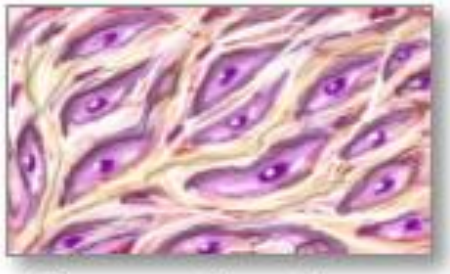
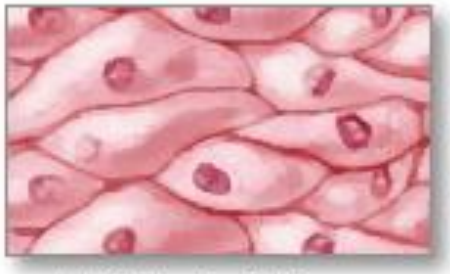
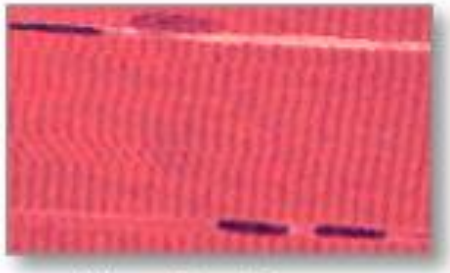
Tissues Review “4 type”



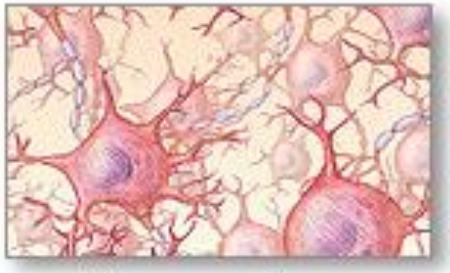
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

Tissues

- Definition: a group of closely associated cells that perform related functions and are similar in structure
- Between cells: nonliving extracellular material
- Four basic types of tissue…function
  - Epithelium…covering
  - Connective tissue…support
  - Muscle tissue…movement
  - Nervous tissue…control

Epithelia (plural)

- Epithelium: sheet of cells that covers a body surface or lines a body cavity; also form most of the body's glands
- Roles: as interfaces and as boundaries
- Functions:

Protection	Absorption
Sensory reception	Ion transport
Secretion	Filtration

Formation of slippery surfaces for movement

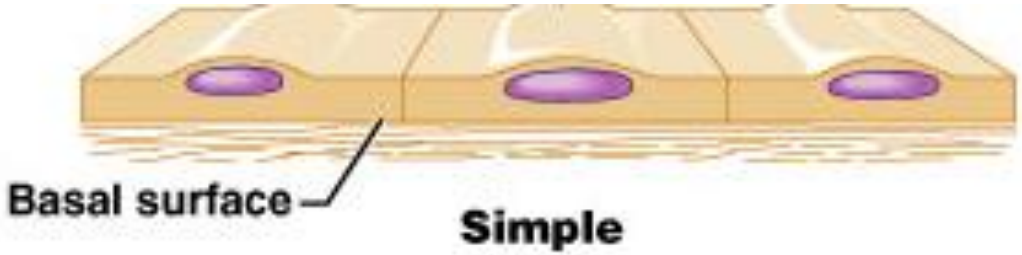
Special characteristics of epithelia

- Cellularity
- Specialized contacts
- Polarity
  - Free upper (apical) surface
  - Lower (basal) surface contributing basal lamina to basement membrane
- Support by connective tissue
- Avascular but innervated
  - *Without* vessels
  - *With* nerve endings
- Regeneration

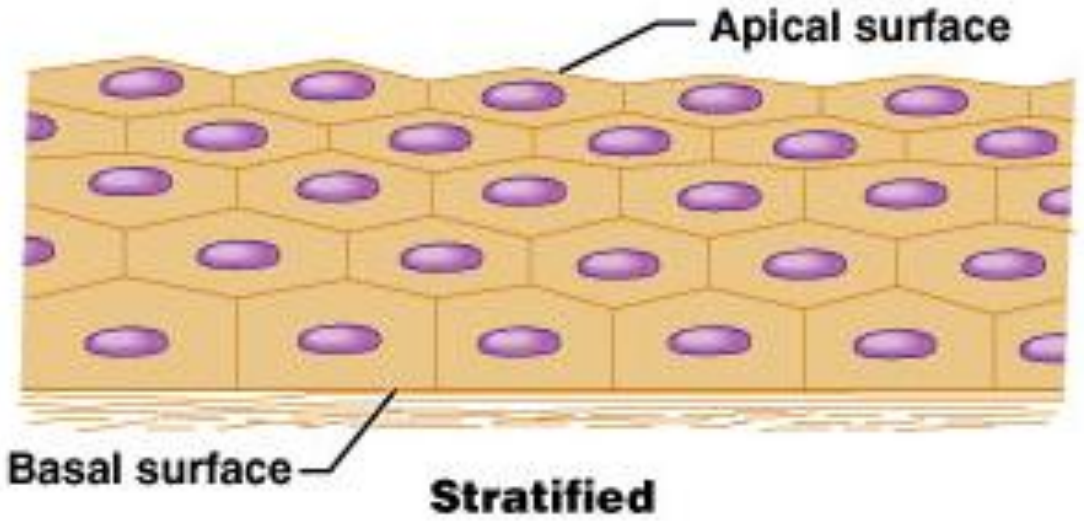
Classification of epithelia

- According to thickness
  - "simple" - one cell layer
  - "stratified" – more than one layer of cells (which are named according to the shape of the cells in the apical layer)

- According to shape
  - "squamous" – wider than tall
  - "cuboidal" – as tall as wide
  - "columnar" - taller than wide

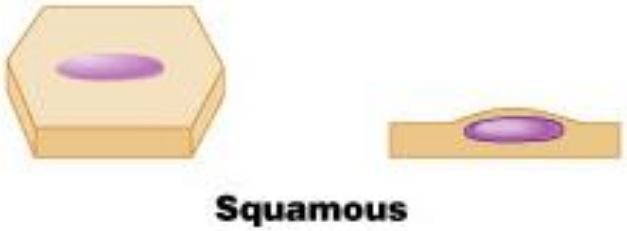


Simple



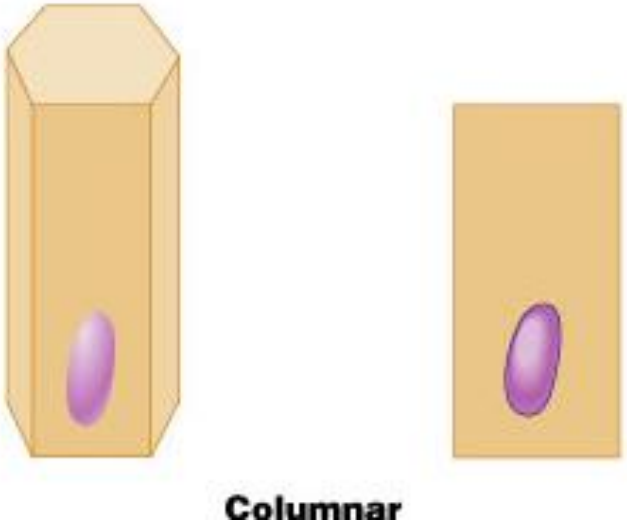
Stratified

to protect



Squamous

Cuboidal



Columnar

where diffusion is important

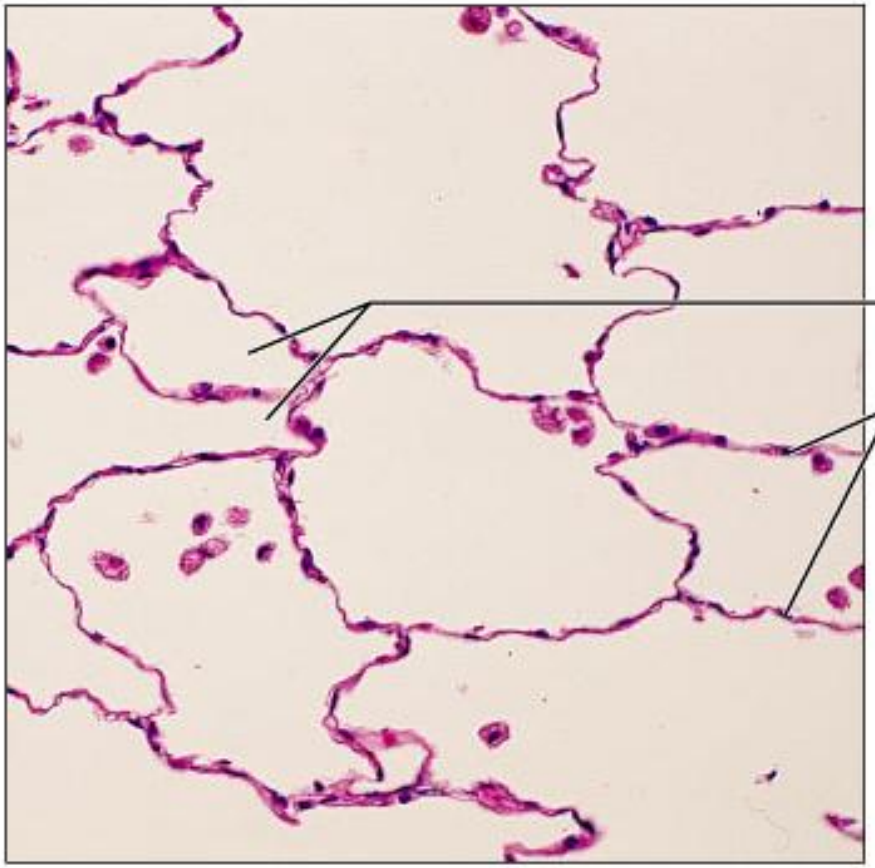
where tissues are involved in secretion and absorption: larger cells because of the machinery of production, packaging, and energy requirements

(a) Simple squamous epithelium

Description: Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.

Function: Allows passage of materials by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosae.

Location: Kidney glomeruli and corpuscles; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosae).



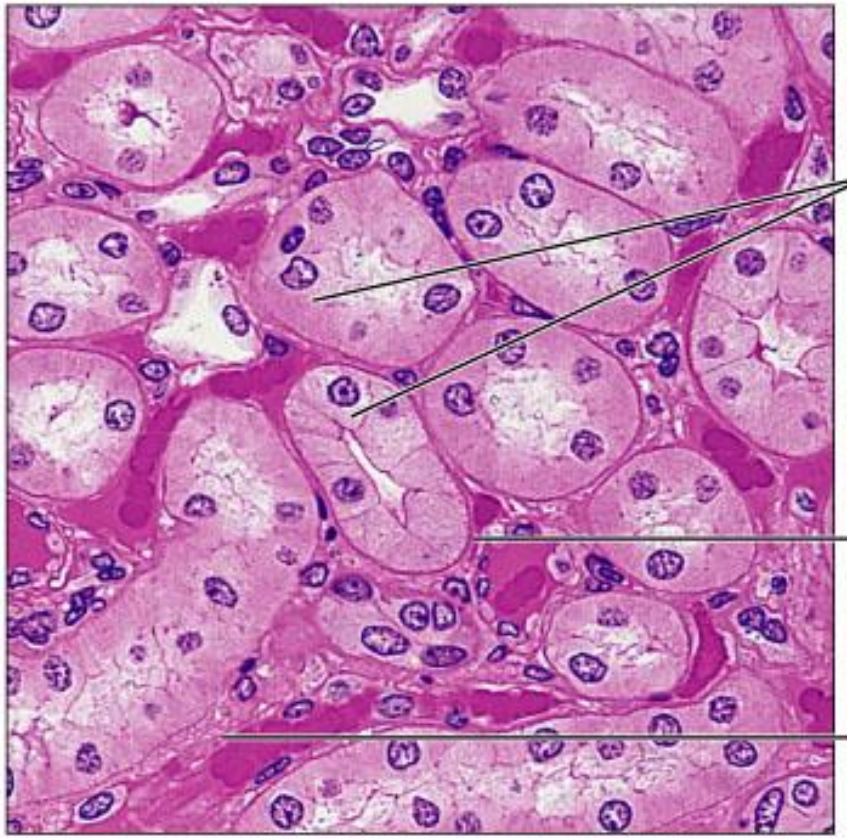
Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (400×).

(b) Simple cuboidal epithelium

Description: Single layer of cubelike cells with large, spherical central nuclei.

Function: Secretion and absorption.

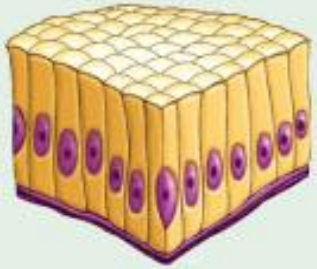
Location: Kidney tubules; ducts and secretory portions of small glands; ovary surface.



Photomicrograph: Simple cuboidal epithelium in kidney tubules (400×).

(c) Simple columnar epithelium

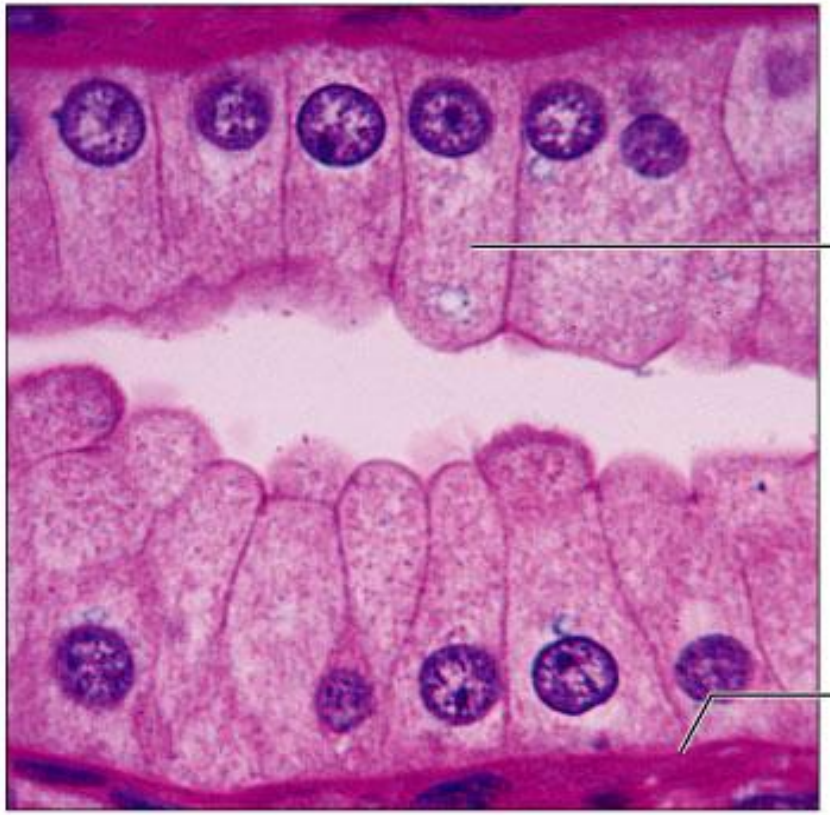
Description: Single layer of tall cells with *round* to *oval* nuclei; some cells bear cilia; layer may contain mucus-secreting unicellular glands (goblet cells).



Function: Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.

Location: Nonciliated type lines most of the digestive tract (stomach to anal canal), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.

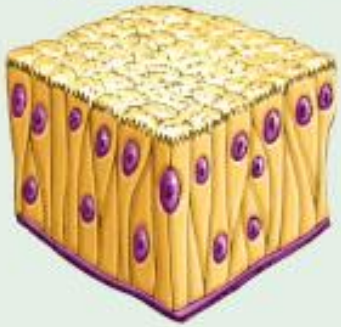
"ciliated" literally = eyelashes
(see next page)



Photomicrograph: Simple columnar epithelium of the stomach mucosa (1300×).

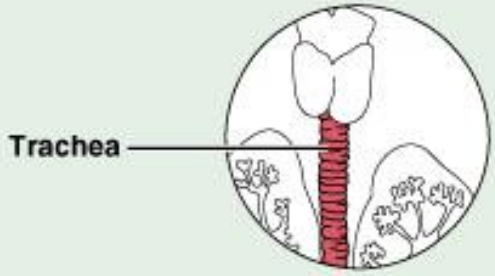
(d) Pseudostratified columnar epithelium

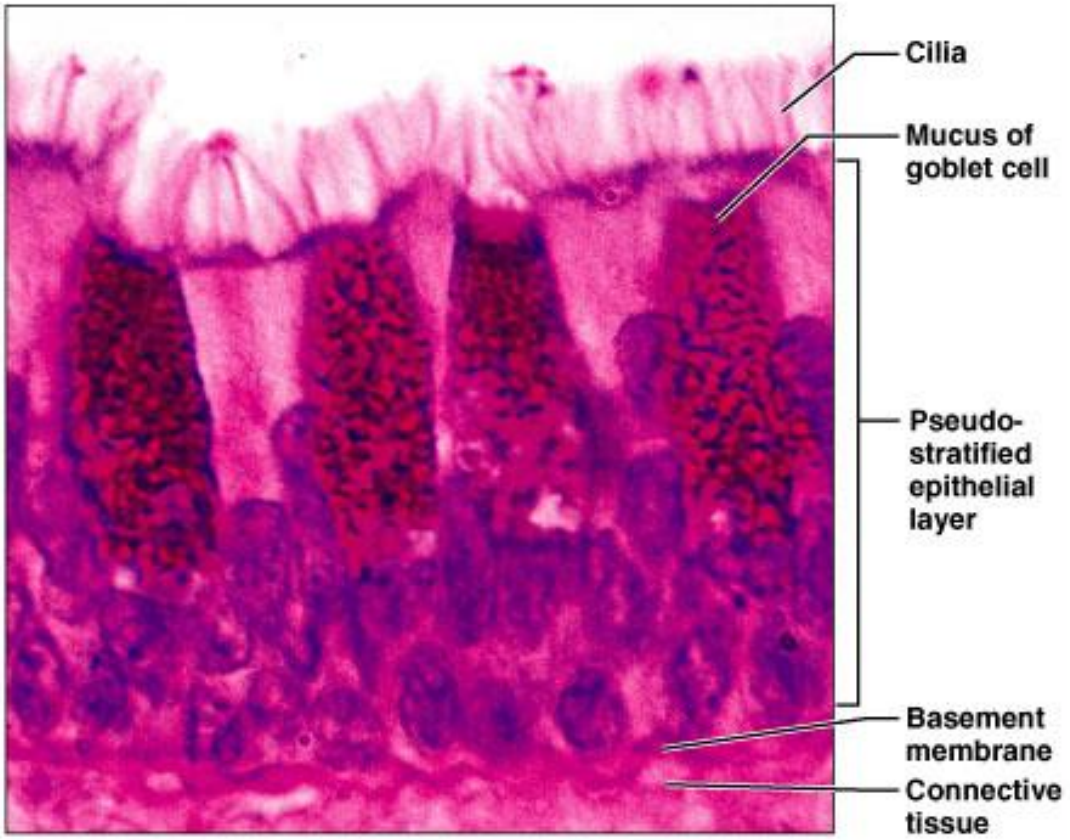
Description: Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels; may contain goblet cells and bear cilia.



Function: Secretion, particularly of mucus; propulsion of mucus by ciliary action.

Location: Nonciliated type in male's sperm-carrying ducts and ducts of large glands; ciliated variety lines the trachea, most of the upper respiratory tract.



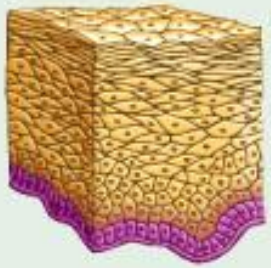


Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (400×).

Stratified: regenerate from below

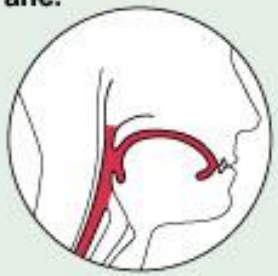
(e) Stratified squamous epithelium

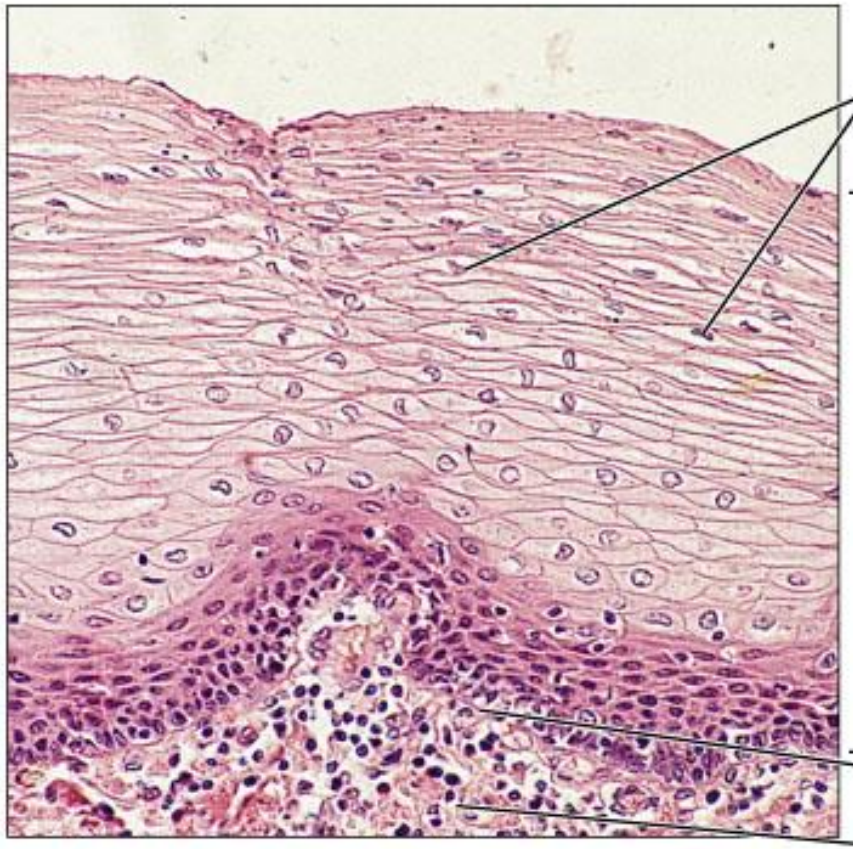
Description: Thick membrane composed of several cell layers; basal cells are cuboidal or columnar and metabolically active; surface cells are flattened (squamous); in the keratinized type, the surface cells are full of keratin and dead; basal cells are active in mitosis and produce the cells of the more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



Function: Protects underlying tissues in areas subjected to abrasion.

Location: Nonkeratinized type forms the moist linings of the esophagus, mouth, and vagina; keratinized variety forms the epidermis of the skin, a dry membrane.





Photomicrograph: Stratified squamous epithelium lining of the esophagus (300×).

Rare…

(f) Stratified cuboidal epithelium

Description: Generally two layers of cube-like cells.

Function: Protection

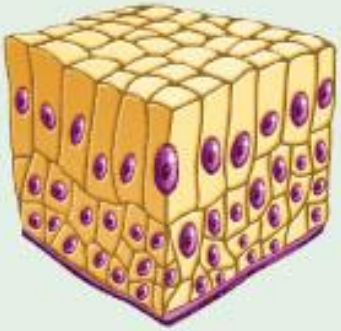
Location: Largest ducts of sweat glands, mammary glands, and salivary glands.

Photomicrograph: Stratified cuboidal epithelium forming a salivary gland duct (300×).

Rare…

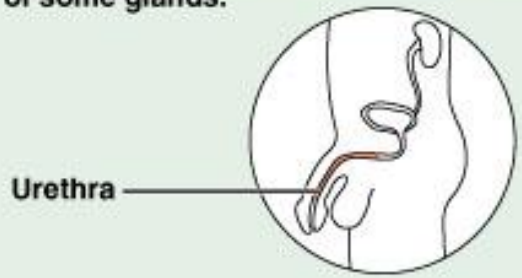
(g) Stratified columnar epithelium

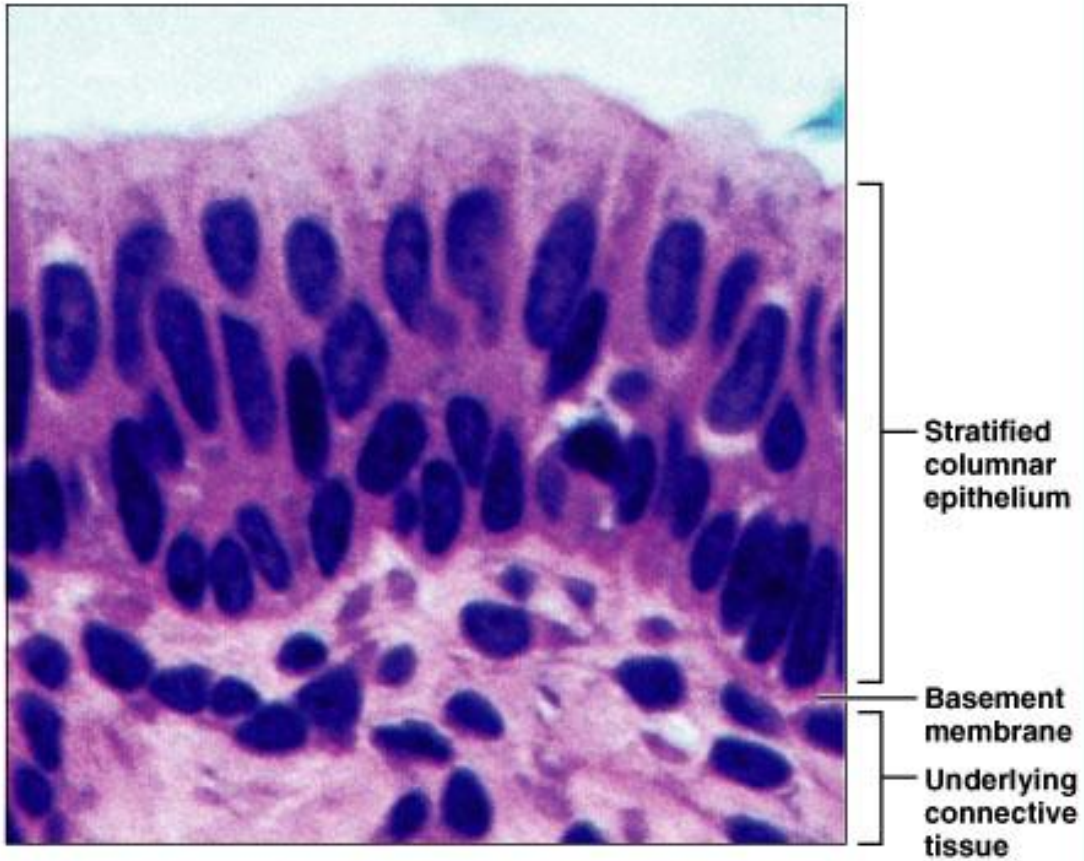
Description: Several cell layers; basal cells usually cuboidal; superficial cells elongated and columnar.



Function: Protection; secretion.

Location: Rare in the body; small amounts in male urethra and in large ducts of some glands.

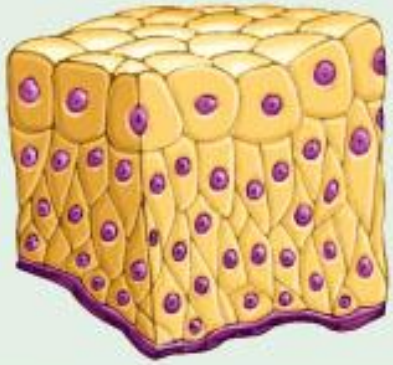




Photomicrograph: Stratified columnar epithelium lining of the male urethra (900×).

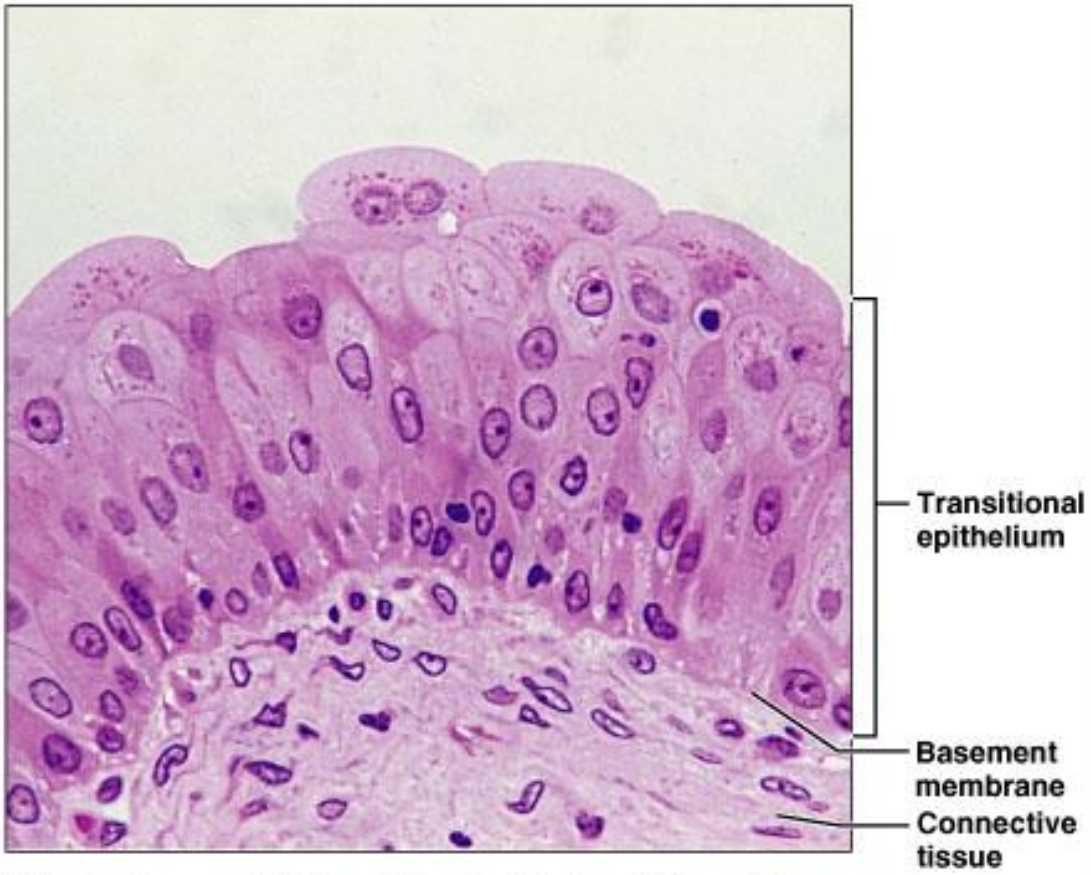
(h) Transitional epithelium

Description: Resembles both stratified squamous and stratified cuboidal; basal cells cuboidal or columnar; surface cells dome shaped or squamouslike, depending on degree of organ stretch.



Function: Stretches readily and permits distension of urinary organ by contained urine.

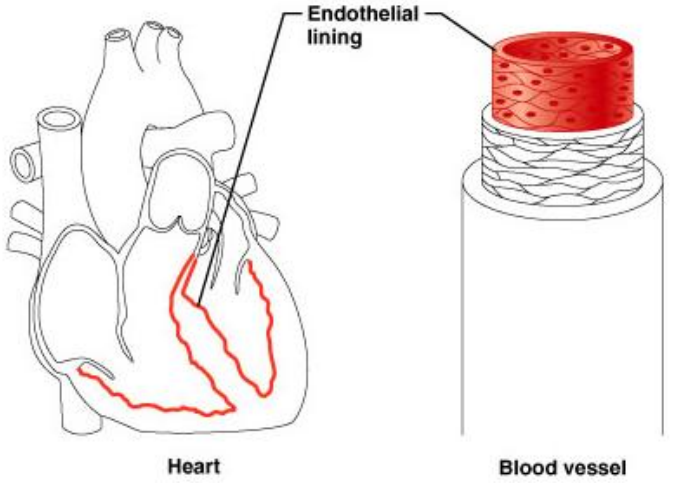
Location: Lines the ureters, bladder, and part of the urethra.



Photomicrograph: Transitional epithelium lining of the bladder, relaxed state (500×); note the bulbous, or rounded, appearance of the cells at the surface; these cells flatten and become elongated when the bladder is filled with urine.

Endothelium

A simple squamous epithelium that lines the interior of the circulatory vessels and heart



Mesothelium

Simple squamous epithelium that lines the peritoneal, pleural and pericardial cavities and covers the viscera

Glands

- Epithelial cells form them
- Production & secretion of needed substances
- Are aqueous (water-based) products
- The protein product is made in rough ER, packed into secretory granules by Golgi apparatus, released from the cell by exocytosis

Classification of glands

- By where they release their product
  - Exocrine: external secretion onto body surfaces (skin) or into body cavities
  - Endocrine: secrete messenger molecules (hormones) which are carried by blood to target organs; "ductless" glands
- By whether they are unicellular or multicellular

Exocrine glands

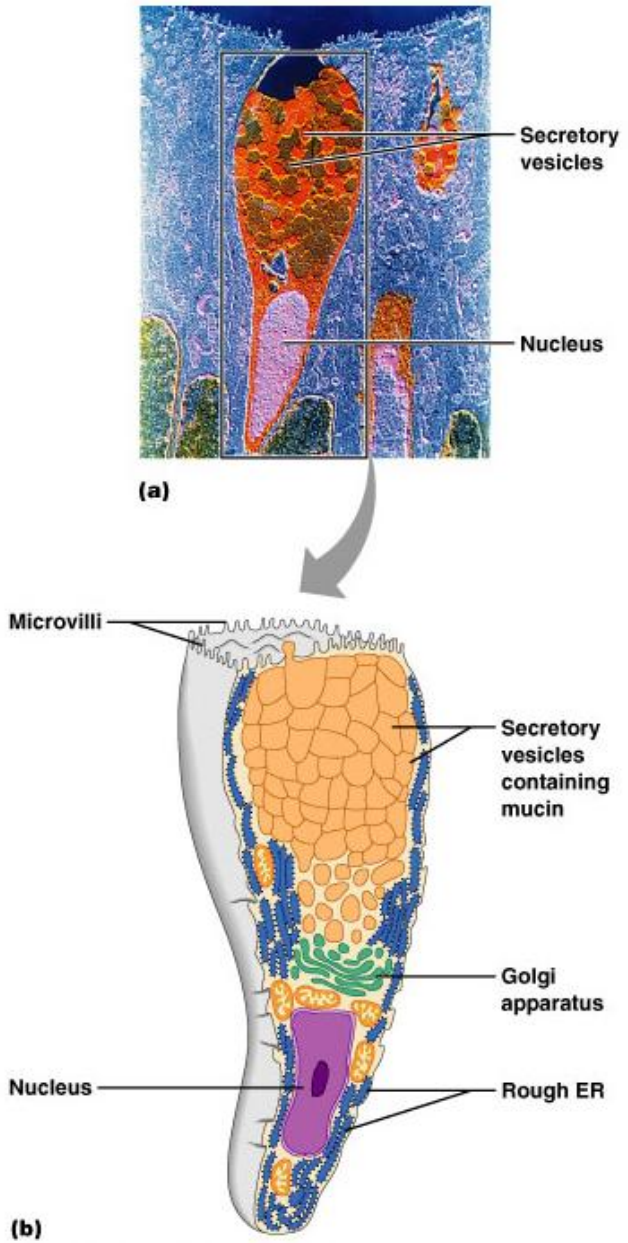
unicellular or multicellular

Unicellular: goblet cell scattered within epithelial lining of intestines and

respiratory tubes

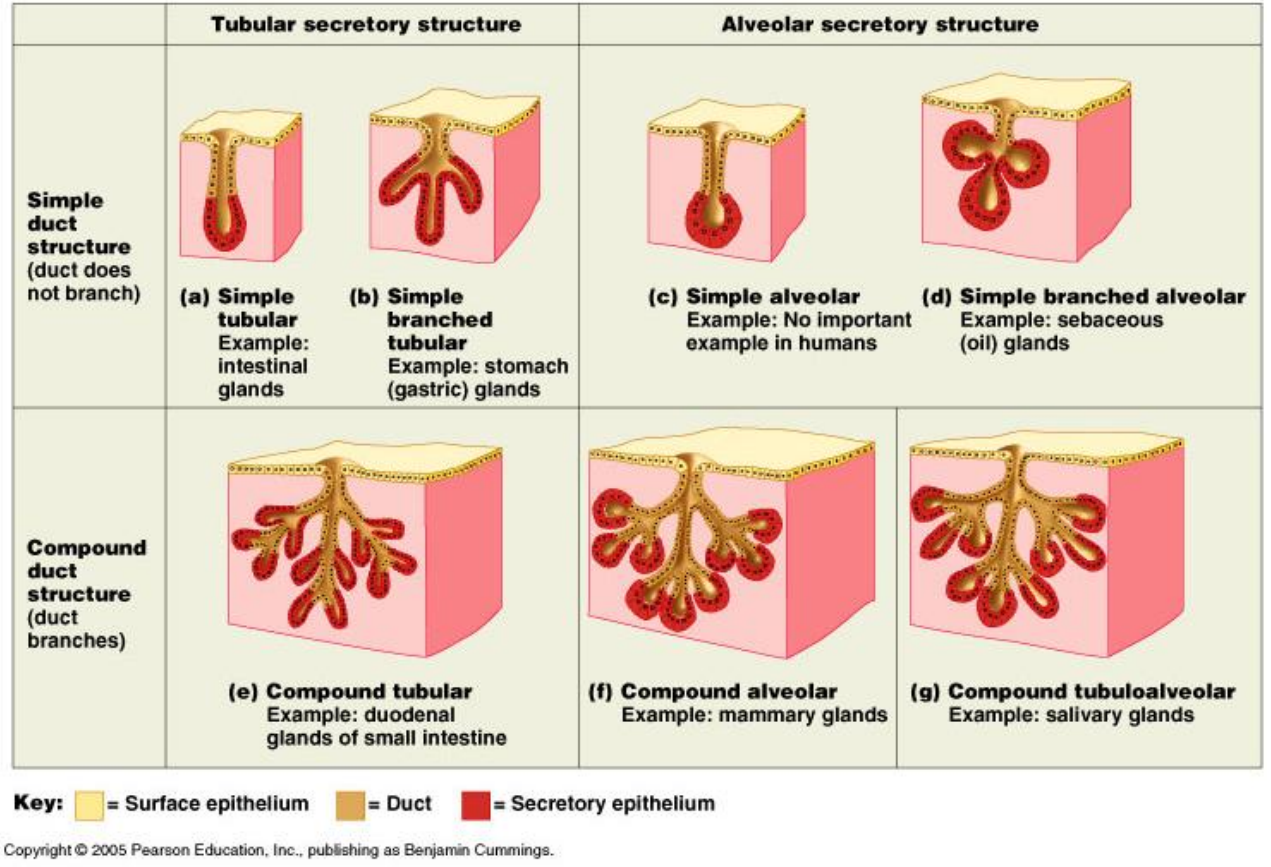
Product: mucin

mucus is mucin & water



Multicellular exocrine glands

Epithelium-walled *duct* and a *secretory unit*



Examples of exocrine gland products

- Many types of mucus secreting glands
- Sweat glands of skin
- Oil glands of skin
- Salivary glands of mouth
- Liver (bile)
- Pancreas (digestive enzymes)
- Mammary glands (milk)

Endocrine glands

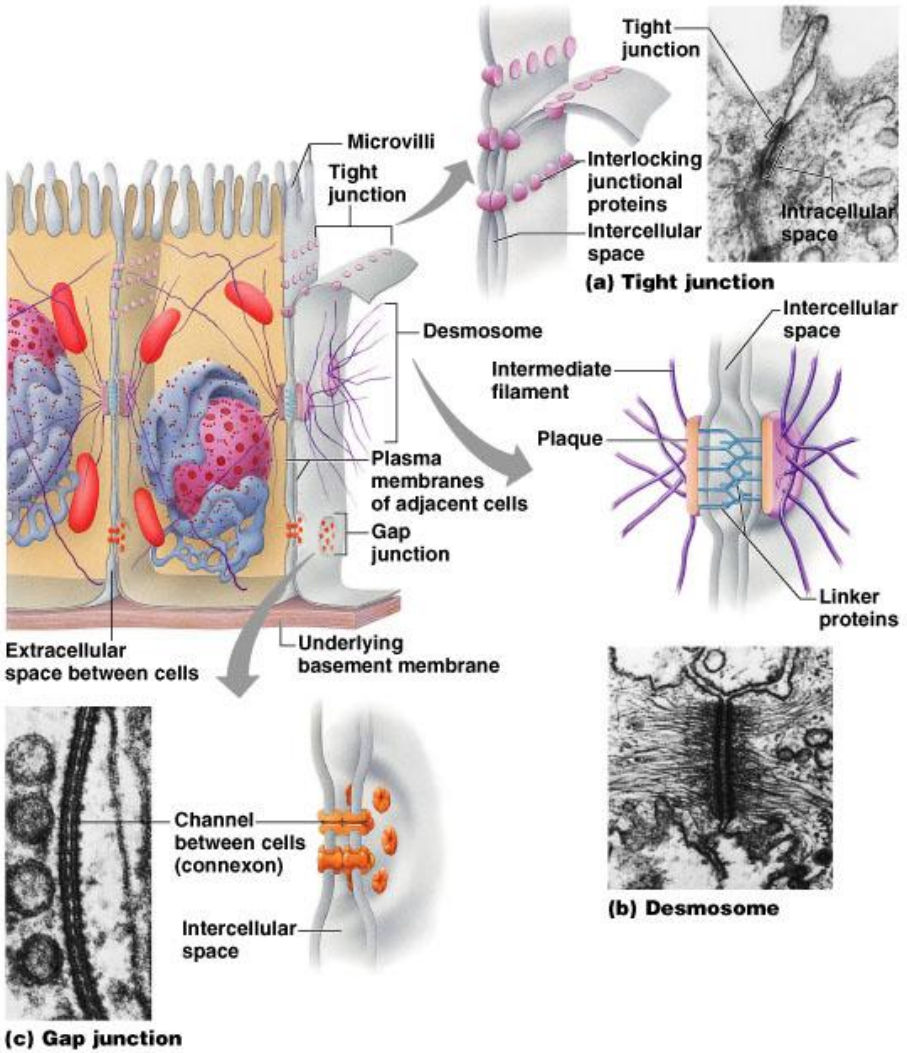
- *Ductless* glands
- Release hormones into extracellular space
  - Hormones are *messenger molecules*
- Hormones enter blood and travel to specific *target organs*

Epithelial surface features

- Lateral surface
  - Adhesion proteins
  - Tongue and groove wavy contours
  - Cell junctions: see next slide
- Basal surface
  - Basal lamina: noncellular sheet of protein together with reticular fibers form basement membrane
- Apical surface

Cell Junctions

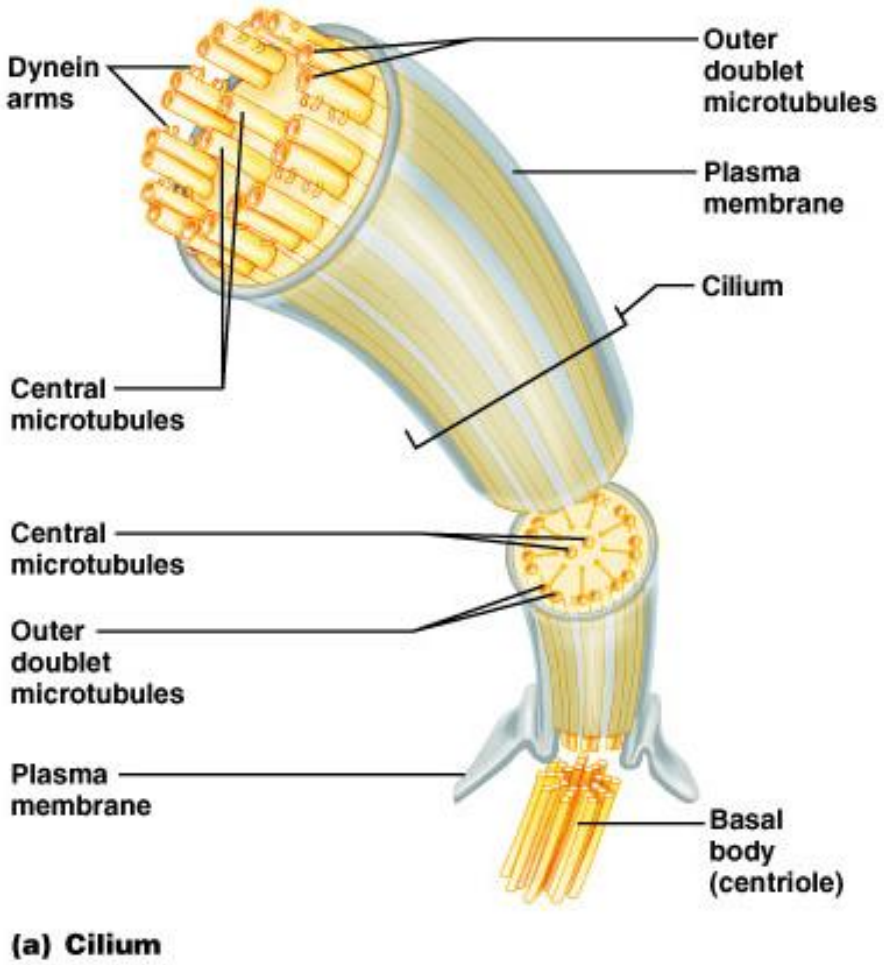
- Tight junctions
  - So close that are sometimes impermeable
- Adherens junctions
  - Transmembrane linker proteir
- Desmosomes
  - Anchoring junctions
  - Filaments anchor to the opposite side
- Gap junctions
  - Allow small molecules to mov between cells

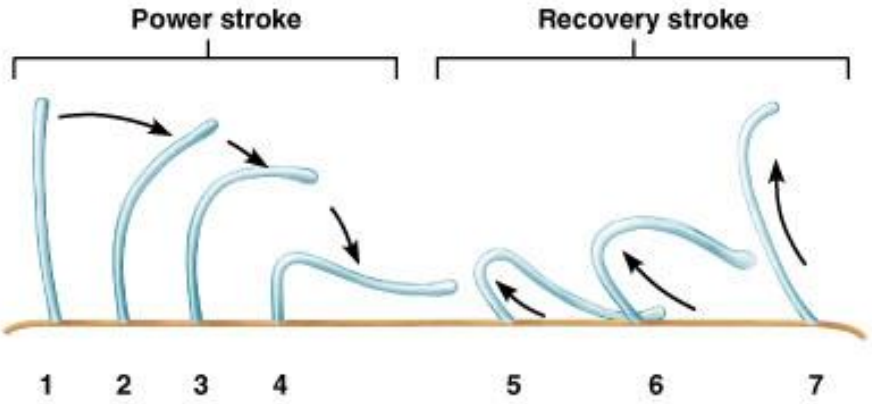


Apical surface features

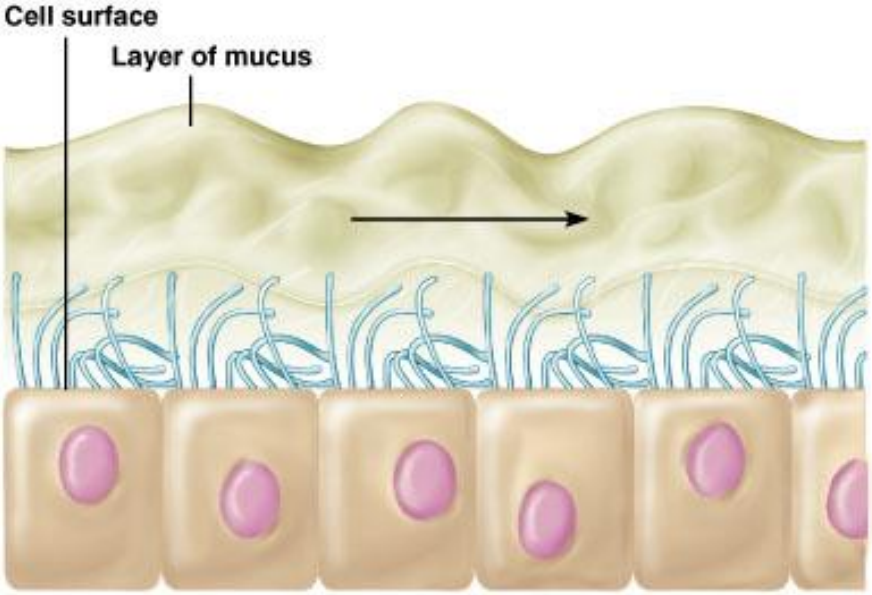
- Microvilli – maximize surface area
  - Fingerlike extensions of the plasma membrane of apical epithelial cells
  - On moist and mucus secreting epithelium
  - Longest on epithelia that absorb nutrients (small intestine) or transport ions (kidneys)

- Cilia
  - Whiplike motile extentions of the apical surface membranes
- Flagellum
  - Long isolated cilium
  - Only found as sperm in human





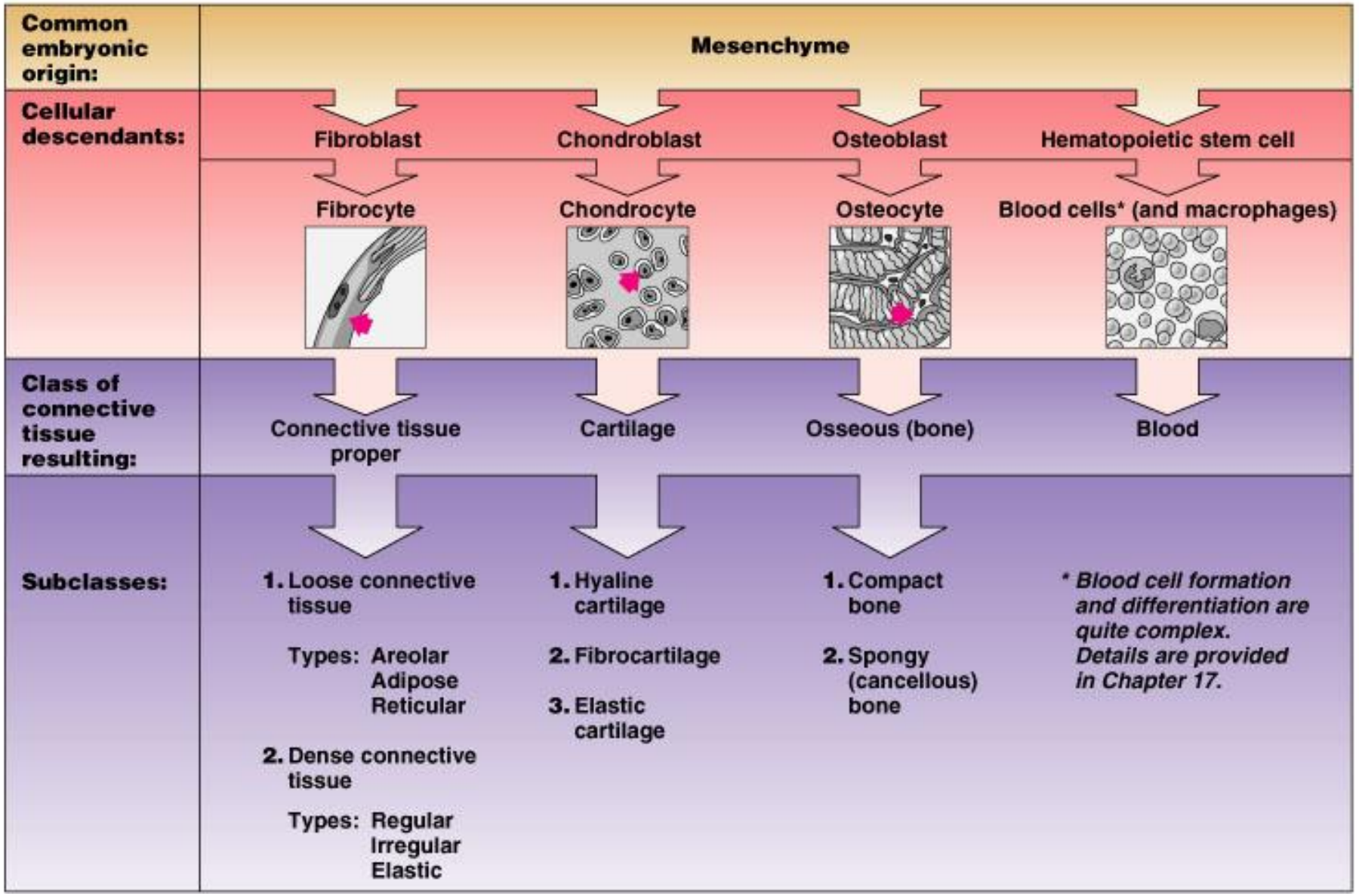
(b) Ciliary motion



(c) Movement of mucus across cell surfaces

- Four basic types of tissue
  - Epithelium
  - Connective tissue
    - Connective tissue proper (examples: fat tissue, fibrous tissue of ligaments)
    - Cartilage
    - Bone
    - Blood
  - Muscle tissue
  - Nervous tissue

Classes of Connective Tissue: note the cell types and great variety of subclasses



Connective Tissue

- Originate from embryonic tissue called **mesenchyme**
- Most diverse and abundant type of tissue
- Many subclasses (see previous slide)
- Function: to protect, support and bind together other tissues
  - Bones, ligaments, tendons
  - Areolar cushions; adipose insulates and is food source
  - Blood cells replenished; body tissues repaired
- Cells separated from one another by large amount of nonliving **extracellular matrix**

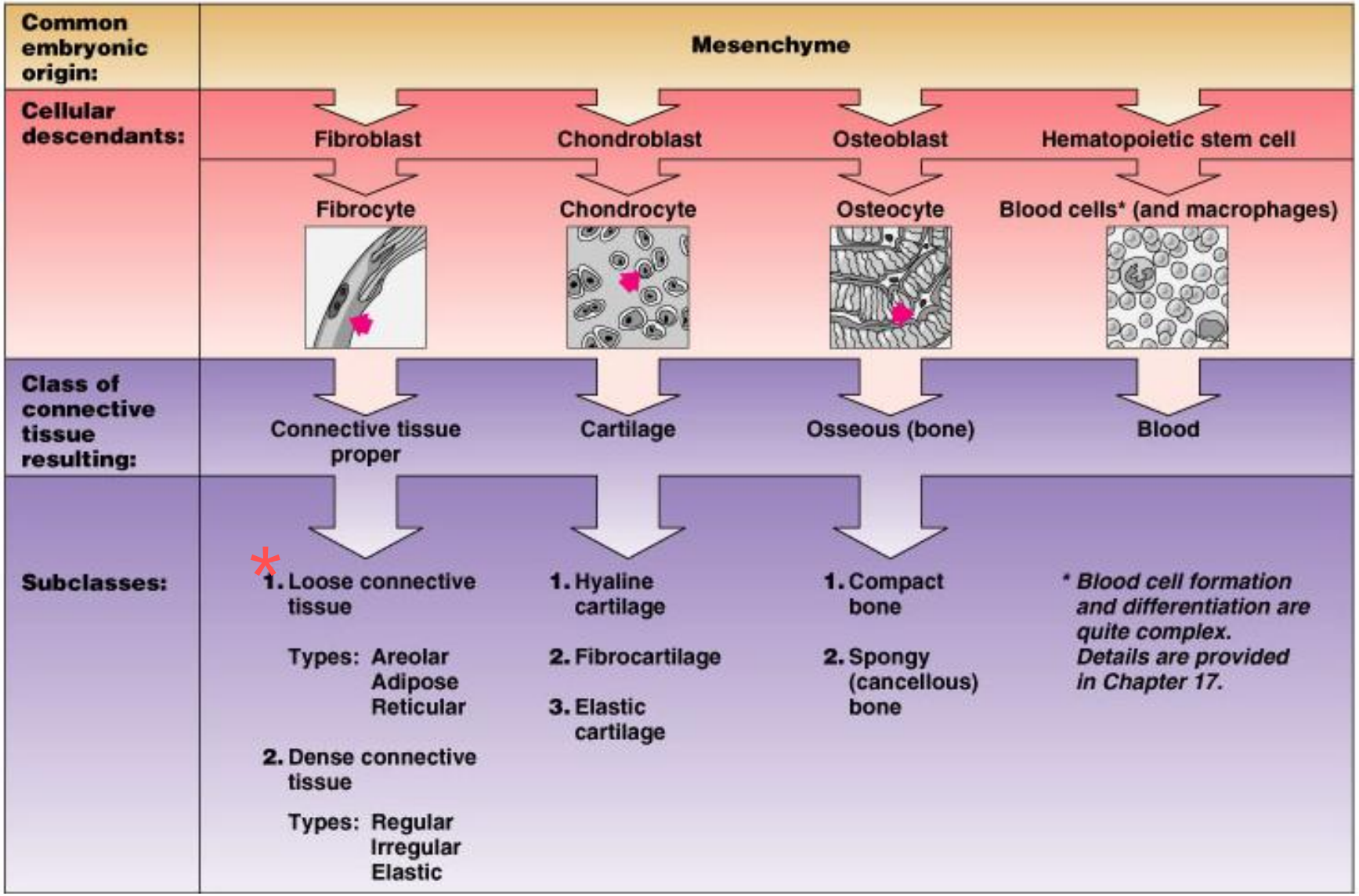
Extracellular Matrix explained

- Nonliving material between cells
- Produced by the cells and then extruded
- Responsible for the strength
- Two components
  1. Ground substance
     - Of fluid, adhesion proteins, proteoglycans
     - Liquid, semisolid, gel-like or very hard
  2. Fibers: collagen, elastic or reticular

Basic functions of connective tissue reviewed

- Support and binding of other tissues
- Holding body fluids
- Defending the body against infection
  - macrophages, plasma cells, mast cells, WBCs
- Storing nutrients as fat

Classes of Connective Tissue

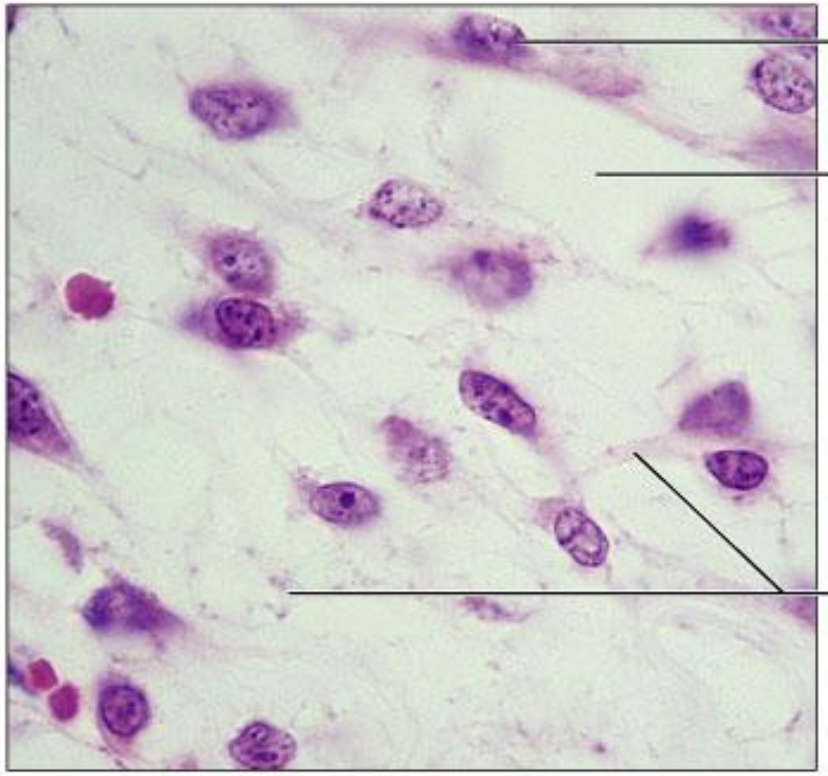


(a) Embryonic connective tissue: mesenchyme

Description: Embryonic connective tissue; gel-like ground substance containing fibers; star-shaped mesenchymal cells.

Function: Gives rise to all other connective tissue types.

Location: Primarily in embryo.



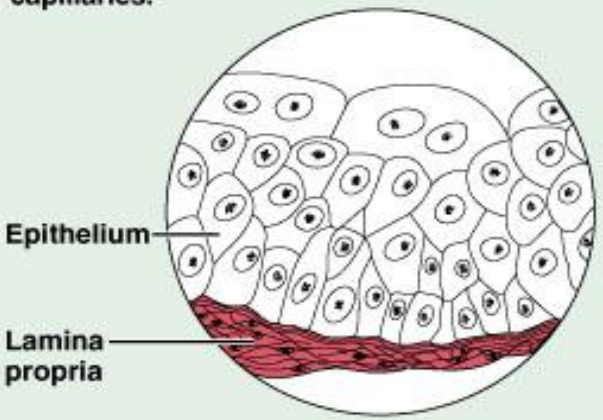
Photomicrograph: Mesenchymal tissue, an embryonic connective tissue (400×); the clear-appearing background is the fluid ground substance of the matrix; notice the fine, sparse fibers.

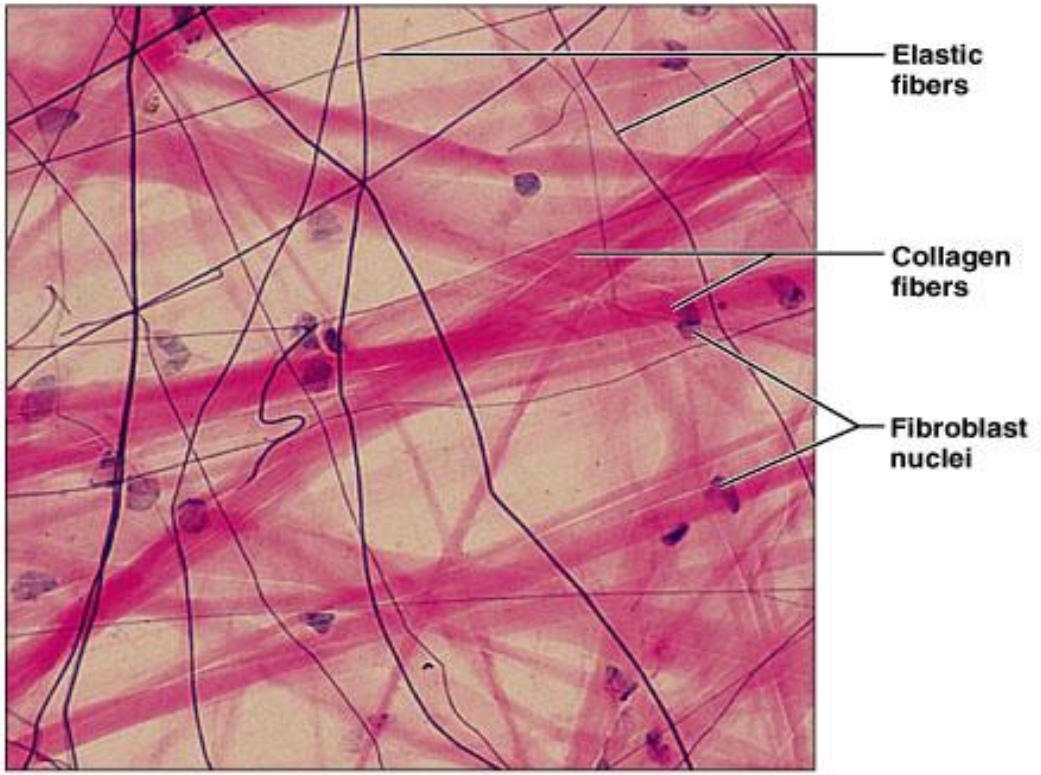
(b) Connective tissue proper: loose connective tissue, areolar

Description: Gel-like matrix with all three fiber types; cells: fibroblasts, macrophages, mast cells, and some white blood cells.

Function: Wraps and cushions organs; its macrophages phagocytize bacteria; plays important role in inflammation; holds and conveys tissue fluid.

Location: Widely distributed under epithelia of body, e.g. forms lamina propria of mucous membranes; packages organs; surrounds capillaries.





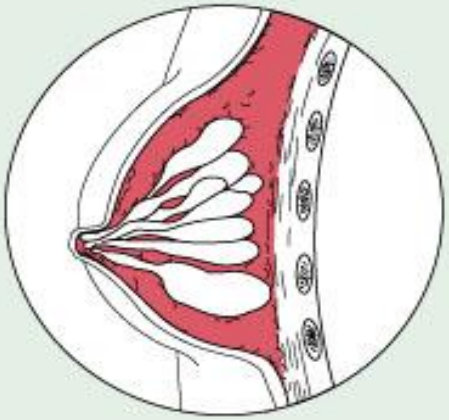
Photomicrograph: Areolar connective tissue, a soft packaging tissue of the body (400×).

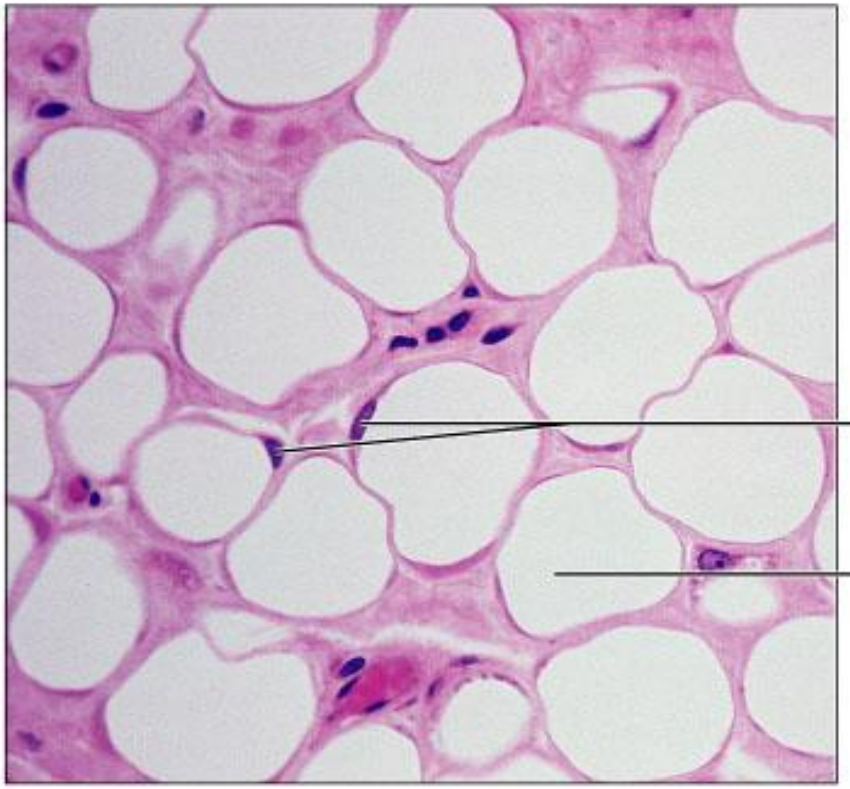
(c) Connective tissue proper: loose connective tissue, adipose

Description: Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by large fat droplet.

Function: Provides reserve food fuel; insulates against heat loss; supports and protects organs.

Location: Under skin; around kidneys and eyeballs; within abdomen; in breasts.





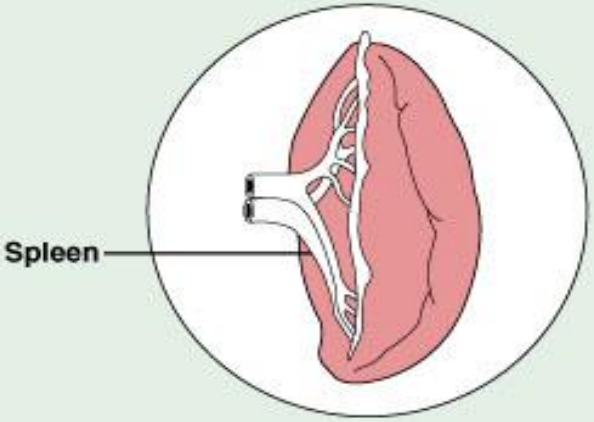
Photomicrograph: Adipose tissue from the subcutaneous layer under the skin (600×).

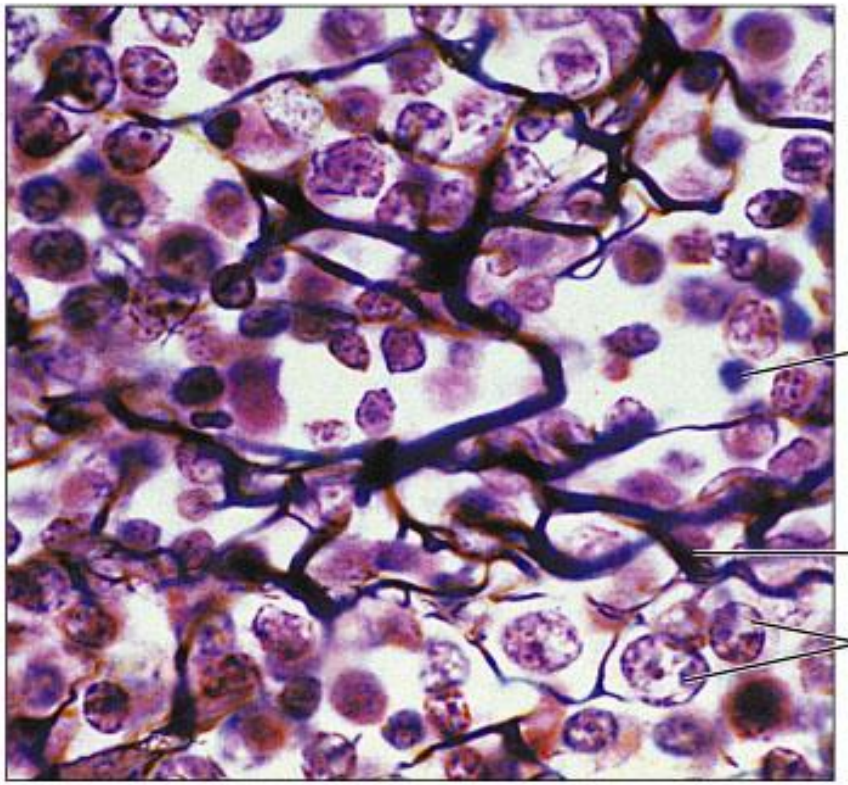
(d) Connective tissue proper: loose connective tissue, reticular

Description: Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

Function: Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells, and macrophages.

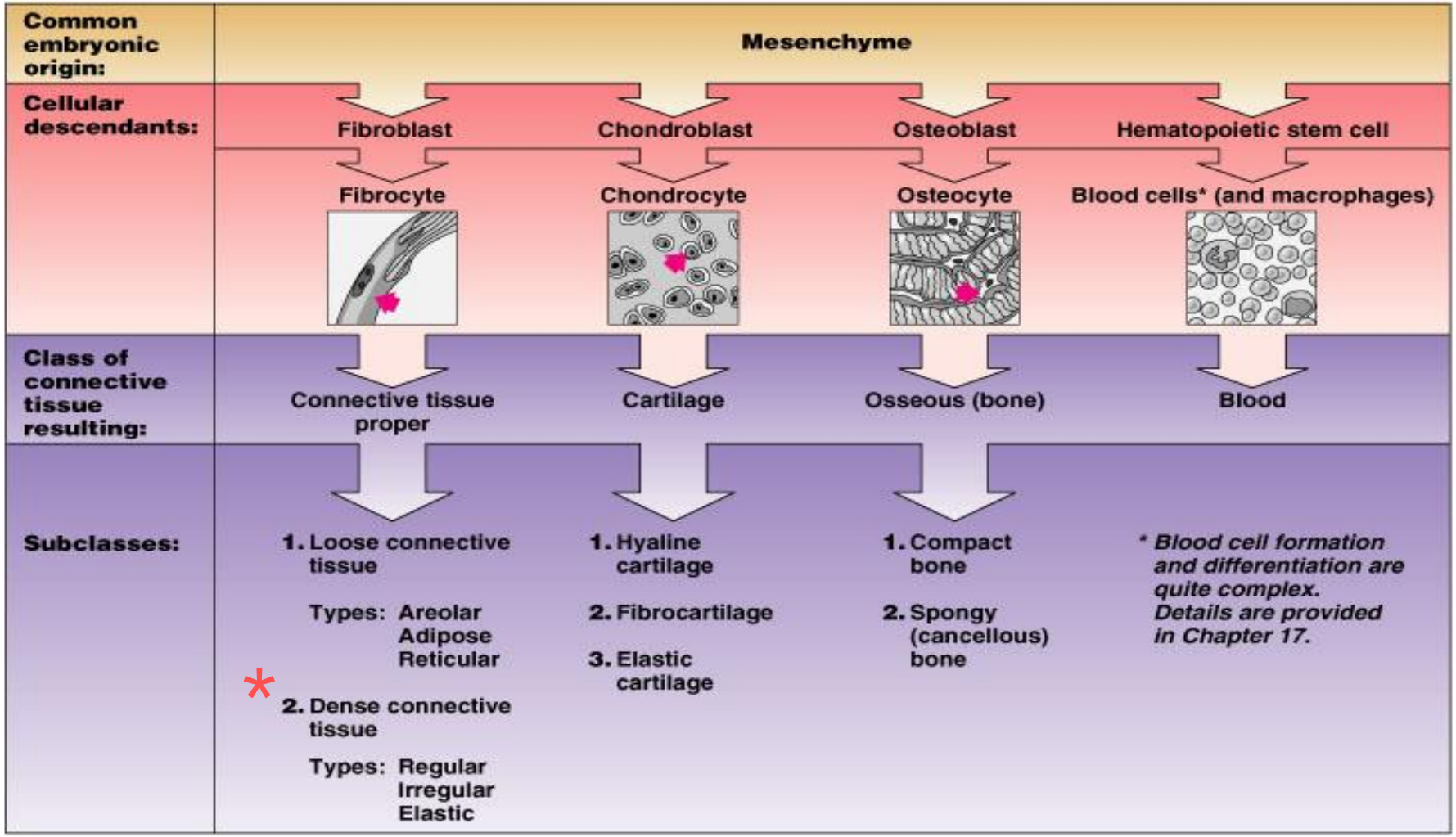
Location: Lymphoid organs (lymph nodes, bone marrow, and spleen).





Photomicrograph: Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350×).

Classes of Connective Tissue

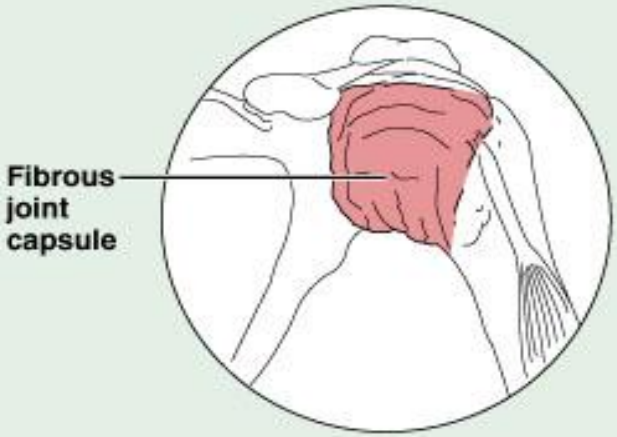


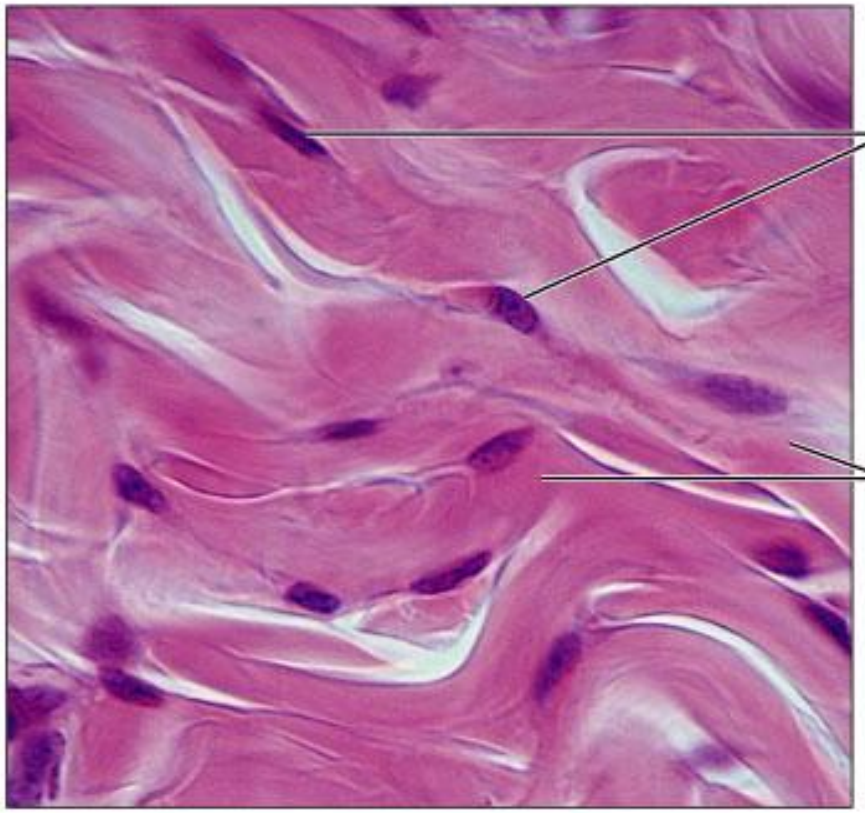
(e) Connective tissue proper: dense connective tissue, dense irregular

Description: Primarily irregularly arranged collagen fibers; some elastic fibers; major cell type is the fibroblast.

Function: Able to withstand tension exerted in many directions; provides structural strength.

Location: Dermis of the skin; submucosa of digestive tract; fibrous capsules of organs and of joints.





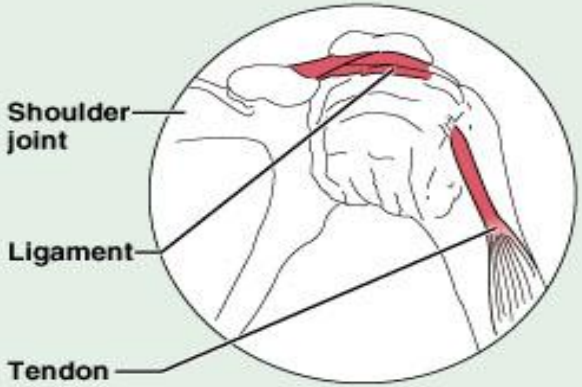
Photomicrograph: Dense irregular connective tissue from the dermis of the skin (400×).

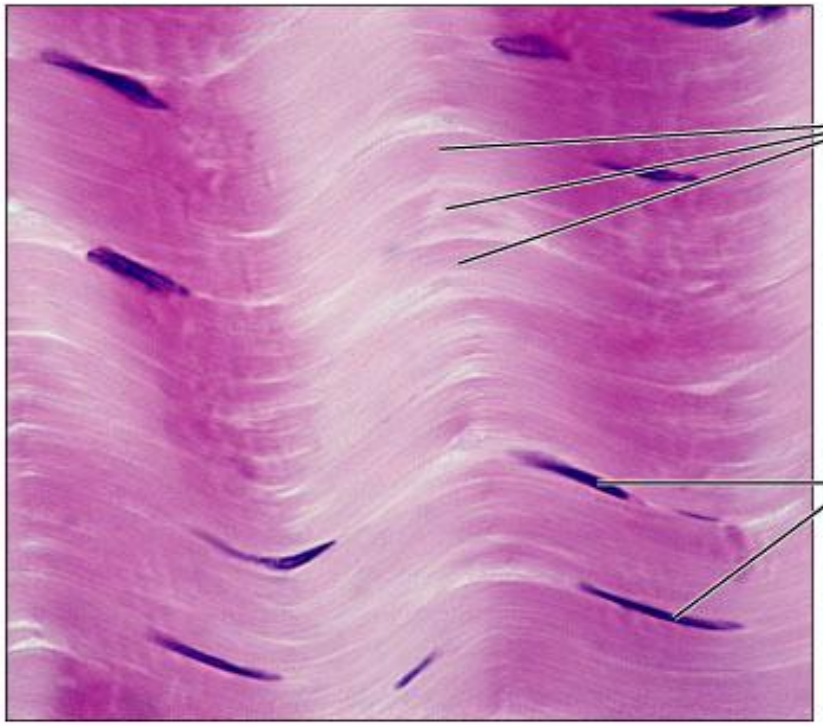
(f) Connective tissue proper: dense connective tissue, dense regular

Description: Primarily parallel collagen fibers; a few elastin fibers; major cell type is the fibroblast.

Function: Attaches muscles to bones or to muscles; attaches bones to bones; withstands great tensile stress when pulling force is applied in one direction.

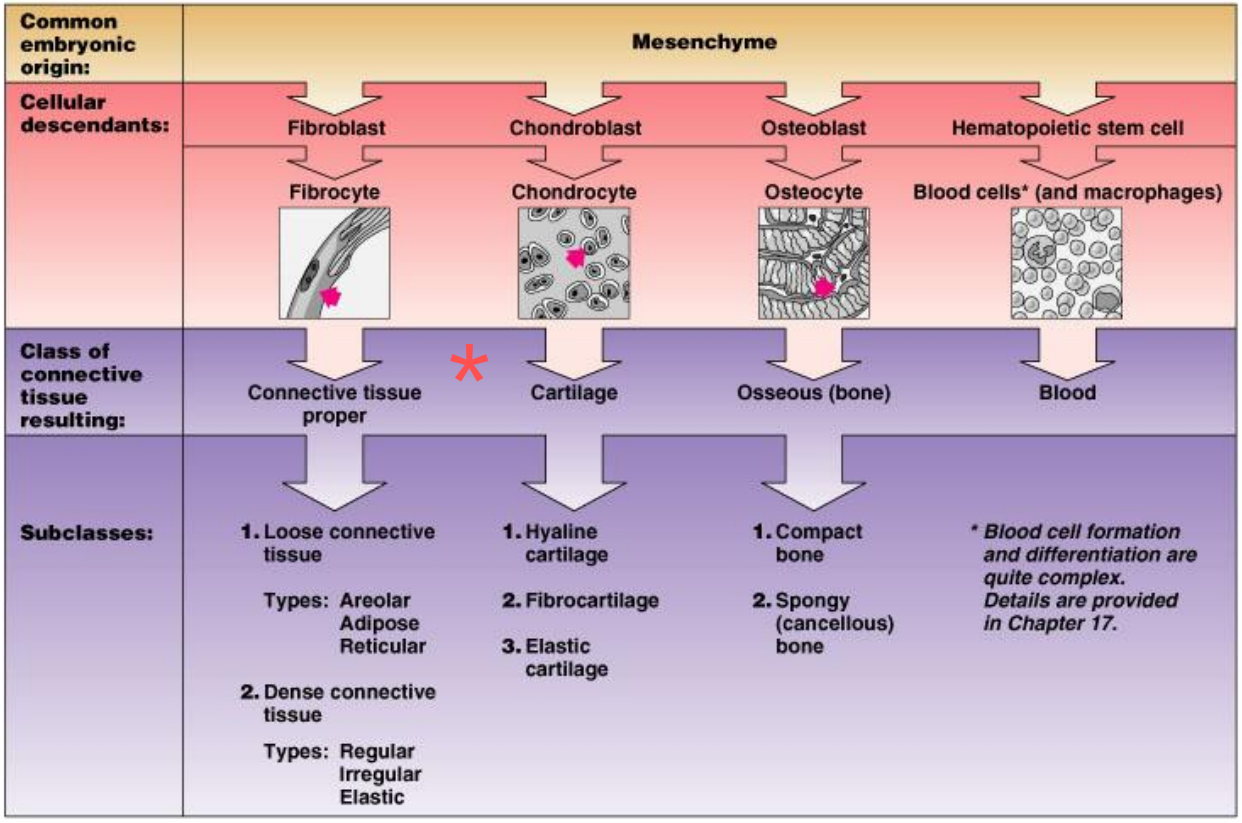
Location: Tendons, most ligaments, aponeuroses.





Photomicrograph: Dense regular connective tissue from a tendon (1000×).

Classes of Connective Tissue

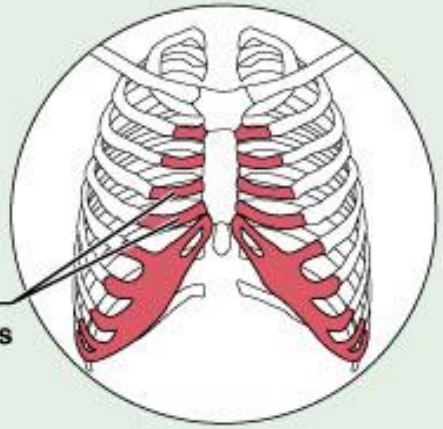


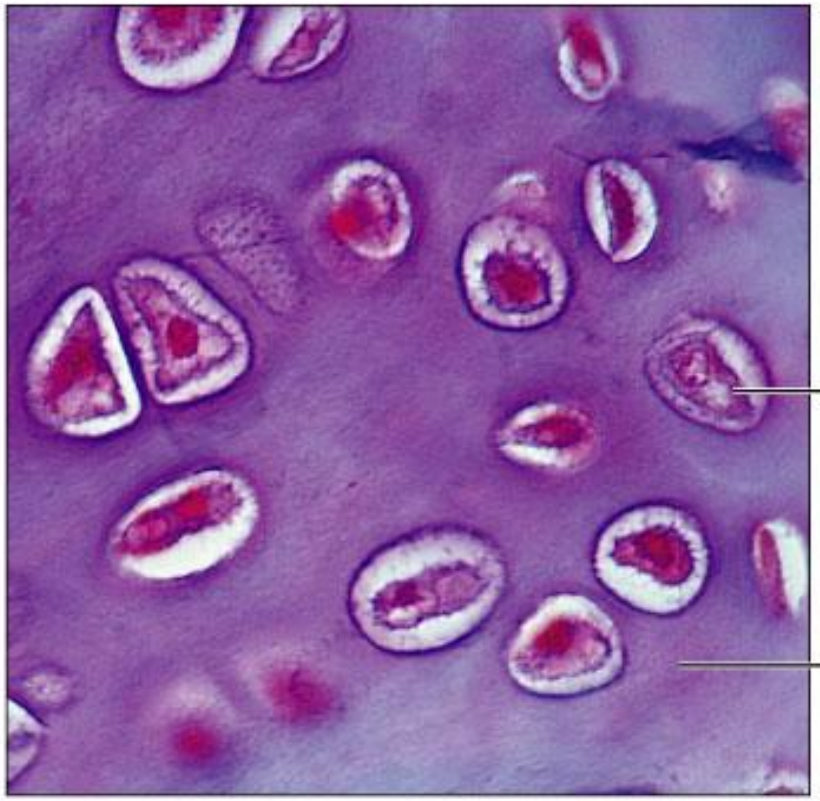
(g) Cartilage: hyaline

Description: Amorphous but firm matrix; collagen fibers form an imperceptible network; chondroblasts produce the matrix and when mature (chondrocytes) lie in lacunae.

Function: Supports and reinforces; has resilient cushioning properties; resists compressive stress.

Location: Forms most of the embryonic skeleton; covers the ends of long bones in joint cavities; forms costal cartilages of the ribs; cartilages of the nose, trachea, and larynx.





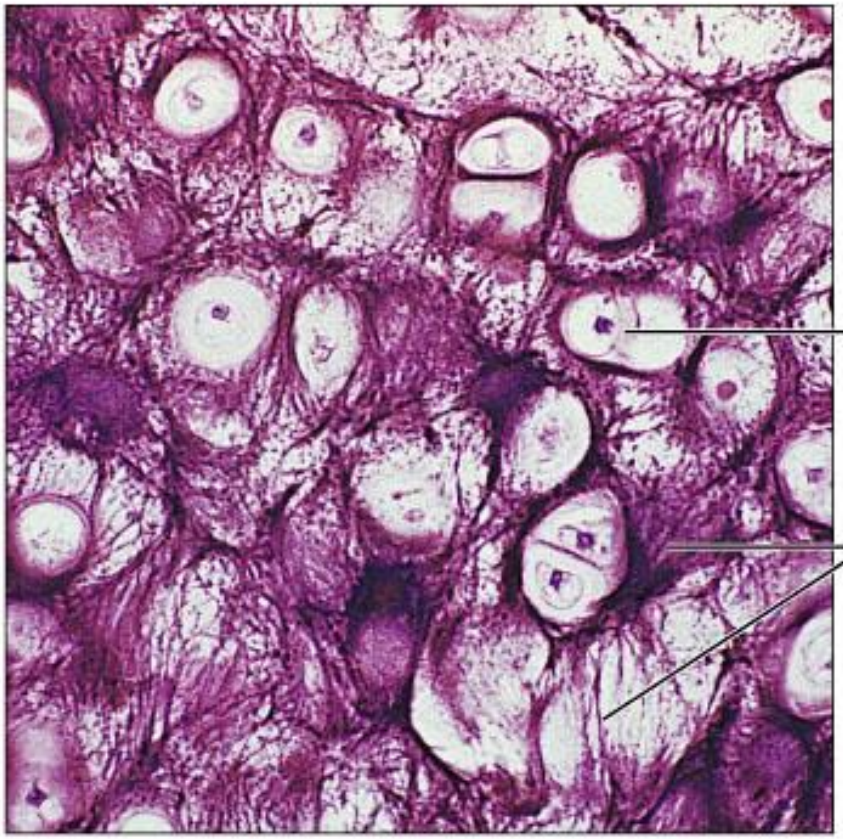
Photomicrograph: Hyaline cartilage from the trachea (300×).

(h) Cartilage: elastic

Description: Similar to hyaline cartilage, but more elastic fibers in matrix.

Function: Maintains the shape of a structure while allowing great flexibility.

Location: Supports the external ear (pinna); epiglottis.



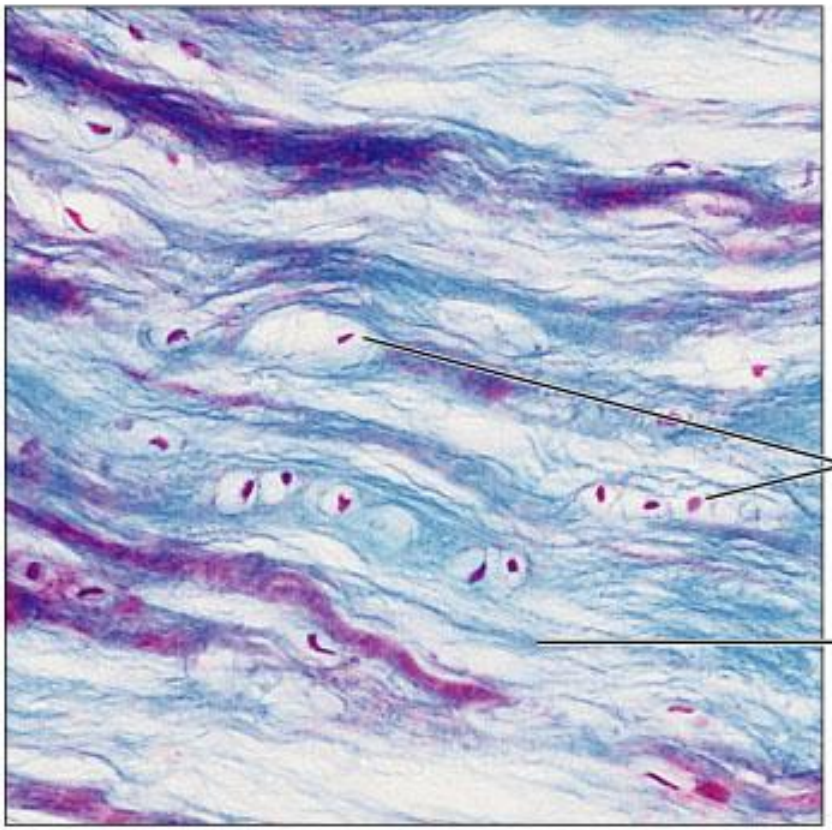
Photomicrograph: Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (400×).

(i) Cartilage: fibrocartilage

Description: Matrix similar to but less firm than that in hyaline cartilage; thick collagen fibers predominate.

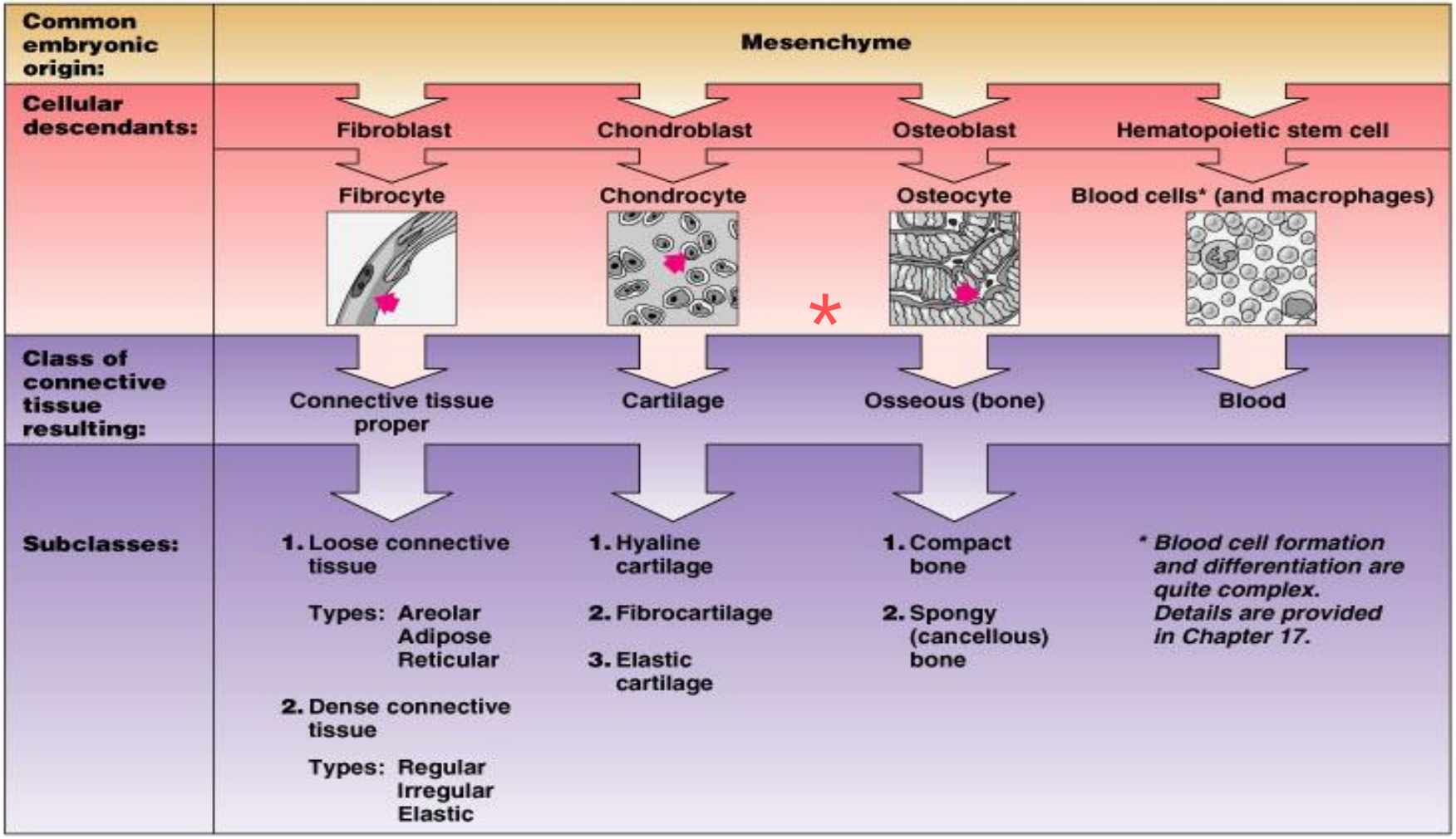
Function: Tensile strength with the ability to absorb compressive shock.

Location: Intervertebral discs; pubic symphysis; discs of knee joint.



Photomicrograph: Fibrocartilage of an intervertebral disc (200×).

Classes of Connective Tissue

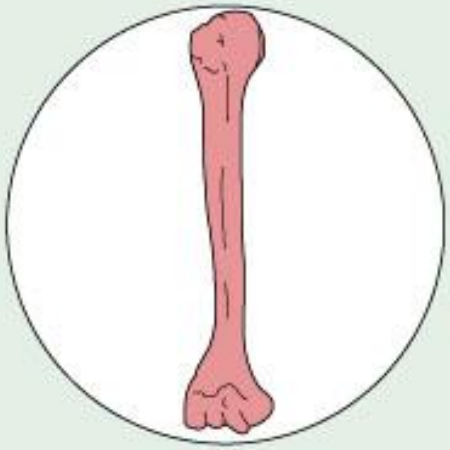


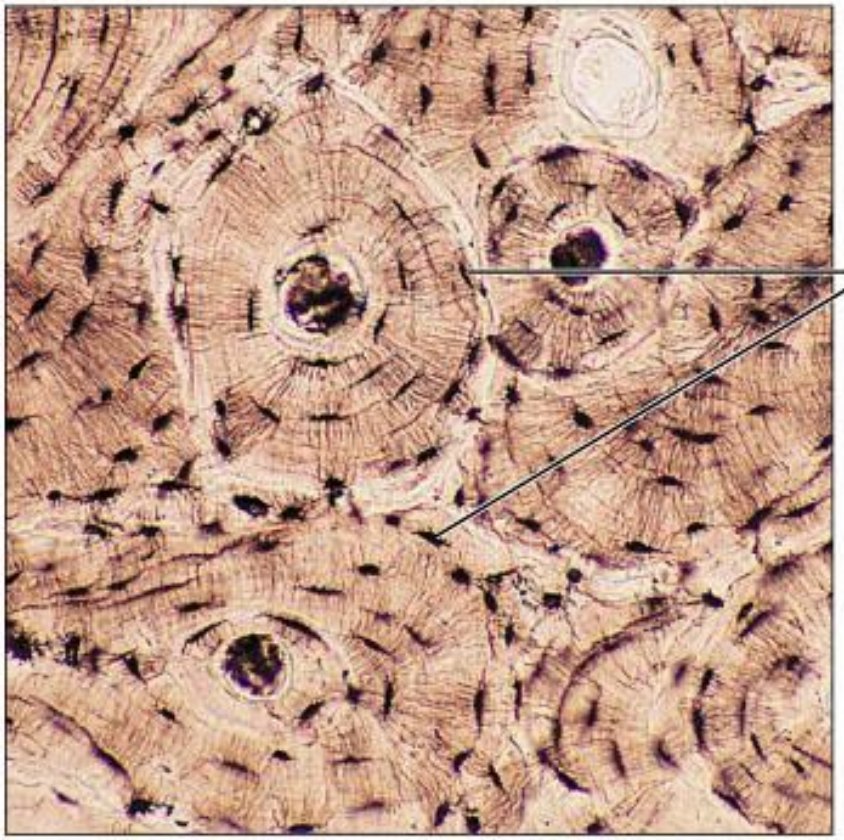
(j) Others: bone (osseous tissue)

Description: Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. Very well vascularized.

Function: Bone supports and protects (by enclosing); 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).

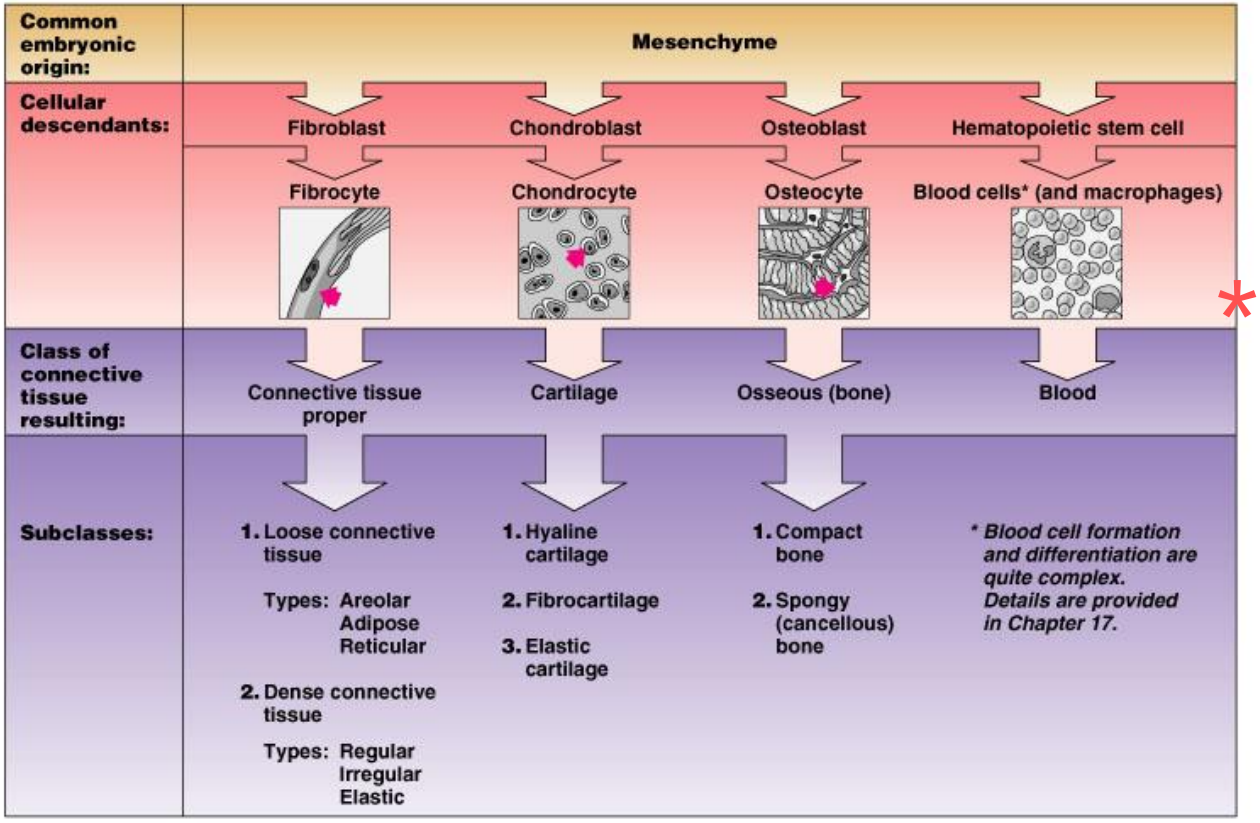
Location: Bones





Photomicrograph: Cross-sectional view of bone (70×).

Classes of Connective Tissue

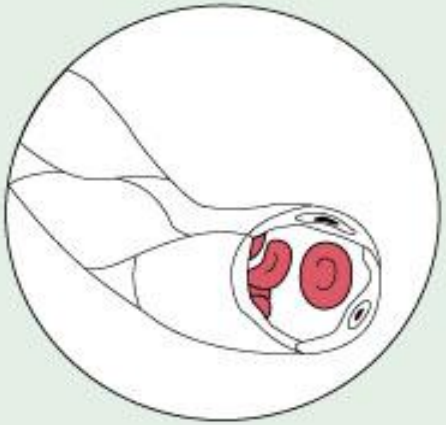


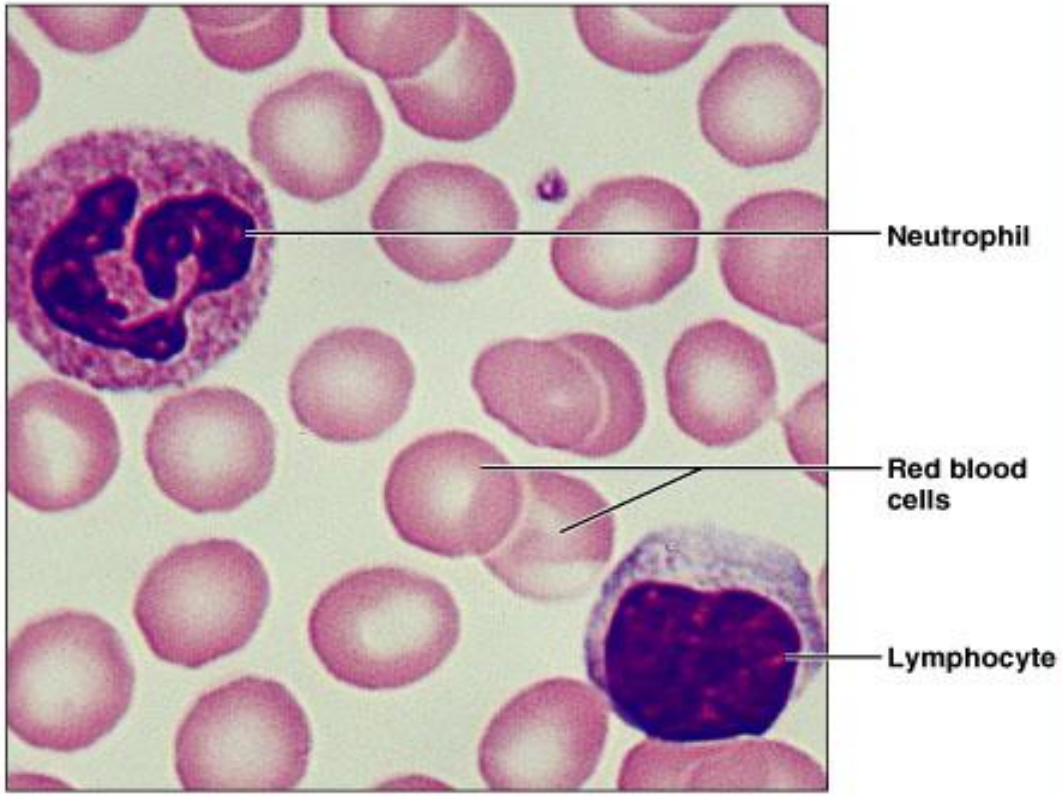
(k) Others: blood

Description: Red and white blood cells in a fluid matrix (plasma).

Function: Transport of respiratory gases, nutrients, wastes and other substances.

Location: Contained within blood vessels.

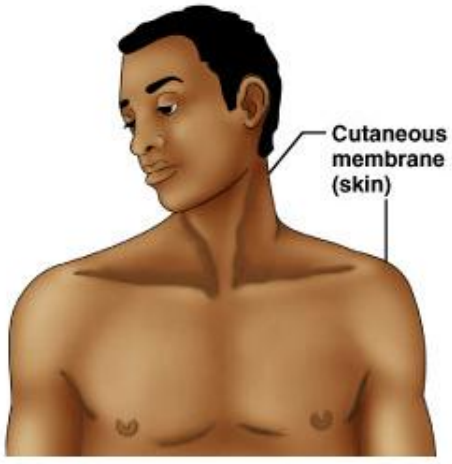




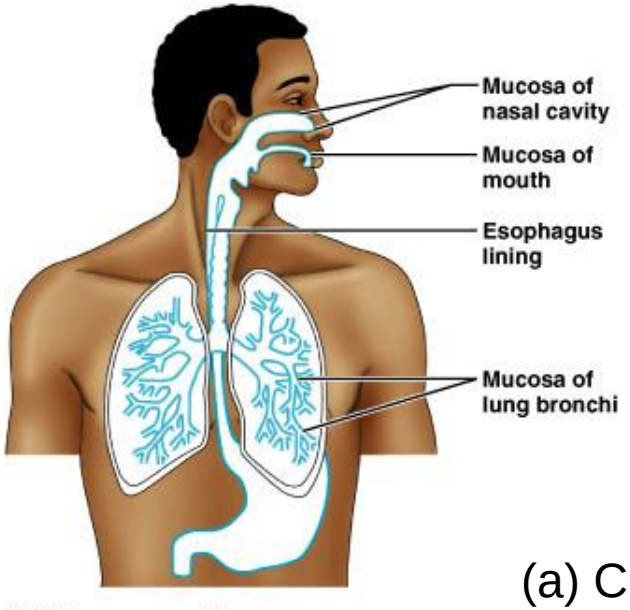
Photomicrograph: Smear of human blood (1500×); two white blood cells (neutrophil in upper left and lymphocyte in lower right) are seen surrounded by red blood cells.

Membranes that combine epithelial sheets plus underlying connective tissue proper (see next slide)

- Cutaneous membranes
  - Skin: epidermis and dermis
- Mucous membranes, or mucosa
  - Lines every hollow internal organ that opens to the outside of the body
- Serous membranes, or serosa
  - Slippery membranes lining the pleural, pericardial and peritoneal cavities
  - The fluid formed on the surfaces is called a transudate
- Synovial membranes
  - Line joints



(a) Cutaneous membrane

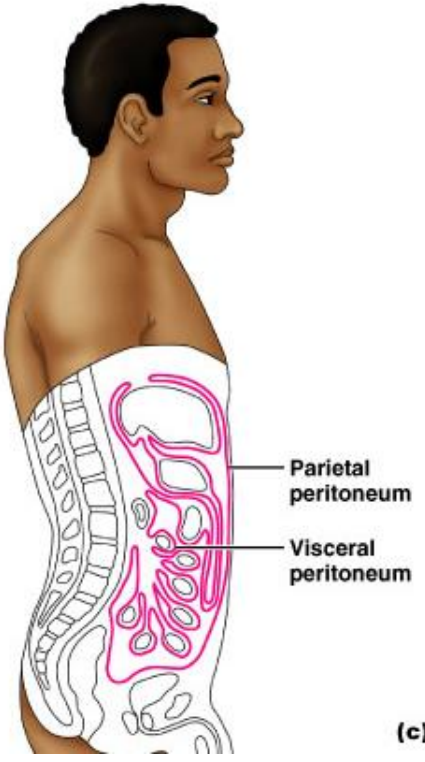


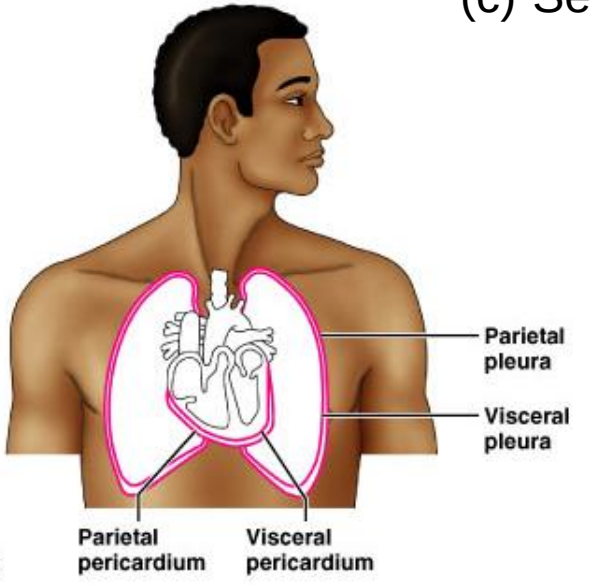
(b) Mucous membranes

(a) Cutaneous membrane

(b) Mucous membrane

(c) Serous membrane





(c) Serous membranes

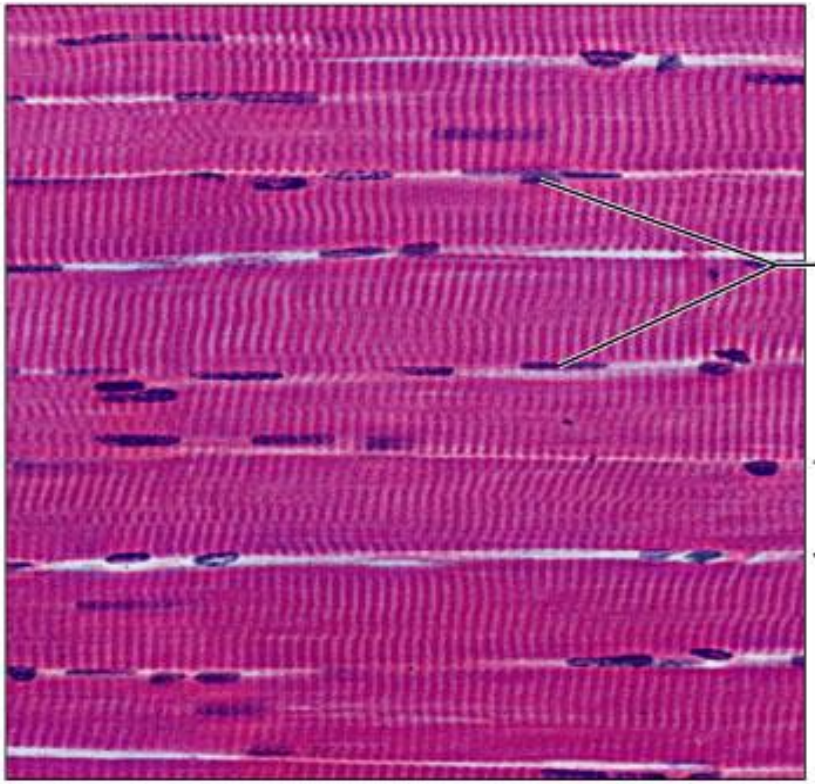
- Four basic types of tissue
  - Epithelium
  - Connective tissue
  - Muscle tissue
    - Skeletal
    - Cardiac
    - Smooth
  - Nervous tissue

(a) Skeletal muscle

Description: Long, cylindrical, multinucleate cells; obvious striations.

Function: Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

Location: In skeletal muscles attached to bones or occasionally to skin.



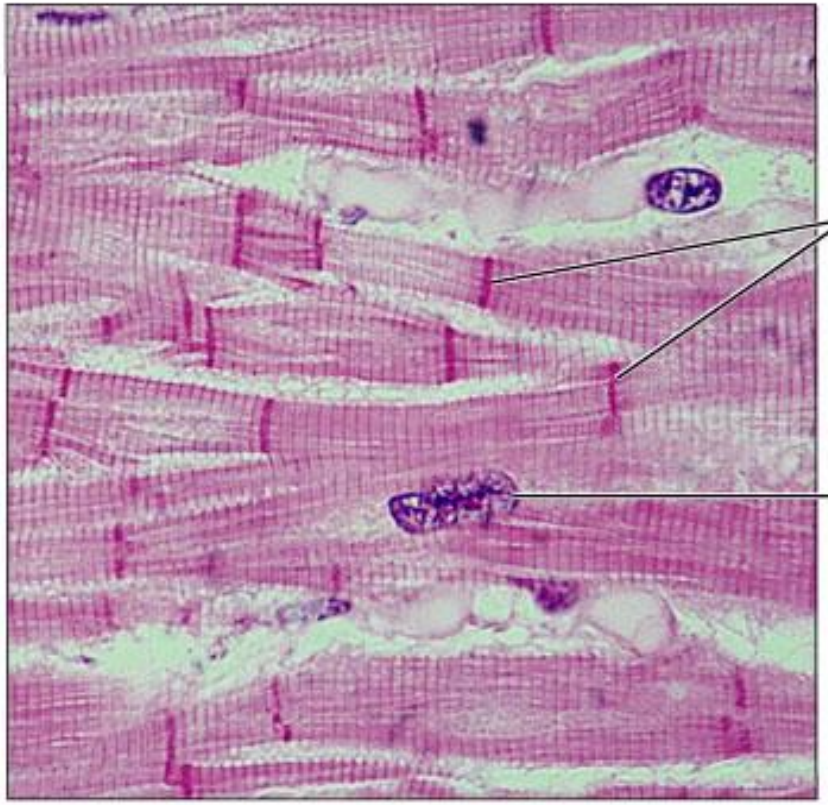
Photomicrograph: Skeletal muscle (approx. 300×). Notice the obvious banding pattern and the fact that these large cells are multinucleate.

(b) Cardiac muscle

Description: Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).

Function: As it contracts, it propels blood into the circulation; involuntary control.

Location: The walls of the heart.



Photomicrograph: Cardiac muscle (800×); notice the striations, branching of cells, and the intercalated discs.

(c) Smooth muscle

Description: Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.

Function: Propels substances or objects (foodstuffs, urine, a baby) along internal passageways; involuntary control.

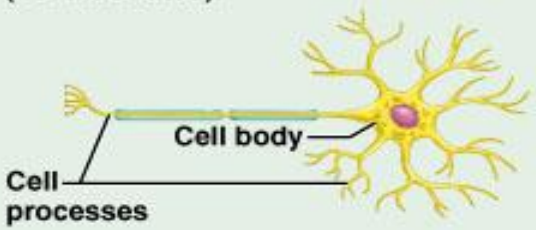
Location: Mostly in the walls of hollow organs.

Photomicrograph: Sheet of smooth muscle (approx. 600×).

- Four basic types of tissue
  - Epithelium
  - Connective tissue
  - Muscle tissue
  - Nervous tissue
    - Neurons
    - Supporting cells

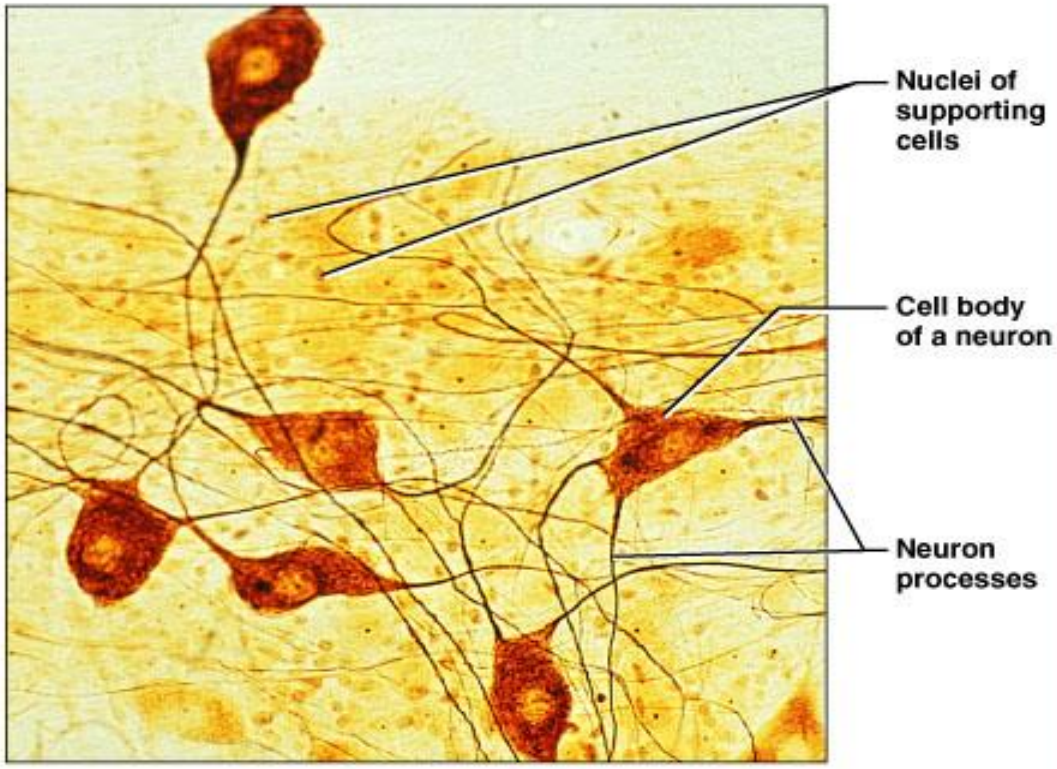
Nervous tissue

Description: Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body; also contributing to nervous tissue are nonirritable supporting cells (not illustrated).



Function: Transmit electrical signals from sensory receptors and to effectors (muscles and glands) that control their activity.

Location: Brain, spinal cord, and nerves.



Photomicrograph: Neurons (100×)