division → Tissues → body



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- **Primary germ layers** → where all body tissues come from

– Superficial to deep:

- **Ectoderm**

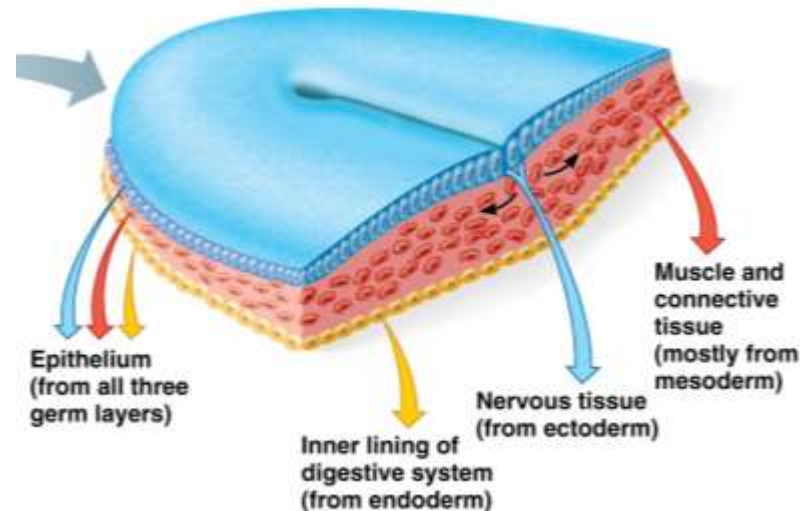
- Nerve tissue
- Some Epithelial tissues

- **Mesoderm**

- Muscle and connective tissues
- Some Epithelial tissues

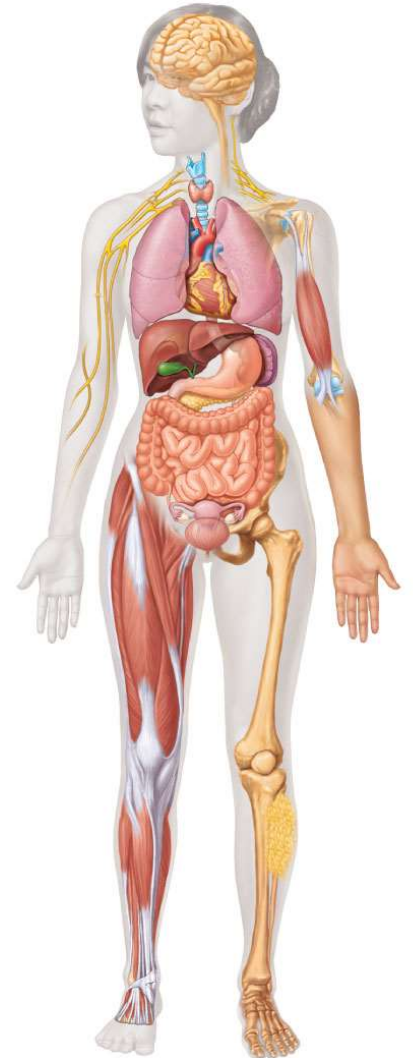
- **Endoderm**

- Some Epithelial tissues



The Living Fabric

- **Tissues** – groups of cells with similar structure that work together to perform a necessary function of life.
 - Four basic tissue types:
 - **Epithelial**
 - **Connective**
 - **Muscle**
 - **Nervous**



Epithelial Tissue

- Epithelial tissue (**epithelium**) is a sheet of cells that covers body surfaces or cavities
- Two main forms:
 - *Coverings and linings*
 - On external and internal surfaces = skin, mucosa, serosa
 - *Glandular*
 - Tissue that produces and releases substances like hormones, saliva, sweat, oil
- Specific functions include:
 - protection, absorption, filtration, excretion, secretion, and sensory reception

Characteristics of ALL Epithelial Tissues

1. **Polarity**

- The top (**apical**) surface is free exposed to air
- The lower surface rests on a basement membrane
 - Secreted by ET & CT cells

2. **Specialized cell-to-cell contacts** – cell junctions

3. **Supported by connective tissues** – Basement membrane

4. **Avascular, but innervated** – no direct blood supply, usually have nerves or neurons

5. **Regeneration** – can create new cells easily

Special Characteristics of Epithelial Tissues

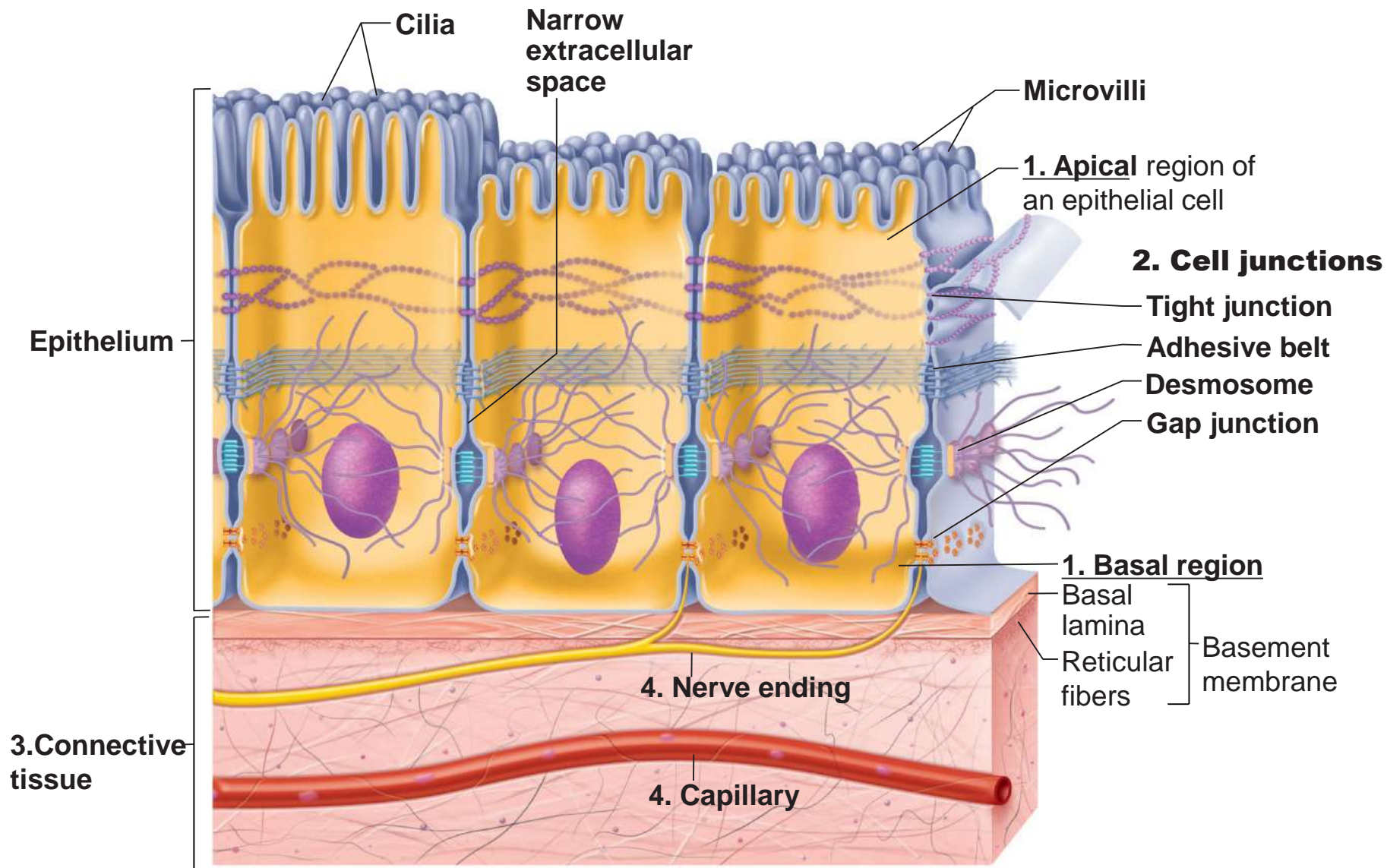
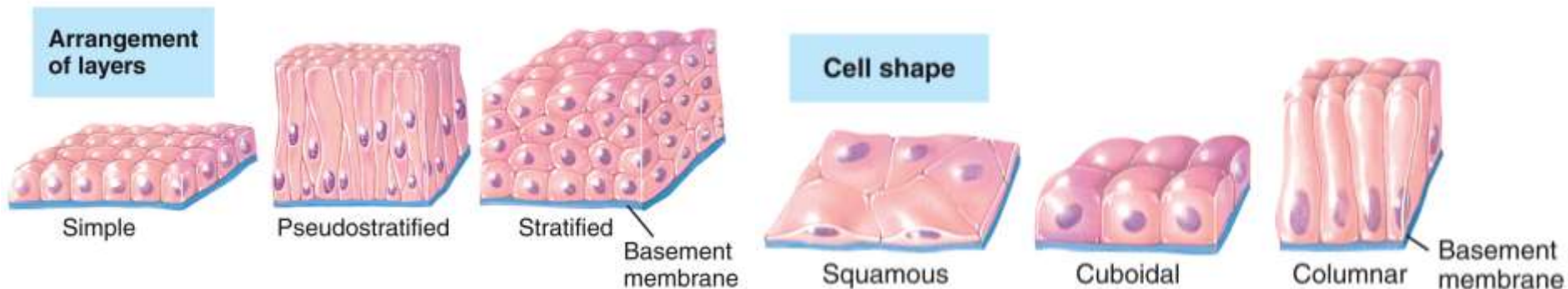


Figure 4.1

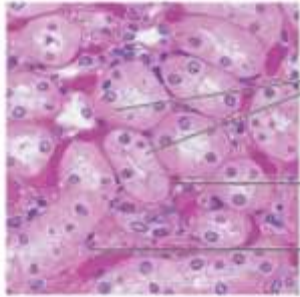
Classification / Naming of Epithelial Tissues

- **First name** - indicates number of cell layers
 - *Simple* – one layer of cells
 - Passive diffusion, absorption, & secretion
 - *Stratified* – more than one layer of cells
 - Durable and help protect underlying tissues/organ
- **Last name** - describes shape of cells
 - *Squamous* – cells wider than tall ; plate-like
 - *Cuboidal* – cells are as wide as tall; like cubes
 - *Columnar* – cells are taller than they are wide; like columns



Epithelial Tissues

Simple Cuboidal



Simple cuboidal epithelial cells
Basement membrane
Connective tissue

Photomicrograph: Simple cuboidal epithelium in kidney tubules (250x).

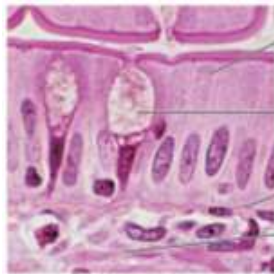
Simple squamous



Air sacs of lungs
Nuclei of squamous epithelial cells

Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (185x).

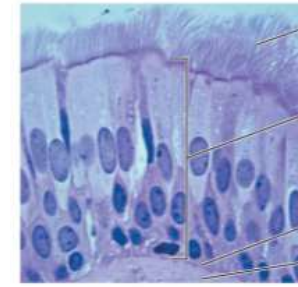
Simple columnar



Simple columnar epithelial cell
Goblet cell
Basement membrane
Connective tissue

Photomicrograph: Simple columnar epithelium of the small intestine (430x).

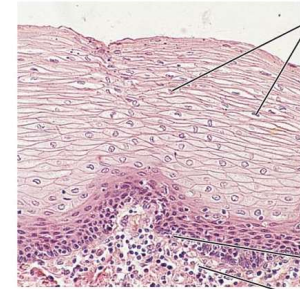
Pseudostratified columnar



Cilia
Pseudo-stratified epithelial layer
Basement membrane
Connective tissue

Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (430x).

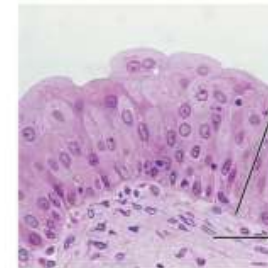
Stratified squamous



Nuclei
Stratified squamous epithelium
Basement membrane
Connective tissue

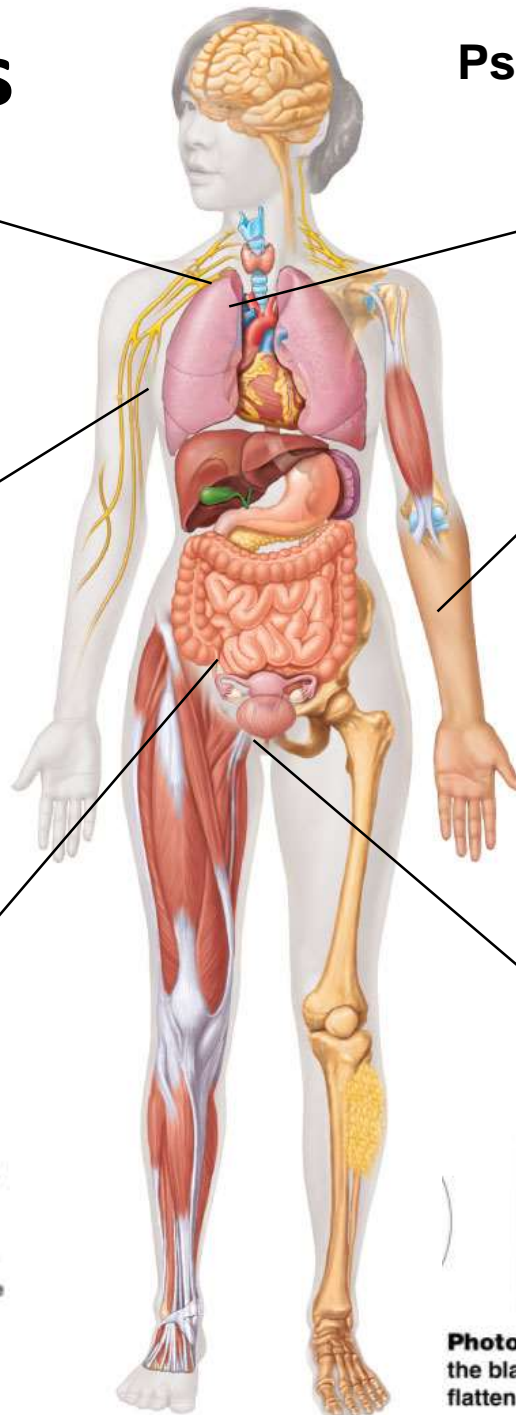
Photomicrograph: Stratified squamous epithelium lining of the esophagus (140x).

Transitional

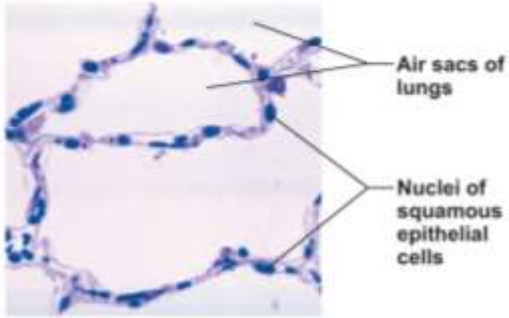
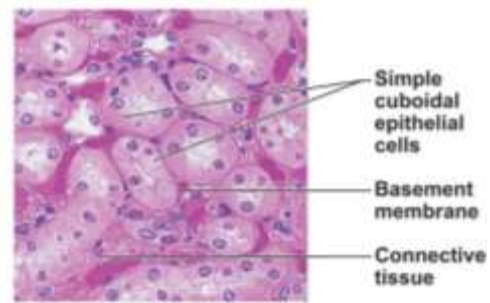
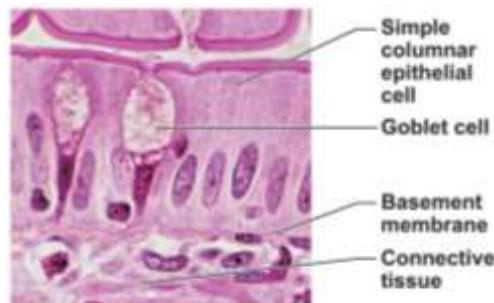


Basement membrane
Transitional epithelium
Connective tissue

Photomicrograph: Transitional epithelium lining of the bladder, relaxed state (270x); surface rounded cells flatten and elongate when the bladder fills with urine.

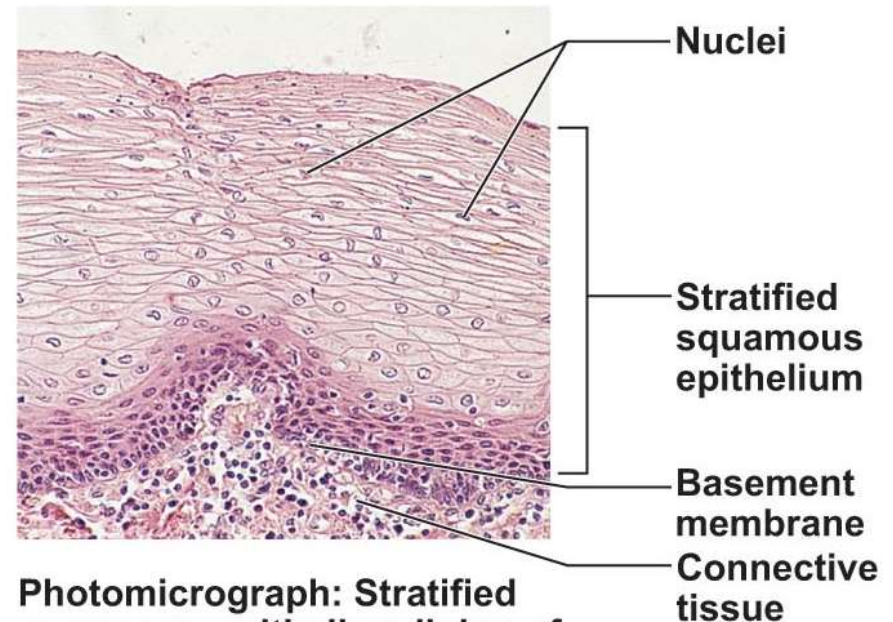


Types of Simple Epithelium

	<u>Squamous</u>	<u>Cuboidal</u>	<u>Columnar</u>
Function(s)	Diffusion, osmosis, secretion, filtration	Secretions and absorption	Secretion and absorption
Location(s)	Serous membranes Lungs Blood vessels & heart linings	Kidney tubules Small Glands Ovary surface	Digestive tract lining Lines respiratory tract Lines uterine tubes
Image	 <p>Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (185x).</p>	 <p>Photomicrograph: Simple cuboidal epithelium in kidney tubules (250x).</p>	 <p>Photomicrograph: Simple columnar epithelium of the small intestine (430x).</p>

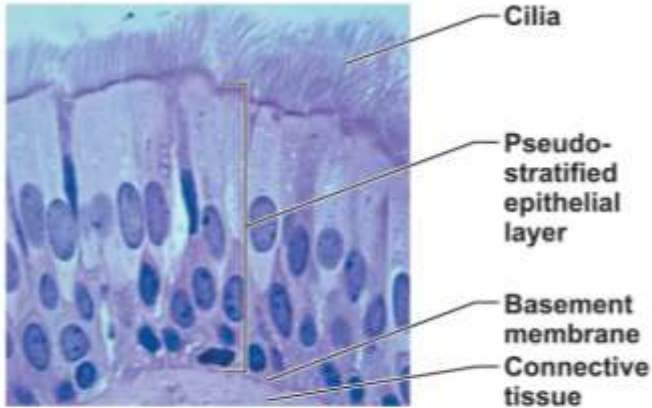
Stratified Epithelia

- Stratified squamous
 - Multiple cells at the free surface are squamous
 - Cells near basement are cuboidal or columnar
 - Functions to provide protection
 - Locations
 - Skin
 - Mouth
 - Esophagus
 - Pharynx
 - Vagina

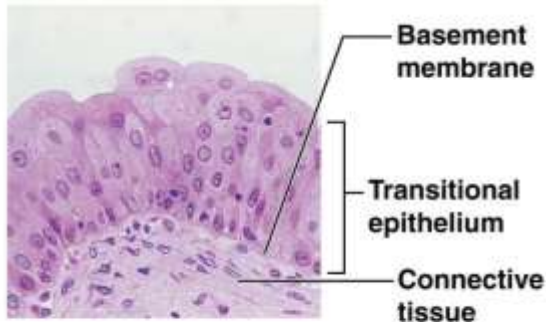


Photomicrograph: Stratified squamous epithelium lining of the esophagus (140 \times).

Classification of Epithelium



Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (430 \times).

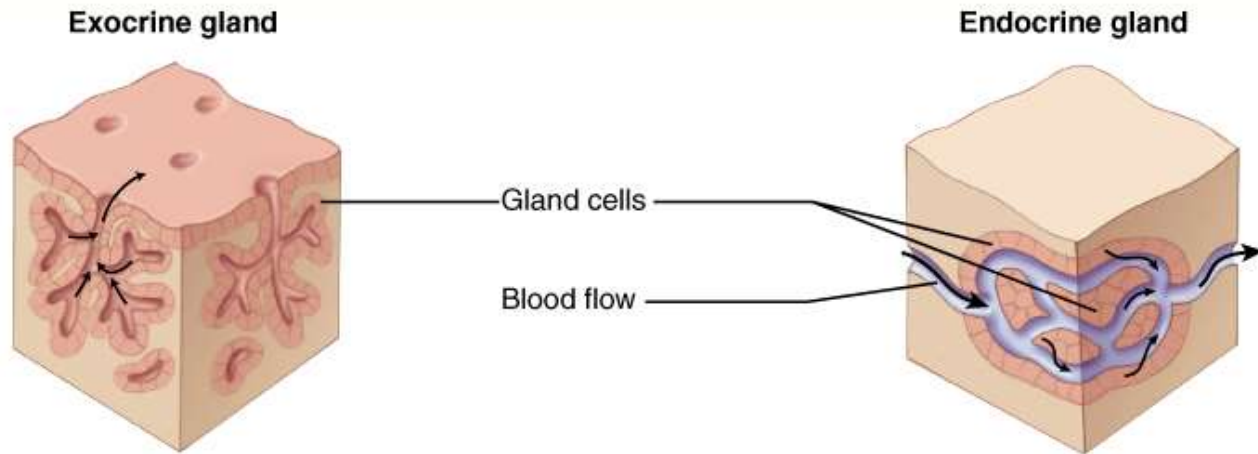


Photomicrograph: Transitional epithelium lining of the bladder, relaxed state (270 \times); surface rounded cells flatten and elongate when the bladder fills with urine.

- Exceptions to the naming rule:
 - Pseudostratified columnar epithelium
 - “Pseudo” = false
 - Cells vary in height and appear to be in many layers, but are in a single layer
 - Involved in secretion
 - Lines the upper respiratory tract
 - Transitional epithelium
 - Basal layer cells are cuboidal or columnar
 - cells to change shape when stretched
 - Allows organs to stretch
 - Lines urinary bladder, ureters, & urethra

Glandular Epithelium

- Gland - One or more cells responsible for secreting a product



Exocrine gland

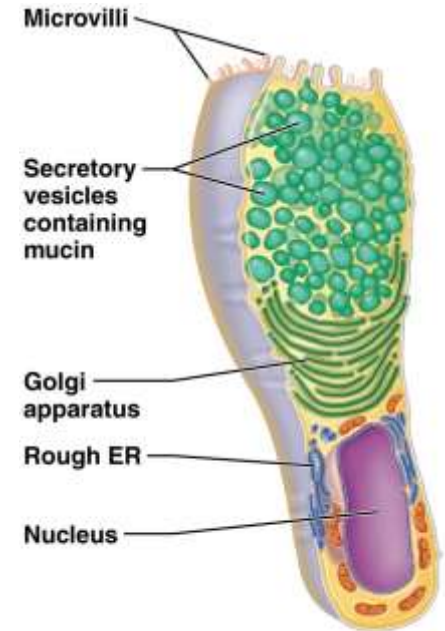
- Secretions empty through openings (ducts) to the epithelial surface
- Include sweat and oil glands

Endocrine gland

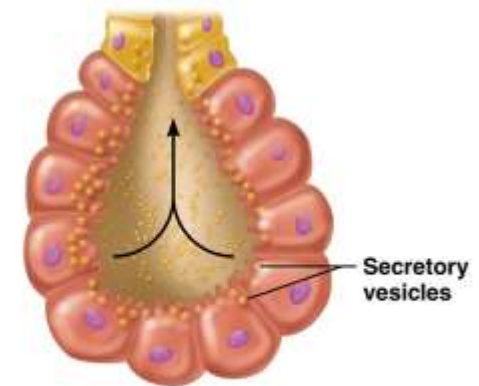
- Ductless - secretions diffuse into blood vessels
- All secretions are hormones

Glandular Epithelium

- Classified by:
 - Site of product release:
 - **Endocrine vs. Exocrine**
 - Number of cells forming the gland
 - Unicellular: 1 cell – Example = goblet cell
 - Produces mucus
 - Multicellular: many cells – Example = salivary glands, pancreas, sweat glands
 - **Merocrine**: most secrete products by exocytosis as they are produced
 - » (sweat, pancreas)
 - **Holocrine**: accumulate products within, then rupture
 - » (sebaceous oil glands)



(b)
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(a) Merocrine glands secrete their products by exocytosis.

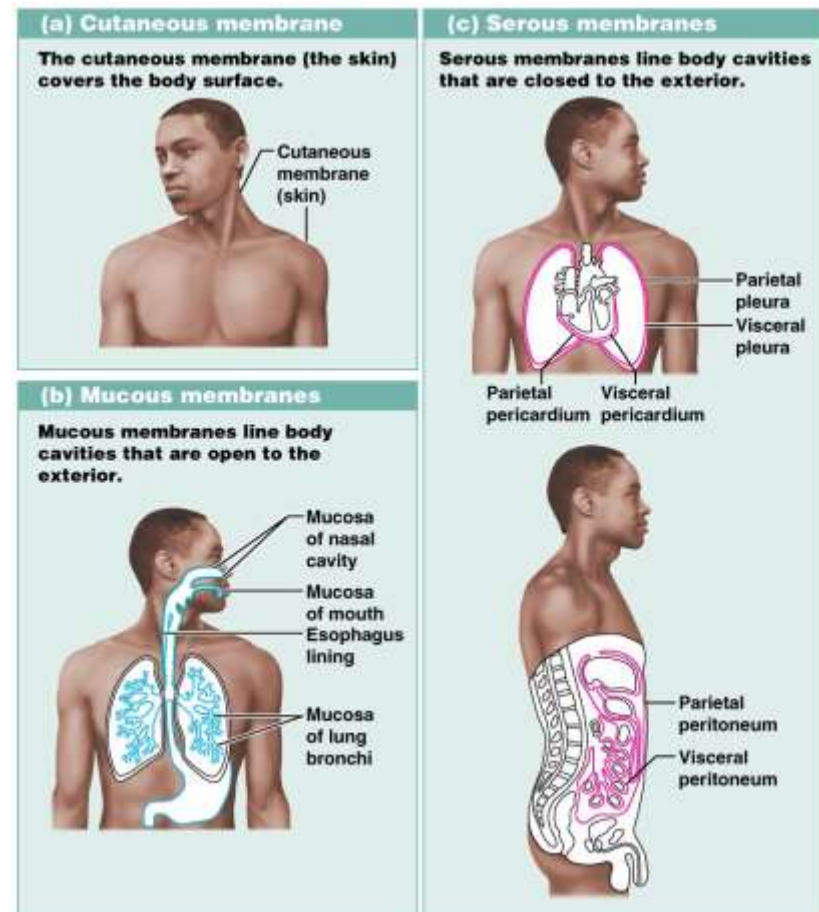
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Covering and Lining Membranes

- Composed of at least two primary tissue types: an **epithelium** bound to underlying **CT proper layer**

– Three types:

- **Cutaneous membranes**
- **Mucous membranes**
- **Serous membranes**



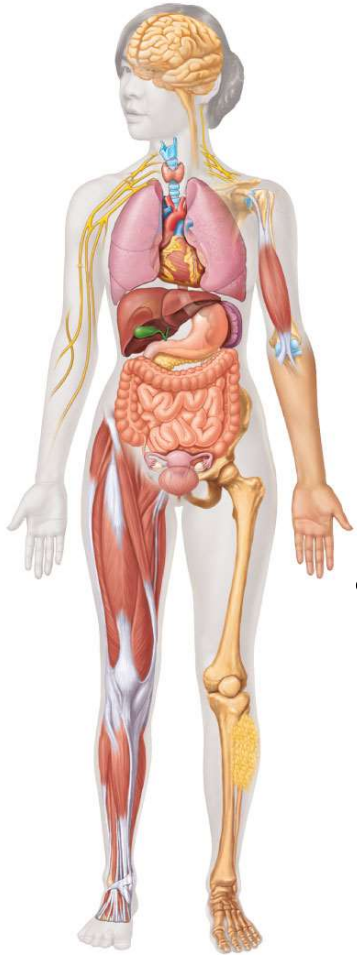
Mucous Membranes

- Also called **mucosae**
 - **Line body cavities that are open to the exterior** (example: digestive, respiratory, urogenital tracts)
- Moist membranes bathed by secretions or urine
- Epithelial sheet lies over layer of loose connective tissue called **lamina propria**
- May secrete mucus

Serous Membranes

- Also called **serosae**
- Found in closed **ventral** body cavities
 - Constructed from simple squamous epithelium resting on thin areolar CT
 - **Parietal**
 - **Visceral**
 - Cavity between layers is filled with slippery **serous fluid**,
 - Special names given to show location:
 - **pleurae**
 - **pericardium**
 - **Peritoneum**

Connective Tissue



- The most abundant, widely distributed, and diverse group of tissues.
 1. All have common embryonic origin
 - all arise from mesenchyme tissue
 2. Have varying degrees of vascularity (blood supply)
 3. Cells surrounded by an extracellular matrix (ECM)
- Specific functions include:
 - binding and support
 - protecting
 - insulating
 - storing reserve fuel
 - transporting substances (blood)

Connective Tissue Characteristics

1. Living cells

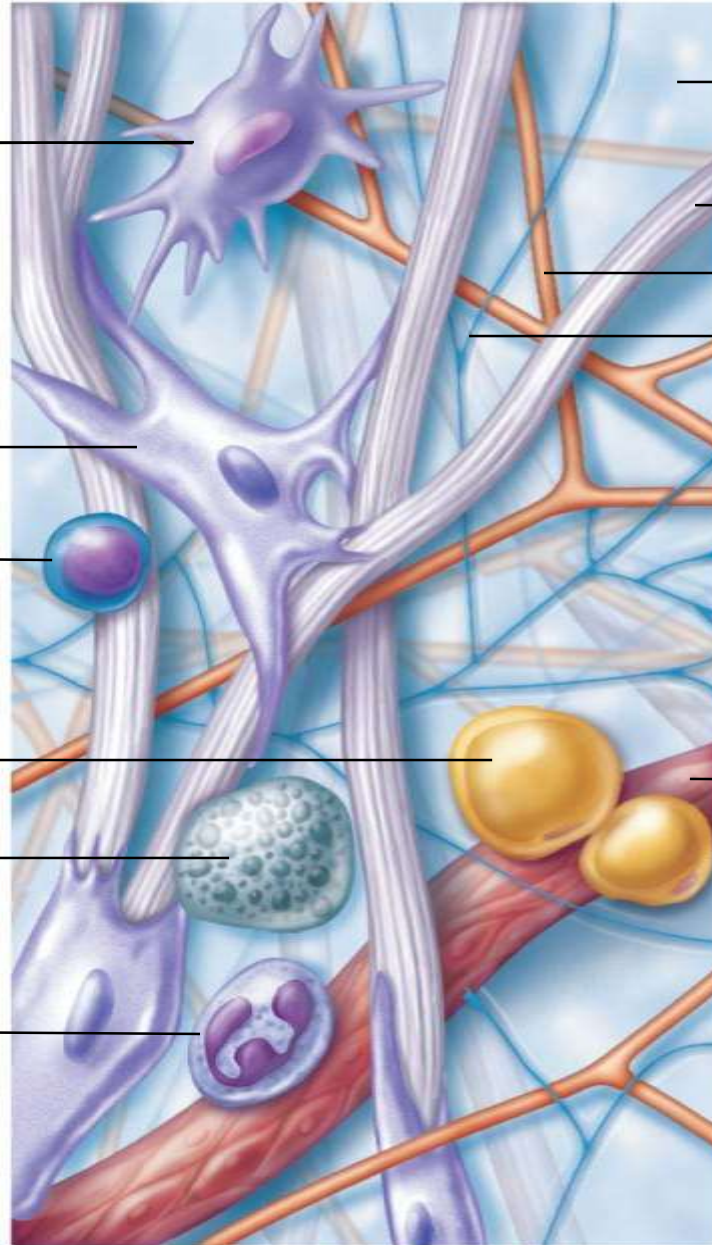
- **“blast”** – immature cells that make ground substance
- **“cyte”** – mature cells that maintain tissue health

2. Extracellular Matrix (ECM)

- **Ground substance:** material that fills space between cells
 - Different for each tissue; Hard → liquid
- **Fibers:** provide support for cells and create a fabric-like tissue
 - **Collagen** – strong & tough → collagen boosters
 - **Elastic** – stretch & recoil → elastic waist band
 - **Reticular** – branched & mesh-like → spider web

Cell types

Extracellular matrix



Macrophage

Fibroblast

Lymphocyte

Fat cell
(adipocyte)

Mast cell

Neutrophil

Ground substance

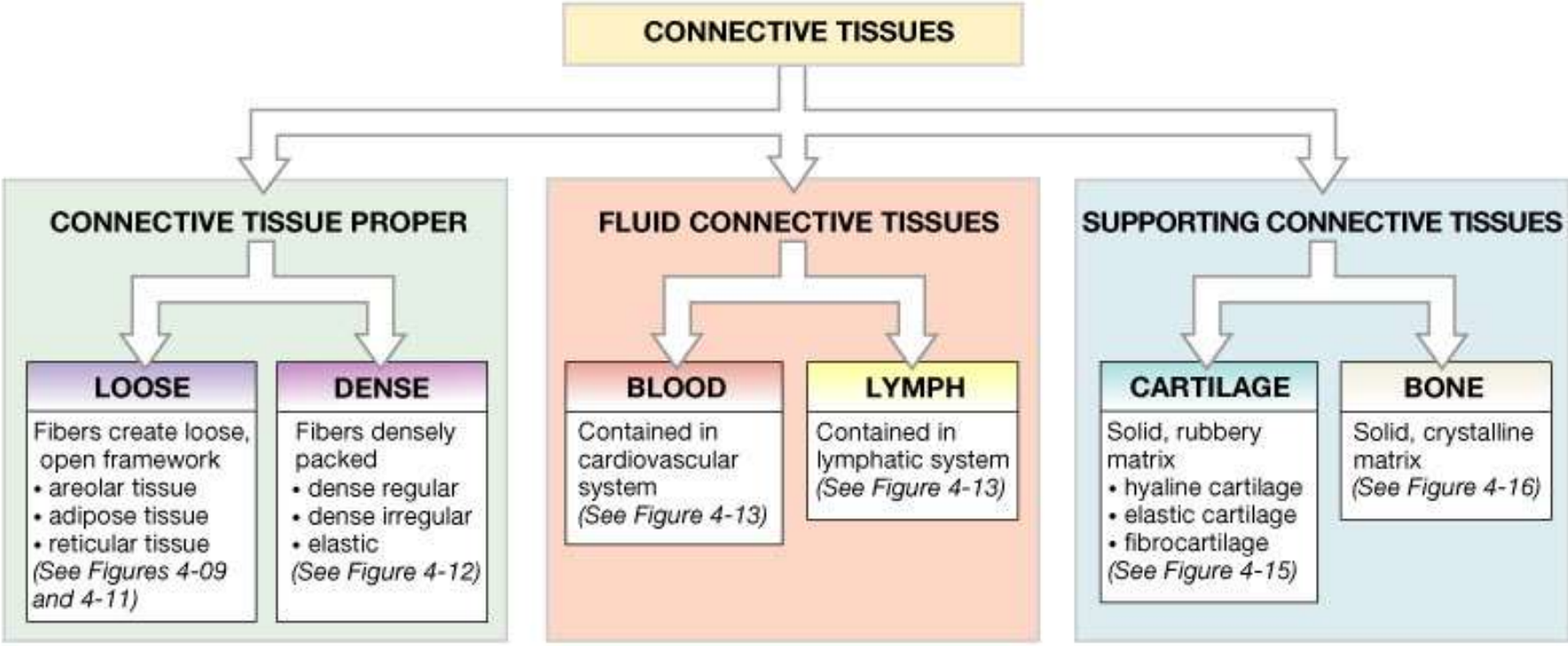
Fibers

- Collagen fiber
- Elastic fiber
- Reticular fiber

Capillary

Areolar CT = prototype
(model) connective tissue.

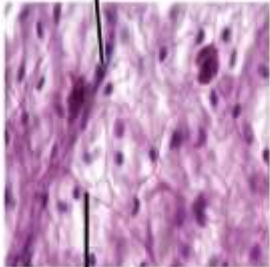
Classification of Connective Tissues



Connective Tissues

Loose connective tissue

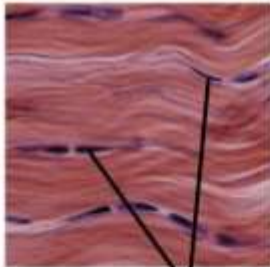
Collagenous fiber



120 μm

Elastic fiber

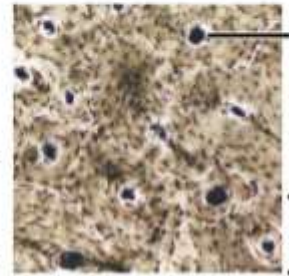
Fibrous connective tissue



30 μm

Nuclei

Bone

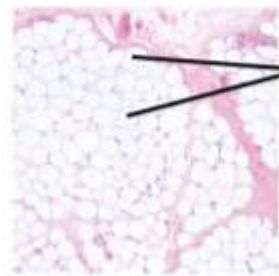


700 μm

Central canal

Osteon

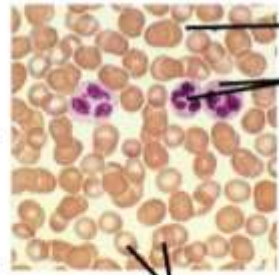
Adipose tissue



150 μm

Fat droplets

Blood



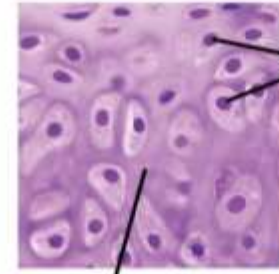
55 μm

Plasma

White blood cells

Red blood cells

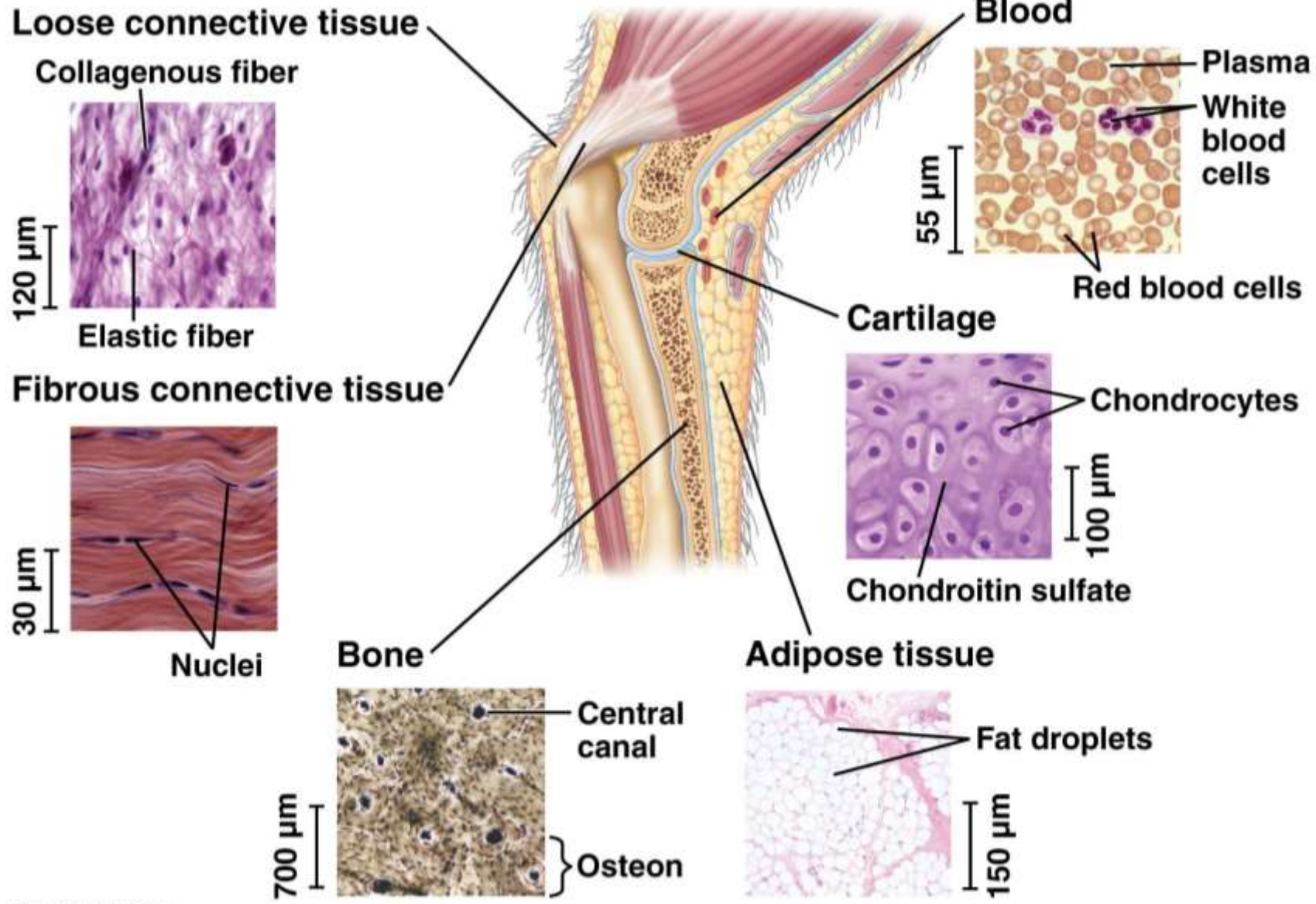
Cartilage



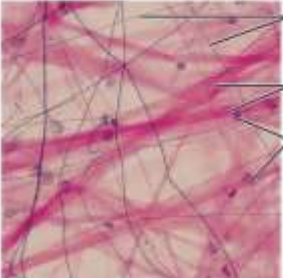
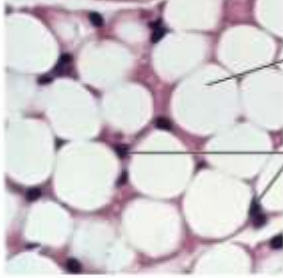
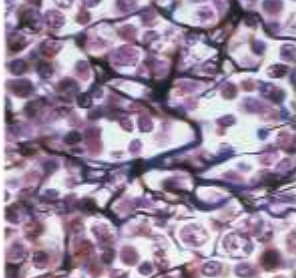
100 μm

Chondrocytes

Chondroitin sulfate



Types of CT Proper

	<u>LOOSE</u> = open ECM		
	Areolar	Adipose	Reticular
Cells	Fibroblasts	Adipocytes	Reticular
Fibers	Collagen Elastic Reticular	Collagen	Reticular
Function(s)	Strength, elasticity & support	Insulation, support & protection	Filtration of blood Binds smooth muscle
Location(s)	Papillary layer of the dermis Around organs	Under skin Around organs	Liver Spleen Lymph nodes
Image	 <p>Photomicrograph: Areolar connective tissue, a soft packaging tissue of the body (270×).</p>	 <p>Photomicrograph: Adipose tissue from the subcutaneous layer beneath the skin (570×).</p>	 <p>Photomicrograph: Dark-staining network of reticular connective tissue (400×).</p>

Types of CT Proper

DENSE = ECM packed with fibers

Regular

Irregular

Elastic

Cells

Fibroblasts

Fibers

Regularly arranged collagen fibers

Irregularly arranged collagen fibers

Regularly arranged elastic fibers

Function(s)

Helps with attachment & resists pulling

Helps with attachment & resists pulling

Allows for expansion and contraction of some organs

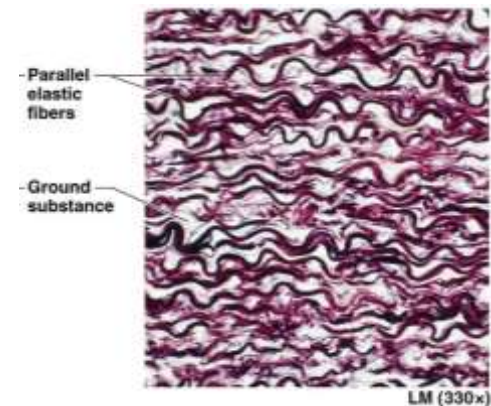
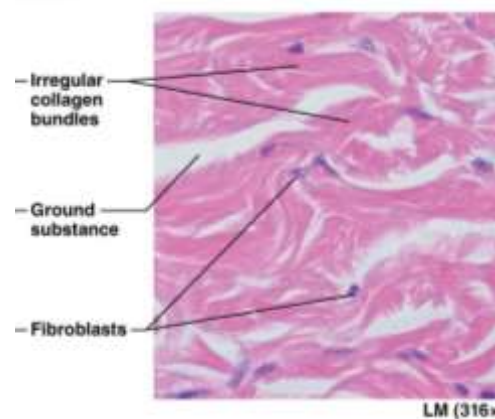
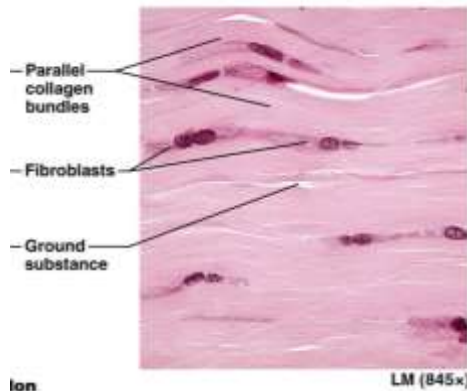
Location(s)

Tendons
Ligaments

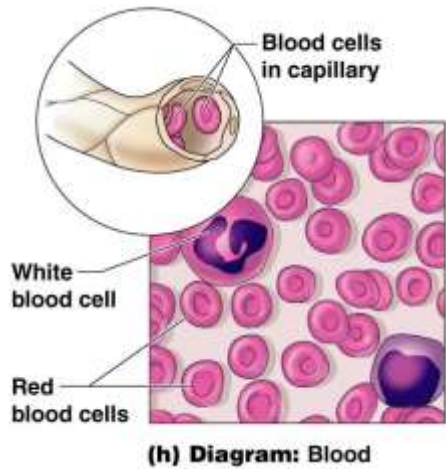
Dermis
Around muscles
Heart valves

Walls of large arteries
Vertebrae ligaments

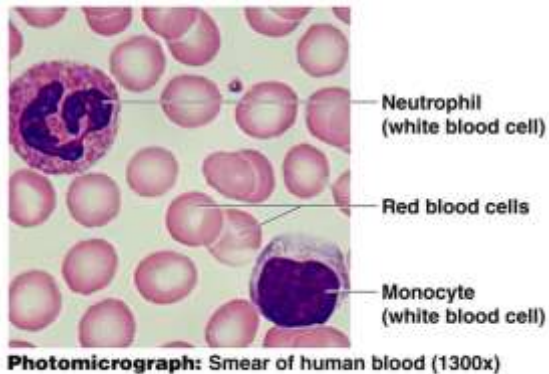
Image



Fluid CT


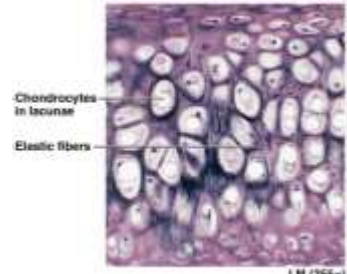
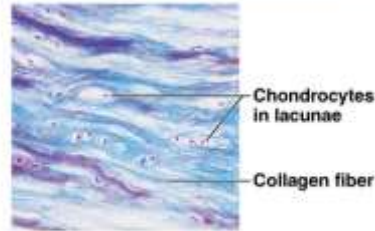
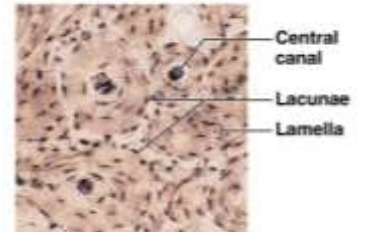


- Blood (vascular tissue)
 - Blood cells surrounded by fluid matrix called blood plasma
 - Fibers are proteins that are visible during clotting
 - Functions to transport materials throughout the body
 - O_2 , CO_2 , nutrients, waste, etc

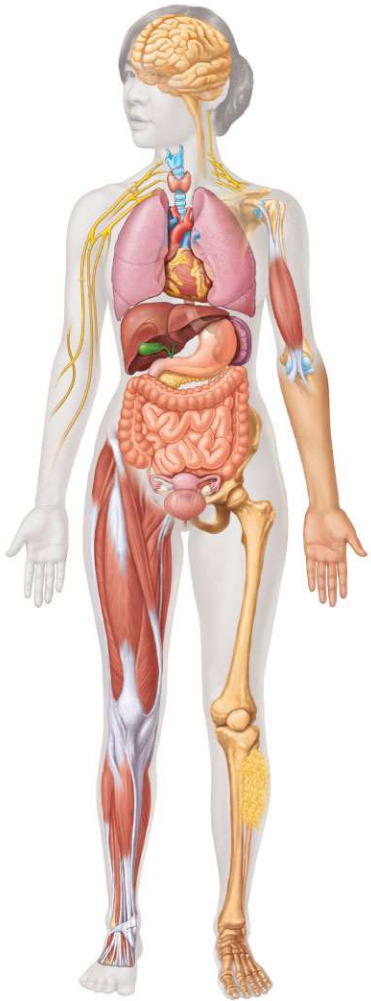


- Lymph
 - Protein-rich interstitial fluid that enters lymphatic vessels

Types of Support CT

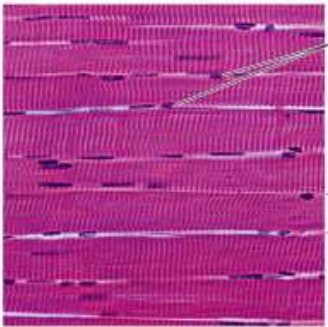
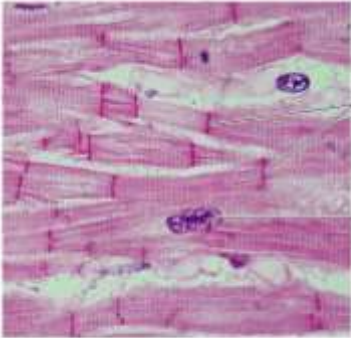

	<u>CARTILAGE</u> = Gel-like ECM			<u>BONE</u> = Hard calcium ECM
	Hyaline	Elastic	Fibrocartilage	
Cells	Chondrocytes in a lacuna			Osteocytes in a lacuna
Fibers	Thin collagen	Elastic	Thick collagen	Collagen
Function(s)	Flexibility and support Smooth surface for joint movements	Strength and elasticity Maintains shape	Support and joining structures Strength and rigidity	Protects organs Provides support for the body Assist with movement
Location(s)	Nose Fetal skeleton Ends of long bones Rib cartilage	External ear	Pubic symphysis Intervertebral discs	Skeleton
Images	 <p>Photomicrograph: Hyaline cartilage from the trachea (400×).</p>	 <p>Photomicrograph: Elastic cartilage (255×).</p>	 <p>Photomicrograph: Fibrocartilage of an intervertebral disc (150×).</p>	 <p>Photomicrograph: Cross-sectional view of ground bone (165×).</p>

Muscle Tissue

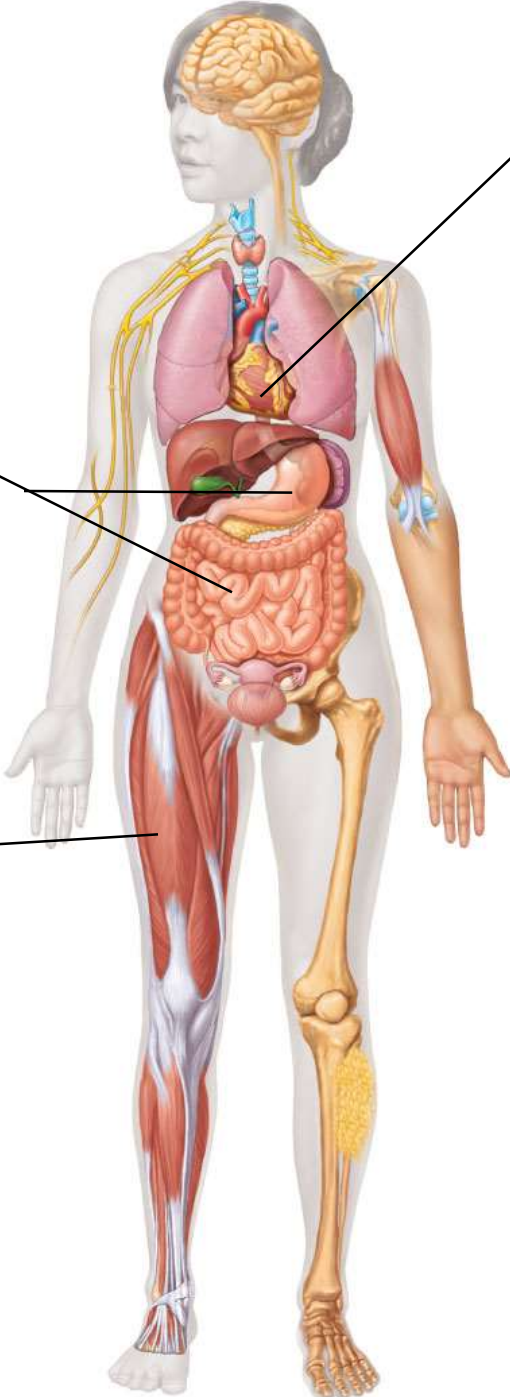


- Common structures
 - Highly vascularized
 - Muscle cells possess **myofilaments**, actin and myosin proteins that cause movement
- Function is to produce movement
 - Voluntary or involuntary
- Three types:
 - Skeletal muscle
 - Cardiac muscle
 - Smooth muscle

Types of Muscle Tissue

	<u>Skeletal</u>	<u>Cardiac</u>	<u>Smooth</u>
Cell Shape	Long, cylindrical	Short, branched	Medium, spindle shaped
Cell structures	Many nuclei Obvious striations	One nucleus Obvious striations Intercalated discs	One nucleus No striations
Function	Movement of bones or skin	Movement of blood thru the heart	Movement of substances thru a hollow organ
Location	Attached to bones	Walls of the heart	Walls of hollow organs
Image	 <p>Nuclei</p> <p>Part of muscle fiber</p> <p>Photomicrograph: Skeletal muscle (approx. 250x).</p>	 <p>Intercalated discs</p> <p>Nucleus</p> <p>Photomicrograph: Cardiac muscle (800x).</p>	 <p>Smooth muscle cell</p> <p>Nuclei</p> <p>Photomicrograph: Sheet of smooth muscle (approx. 250x).</p>

Muscle Tissues



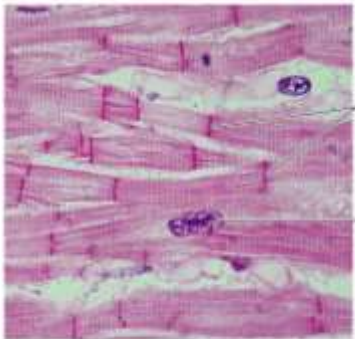
Smooth muscle



Smooth muscle cell
Nuclei

Photomicrograph: Sheet of smooth muscle (approx. 250x).

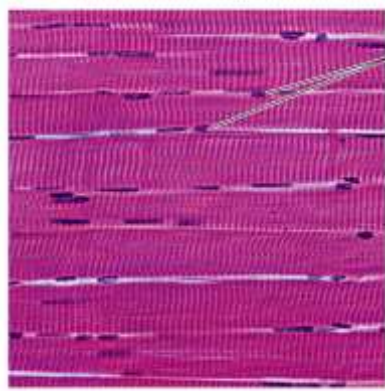
Cardiac muscle



Intercalated discs
Nucleus

Photomicrograph: Cardiac muscle (800x).

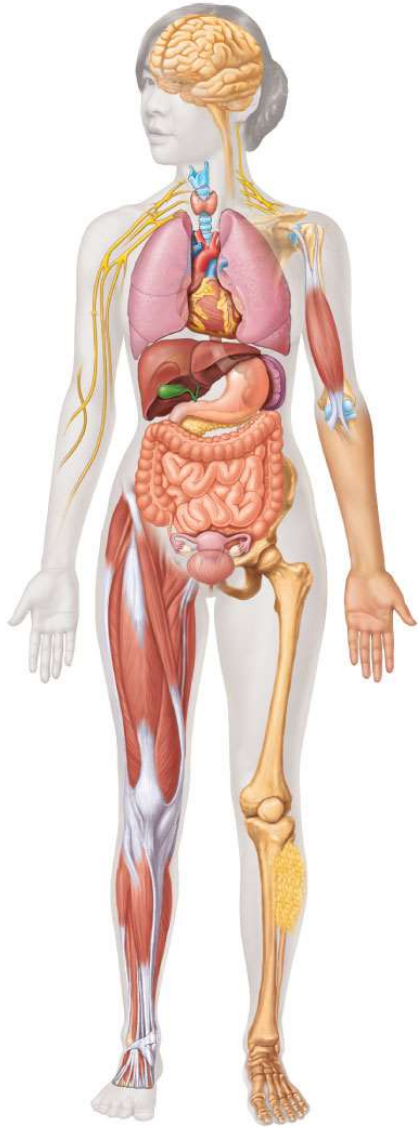
Skeletal muscle



Nuclei
Part of muscle fiber

Photomicrograph: Skeletal muscle (approx. 250x).

Nervous Tissue

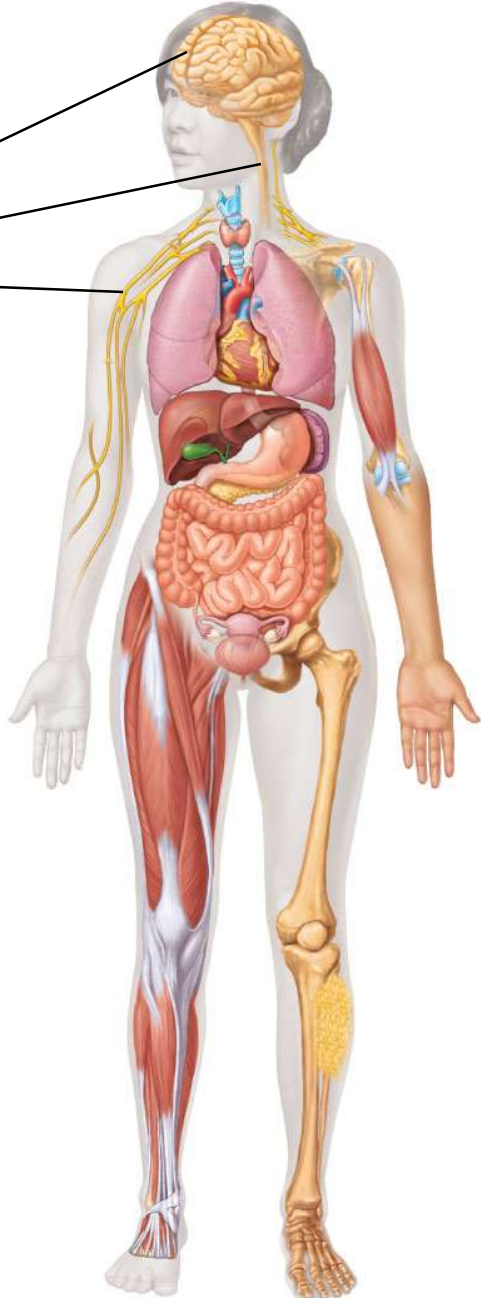


- Composed of neurons and neuroglia

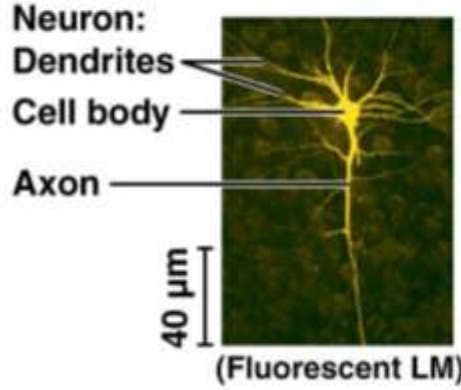
Neurons:

- Dendrites: Receive incoming messages & send them to the cell body
 - Cell body: metabolic, control center
 - Axon: Generate nerve impulse & conduct them way from the cell body
- Function: Convert stimuli into nerve impulses and send these impulses to other neurons, muscle cells, or glands.

Nervous Tissue



Neurons



Glia

