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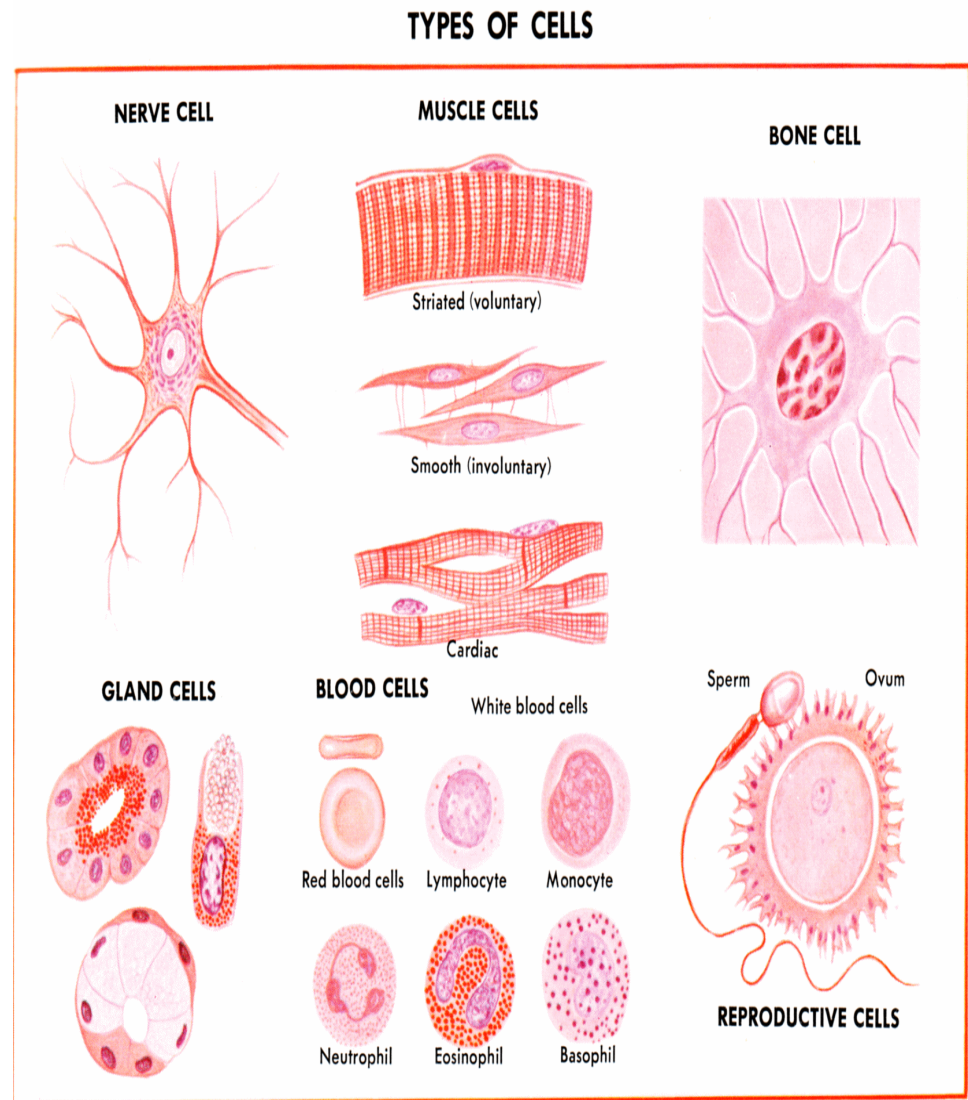
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Human Body Tissues



Cells

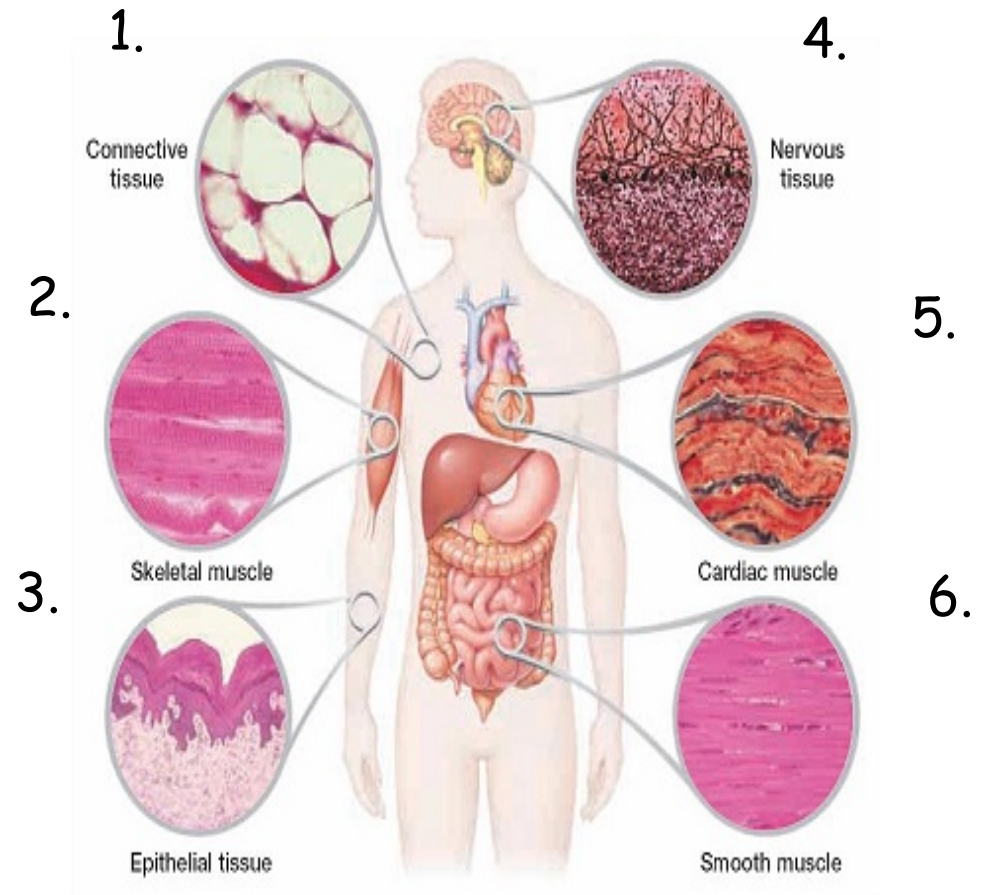
- Cell are the building blocks of the human body.
- There are ~ 100 trillion cells in an adult body.
- Our cells can be categorized into over 200 different types.
- Cells are joined together as different types of tissues that make up functional units of the human body.
- A cell all by itself rare in the human body even though cells are commonly shown as individuals in many images.



Tissue Definition

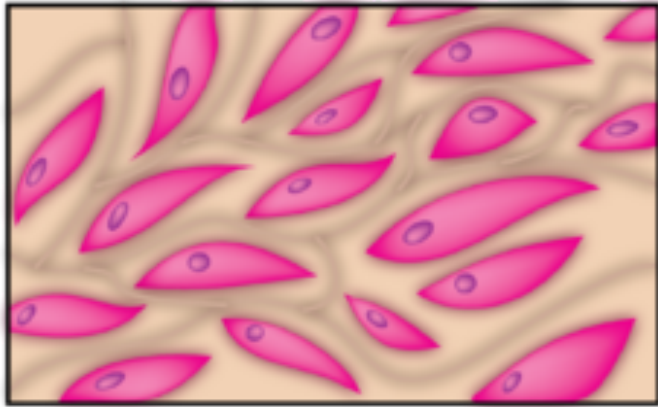
- Tissue = a group of cells that have similar structure and that function together as a unit.
- Each tissue type has a very specific set of functions.
- A nonliving material, called the intercellular matrix, fills the spaces between the cells.

Human Body Tissues

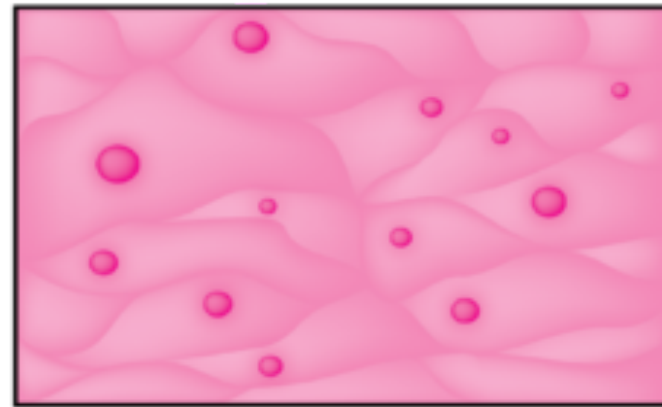


1. Connective, 2. Muscle (skeletal), 3. Epithelial, 4. Nervous, 5. Muscle (cardiac), 6. Muscle (smooth).

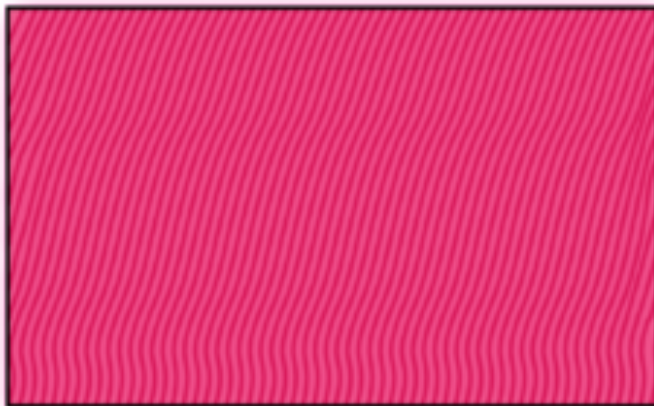
Four Human Tissue Types



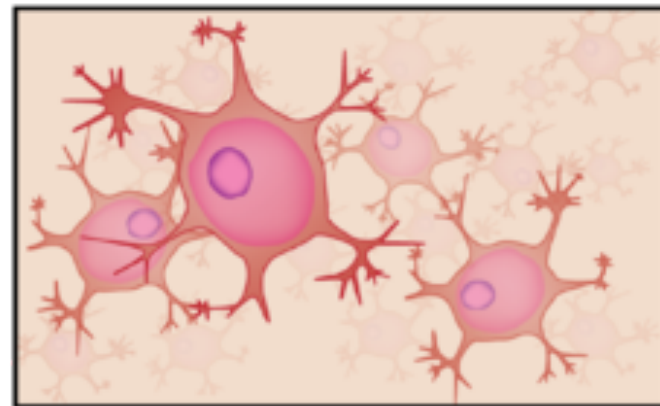
Connective tissue



Epithelial tissue



Muscle tissue



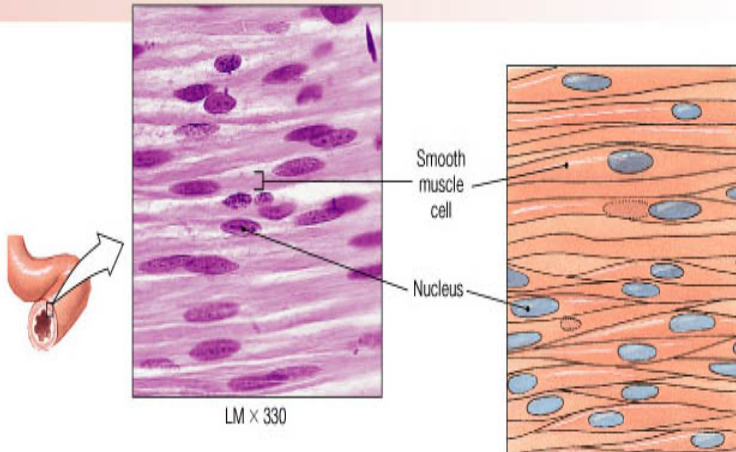
Nervous tissue

1. Muscle Tissue: Smooth, Skeletal, Cardiac

Smooth Muscle Tissue

LOCATIONS: Encircles blood vessels; in the walls of digestive, respiratory, urinary, and reproductive organs

FUNCTIONS: Moves food, urine, and reproductive tract secretions; controls diameter of respiratory passageways; regulates diameter of blood vessels and contributes to regulation of tissue blood flow



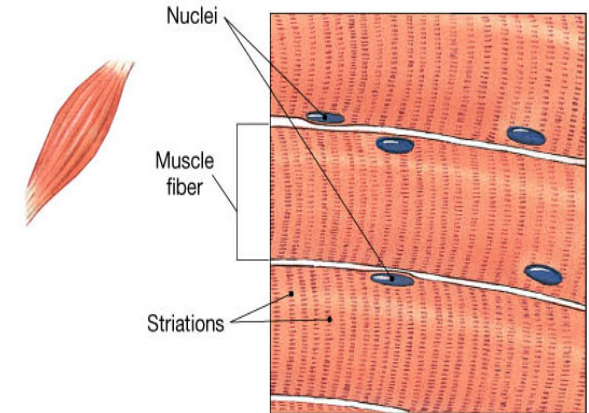
1a. Smooth muscle:

- non-striated (no stripes)
- used for long, sustained contractions
- Example: digestive tract, uterus

Skeletal Muscle Tissue

LOCATIONS: Combined with connective tissues and nervous tissue in skeletal muscles

FUNCTIONS: Moves or stabilizes the position of the skeleton; guards entrances and exits to the digestive, respiratory, and urinary tracts; generates heat; protects internal organs



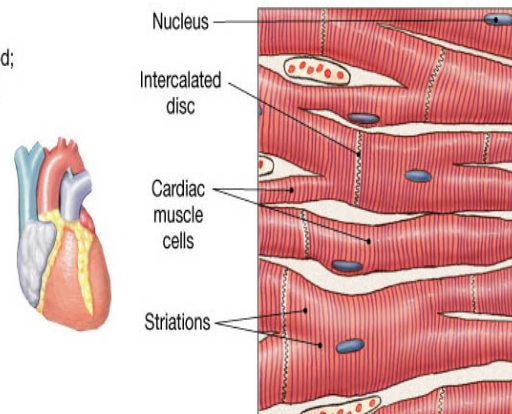
1b. Skeletal muscle tissue:

- striated (stripes), long cylindrical cells
- that contract voluntarily

Cardiac Muscle Tissue

LOCATION: Heart

FUNCTIONS: Circulates blood; maintains blood (hydrostatic) pressure



1c. Cardiac muscle tissue:

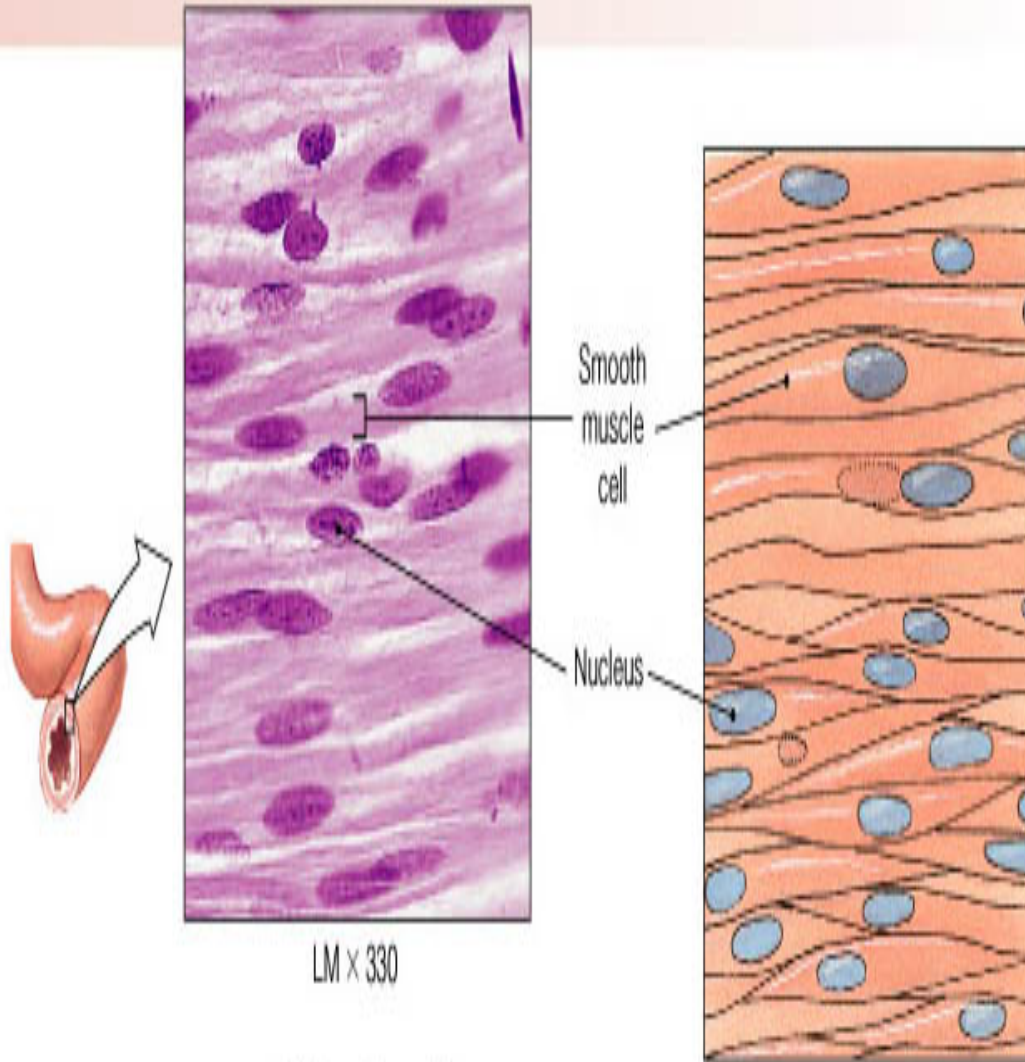
- striated, like skeletal muscle, but branched
- connections between cardiac muscle cells allow coordination of the heart beat

Muscle Tissue: 1a. Smooth

Smooth Muscle Tissue

LOCATIONS: Encircles blood vessels; in the walls of digestive, respiratory, urinary, and reproductive organs

FUNCTIONS: Moves food, urine, and reproductive tract secretions; controls diameter of respiratory passageways; regulates diameter of blood vessels and contributes to regulation of tissue blood flow



(c) Smooth muscle

Smooth muscle:

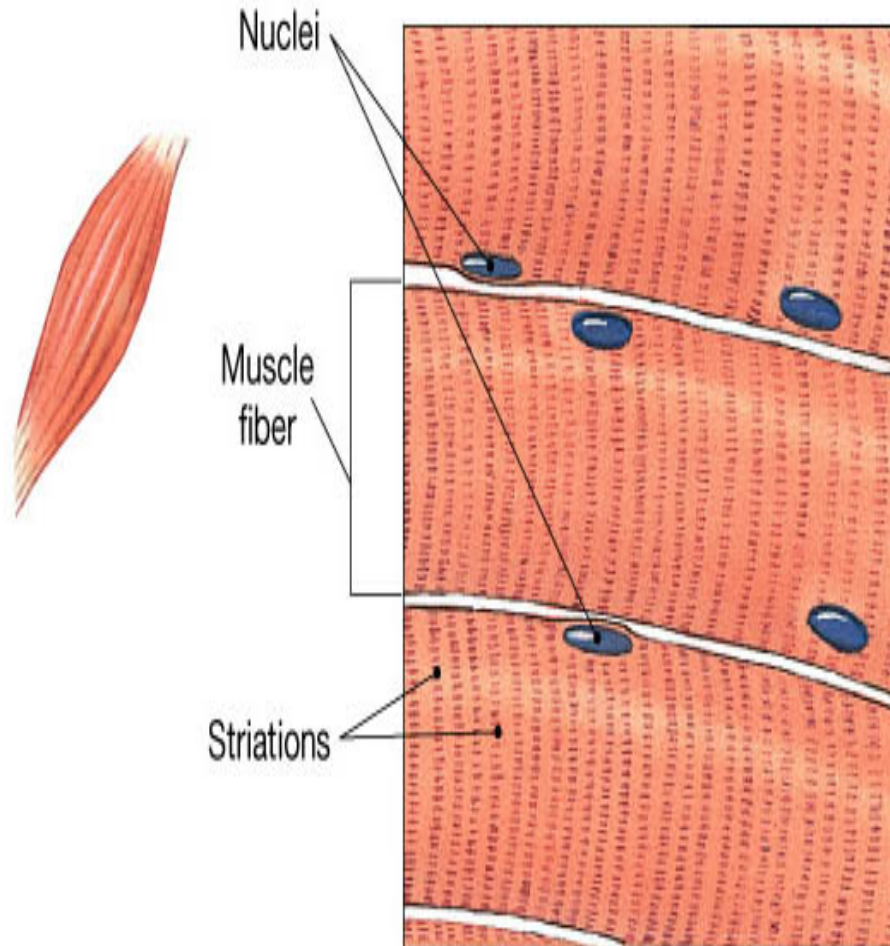
- non-striated
- used for long, sustained contractions
- Example: digestive tract, uterus

Muscle Tissue: 1b. Skeletal

Skeletal Muscle Tissue

LOCATIONS: Combined with connective tissues and nervous tissue in skeletal muscles

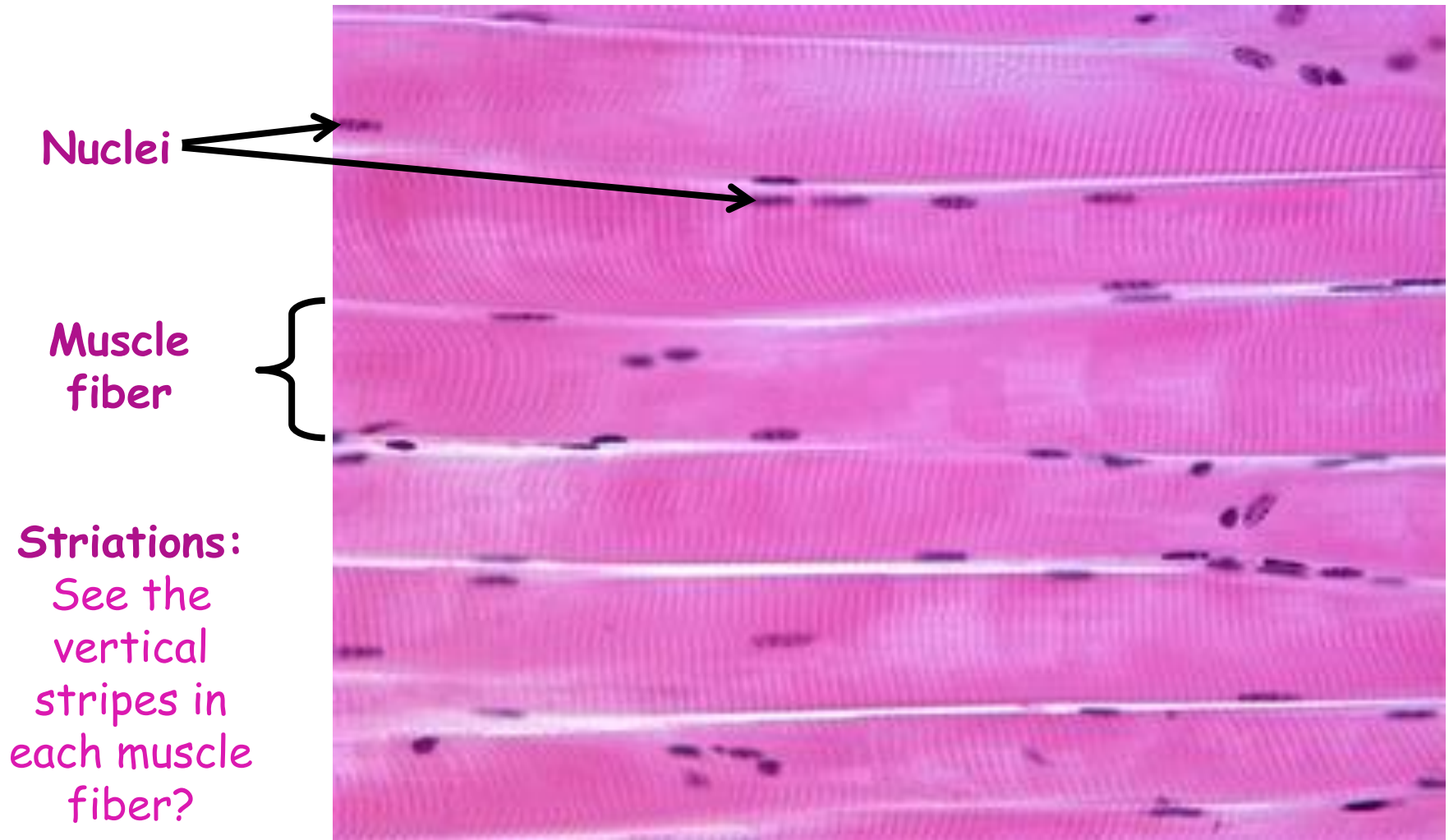
FUNCTIONS: Moves or stabilizes the position of the skeleton; guards entrances and exits to the digestive, respiratory, and urinary tracts; generates heat; protects internal organs



Skeletal muscle tissue:

- striated, long cylindrical cells
- can contract voluntarily (you consciously make the contraction happen)

Muscle Tissue: 1b. Skeletal



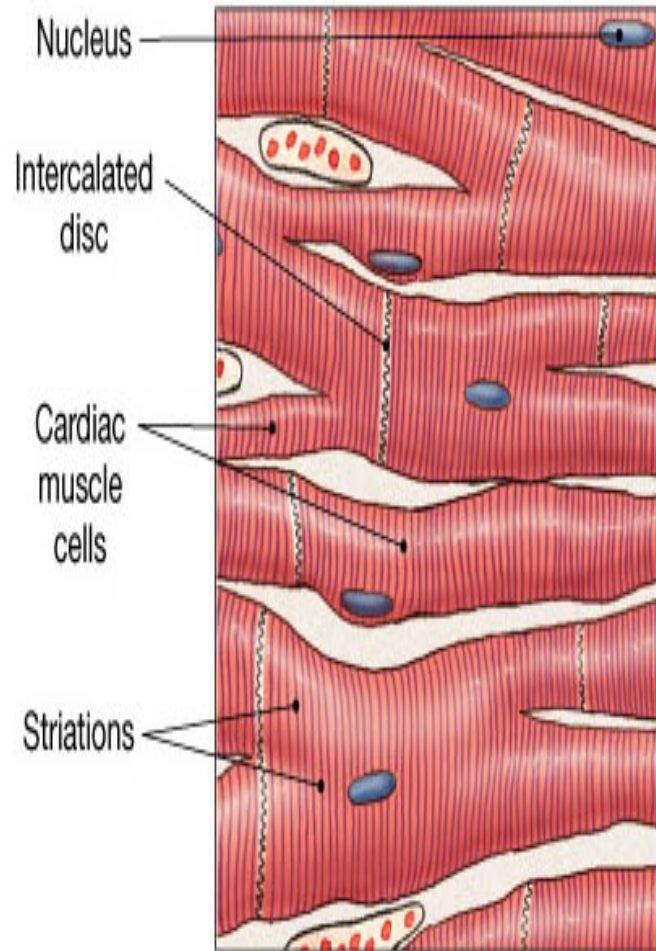
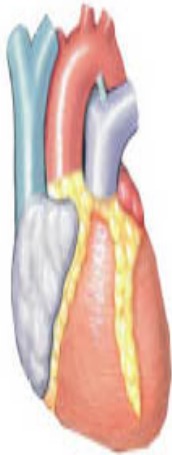
Protein fibers of skeletal muscle gives this tissue stripes or "*striations*" when viewed under a microscope.

Muscle Tissue: 1c. Cardiac

Cardiac Muscle Tissue

LOCATION: Heart

FUNCTIONS: Circulates blood; maintains blood (hydrostatic) pressure



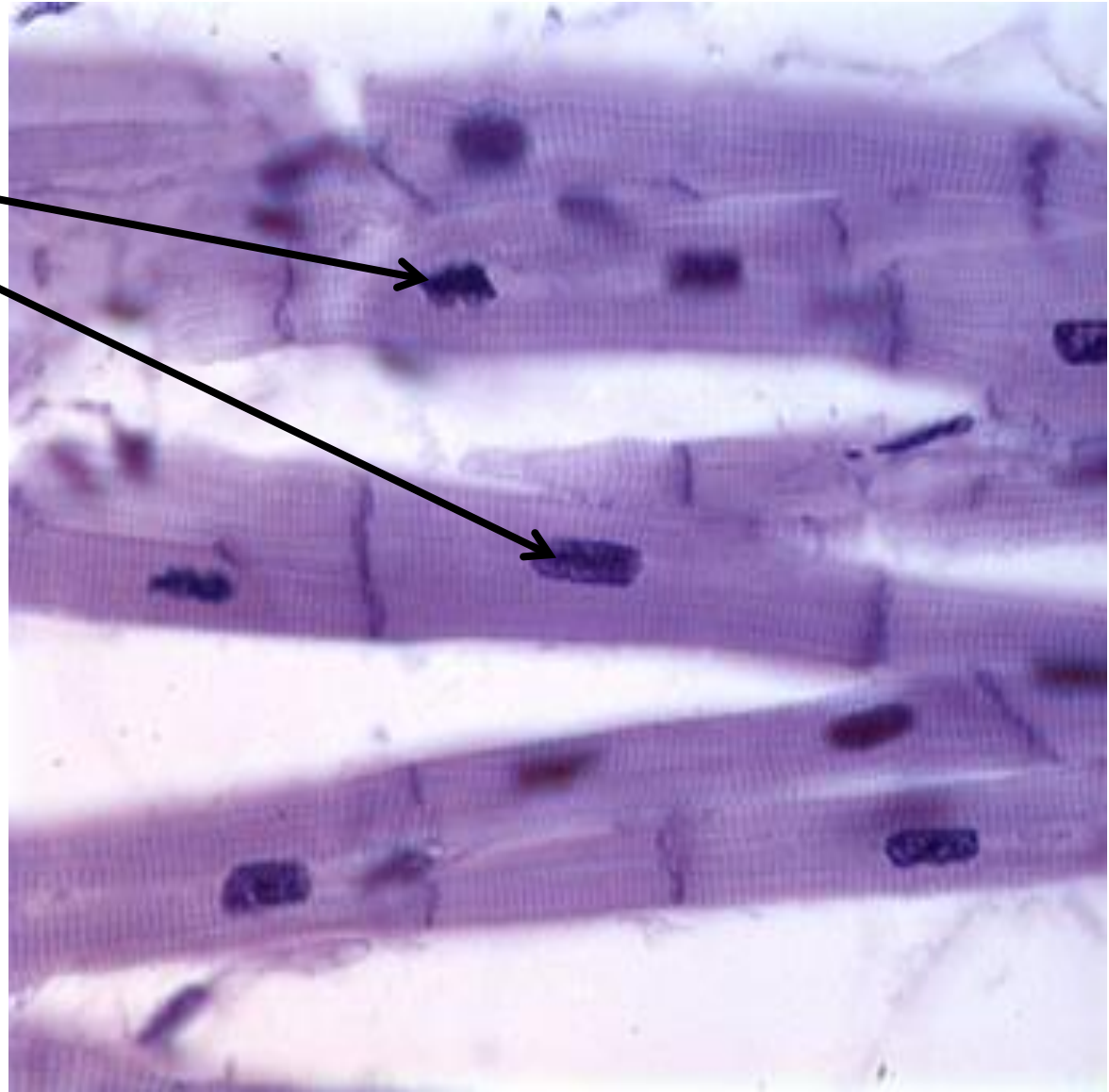
Cardiac muscle tissue:

- striated, branched cells
- contraction is involuntary (You don't consciously control.)
- connections between cardiac muscle cells allow coordination of the heart beat.
- Fibrillation is a deadly condition where heart cells are not beating in sync.

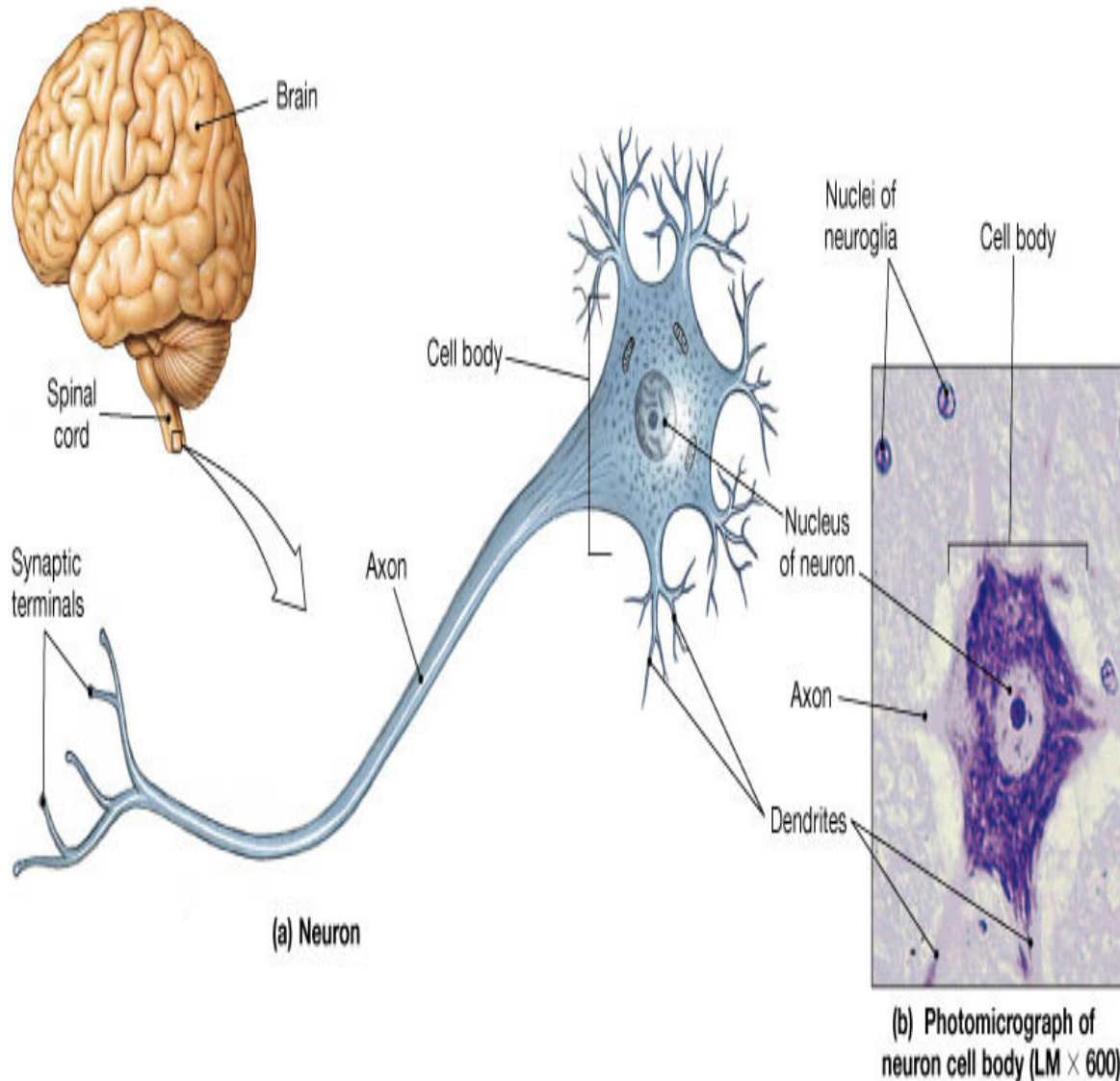
Muscle Tissue: 1c. Cardiac

Nuclei

Muscle fiber
(See how it branches for communication!)

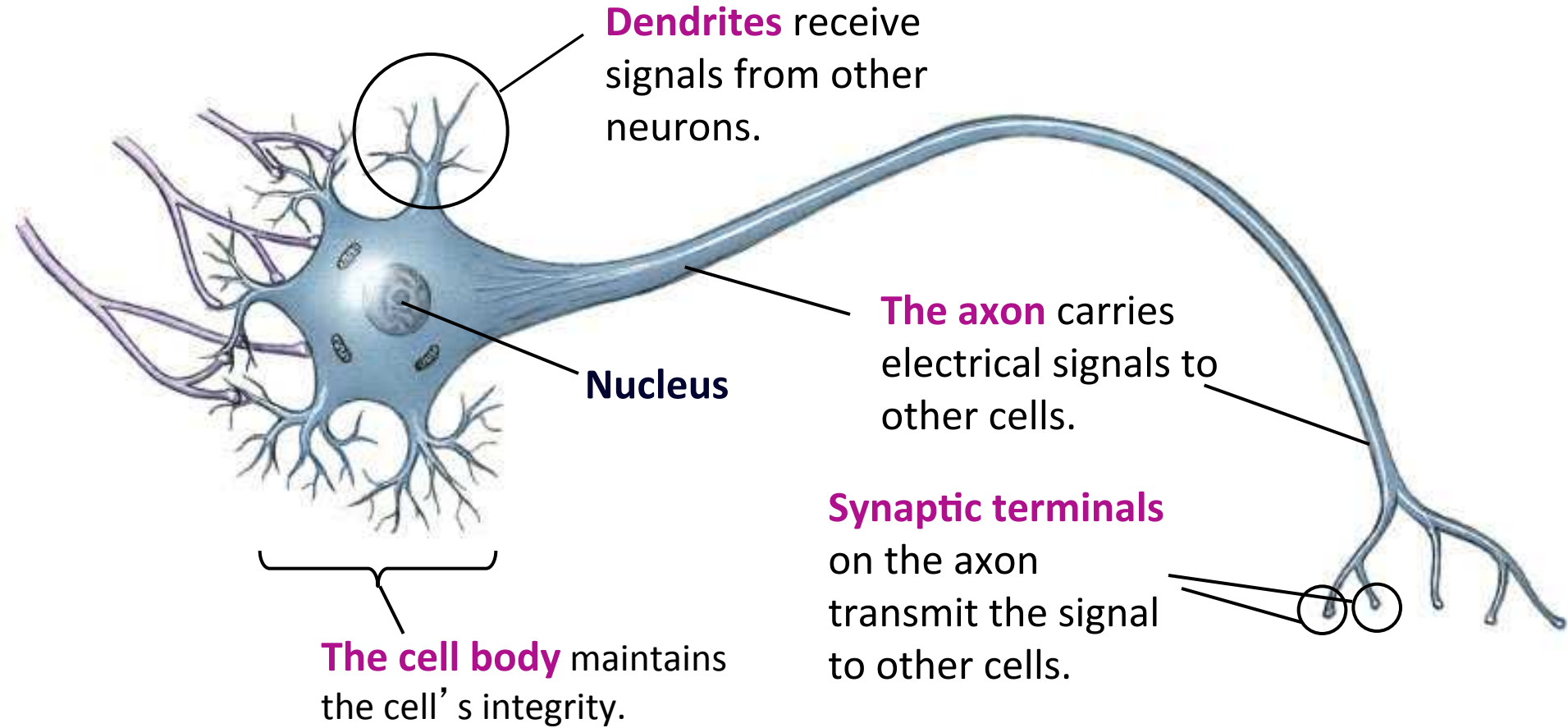


2. Nervous Tissue



- used for communication throughout the body
- *nerve cells* are called neurons
- nerve cells vary in shape, depending on their functions in the nervous system.

A nerve cell has four major parts, each specialized for a specific function.



WATCH THIS: [Schoolhouse Rock! Telegraph line](#)

3. Connective Tissue

Cushions and Protects Body Parts

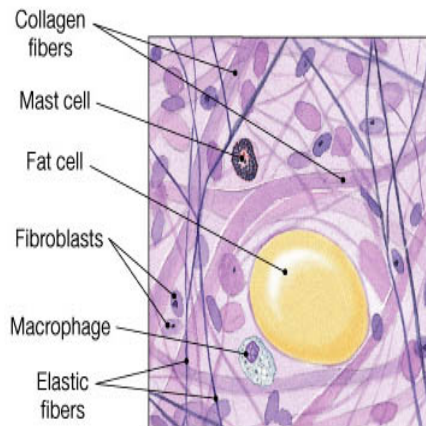
Main Components of Connective Tissues:

- loosely associated cells (fibroblasts).
- surrounded by an extracellular/ intercellular matrix of ground substance and protein fibers

Loose Connective Tissue

LOCATIONS: Beneath dermis of skin, digestive tract, respiratory and urinary tracts; between muscles; around blood vessels, nerves, and around joints

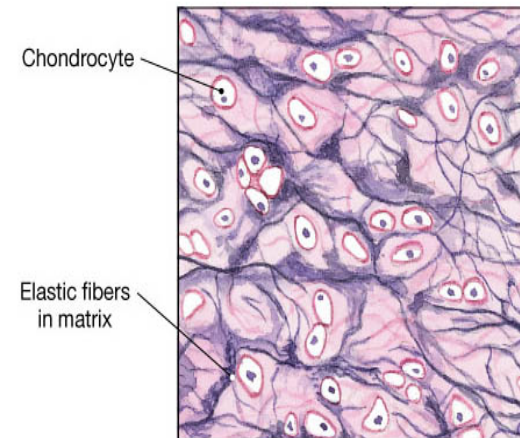
FUNCTIONS: Cushions organs; provides support but permits independent movement; phagocytic cells provide defense against pathogens



Elastic Cartilage

LOCATIONS: Auricle of external ear; auditory canal; epiglottis

FUNCTIONS: Provides support, but tolerates distortion without damage and returns to original shape



a. Fibrous Connective Tissue:
i. Loose and ii. Dense

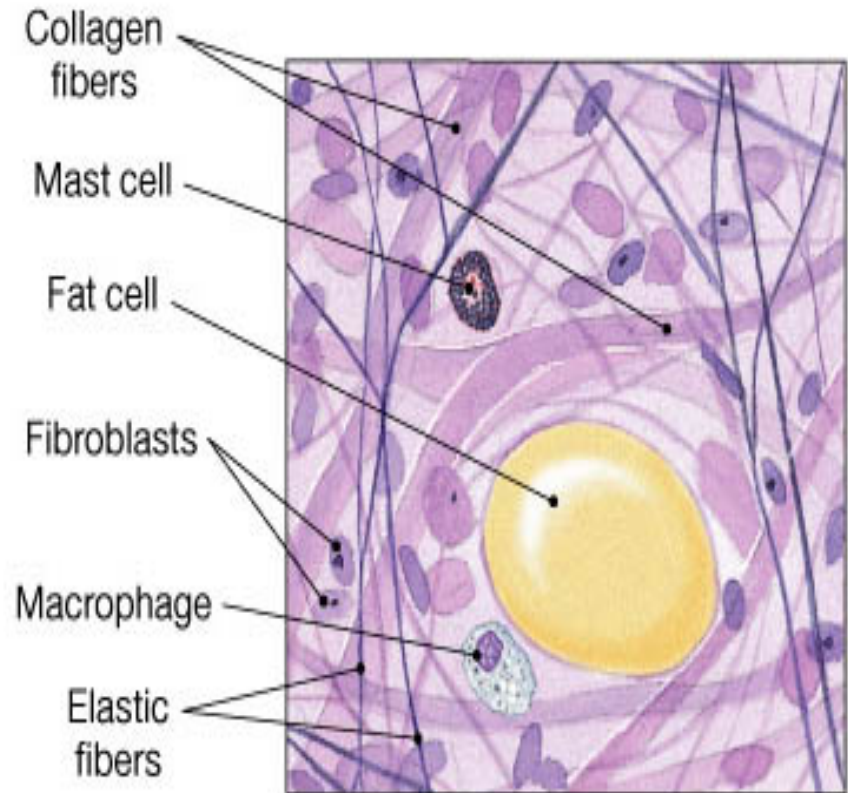
b. Specialized Connective Tissue:
i. Bone, ii. Cartilage and iii. Blood

3ai. Loose Fibrous Connective Tissue

Loose Connective Tissue

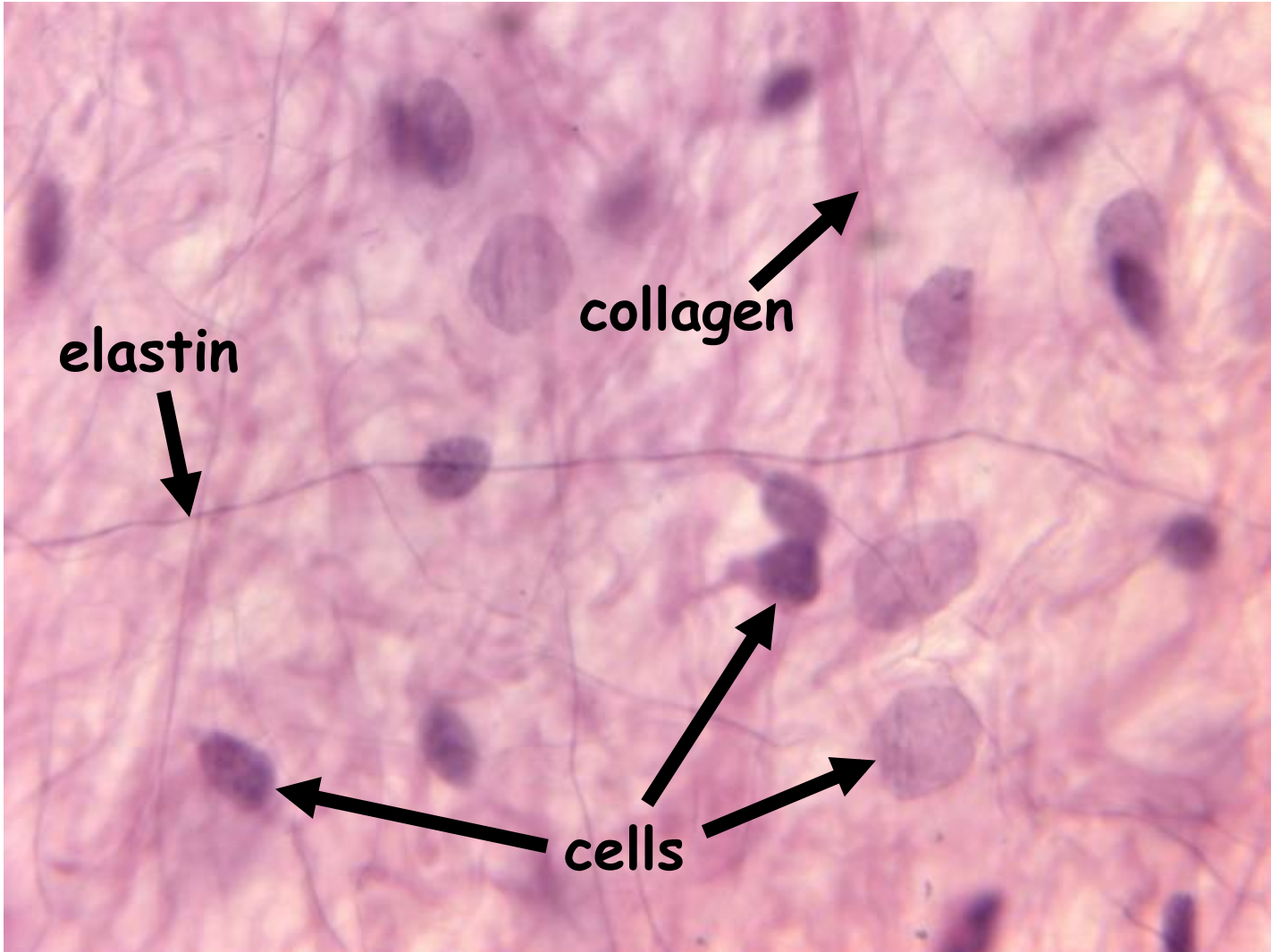
LOCATIONS: Beneath dermis of skin, digestive tract, respiratory and urinary tracts; between muscles; around blood vessels, nerves, and around joints

FUNCTIONS: Cushions organs; provides support but permits independent movement; phagocytic cells provide defense against pathogens



Loose array of cells in a matrix of ground substance and randomly placed protein fibers.

3ai. Loose Fibrous Connective Tissue: Areolar



Areolar tissue is found in many locations in the body.

Areolar tissue is found in skin; both the dermis and subcutaneous layers, where it binds the outer layers of the skin to the muscles beneath.

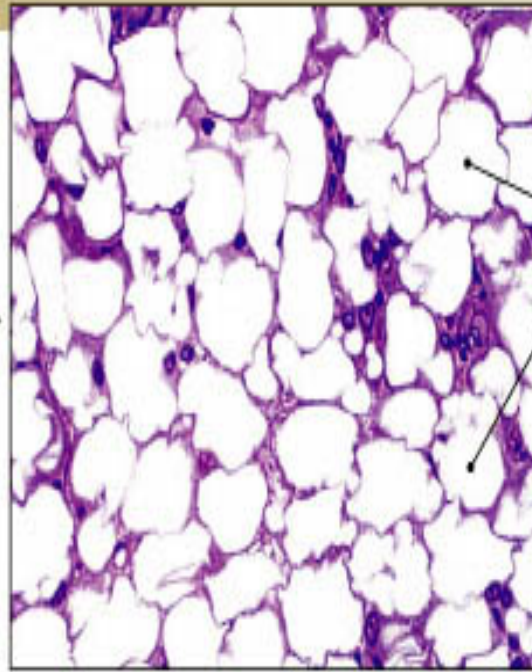
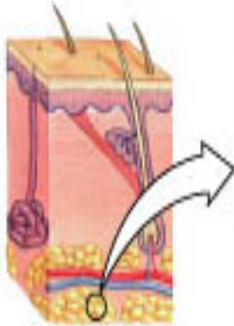
Areolar tissue is also found in or around mucous membranes, and around blood vessels, nerves, and the organs of the body.

3ai. Loose Fibrous Connective Tissue: Adipose (Fat)

Adipose Tissue

LOCATIONS: Beneath skin, especially at sides, buttocks, breasts; behind eyeballs; around kidneys

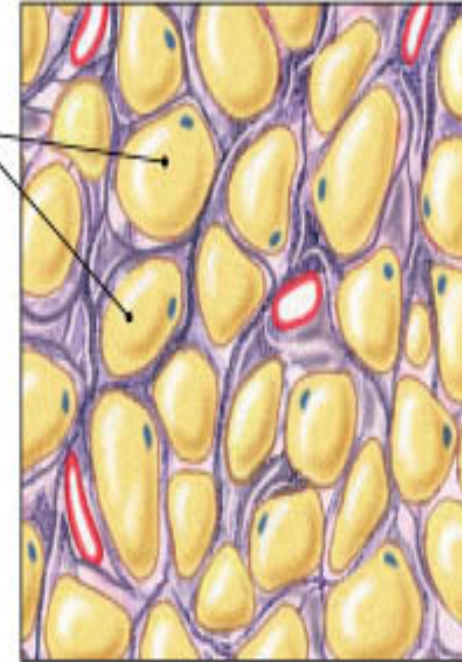
FUNCTIONS: Provides padding and cushions shocks; insulates (reduces heat loss); stores energy reserves



LM × 133

(b) Adipose tissue

Adipocytes
(fat cells)



Adipocytes, bulging with fat droplets made of triglyceride molecules, have little space between them.

Fat is important for insulation, cushioning and energy reserves.

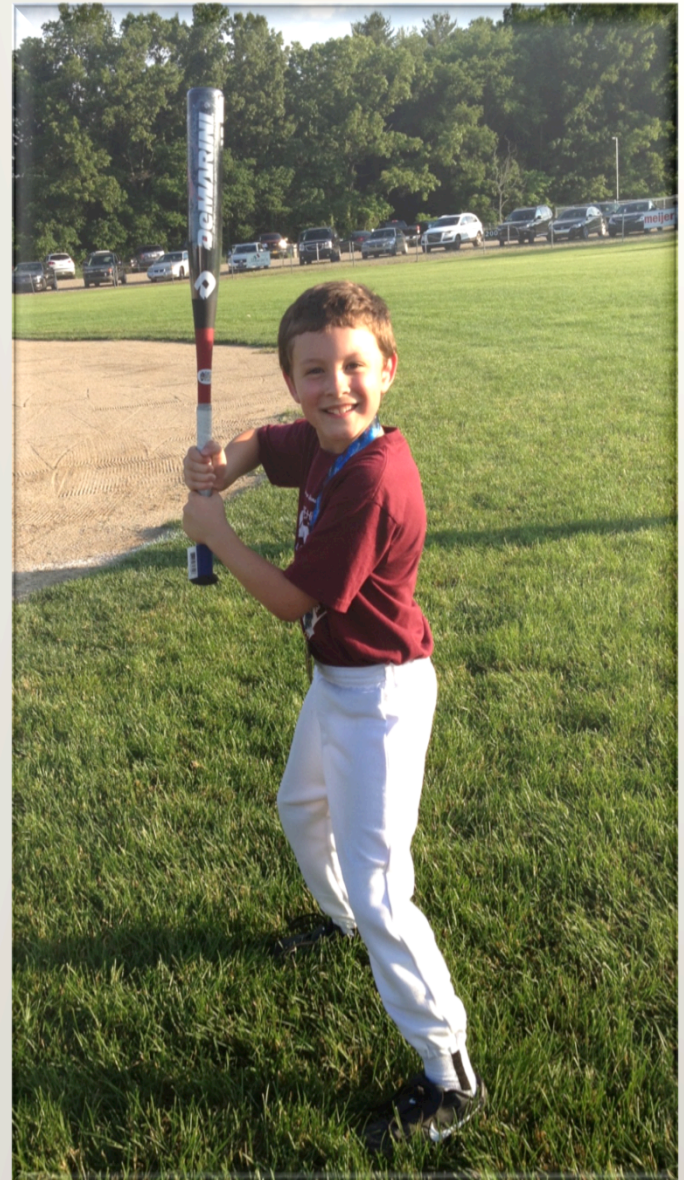


A hooded seal at 4 days of age. At 100 pounds, she is almost too fat to move. Fat from her mother's milk will feed and insulate the pup as she dives into icy water to learn to hunt and feed.



MY SON:

Lots of adipose tissue as a chubby li'l baby. He needed it for energy reserves to grow into a skinny young man!

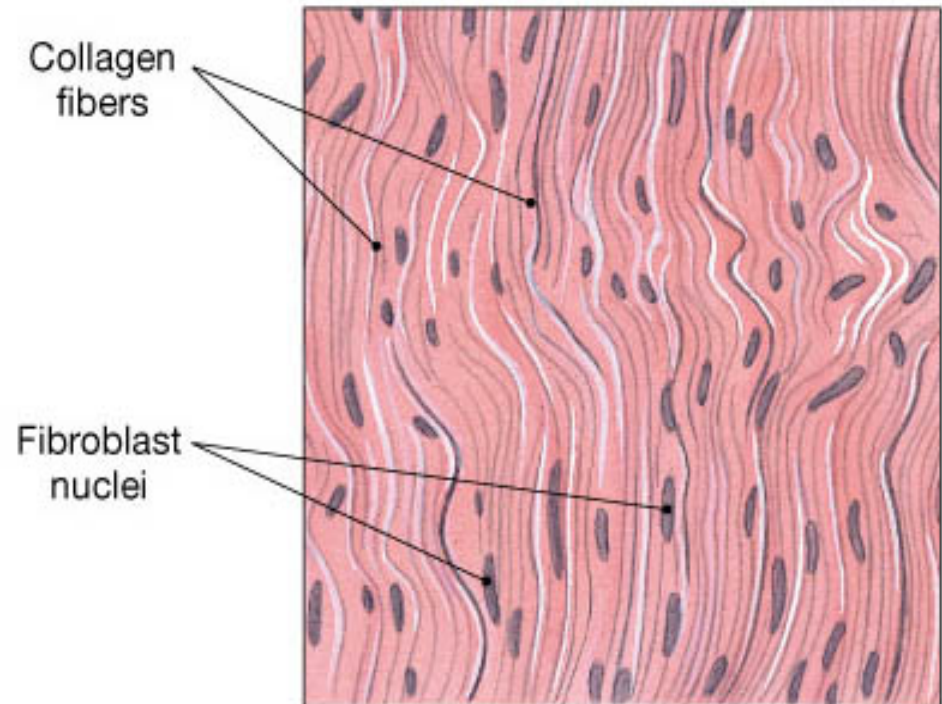


3a.ii. Dense Fibrous Connective Tissue:

Dense Connective Tissues

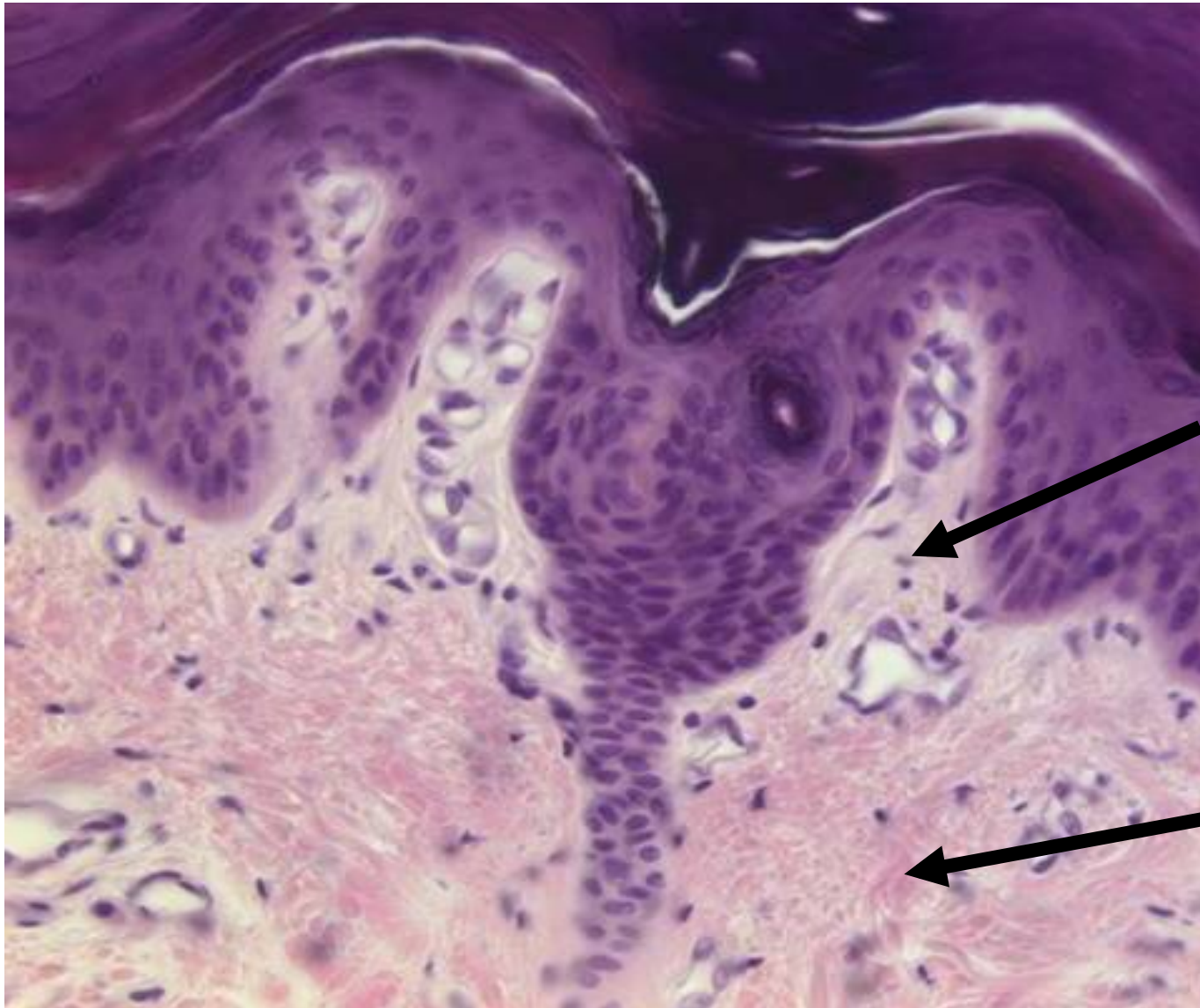
LOCATIONS: Between skeletal muscles and skeleton (tendons); between bones (ligaments); covering skeletal muscles; capsules of visceral organs

FUNCTIONS: Provide firm attachment; conduct pull of muscles; reduce friction between muscles; stabilize relative positions of bones; help prevent overexpansion of organs such as the urinary bladder



Cells in a matrix with densely packed protein fibers
May be irregular fibers (dermis)
or regular arrayed fibers (tendons, ligaments)

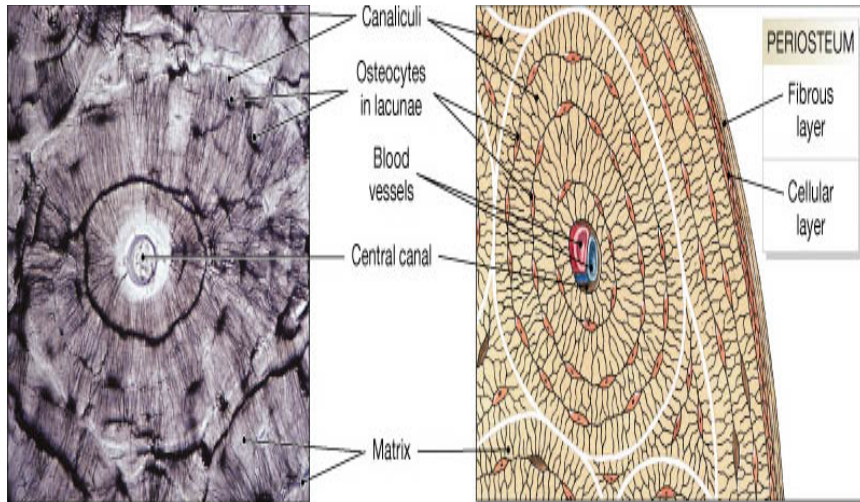
Compare Loose to Dense CT in the Dermis



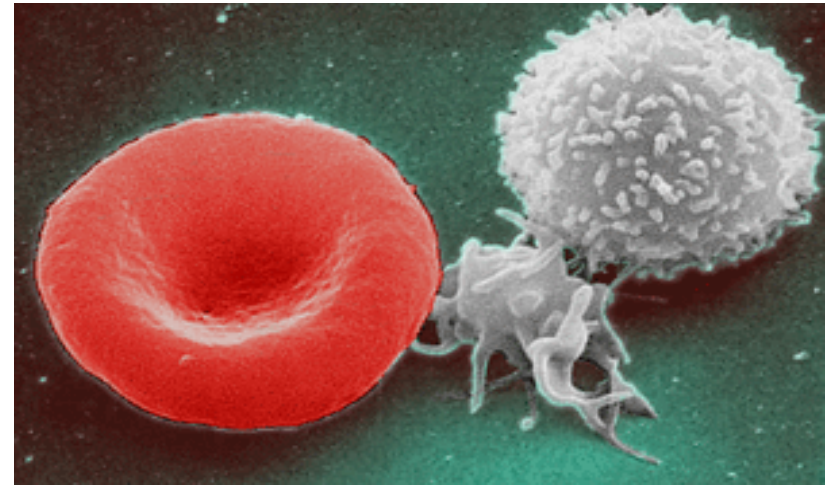
Loose
CT

Dense
CT

3b. Specialized Connective Tissue: Bone, Cartilage, Blood



i. Bone



iii. Blood

Elastic Cartilage

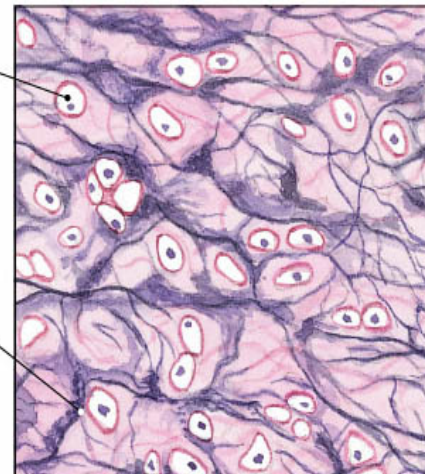
LOCATIONS: Auricle of external ear; auditory canal; epiglottis

FUNCTIONS: Provides support, but tolerates distortion without damage and returns to original shape



Chondrocyte

Elastic fibers in matrix

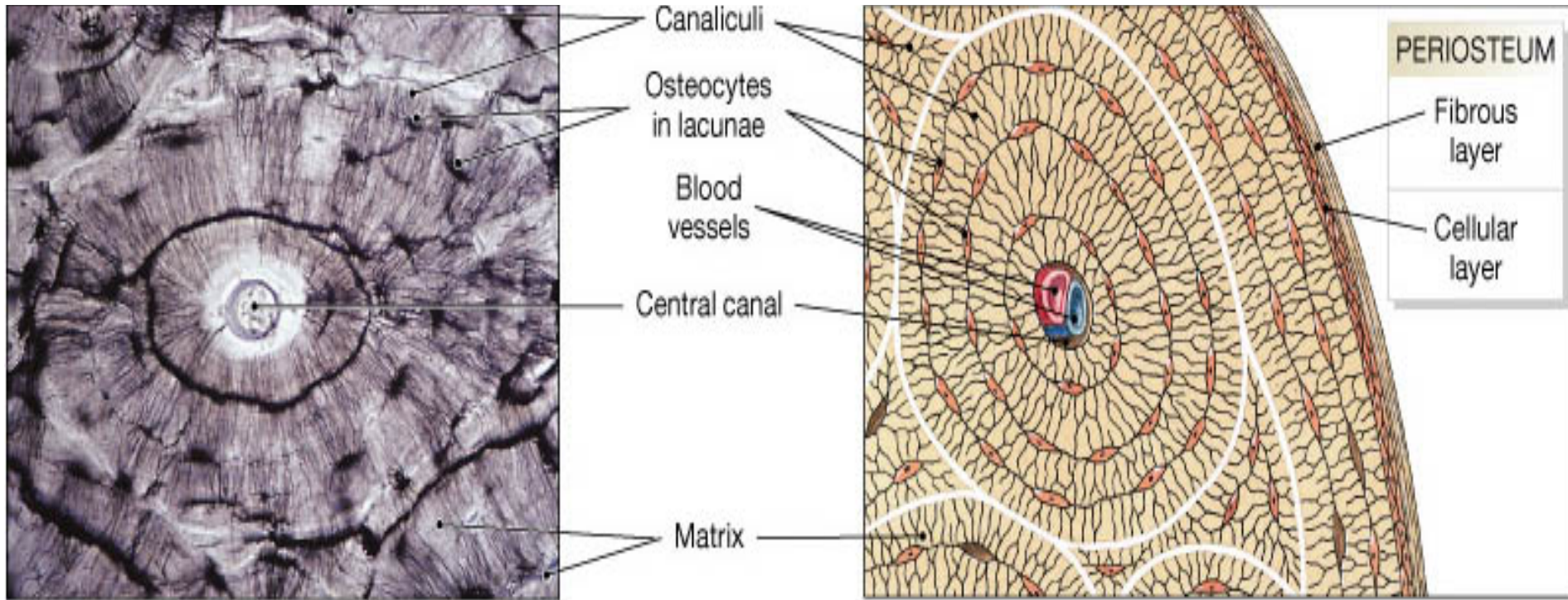


ii. Cartilage

Specialized Connective Tissue: 3bi. Bone

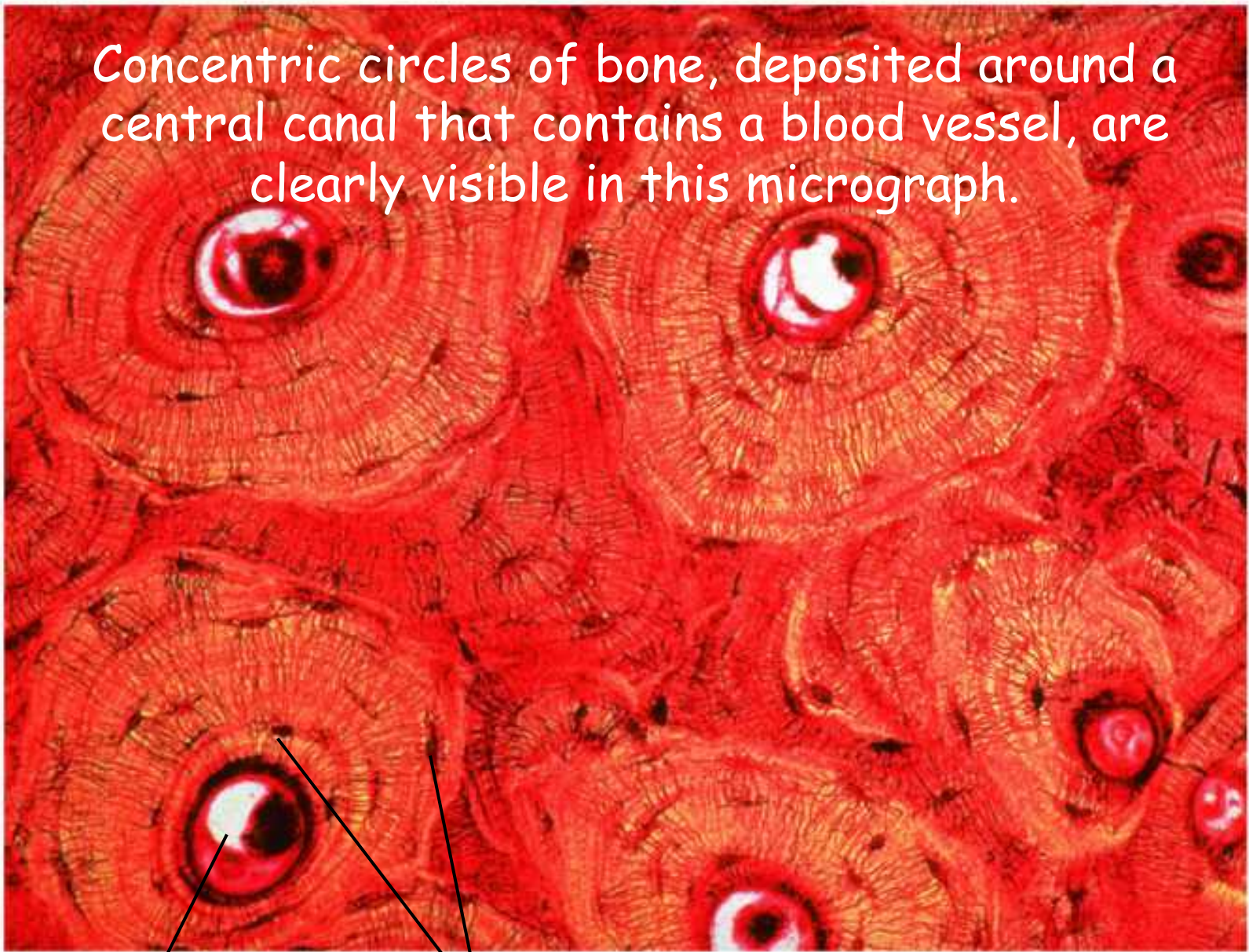
Cross Section of Bone Tissue

Bone cells (osteocytes) are trapped in a mineralized matrix of calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$.



Bone cells appear as dark spots in small chambers (lacunae) within the hard matrix that the cells themselves have secreted.

Concentric circles of bone, deposited around a central canal that contains a blood vessel, are clearly visible in this micrograph.



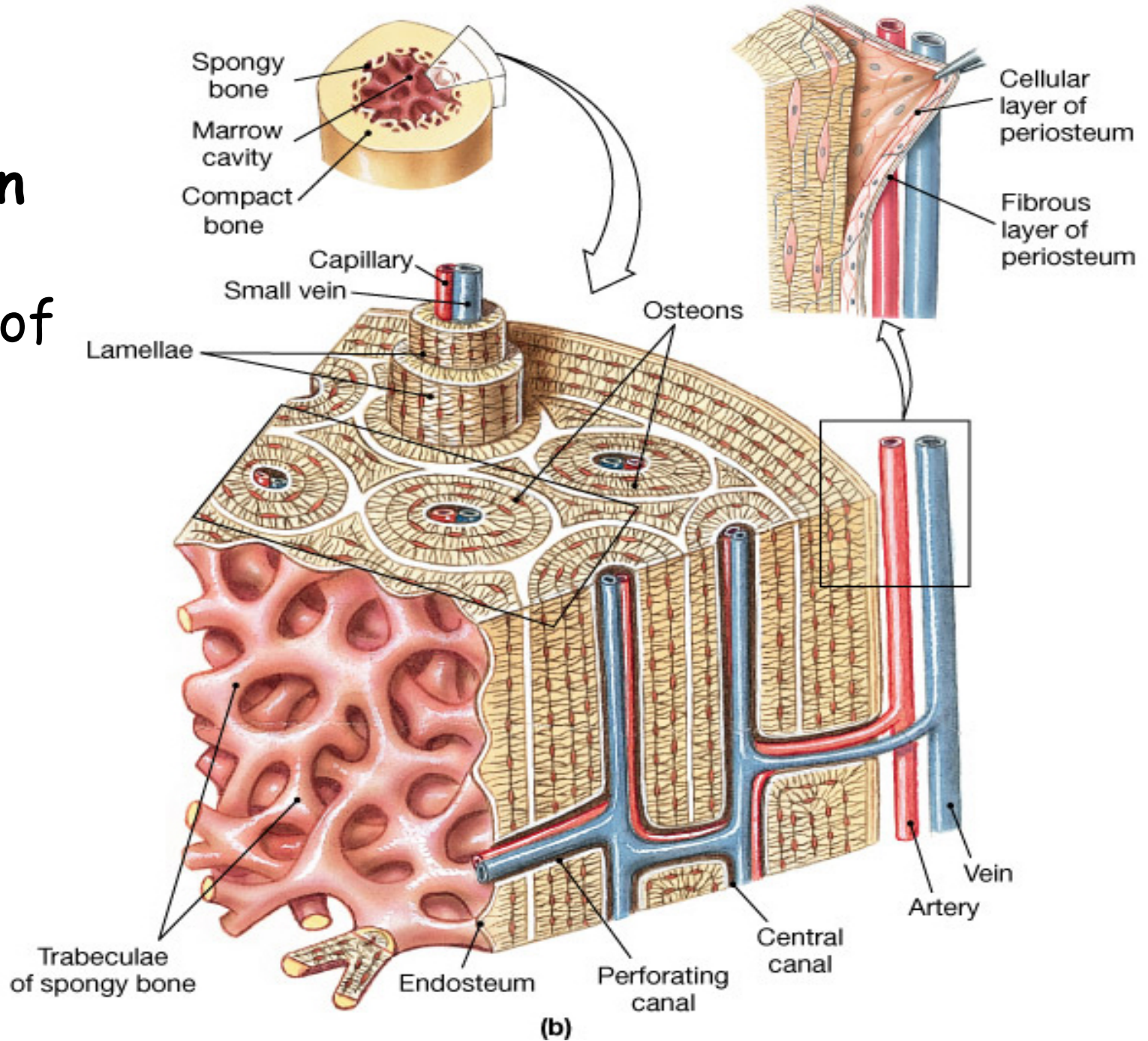
central canal for
blood vessel

bone cells

concentric
bone matrix

The Human Skeleton

Anatomy of Bone



Specialized Connective Tissue: 3bii. Cartilage

Elastic Cartilage

LOCATIONS: Auricle of external ear; auditory canal; epiglottis

FUNCTIONS: Provides support, but tolerates distortion without damage and returns to original shape

Cartilage cells are called *chondrocytes*, in small cavities (lacunae).

These cells are in a rubbery matrix of elastic protein fibers for flexibility.

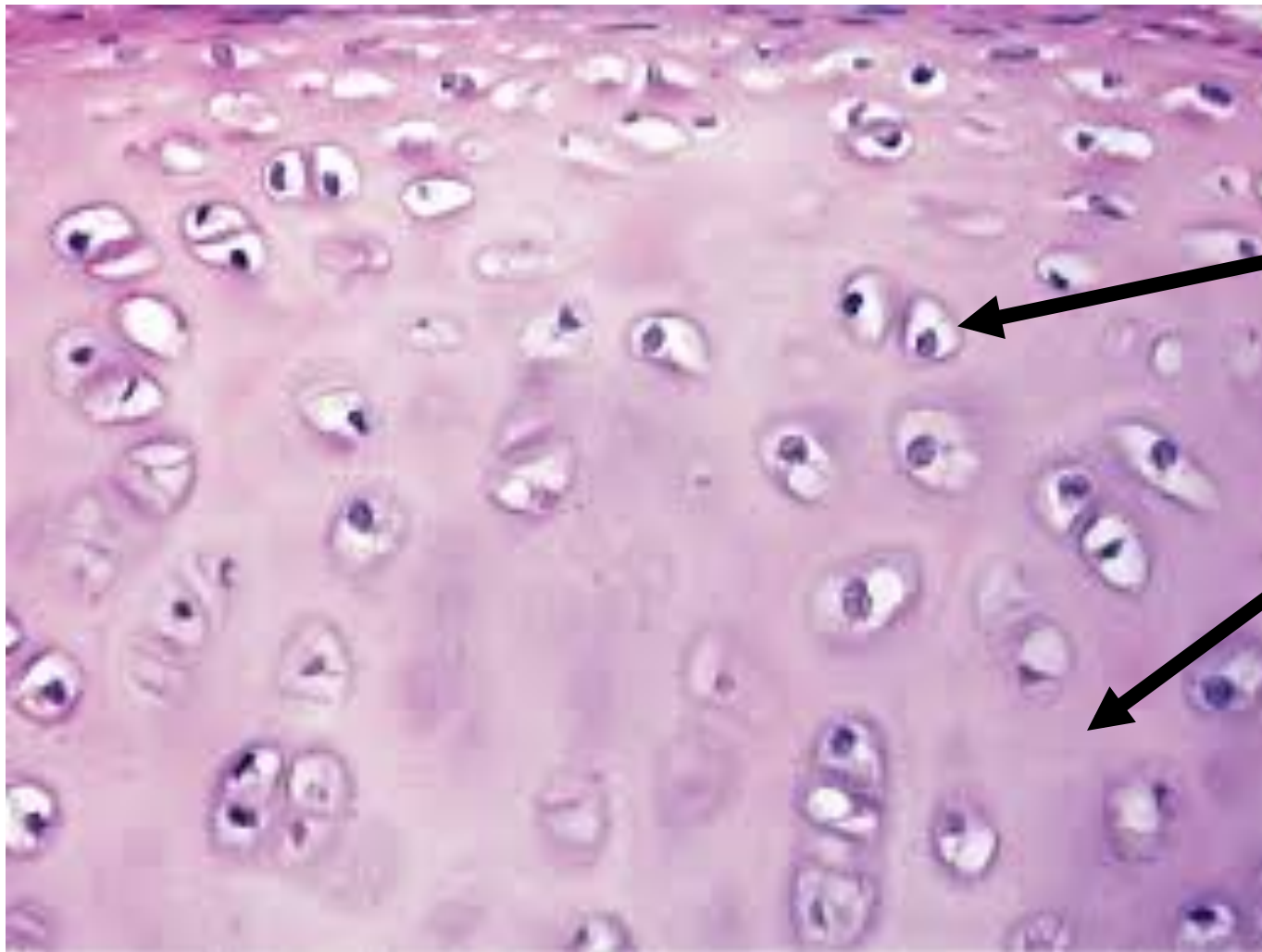


Chondrocyte

Elastic fibers in matrix



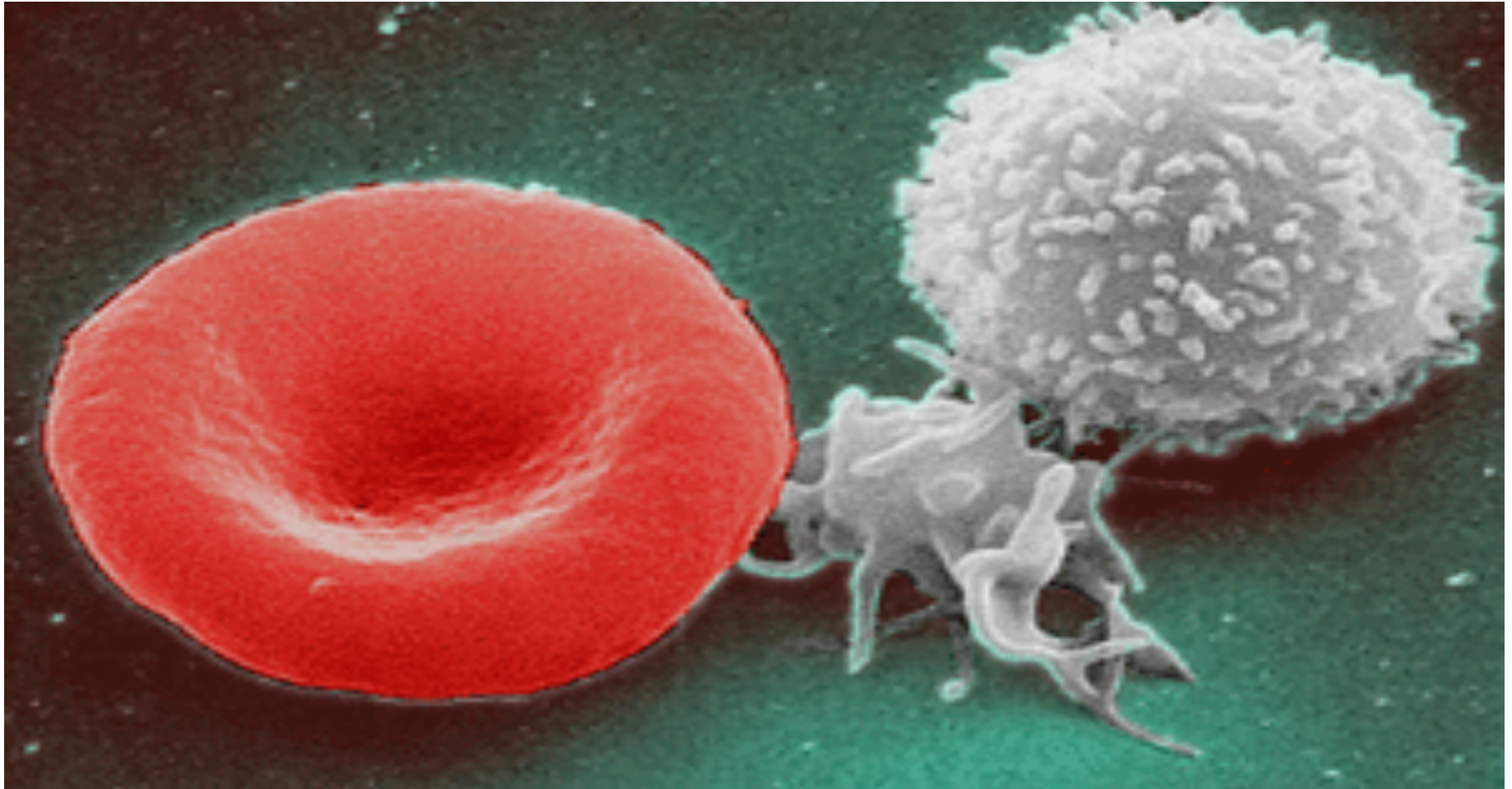
Specialized Connective Tissue: 3bii. Cartilage



Fibroblast

**Matrix:
ground
substance
& protein
fubers**

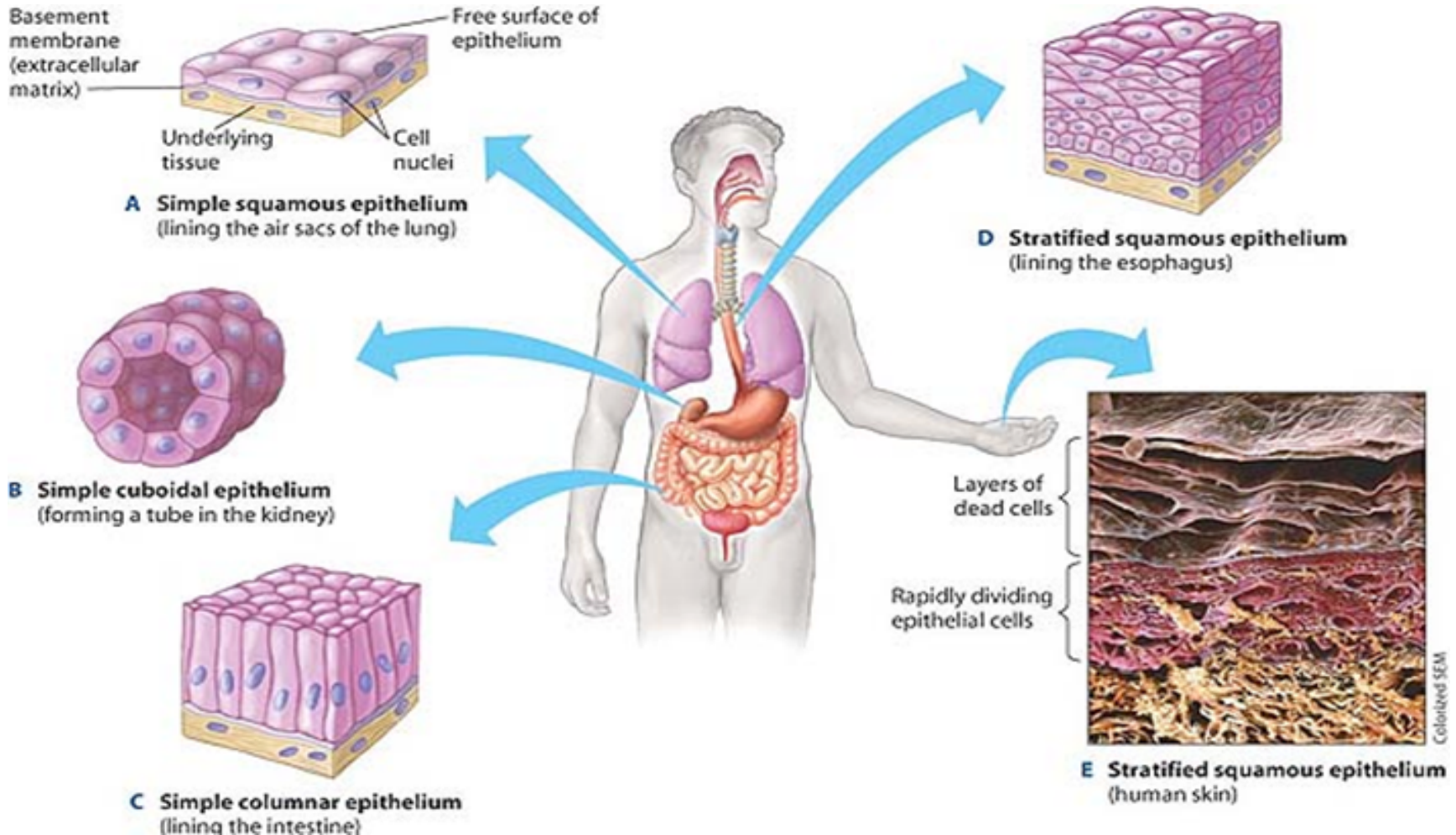
Specialized Connective Tissue: 3biii. Blood



Blood cells arise from bone marrow, so blood is classified as a connective tissue.

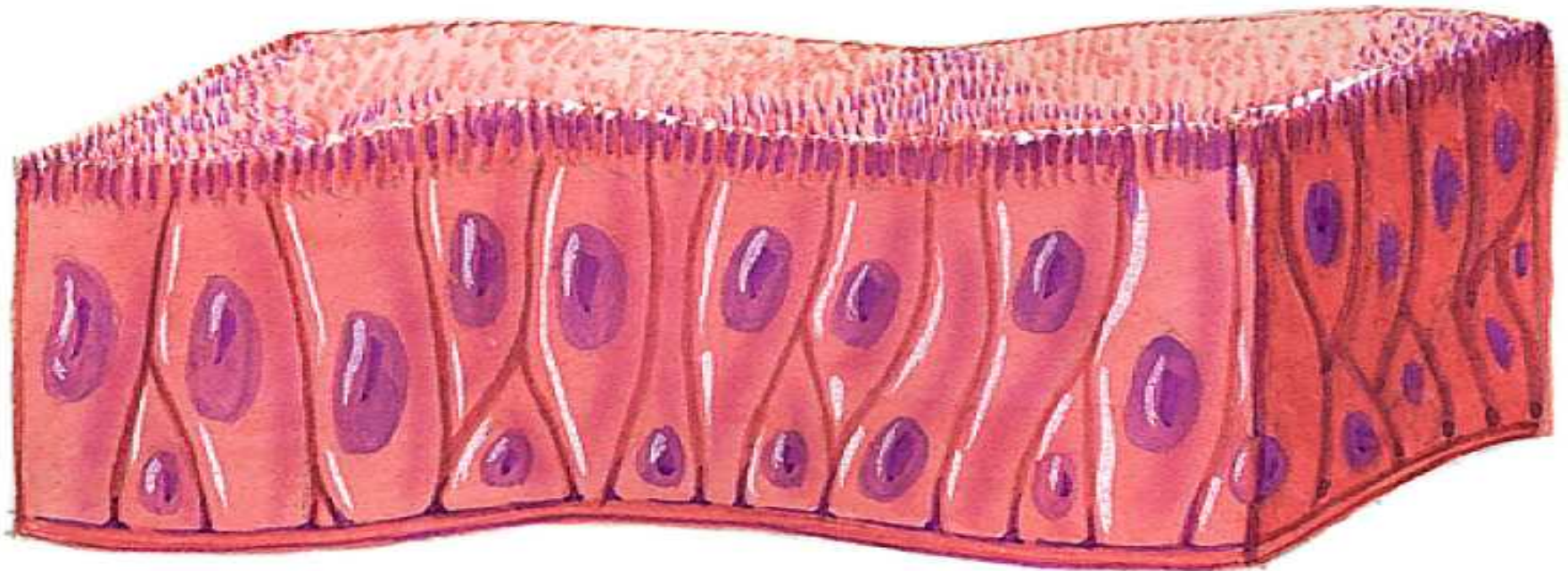
4. Epithelial Tissue

- Cells that line or cover all internal and external body surfaces.
- Cell structure and function varies depending on where it is in the body.



Epithelial Tissue Characteristics

Free surface, Basement membrane, Tightly packed cells



Function: Often form barriers.

Example: Elongated epithelial cells bearing cilia line the passage to the lungs and tubes of the reproductive organs.

4. Epithelial Tissue Characteristics

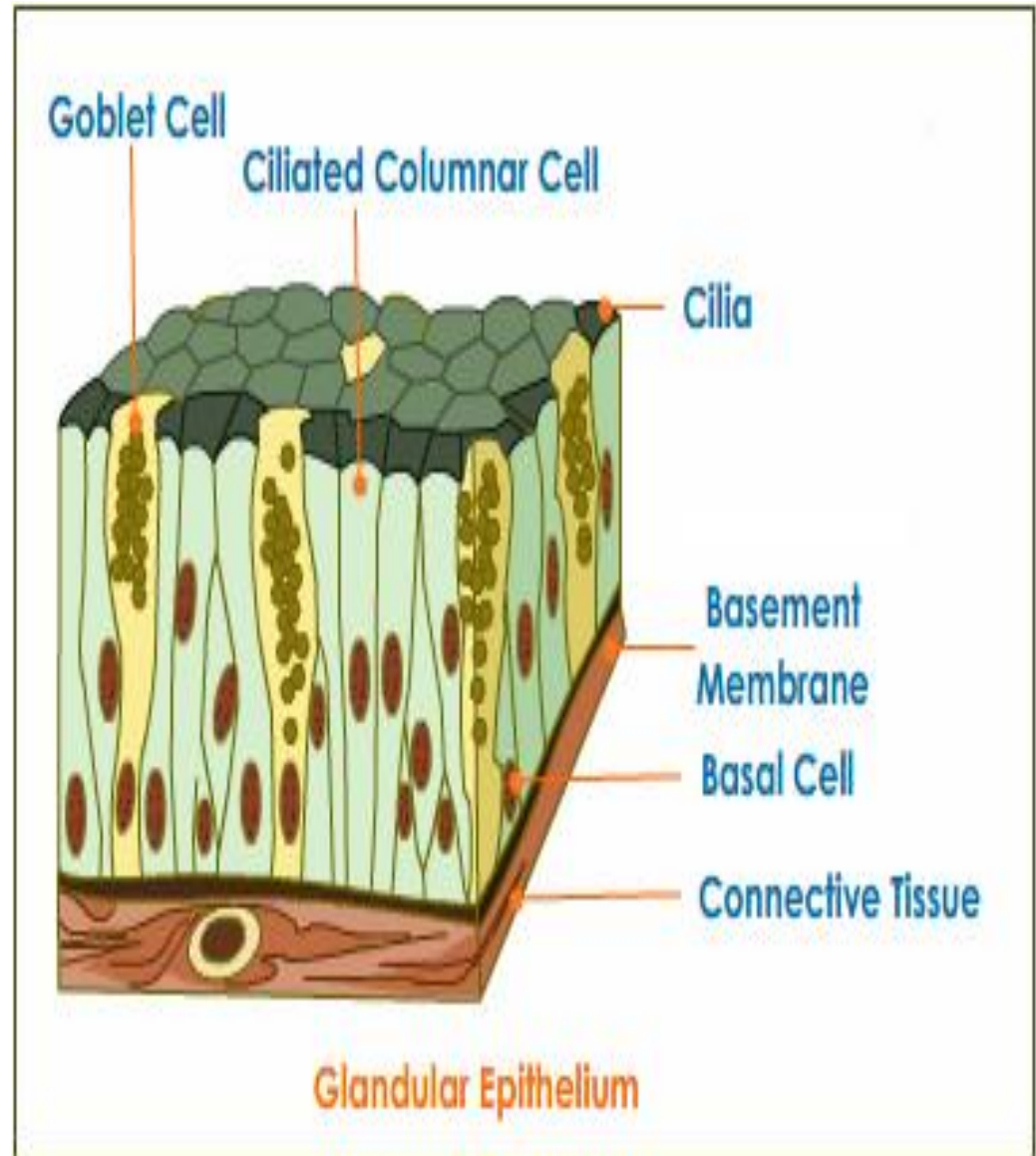
- Barrier between body tissues
- Tightly bound cells
- One free surface and one bound surface
- Attached to a basement membrane

a. Classified by Layers

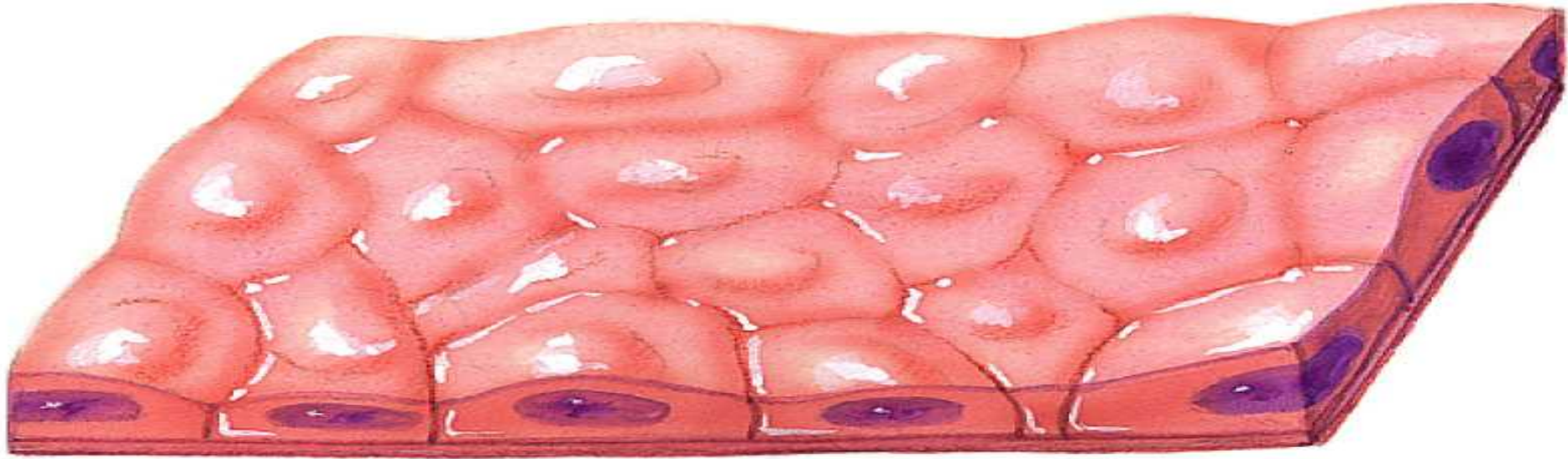
- i. *Simple* - single layer of cells
- ii. *Stratified* - many layers of cells

b. Classified by Cell Shape

- i. *Squamous* - flattened cells
- ii. *Cuboidal* - square cells
- iii. *Columnar* - tall cells



4. Types of Epithelial Tissue by Layer



4ai. **Simple Epithelium:** Single layer of cells

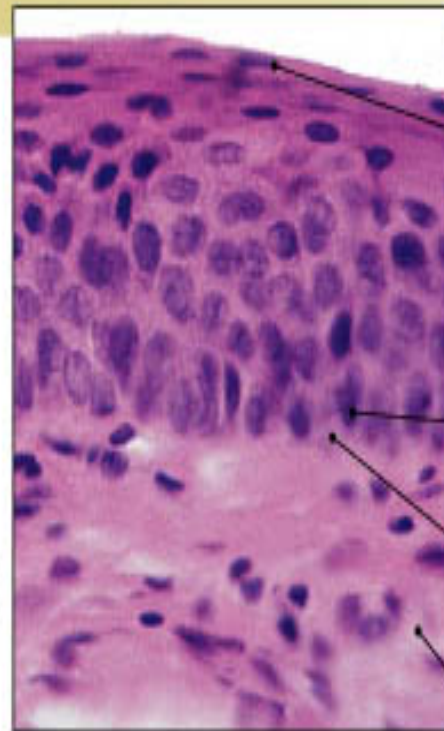
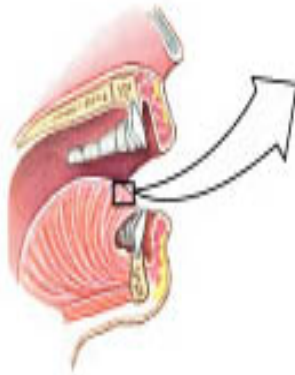
Example: Lining of lungs and blood vessels

Types of Epithelial Tissue by Layer

Stratified Squamous Epithelium

LOCATIONS: Surface of skin; lining of mouth, throat, esophagus, rectum, anus, and vagina

FUNCTIONS: Provides physical protection against abrasion, pathogens, and chemical attack



LM × 310

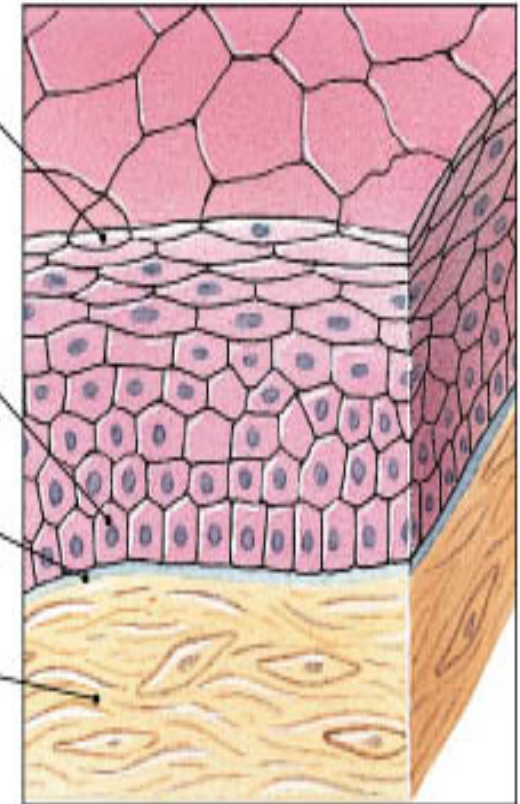
(c) Surface of tongue

Squamous superficial cells

Stem cells

Basement membrane

Connective tissue



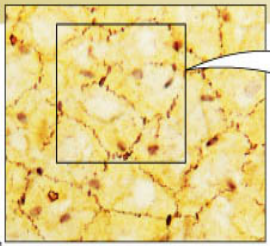
4a.ii. **Stratified Epithelium:** More than one layer of cells

4b. Types of Epithelial Tissue by Cell Shape

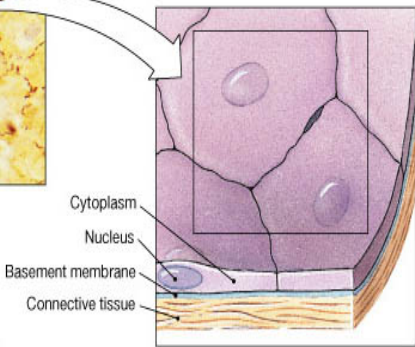
Simple Squamous Epithelium

LOCATIONS: Epithelia lining ventral body cavities; lining of heart and blood vessels; portions of kidney tubules (thin sections of loop of Henle); inner lining of cornea; exchange surfaces of lungs

FUNCTIONS: Reduces friction, controls vessel permeability, performs absorption and secretion



LM × 238



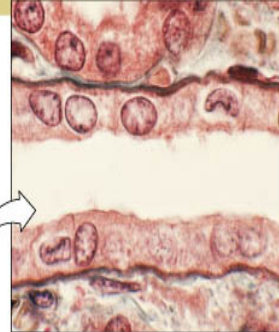
Cytoplasm
Nucleus
Basement membrane
Connective tissue

(a) Lining of peritoneal cavity

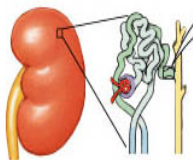
Simple Cuboidal Epithelium

LOCATIONS: Glands, ducts, portions of kidney tubules, thyroid gland

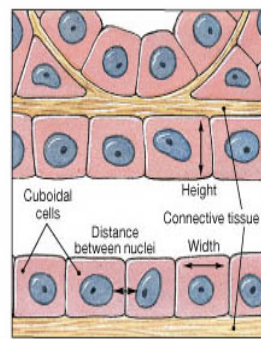
FUNCTIONS: Limited protection, secretion and/or absorption



LM × 1426



(b) Kidney tubule



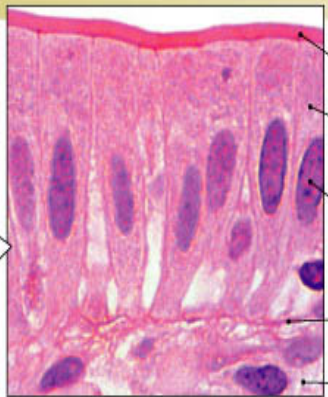
i. Squamous-flattened cells

ii. Cuboidal- Square cells

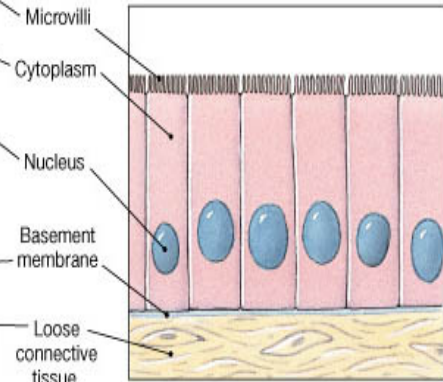
Simple Columnar Epithelium

LOCATIONS: Lining of stomach, intestine, gallbladder, uterine tubes, collecting ducts of kidneys

FUNCTIONS: Protection, secretion, absorption



LM × 350



Microvilli
Cytoplasm
Nucleus
Basement membrane
Loose connective tissue

(c) Intestinal lining

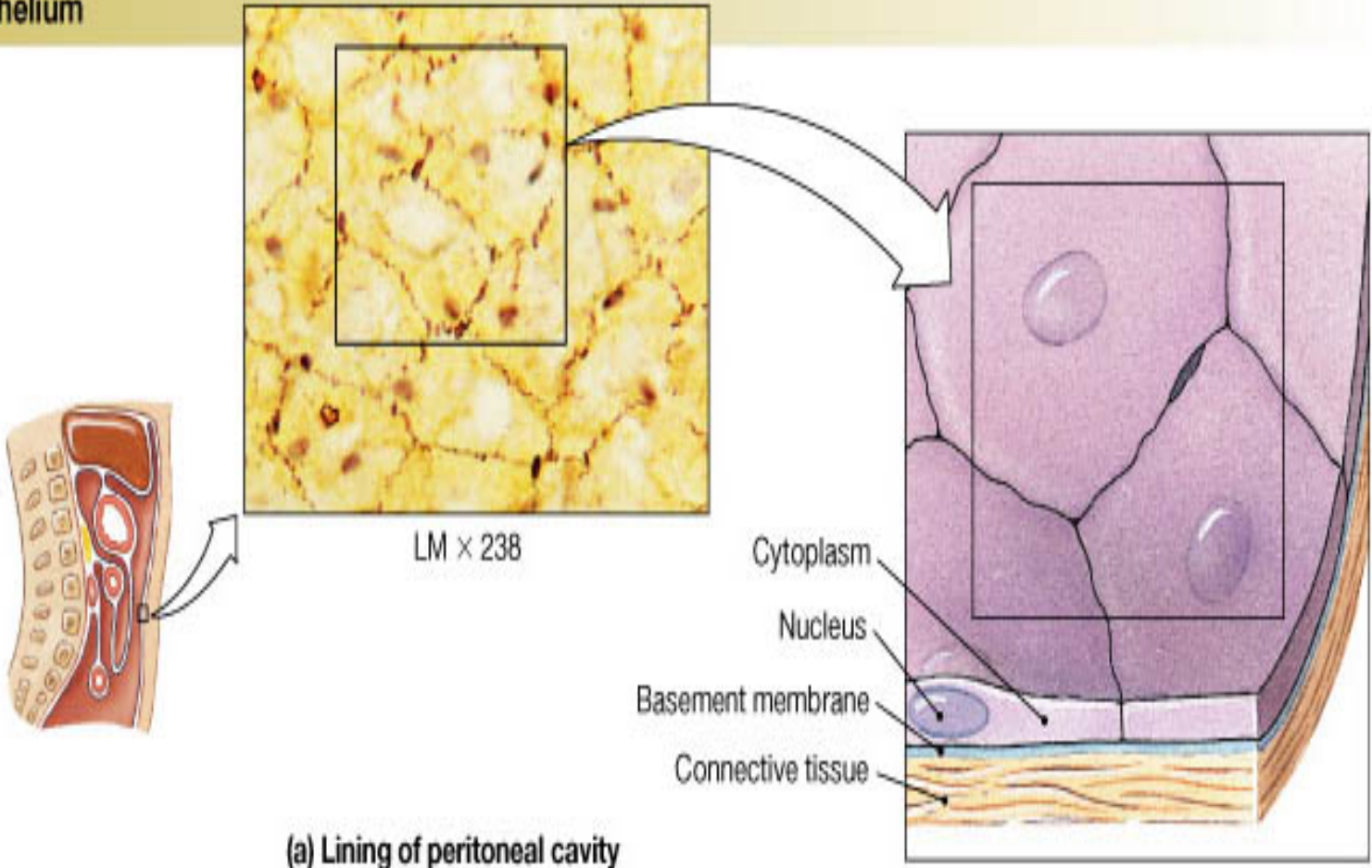
ii. Columnar- Tall cells

4b. Types of Epithelial Tissue by Cell Shape

Simple Squamous Epithelium

LOCATIONS: Epithelia lining ventral body cavities; lining of heart and blood vessels; portions of kidney tubules (thin sections of loop of Henle); inner lining of cornea; exchange surfaces of lungs

FUNCTIONS: Reduces friction, controls vessel permeability, performs absorption and secretion



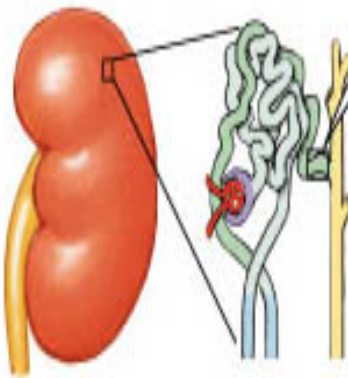
i. Squamous = flattened cells

4b. Types of Epithelial Tissue by Cell Shape

Simple Cuboidal Epithelium

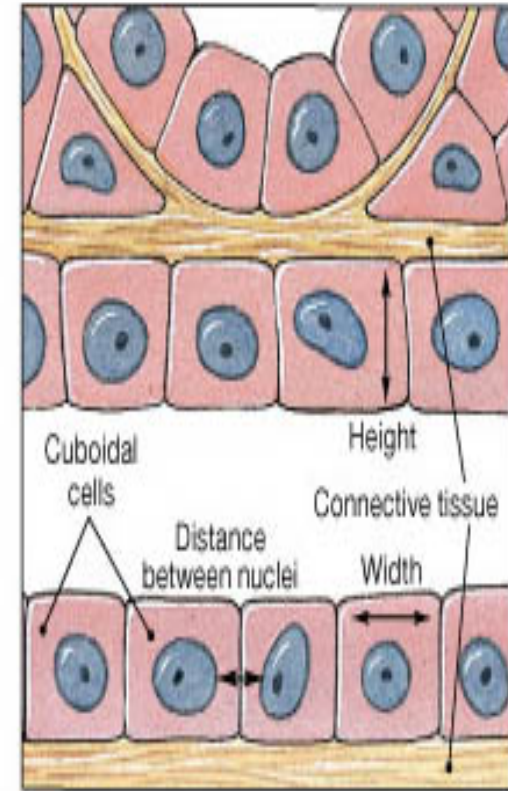
LOCATIONS: Glands, ducts, portions of kidney tubules, thyroid gland

FUNCTIONS: Limited protection, secretion and/or absorption



LM x 1426

(b) Kidney tubule



Basement membrane between cuboidal cells and connective tissue.

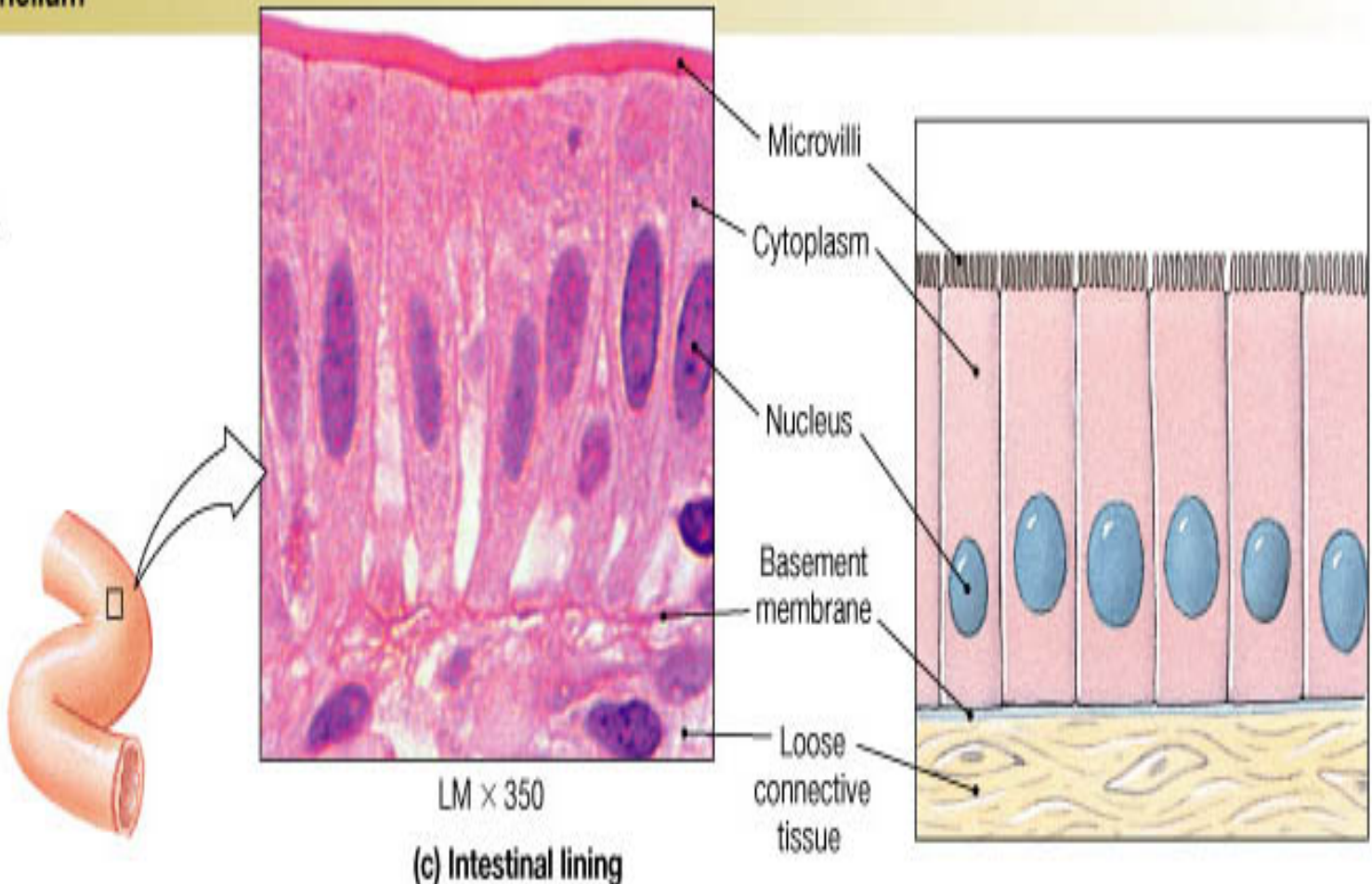
ii. Cuboidal = square cells

4b. Types of Epithelial Tissue by Cell Shape

Simple Columnar Epithelium

LOCATIONS: Lining of stomach, intestine, gallbladder, uterine tubes, collecting ducts of kidneys

FUNCTIONS: Protection, secretion, absorption



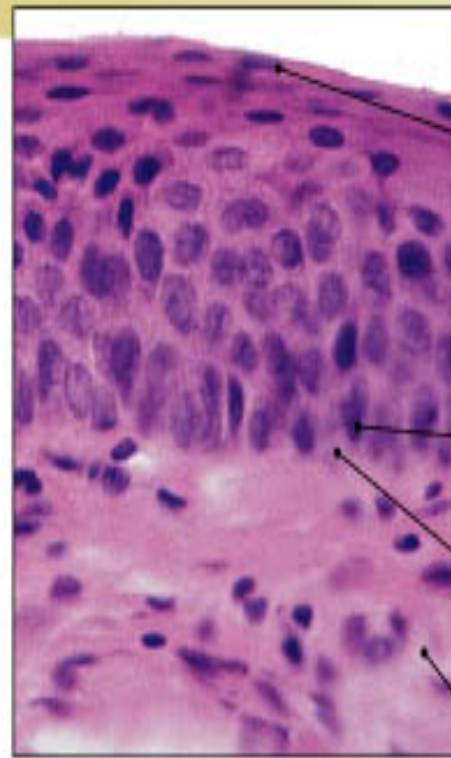
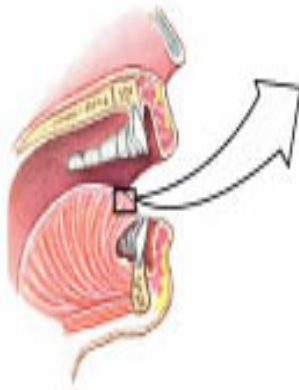
iii. Columnar = tall cells

Epithelial Tissue Terms Combine Layer & Shape

Stratified Squamous Epithelium

LOCATIONS: Surface of skin; lining of mouth, throat, esophagus, rectum, anus, and vagina

FUNCTIONS: Provides physical protection against abrasion, pathogens, and chemical attack



LM × 310

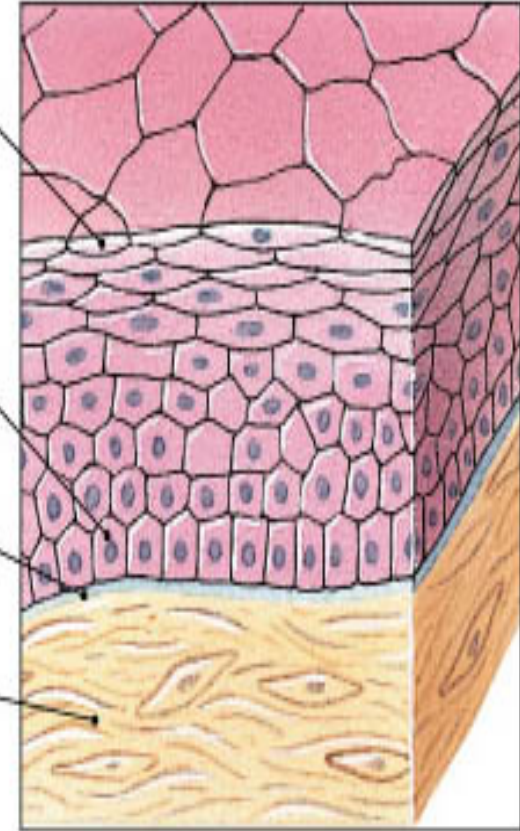
(c) Surface of tongue

Squamous superficial cells

Stem cells






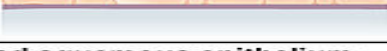

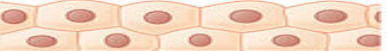
Basement membrane

Connective tissue



**Combining layering and shape terms:
Stratified Squamous Epithelium**

4. Epithelial Tissue

Cells	Location	Function
Simple squamous epithelium 	Air sacs of lungs and the lining of the heart, blood vessels, and lymphatic vessels	Allows materials to pass through by diffusion and filtration, and secretes lubricating substance
Simple cuboidal epithelium 	In ducts and secretory portions of small glands and in kidney tubules	Secretes and absorbs
Simple columnar epithelium 	Ciliated tissues are in bronchi, uterine tubes, and uterus; smooth (nonciliated tissues) are in the digestive tract, bladder	Absorbs; it also secretes mucous and enzymes
Pseudostratified columnar epithelium 	Ciliated tissue lines the trachea and much of the upper respiratory tract	Secretes mucus; ciliated tissue moves mucus
Stratified squamous epithelium 	Lines the esophagus, mouth, and vagina	Protects against abrasion
Stratified cuboidal epithelium 	Sweat glands, salivary glands, and the mammary glands	Protective tissue
Stratified columnar epithelium 	The male urethra and the ducts of some glands	Secretes and protects
Transitional epithelium 	Lines the bladder, urethra, and the ureters	Allows the urinary organs to expand and stretch

Let's Check Out the Interactive [Tissues of Life](#) Website!

TISSUES OF LIFE

GLOSSARY

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EXPLORE

HELP

sound is ON

Explore an interactive comic about stem cells!

? bonus feature

Learn where stems cells are found in the body and how they are gathered.


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Confused?

Here are some links to fun resources that further explain Human Tissues:

- [Animation of Different Cell & Tissue Types](#) from Paradise Valley Bio 156.
- [Tissues \(biology\)](#) from Wikipedia.
- [Tissues of Life Animated Tutorial](#) from the Science Museum of Minnesota, with tissues of the body. Includes games ("super healers" and "tissue invaders"), interviews with scientists who work with tissues, read the "Stem Cell Comic" and explore various tissue types.
- [Al's Interactive Tutorial for Histology](#) from the University of British Columbia has a written tutorial with links to visuals on the right half of screen. It provides good diagrams of different types of tissues, should you wish to elaborate on that topic.
- [Human Body 101 video](#) from National Geographic.

(You must be in PPT slideshow view to click on links.)

Smart Links

