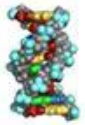
Tissues and cell types

Alexandra Stayer-Harci

The levels of organization

Level of Organization	Explanation	Example
 Atomic Level	Atoms are defined as the smallest unit of an element that still maintains the property of that element.	Carbon, Hydrogen, Oxygen
 Molecular Level	Atoms combine to form molecules which can have entirely different properties than the atoms they contain.	Water, DNA, Carbohydrates
 Cellular Level	Cells are the smallest unit of life. Cells are enclosed by a membrane or cell wall and in multicellular organisms often perform specific functions.	Muscle cell, Skin cell, Neuron
 Tissue Level	Tissues are groups of cells with similar functions	Muscle, Epithelial, Connective
 Organ Level	Organs are two or more types of tissues that work together to complete a specific task.	Heart, Liver, Stomach
 Organ System Level	An organ system is group of organs that carries out more generalized set of functions.	Digestive System, Circulatory System
 Organismal Level	An organism has several organ systems that function together.	Human

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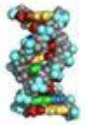 Molecular Level	Atoms combine to form molecules which can have entirely different properties than the atoms they contain.	Water, DNA, Carbohydrates
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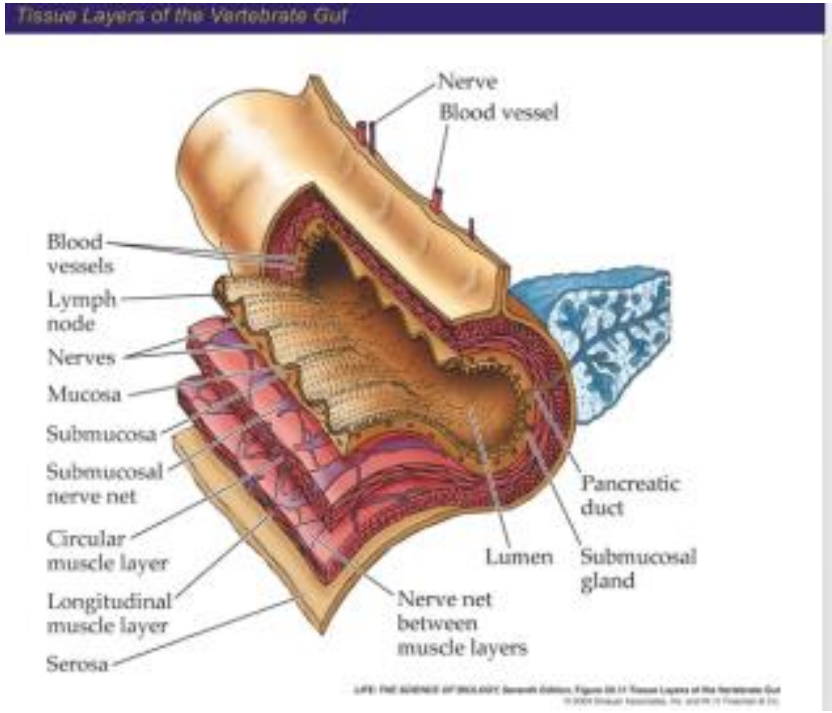
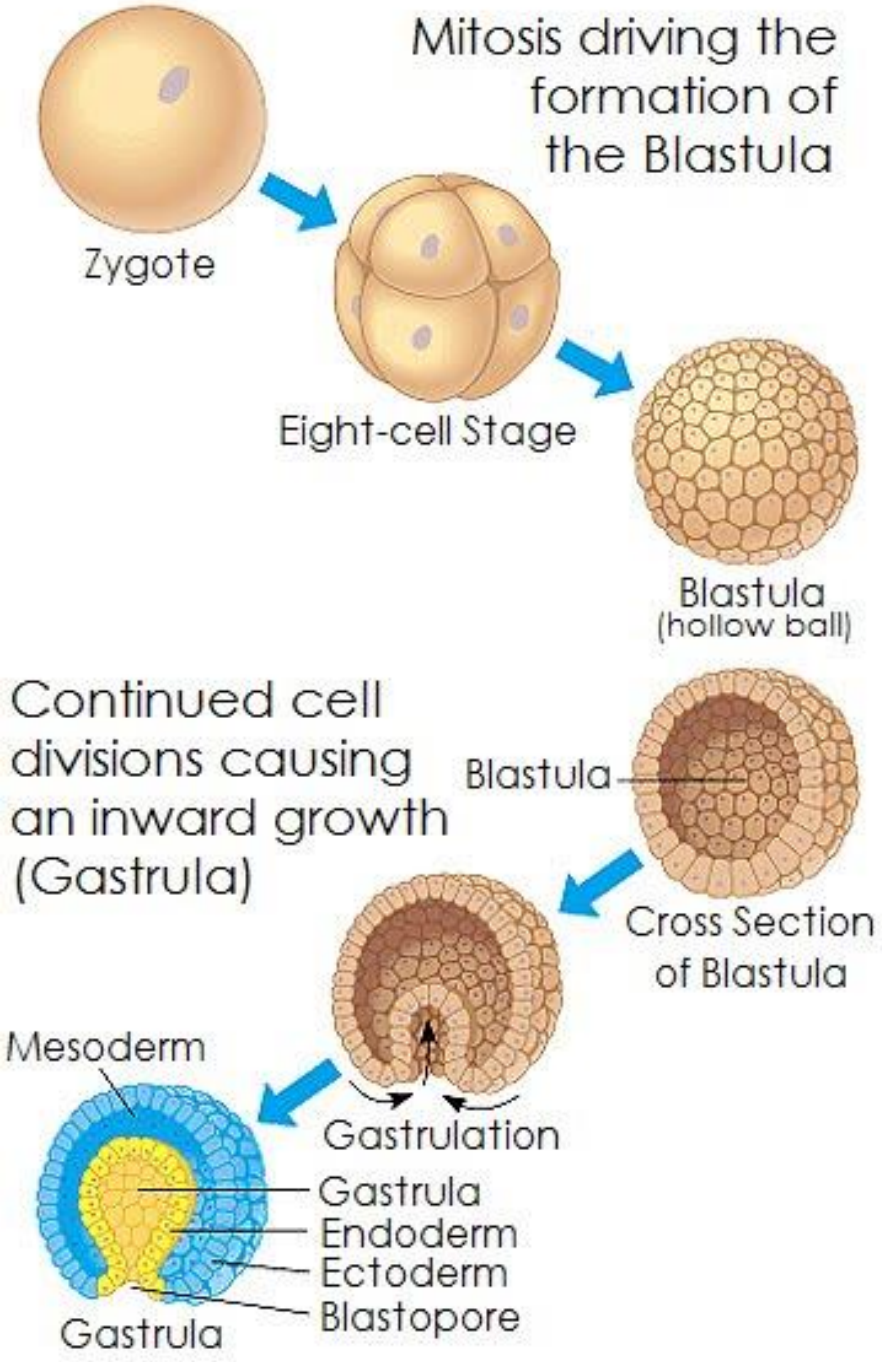
Tissue

- cellular organizational level between cells and a complete organ
- similar cells and their extracellular matrix → carry out a specific function
- organs: are formed by the functional grouping together of multiple tissues



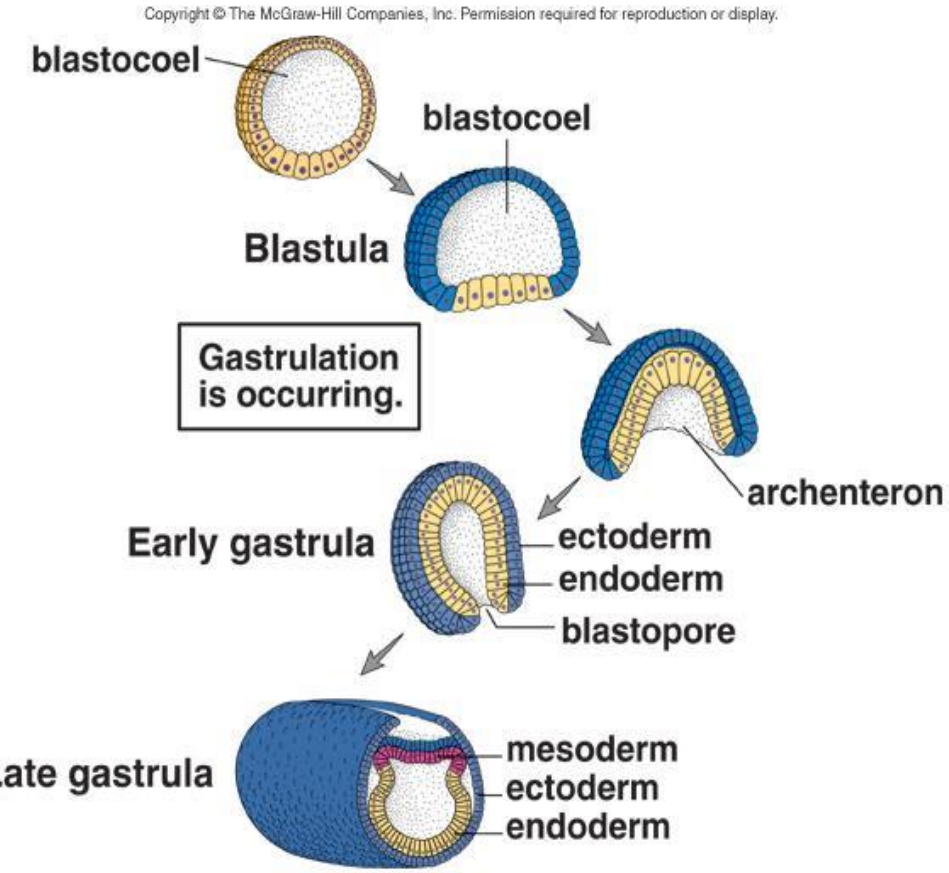
Gastrulation

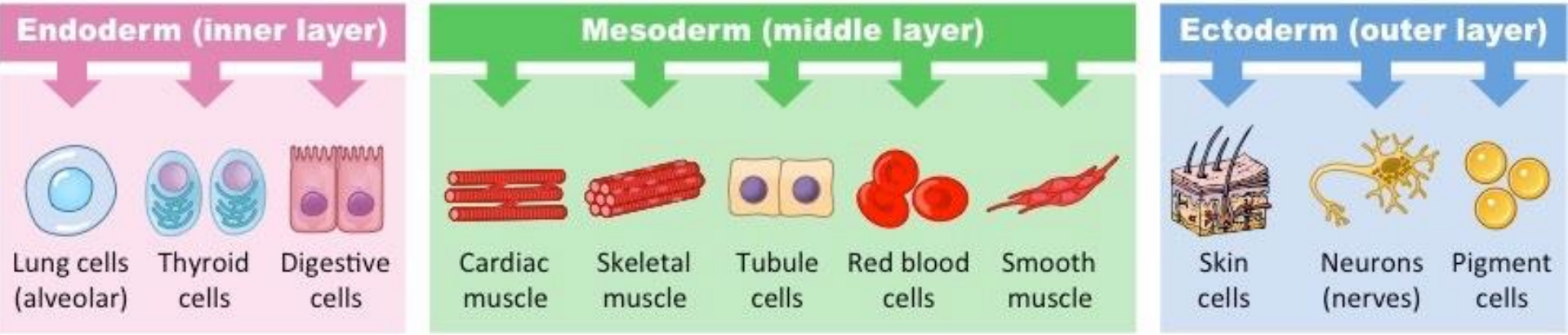
Fertilization → cell divisions → blastula → gastrula → formation of 3 germ layers



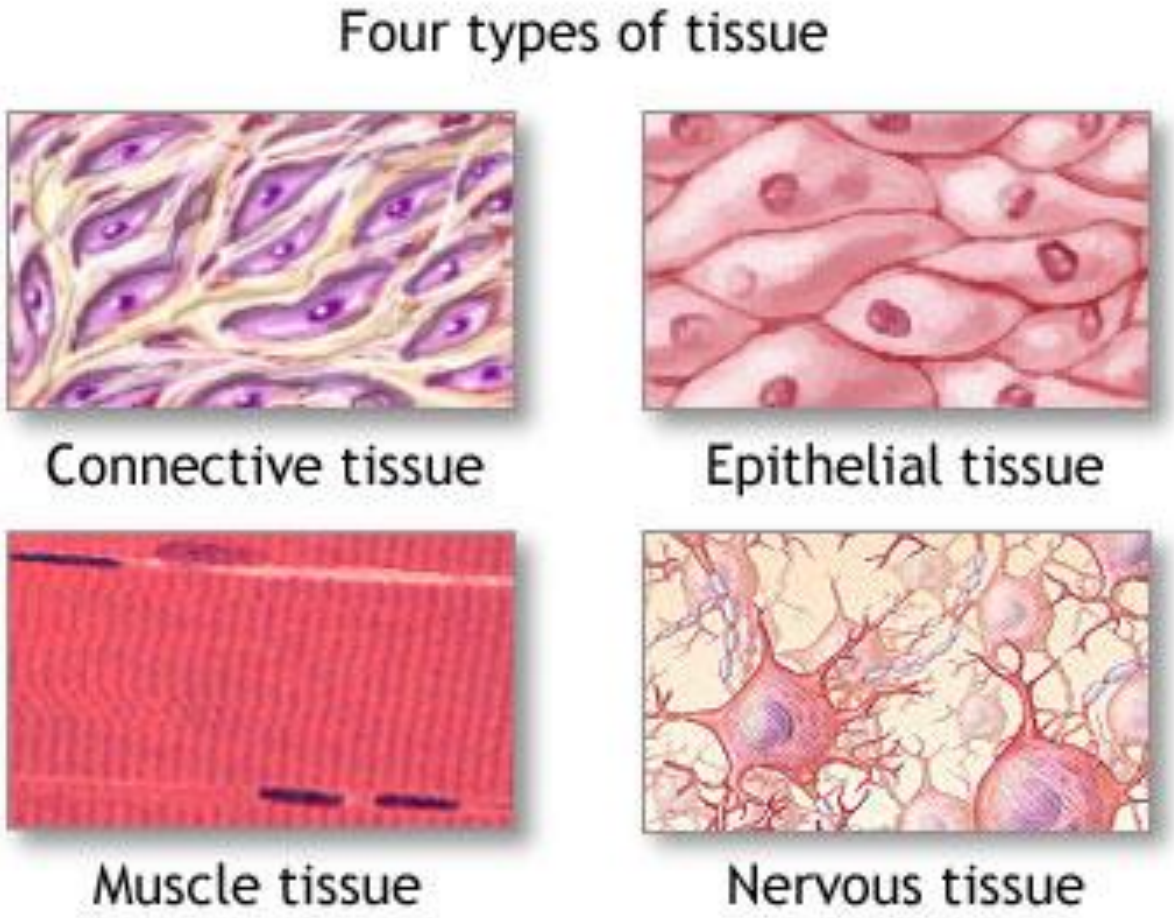
Germ layers are formed:

1. **Ectoderm**: the outer layer → forms the exoskeleton
2. **Mesoderm**: layer between the endoderm and the ectoderm → develops into organs
3. **Endoderm**: the innermost layer → forms the inner lining of organs





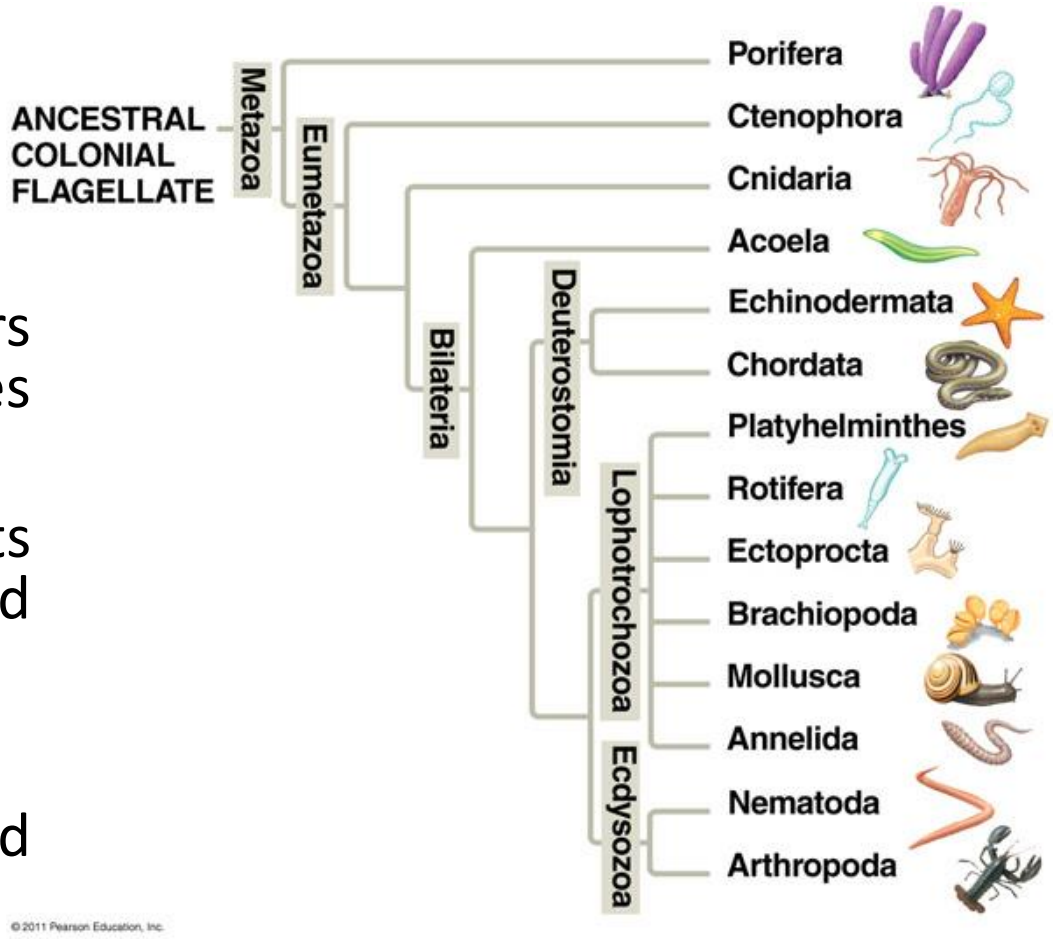
Animal and human tissues



Types of tissues

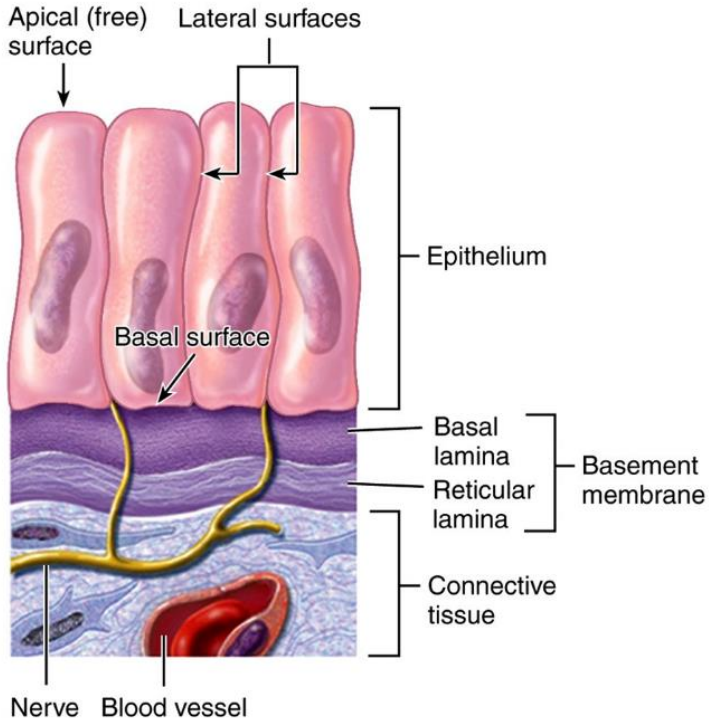
All eumetazoans (animals more complex than the sponge) contain four tissue types:

- **Epithelial tissue**: covers external and internal surfaces of the body; secretory glands
- **Connective tissue**: protects and supports other tissues and various organs
- **Muscle tissue**: movement
- **Nervous tissue**: collects and analyzes informations



1. Epithelial tissues

- covering or lining of all internal and external body surfaces
- is derived from the ectoderm or endoderm
- usually very thin, one or more layers
- cells are tightly packed together
- no intercellular spaces and only a small amount of extracellular matrix
- is avascular (no blood vessels)
- is usually (regardless of the type) separated from the underlying tissue by a basement membrane
- protection, secretion, and absorption



1. Epithelial tissues

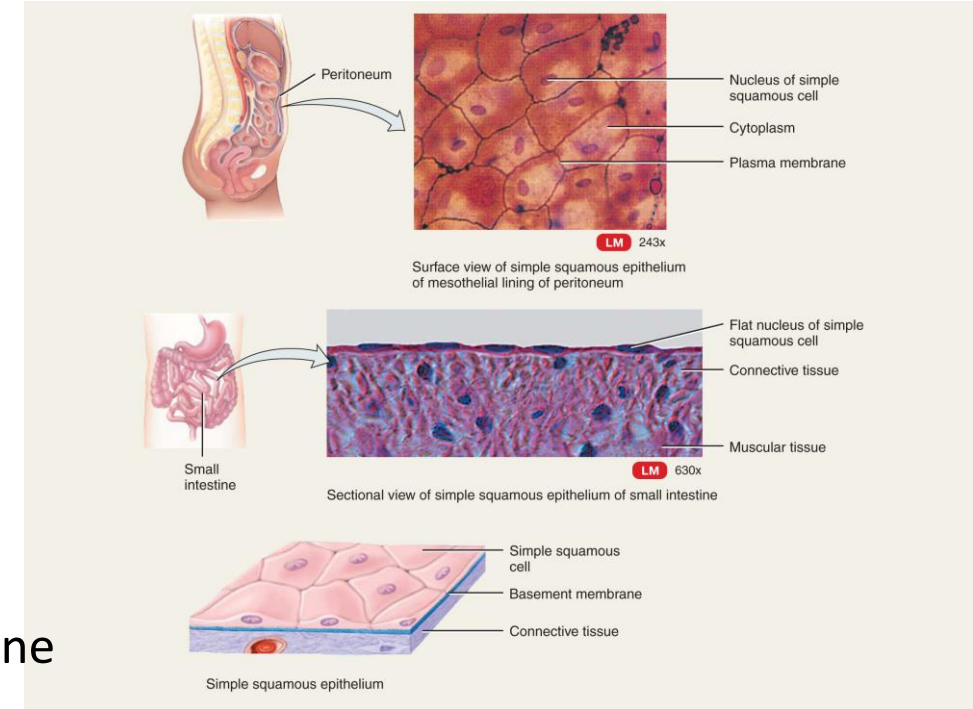
Classification:

- ***according to the function:*** lining, glandular, sensory, absorptive
- ***according to the shape:*** squamous, cuboidal, columnar (ciliated)
- ***according to the layers:*** one or more

1. Epithelial tissues

I. Lining (surface) epithelial tissue: can be divided into two groups depending on the number of layers

a) simple epithelium: is only **one** cell thick

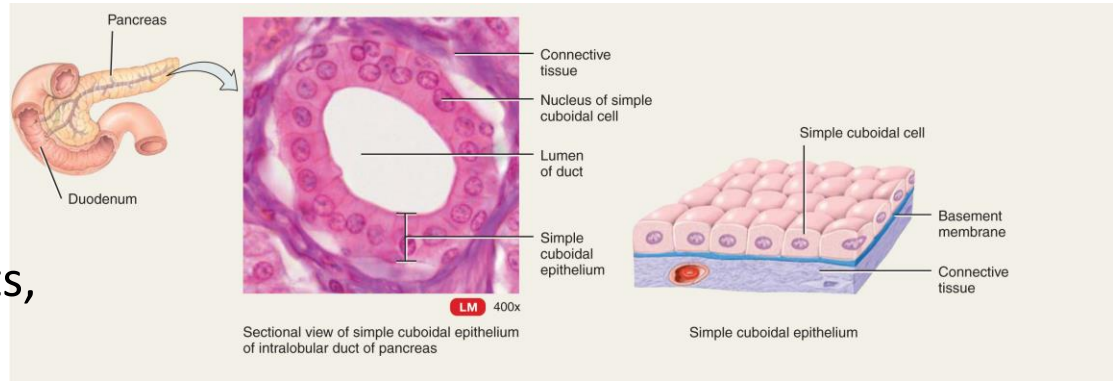


Squamous:

-single layer of flattened cells

-allow passage of materials, secretes lubricating substances

-location: kidney glomeruli, air sacs of lungs, blood vessels, small intestine



Cuboidal:

-single layer of cube-like cells

-secretion and absorption

-location: kidney tubules, ducts, ovary surface

1. Epithelial tissues

I. Lining (surface) epithelial tissue:

a) simple epithelium: is only **one** cell thick

<u>Columnar:</u>

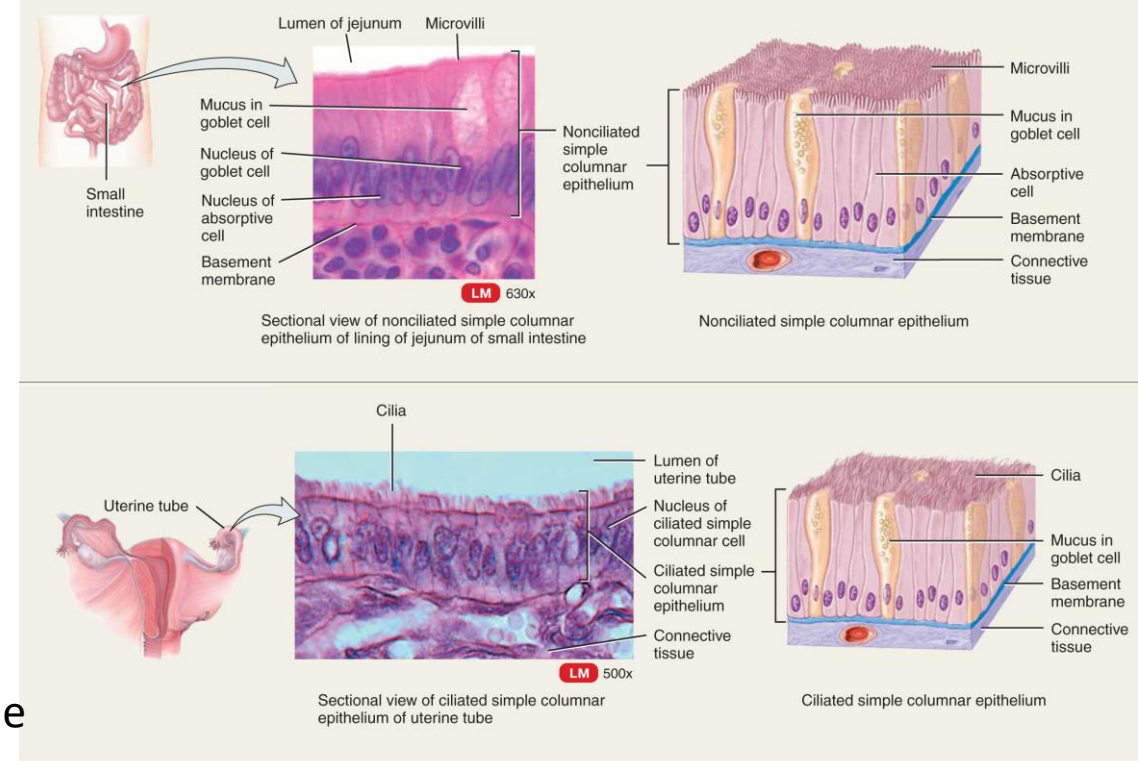
-single layer of tall cells

-some cells have cilia

-absorbtion, secretion of mucus

-location:

- *nonciliated*-digestive tract, gallblader
- *ciliated*-small bronchi, uterine tubes



1. Epithelial tissues

I. Lining (surface) epithelial tissue:

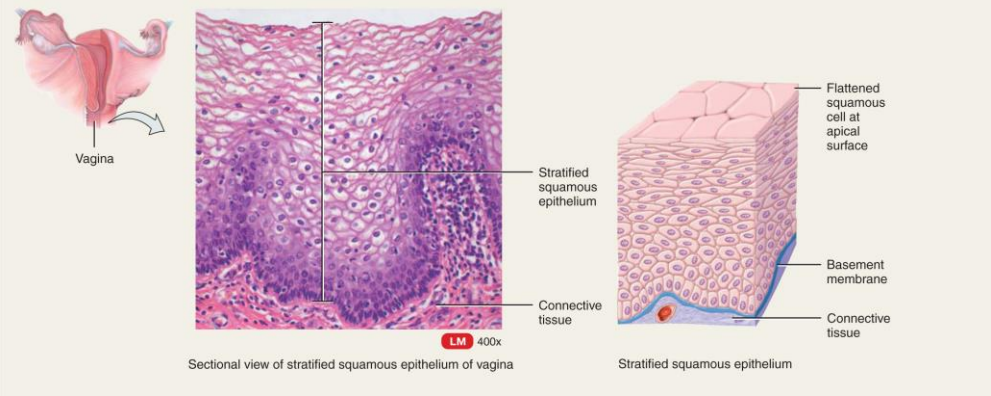
b)stratified epithelium: is **two or more** cells thick

<u>Squamous:</u>

-basal cells are cuboidal or columnar, surface cells are flattened

-protects underlayig tissues

-location: esophagus, mouth, vagina, urethra, anus, skin

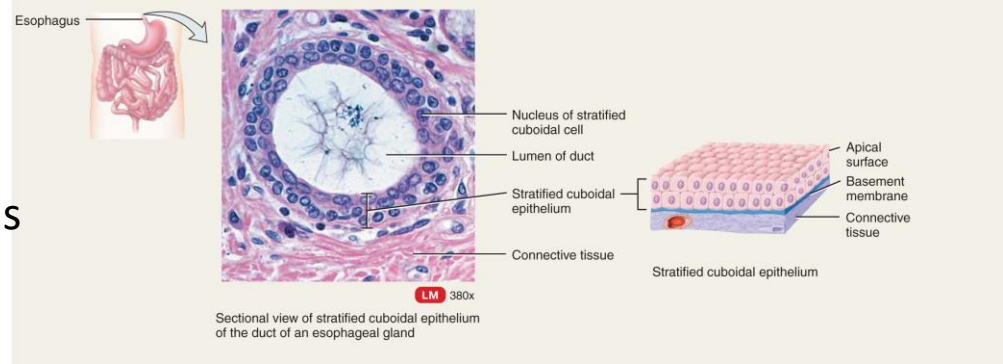


<u>Cuboidal:</u>

-generally two layers of cubelike cells

-protection

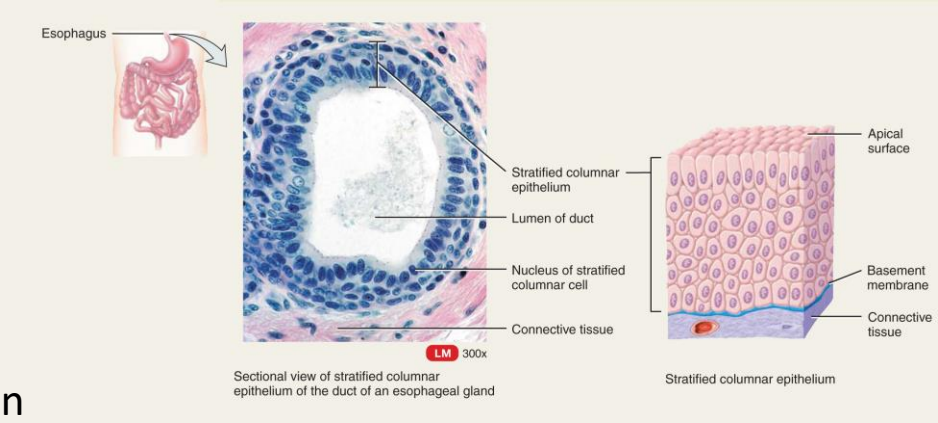
-location: largest ducts of sweatglands, mammary and salivary glands



1. Epithelial tissues

I. Lining (surface) epithelial tissue:

b) stratified epithelium: is **two or more** cells thick



Columnar:

-basal cells are usually cuboidal, surface cells are columnar

-protection and secretion

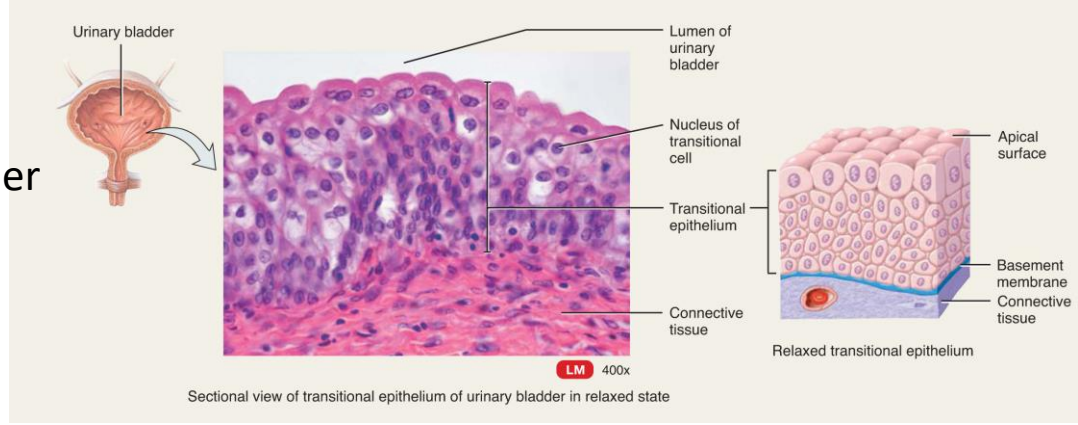
-location: rare in the body, small amount in male urethra and in large ducts of some glands

Transitional:

-basal cells are cube-like or columnar, surface cells squamous-like

-when stretched, they can change shape

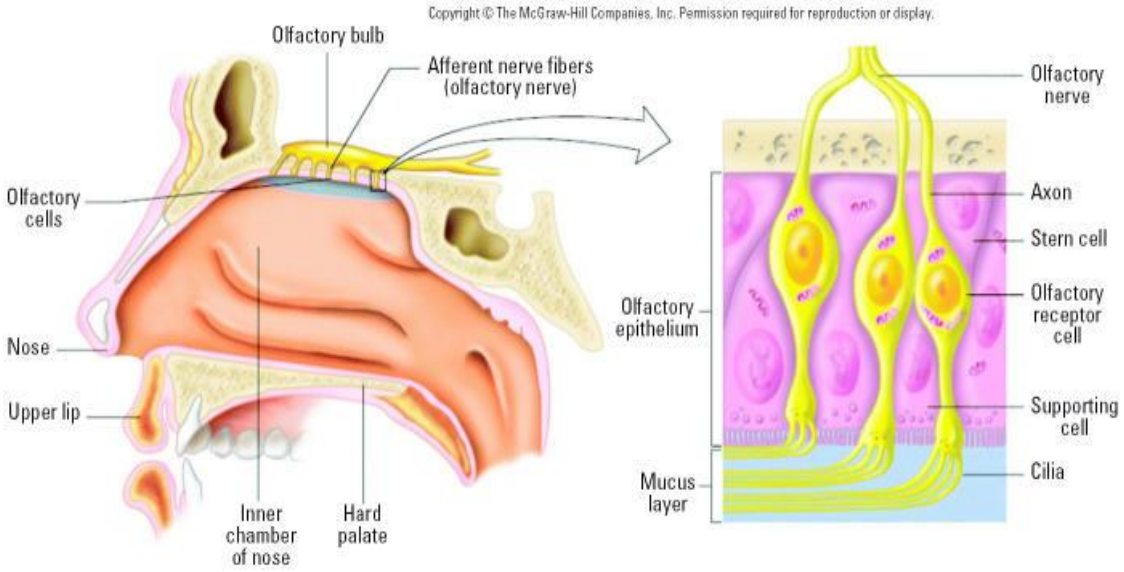
-location: lines the ureters, bladder

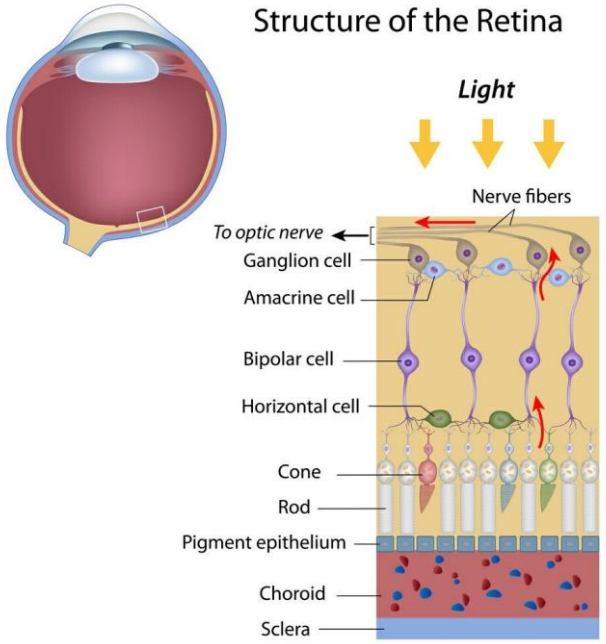


1. Epithelial tissues

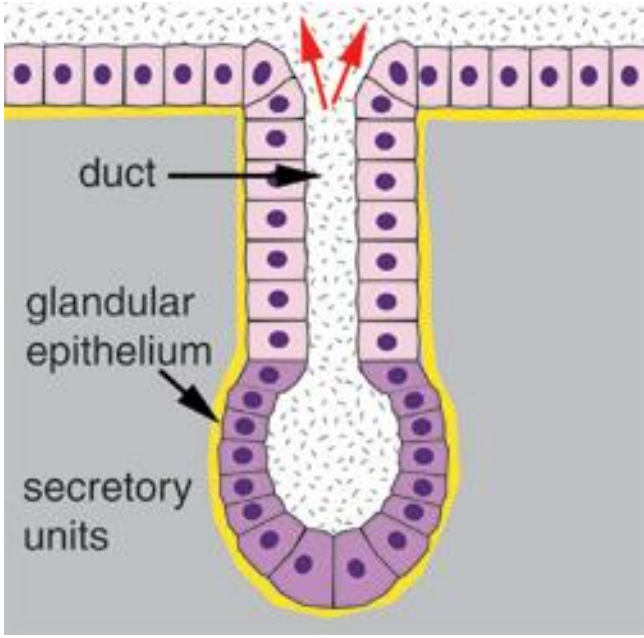
II. Sensory epithelia

- is specialized to serve as sensor for reception of external stimuli
- the sensory tissues of the nose, the ears, tongue and the eyes





1. Epithelial tissues

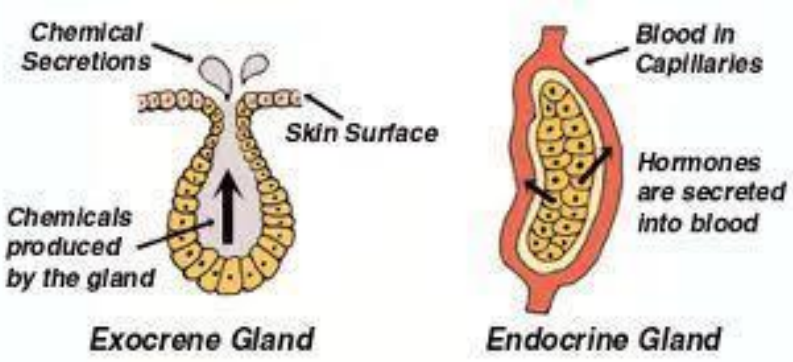


III. Glandular epithelia

- is specialized for secretion
- they form invaginations
- two parts: secretory units and ducts

Two major classifications of glands:

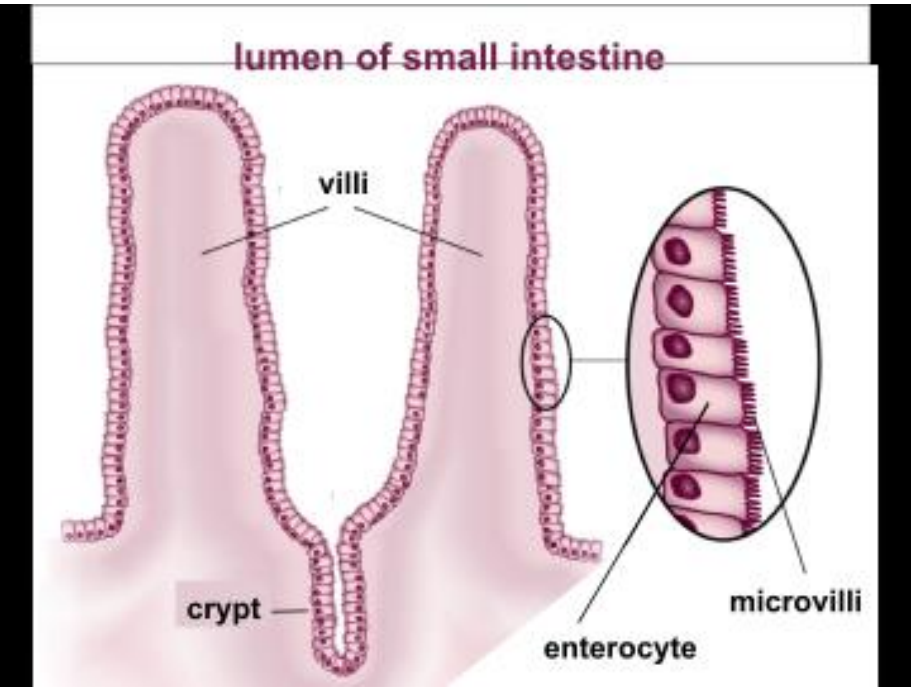
- endocrine glands → secrete their product into the blood
- exocrine glands→ secrete their products into the lumen of an organ or onto the free

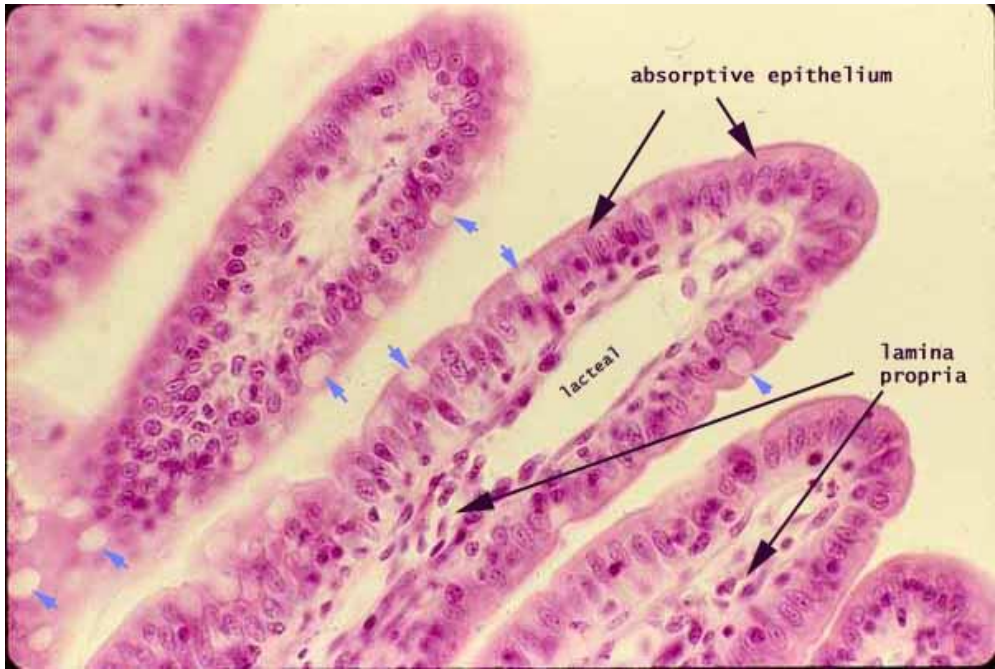


1. Epithelial tissues

IV. Absorptive epithelia

- cells are specialized for uptake of substances
- they have microvilli → to increase the surface
- location: lumen of the small intestine and colon



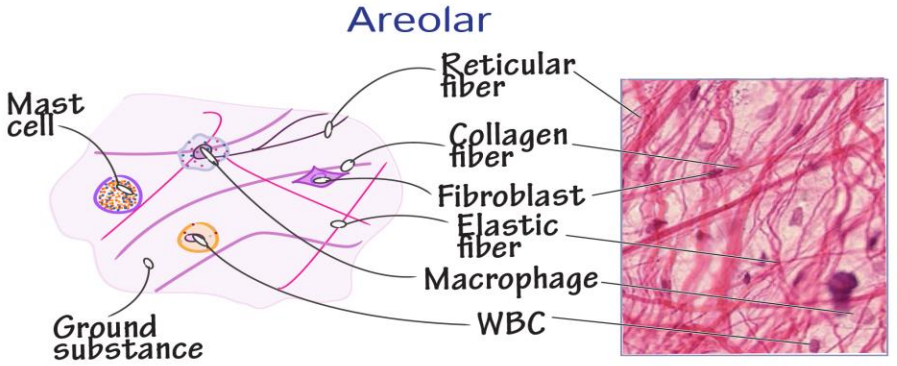


2. Connective tissues

- most diverse of the tissue categories
- develops from the middle layer of the embryo (mesoderm)
- between other tissues everywhere in the body
- support and protect the body and organs → form an architectural framework of the musculoskeletal system
- are immersed in the body water
- is vascular, and most also have nervous innervation

2. Connective tissues

- **Three** main components:
  - **Fibers:**
    - *Elastic*-: for elasticity; Allow organs like arteries and lungs to recoil
    - *Collagenous*-: for strenght; Bind bones and other tissues to each other
    - *Reticular fibers*: Form a scaffolding for other cells
  - **Ground substance**: gel-like, secreted by fibroblasts, primarily composed of water, glycosaminoglycans (GAGs)
  - **Cells**:
    - Fibroblasts
    - Macrophages
    - Mast cells
    - Adipocytes
    - White blood cells
    - Plasma cells

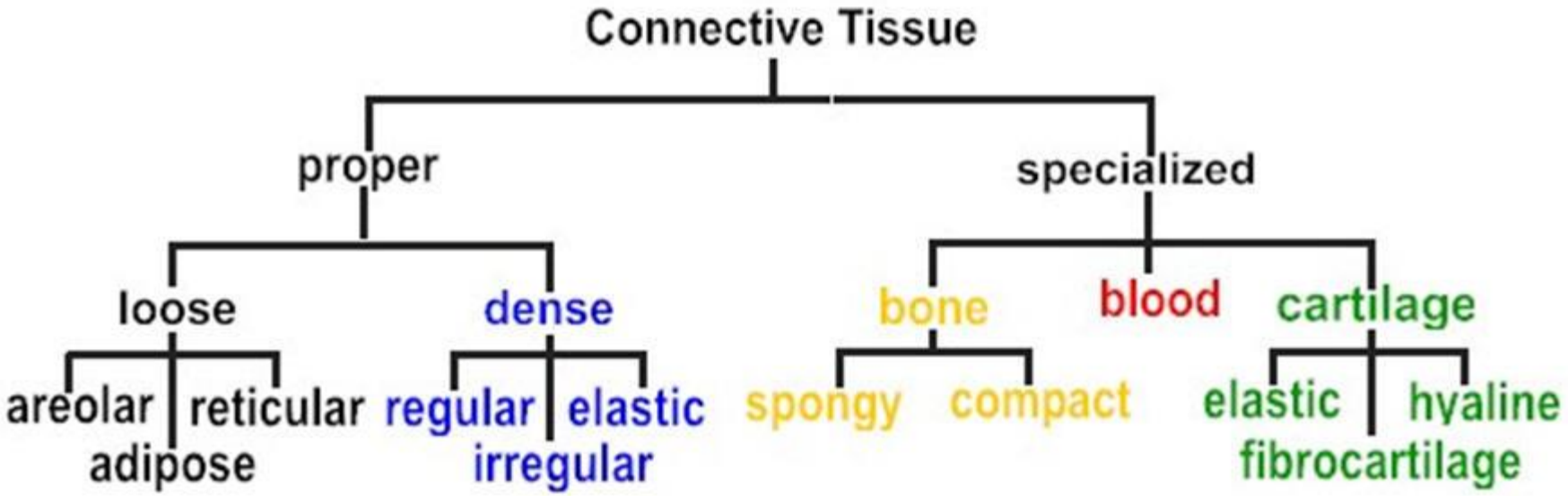


2. Connective tissues

Classification:

I. **Connective Tissue Proper**: encompasses organs and body cavities, connecting epithelial tissues to other underlaying tissues, holds organs in place, surrounds vessels and nerves

II. **Specialized Connective Tissues**: this group includes cartilage, bone (skeletal framework), and blood (transport)



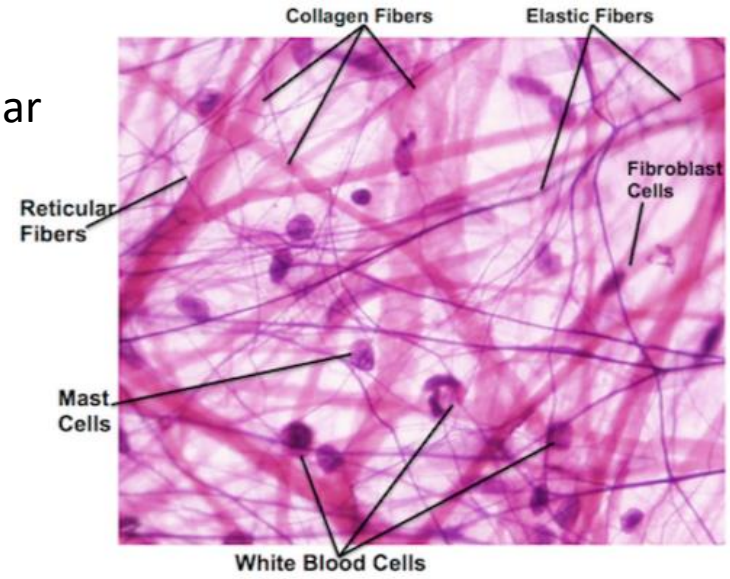
2. Connective tissues

I. Connective Tissue Proper

A. *Connective tissue proper-loose*: fewer fibers, more ground substance

1. Areolar (Loose) Connective Tissue

- is the most widespread connective tissue
- forms a loose network between the intercellular material
- consists of fibers and cells embedded in a gel-like ground substance
- attaches the skin to the underlying tissue, surrounds and supports the blood vessels, nerves and organs and fills the spaces between organs



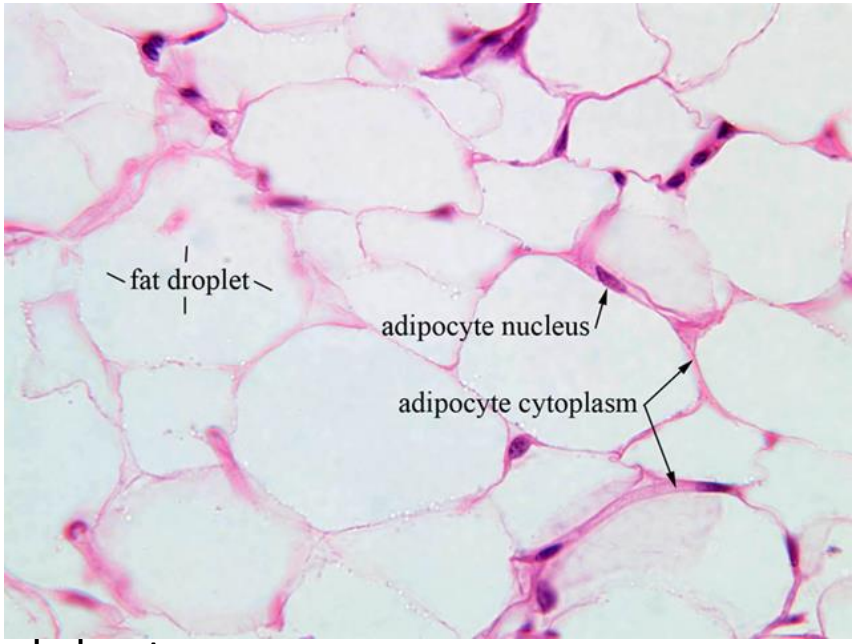
2. Connective tissues

I. Connective Tissue Proper

A. *Connective tissue proper-loose*: fewer fibers, more ground substance

2. Adipose Connective Tissue

- the cells (=adipocytes) store fats as a large internal fat droplet
- the cytoplasm is reduced, the nucleus is on the periphere
- storage site for fats
- protection of organs
- regulation of body temperature
- major endocrine organ: produces hormones such as leptin, estrogen, etc.
- white adipose tissue (WAT): stores energy
- brown adipose tissue (BAT): generates body heat



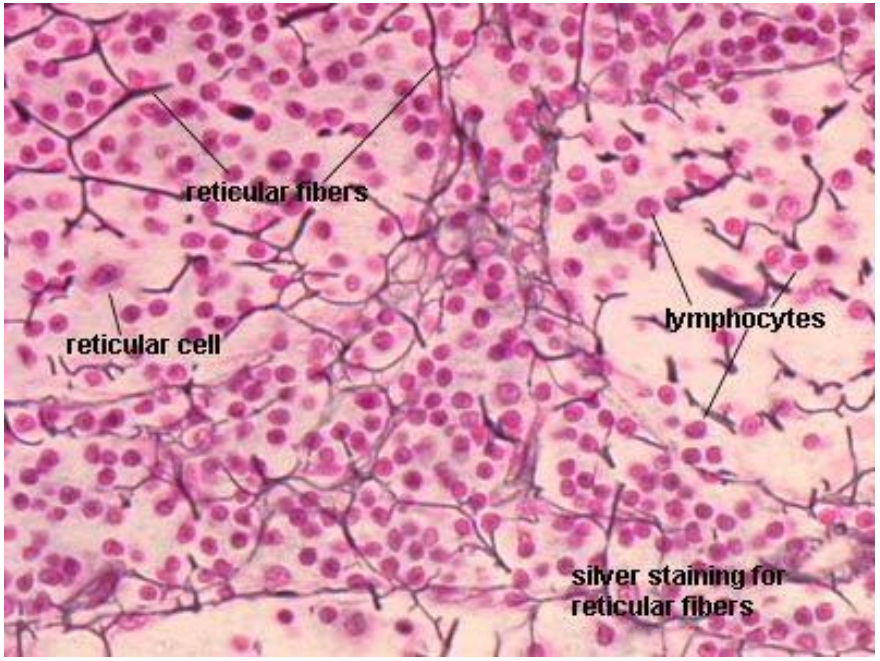
2. Connective tissues

I. Connective Tissue Proper

A. *Connective tissue proper-loose*: fewer fibers, more ground substance

3. Reticular Connective Tissue

- a network of thin brunching reticular fibers (made of type III collagen) and reticular cells
- around the kidney, spleen, lymph nodes, and in bone marrow
- the fibers form a soft skeleton (stroma) to support the lymphoid organs (lymph node stromal cells, red bone marrow and spleen).

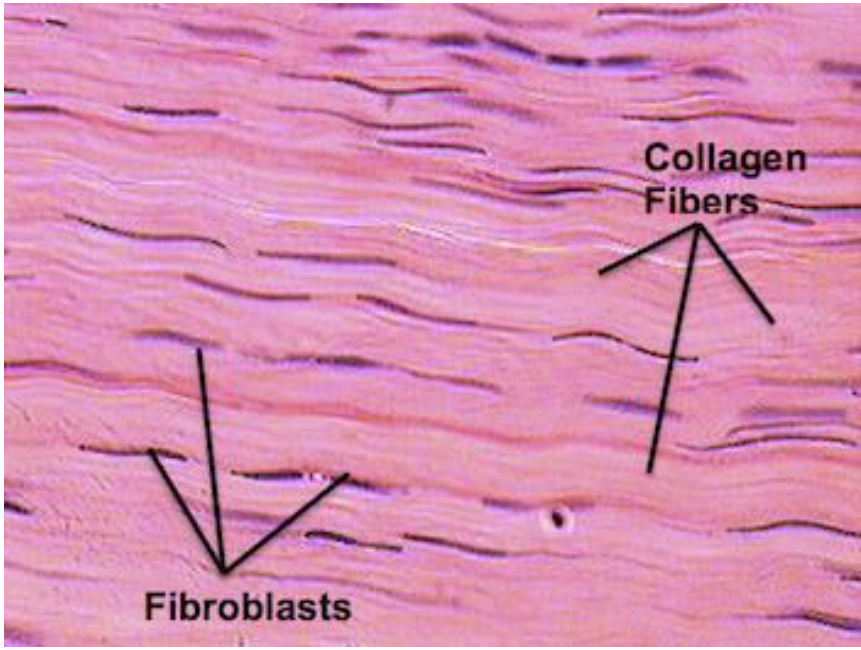


2. Connective tissues

I. Connective Tissue Proper

B. *Connective tissue proper-dense*: more fibers, less ground substance

1. Dense-Regular Connective Tissue:
   - connection between different tissues
   - consists of mainly collagen fibers arranged in parallel bundles
   - very poor blood supply → slow to heal
   - forms tendons, ligaments → great tensile strength



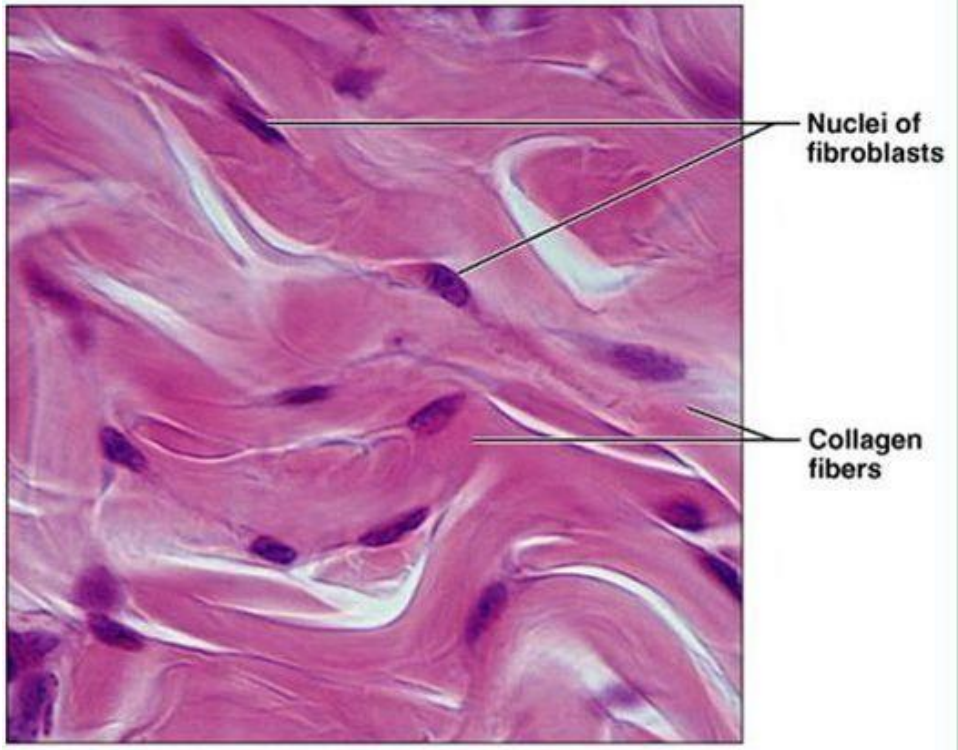
2. Connective tissues

I. Connective Tissue Proper

B. *Connective tissue proper-dense*: more fibers, less ground substance

2. Dense-Irregular Connective Tissue:

- collagen fibers are not arranged in parallel bundles
- fascia (tissue around muscles and organs), dermis of skin, fibrous capsules of joints



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

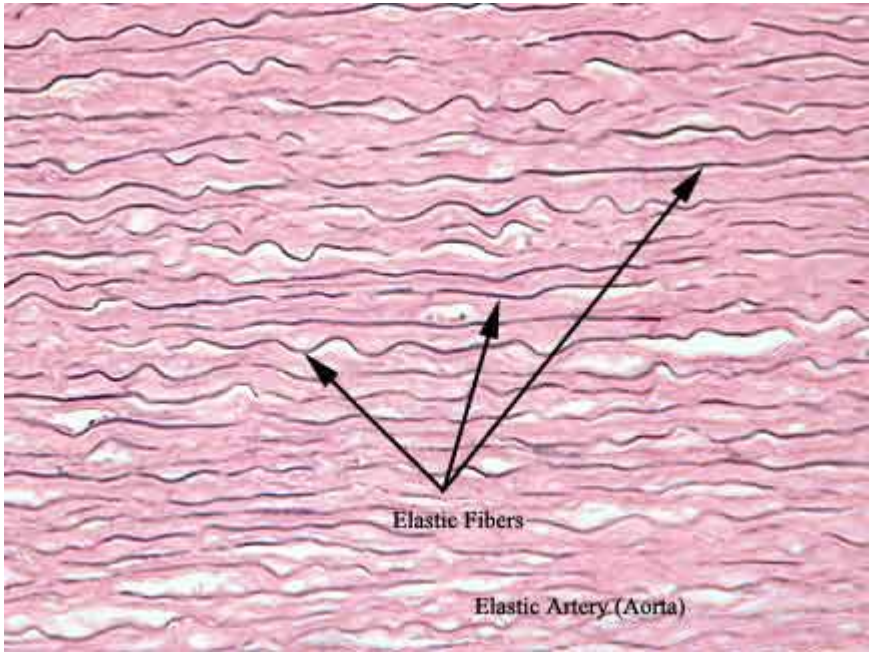
2. Connective tissues

I. Connective Tissue Proper

B. *Connective tissue proper-dense*: more fibers, less ground substance

3. Dense-Elastic Connective Tissue:

- consists of predominantly elastic fibers
- lung tissue, trachea, walls of some arteries
- allows stretching of various organs



2. Connective tissues

II. Specialized Connective Tissues

A. Cartilage

1. Hyaline cartilage:

- ground substance + collagen fibers + chondrocytes (cells found in healthy cartilage, they produce and maintain the cartilaginous matrix)
- on many joint surfaces, ribs, parts of nose, larynx, and trachea
- no nerves or blood vessels
- provides smooth surface, support

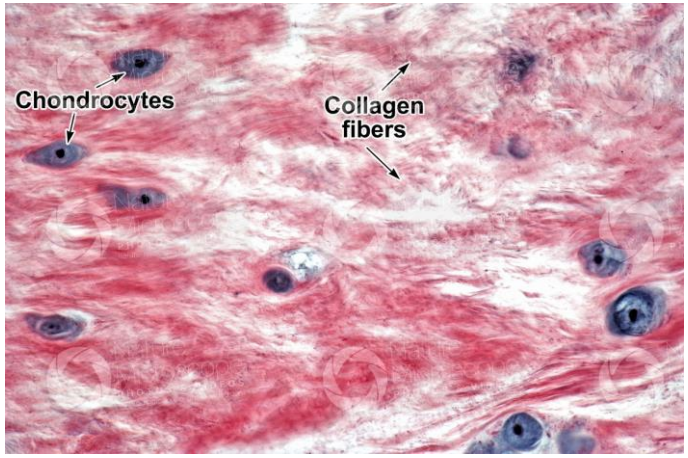
2. Connective tissues

II. Specialized Connective Tissues

A. Cartilage

2. Fibrocartilage:

- extracellular matrix+ collagen fibers + chondrocytes
- discs between vertebrae, cartilage pads of knee (meniscus)
- if hyaline cartilage breaks down, fibrocartilage helps fill in the torn part of the cartilage
- provides support

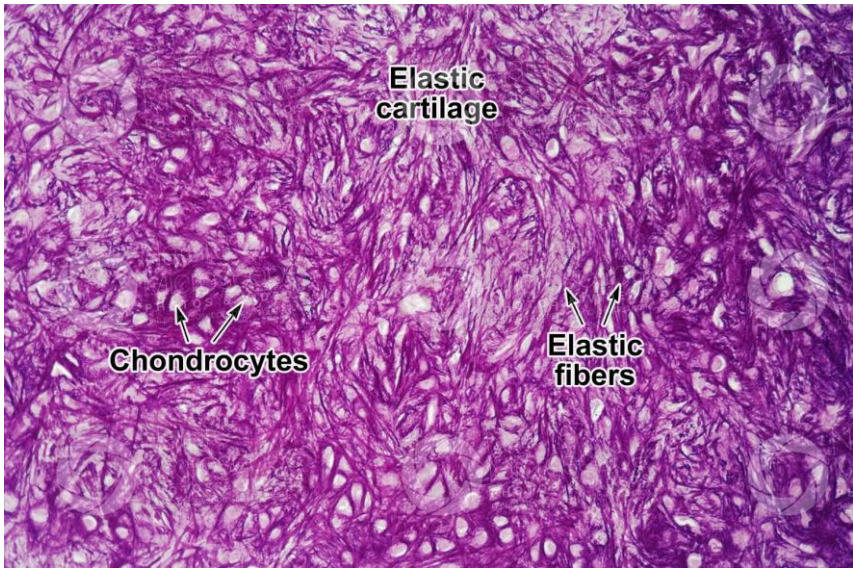


2. Connective tissues

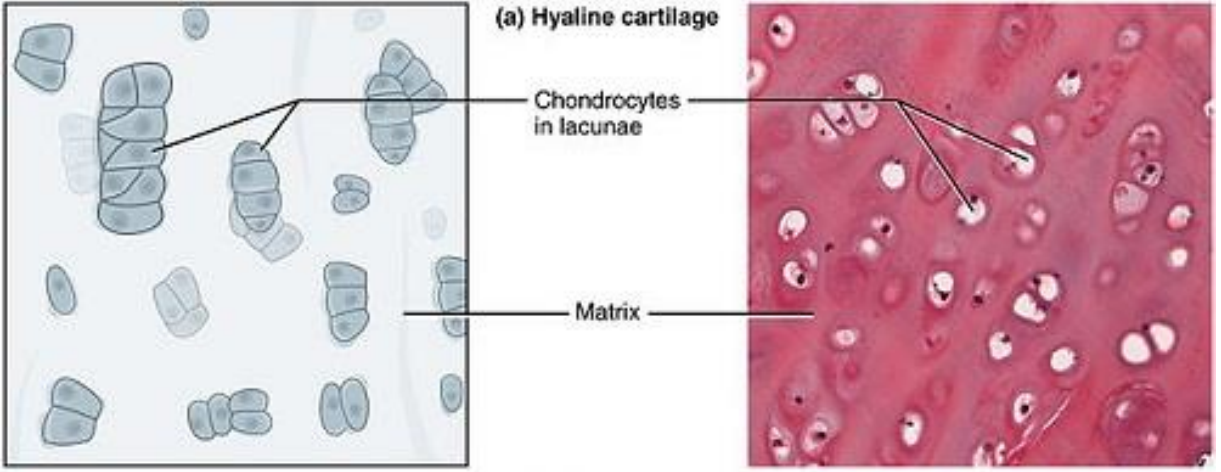
II. Specialized Connective Tissues

A. Cartilage

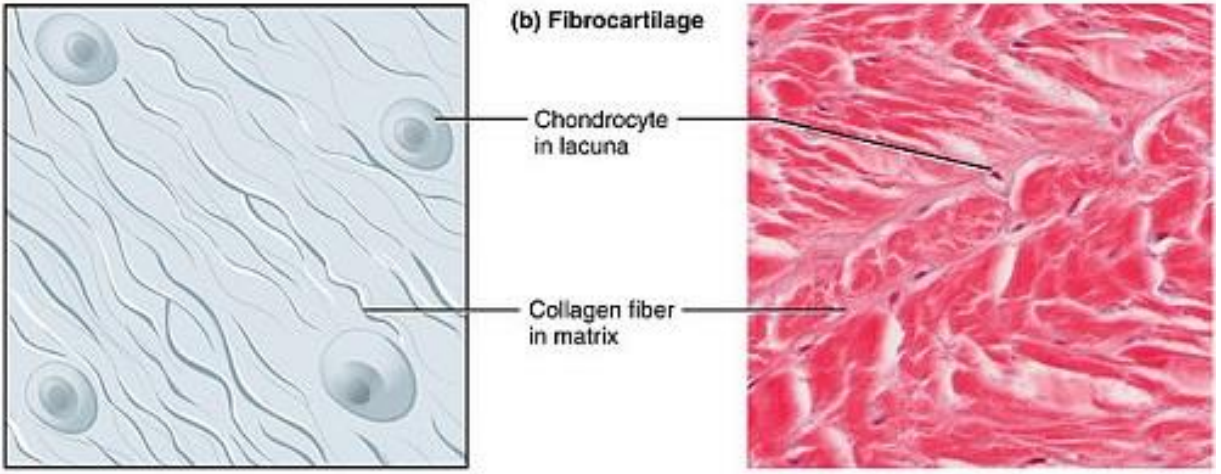
3. Elastic cartilage:



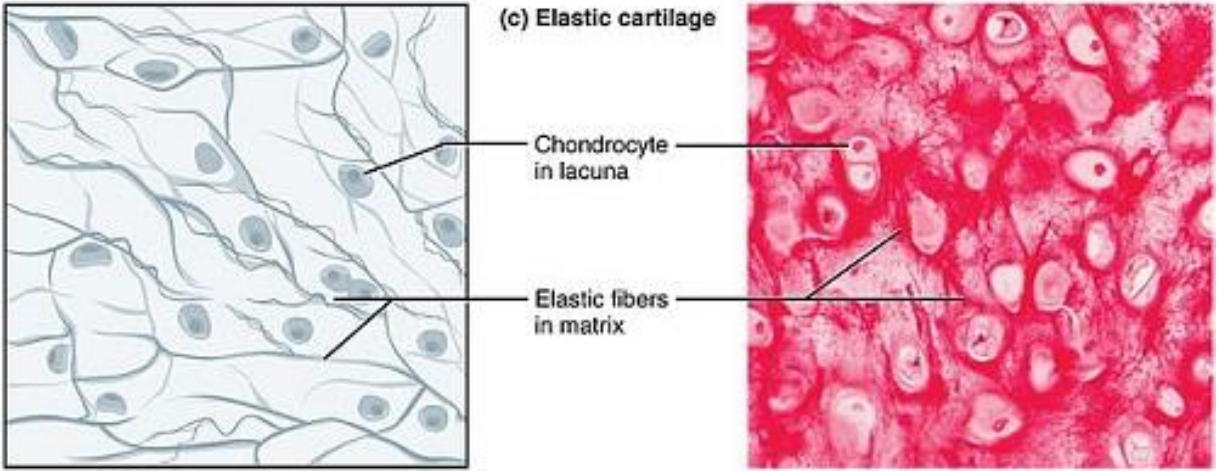
- extracellular matrix+ elastic fibers + chondrocytes
- part of external ear, epiglottis (lid on top of larynx)
- flexible support, maintains shape
- similar to hyaline cartilage but contains many yellow elastic fibers→ high flexibility



-joint surfaces, ribs,
parts of nose, larynx, and trachea
-provides smooth surface,
support



-discs, cartilage pads of knee
(meniscus)
-support



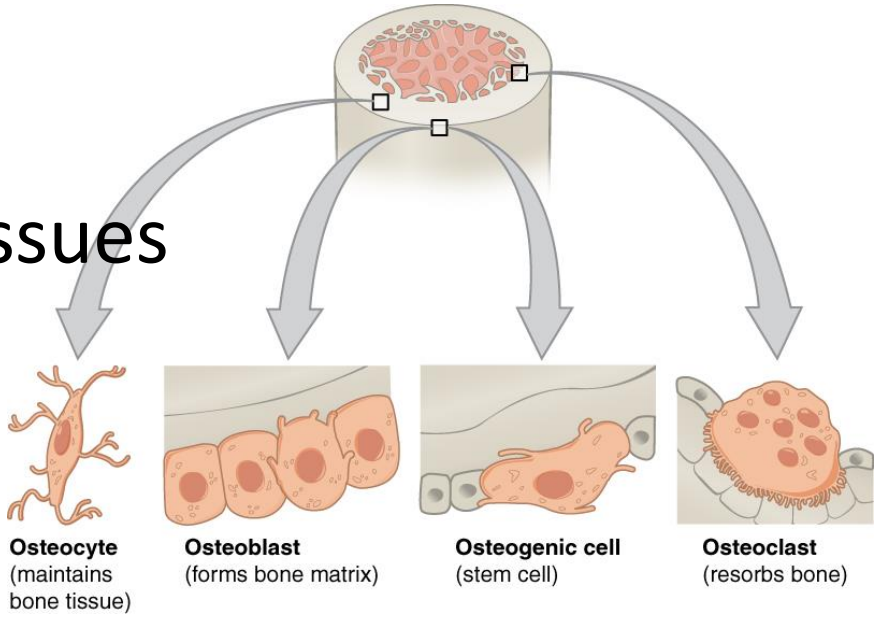
- external ear, epiglottis
- flexibility, support

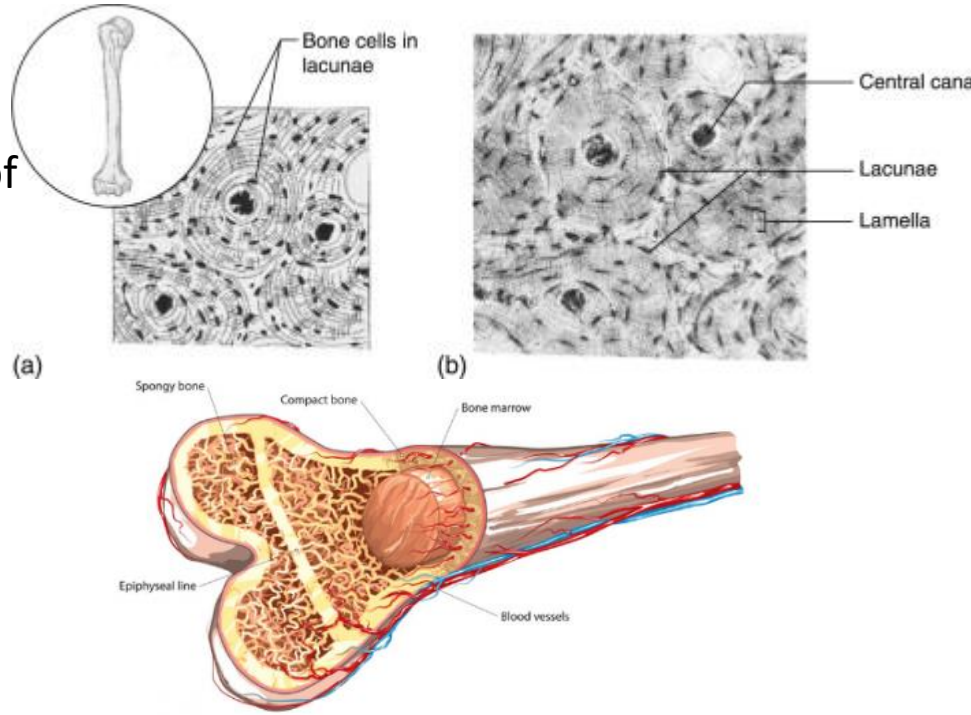
2. Connective tissues

II. Specialized Connective Tissues

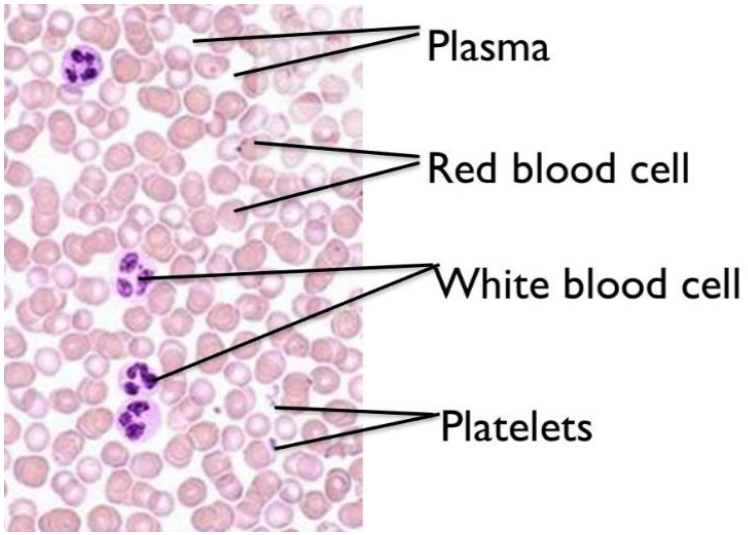
B. Bone tissue (osseous tissue)

- hard tissue
- consists of different cells and mineralized extracellular matrix (collagen and salts) arranged in concentric rings or columns
- mechanical protection , support, storage of minerals (Ca, P)
- bone marrow produces blood cells (hematopoiesis)
- two types: compact- (extremly hard) and spongy bone (fills the hollow interior)





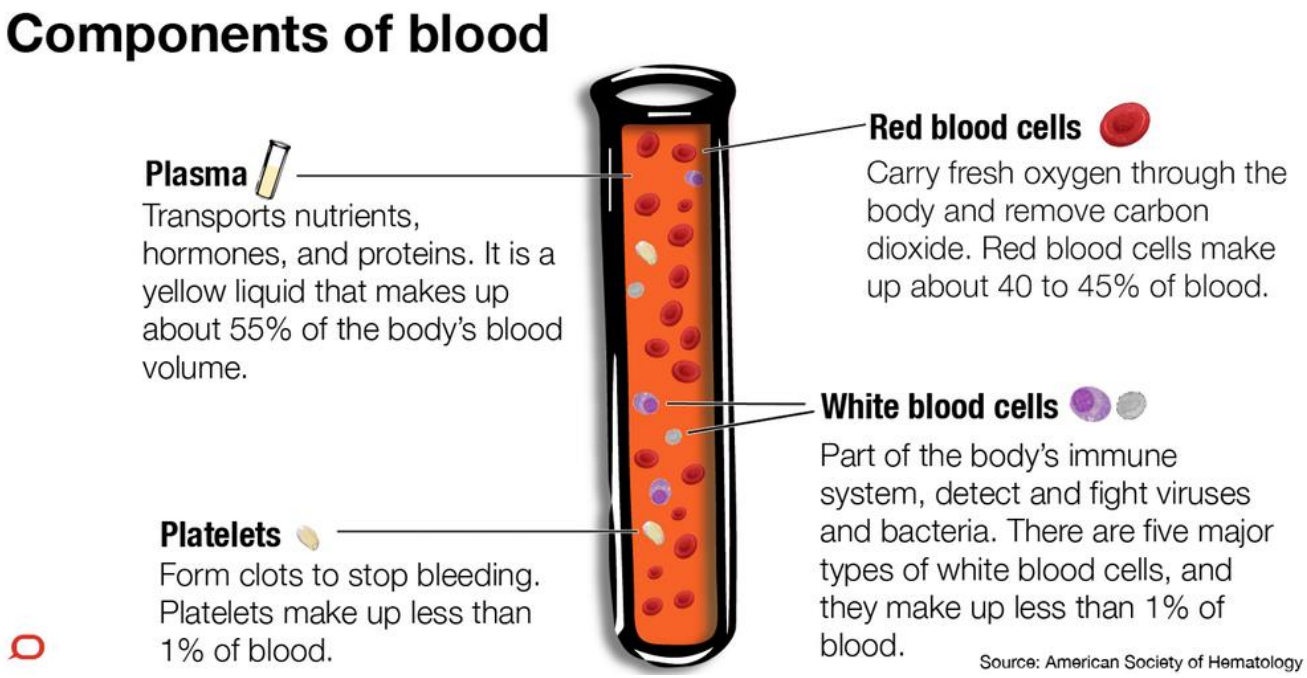
2. Connective tissues



II. Specialized Connective Tissues

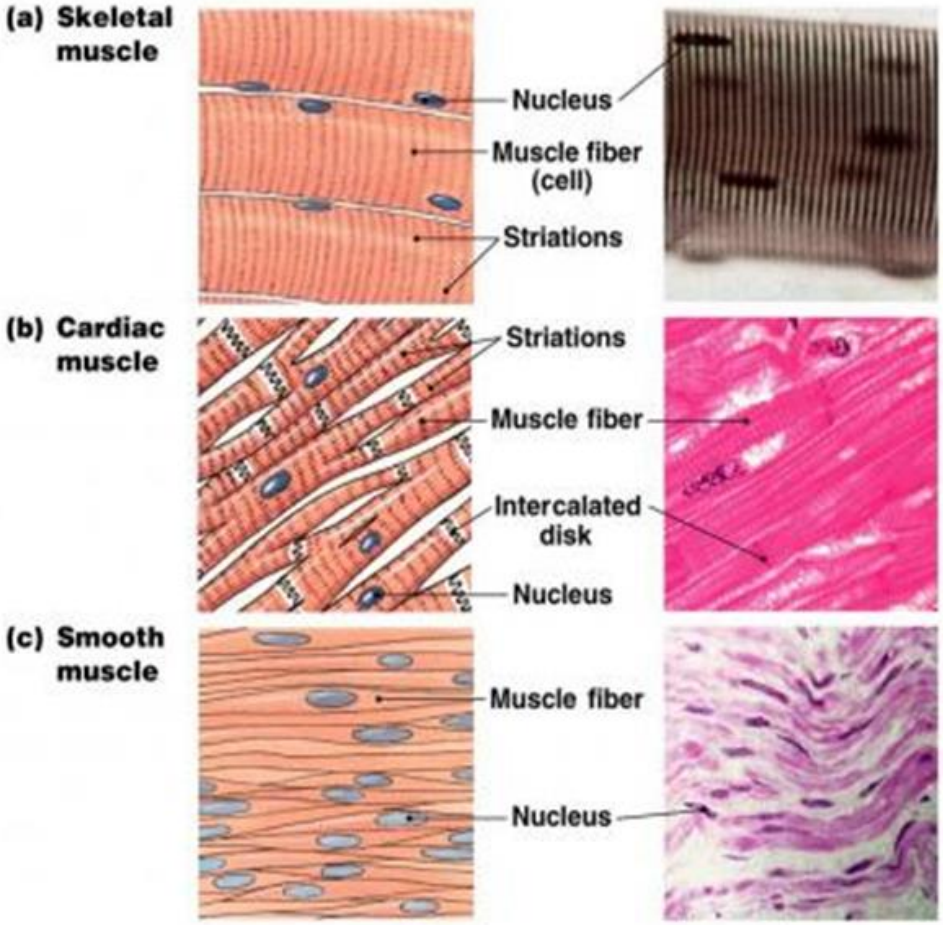
C. Blood

- body fluid → delivers necessary substances (nutrients and oxygen) to the cells and transports metabolic waste products away
- composed of blood cells suspended in blood plasma



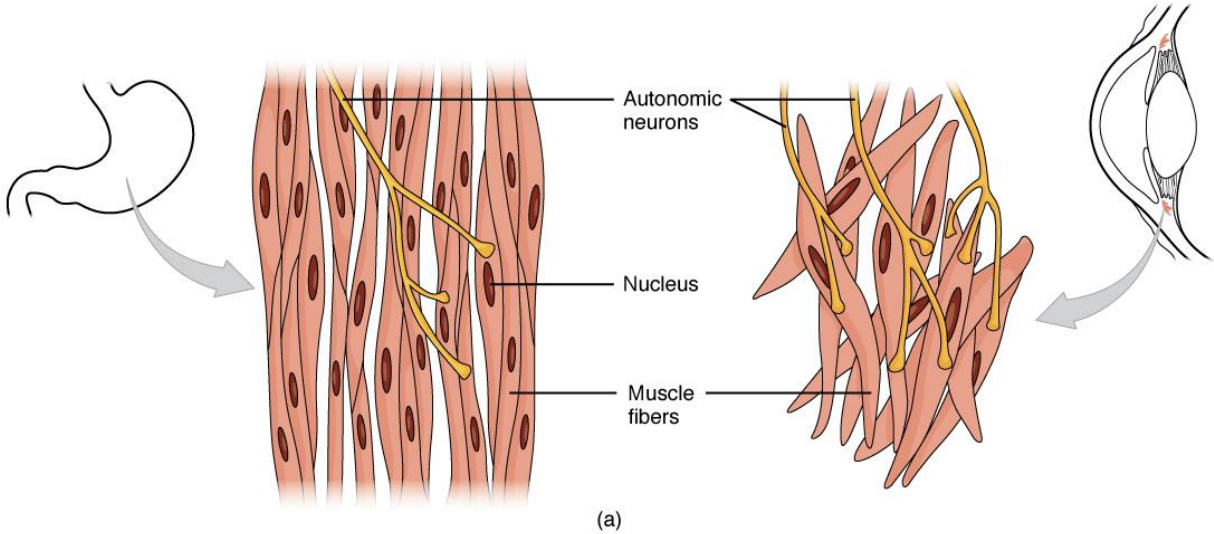
3. Muscle tissue

- is derived from the middle layer (mesoderm) of the embryo
- is a very specialized tissue that has the ability to contract and relax
- muscle cells contain contractile filaments
- each muscle cell is filled with a specialised cytoplasm (sarcoplasm) and is surrounded by a thin cell membrane (sarcolemma)
- Energy source: ATP
- three types (based on structure, function and location):
  - skeletal
  - cardiac
  - smooth muscle



3. Muscle tissue

I. Smooth muscle tissue



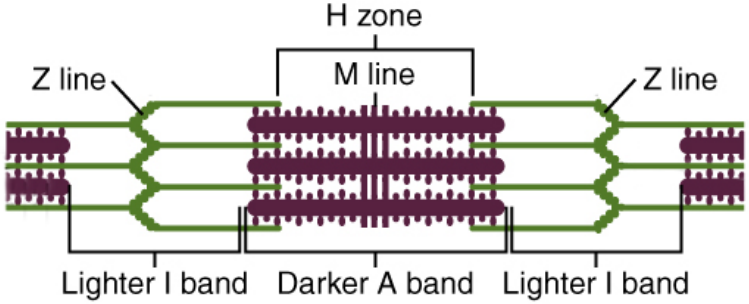
(a)

- thin-elongated cells (fibers)
- single, large and oval nucleus
- non-striated
- involuntary → it is not controlled by the brain
- slow, weak, persistent
- location:
  - in the walls of organs (stomach, intestines, urinary bladder and uterus),
  - in the walls of arteries and veins
  - in tracts of the respiratory, urinary, and reproductive systems
  - eyes, skin, ...

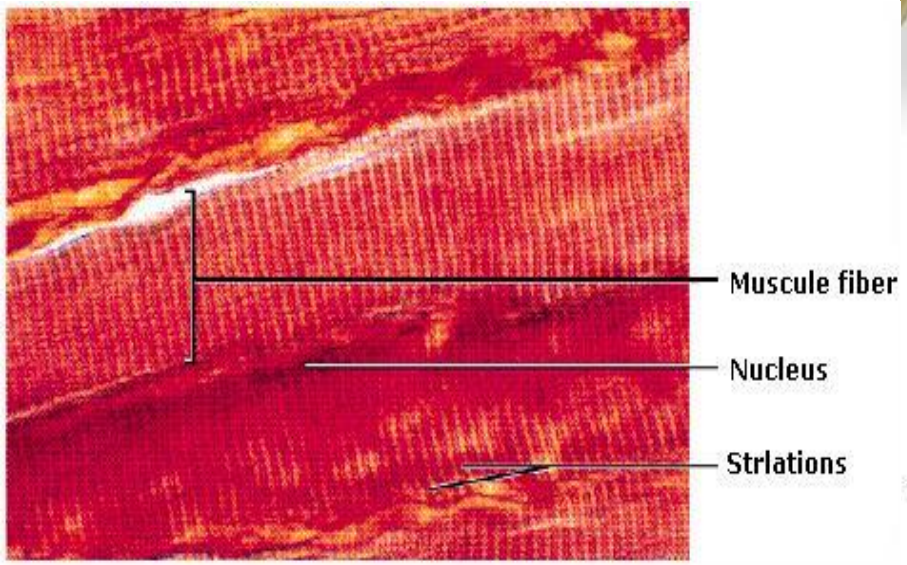

(b)

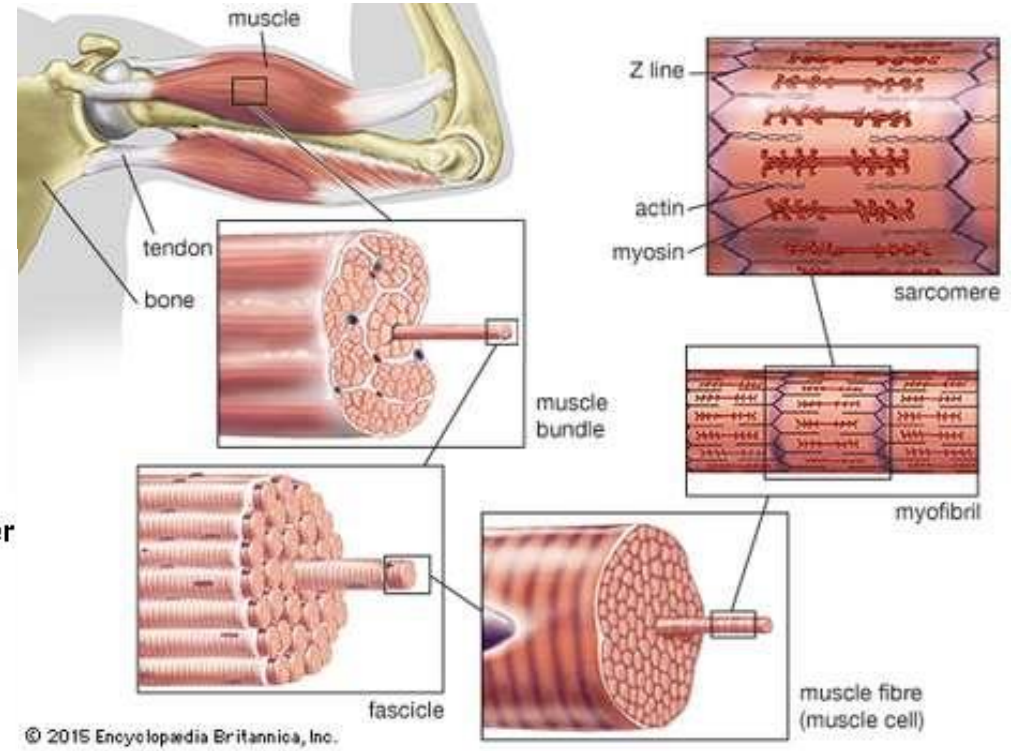
3. Muscle tissue

II. Skeletal (striated) muscle tissue



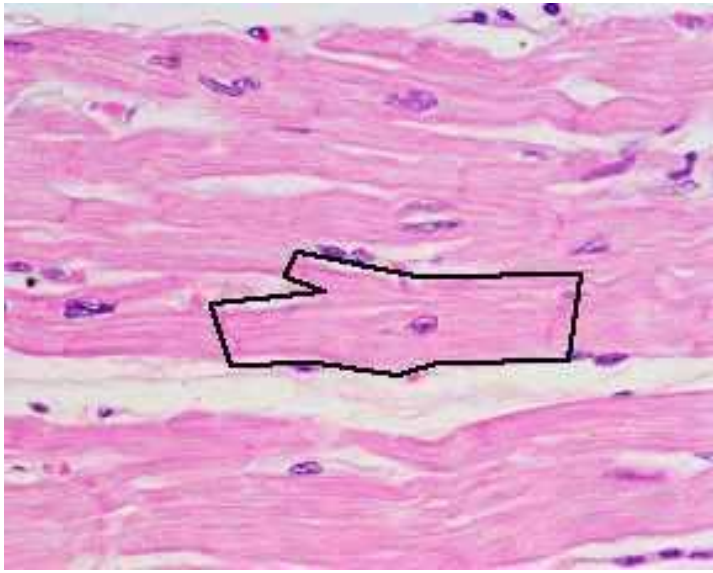
- elongated cells with many peripheral nuclei (=multinucleated)
- striations
  - darker A-band: thick myosin filaments
  - lighter I-bands: from actin
    → sarcomer (repeating functional units)
- voluntary
- stronger, works for a shorter time and gets tired
- function: coordination of movement of the body



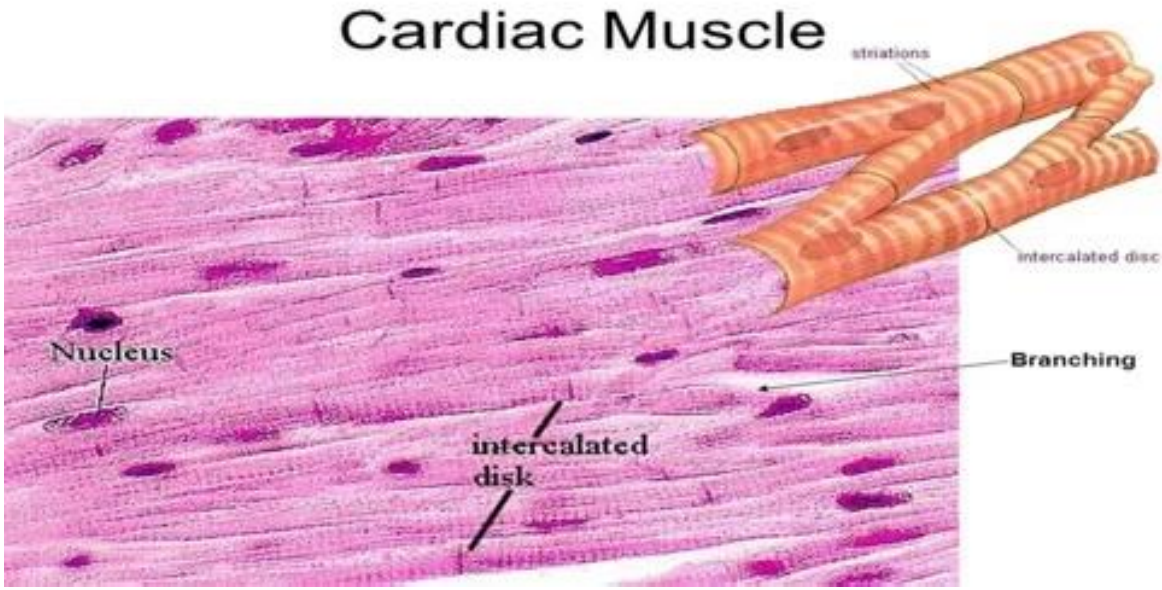


3. Muscle tissue

III. Cardiac (heart) muscle tissue

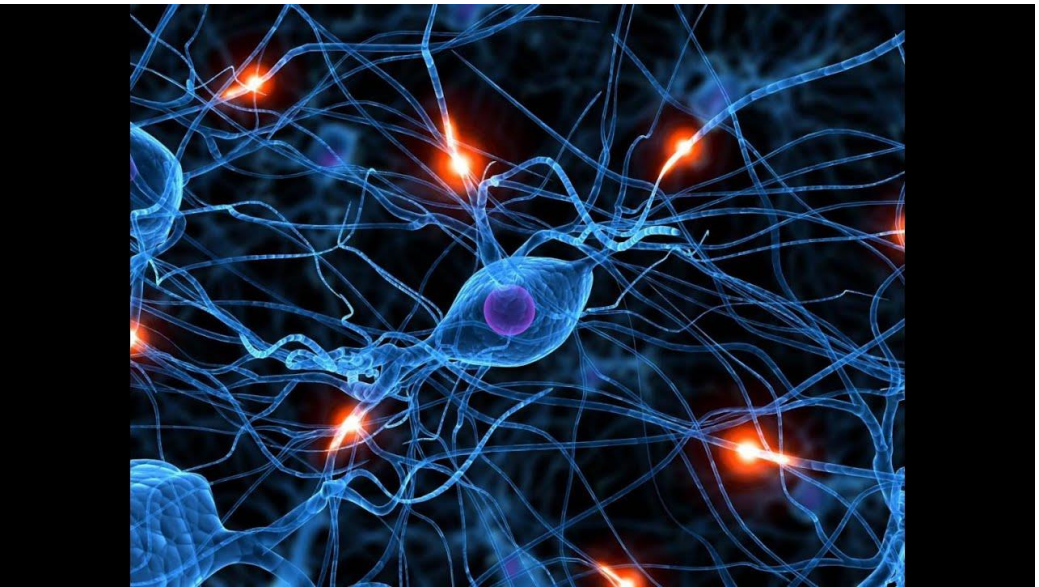


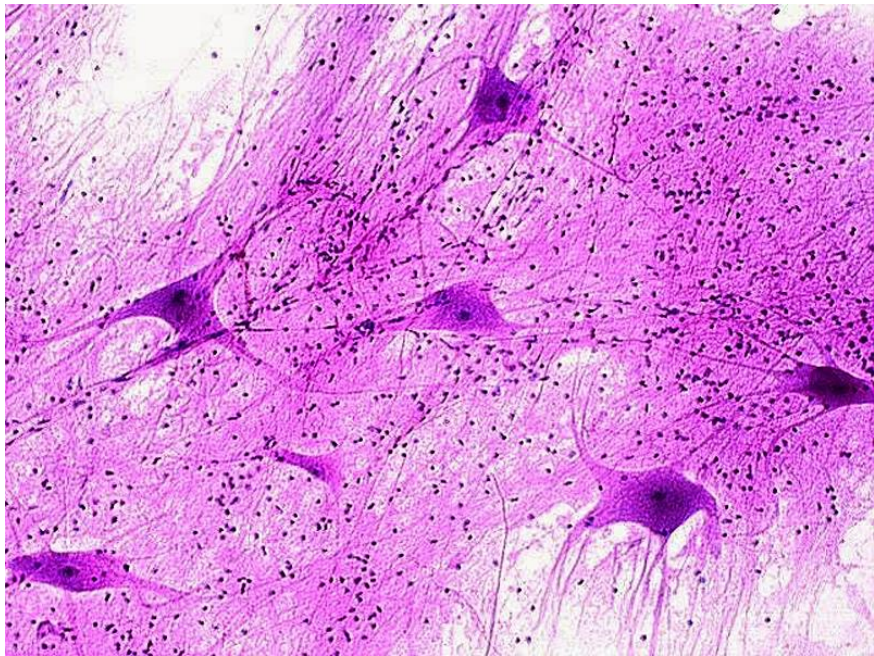
- striated muscle with single or more nucleus
- involuntary
- branched cells
- intercalated discs between the cells → rapid transmission of electrical impulses
- only in the heart
- strong, works for a long time, does not get tired



4. Nervous tissue (neural tissue or nerve tissue)

- is derived from the external layer (ectoderm) of the embryo
- is the main component of the nervous system (the brain, spinal cord, nerves)
- it makes up the central nervous system and the peripheral nervous system
- is specialised to react to stimuli and to conduct impulses to various organs → regulates and controls body functions
- it is composed of **neurons** (specialized nerve cells) + **supporting cells**+ **other elements** (connective tissue, blood etc)



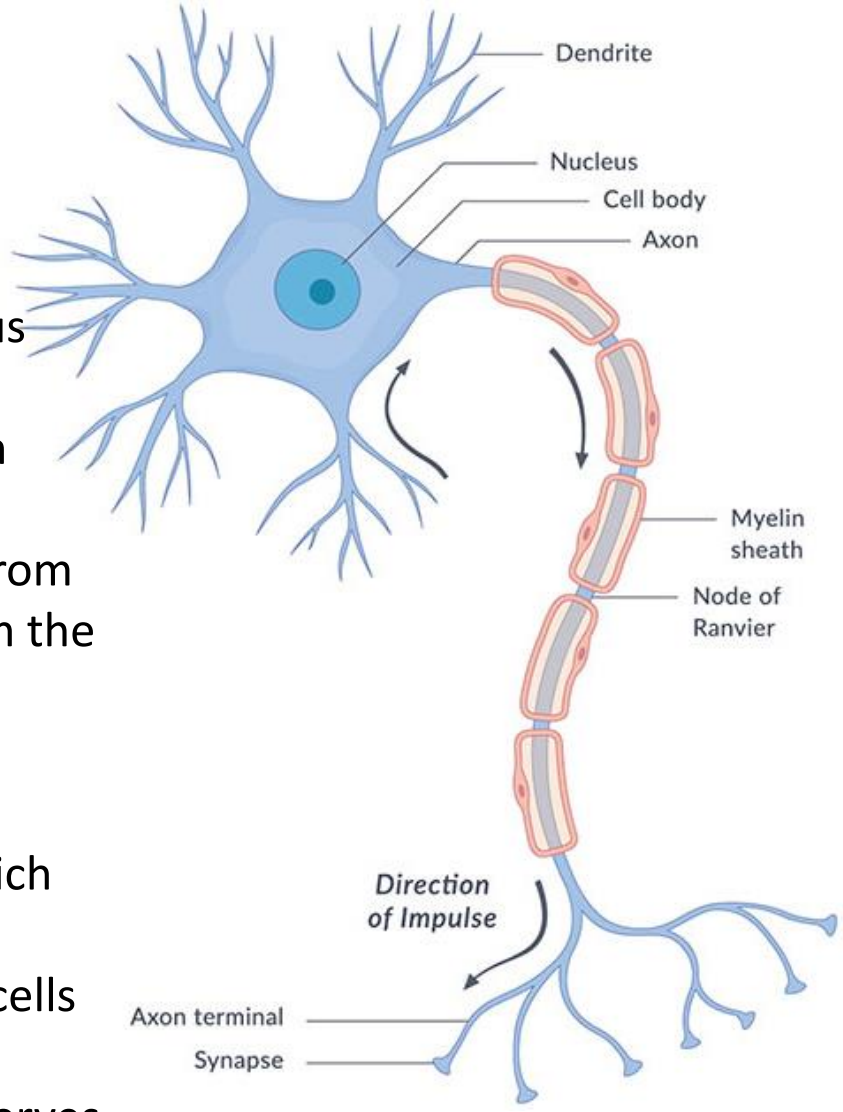


4. Nervous tissue

I. Neurons

Structure:

- **cell body** (**soma**): contains a central nucleus
- **dendrites**: cellular extensions with many branches→ „dendritic tree", inputs happen here
- **axon**: special cable-like projection, arises from the cell → carries nervous signal away from the soma
- **myelin sheath**: surrounds the axon → functions as an insulator around the axon
- **Schwann cells**: special supporting cells which produce myelin sheat
- **node of Ranvier**: Gaps between Schwann cells → conducts the impulse
- **synapse**: connection point between two nerves
- neurons do not undergo cell division

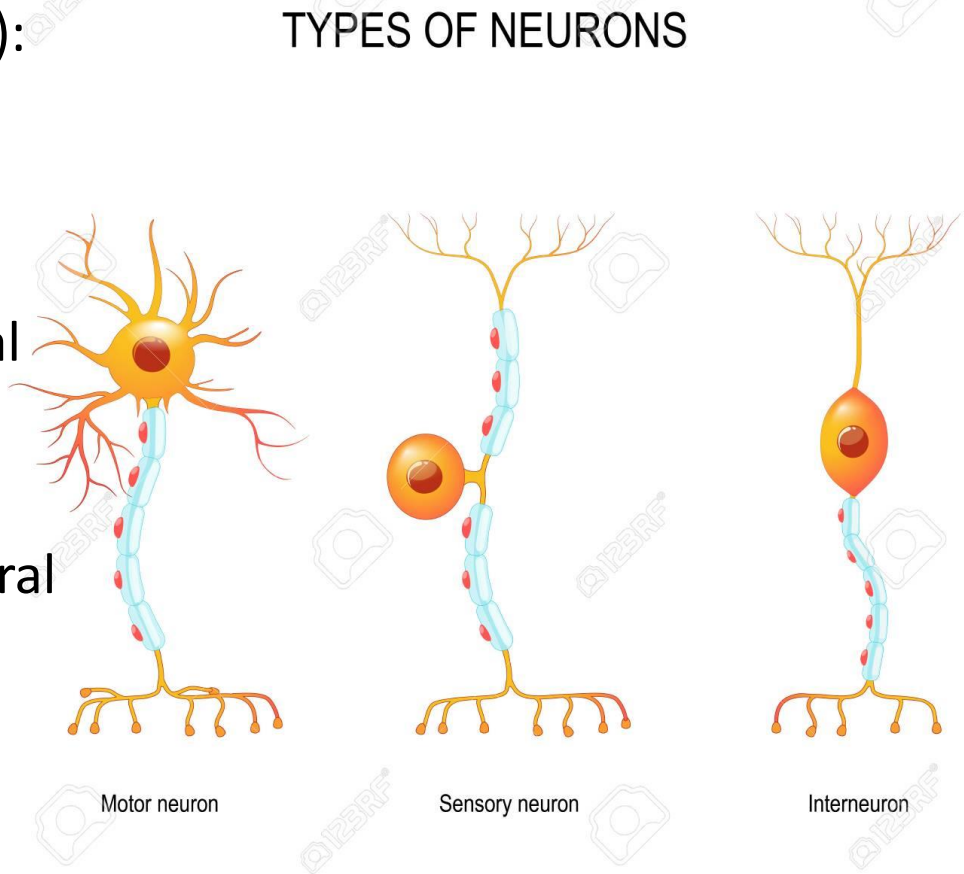


4. Nervous tissue

I. Neurons

Types (according to their function):

- **sensory** (or afferent) neurons: conduct impulses from the sensory organs to the central nervous system (brain and spinal cord)
- **motor** (or efferent) neurons : conduct impulses from the central nervous system to the effector organs (such as muscles and glands)
- **interneurons**: neurons that connect two other neurons

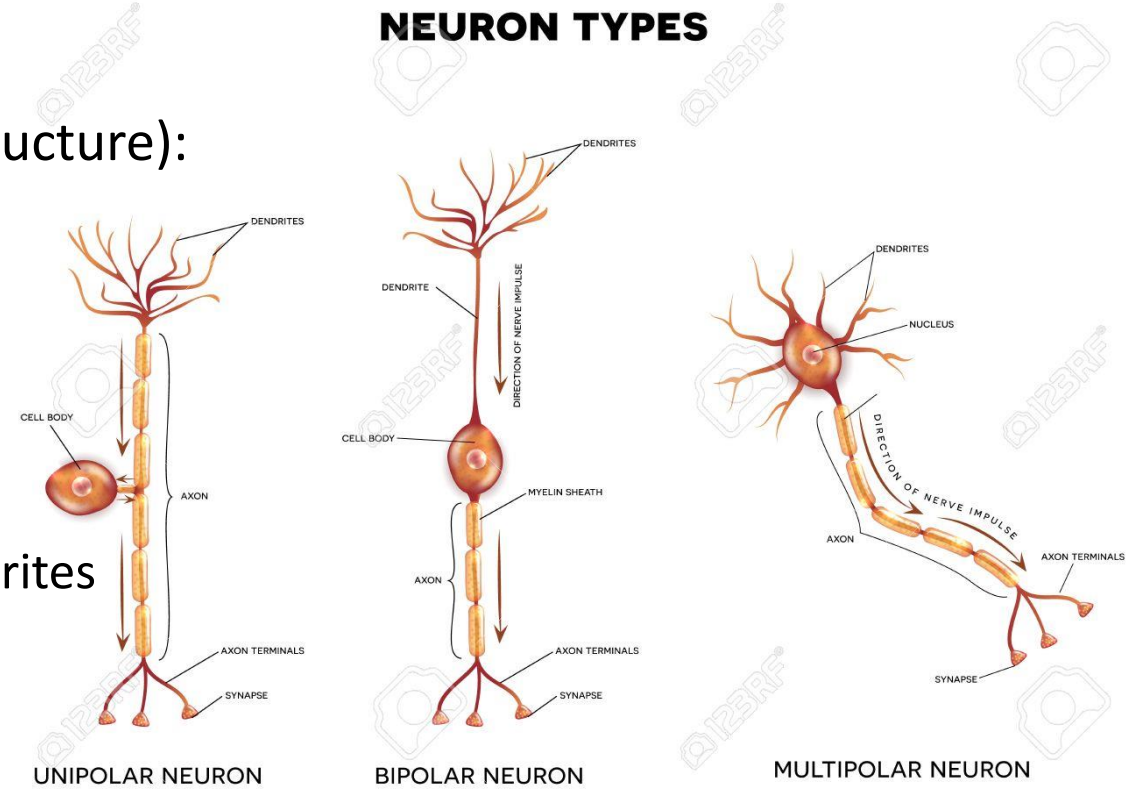


4. Nervous tissue

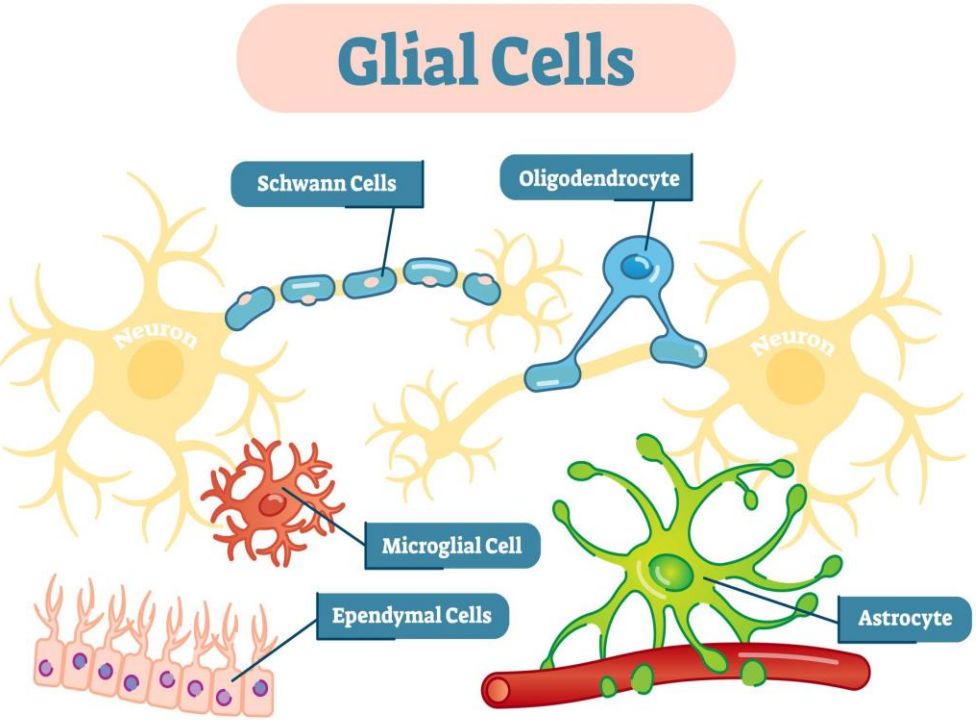
I.Neurons

Types (according to their structure):

- **unipolar** neuron:
  - single process
  - sensory neurons
- **multipolar** neurons:
  - 1 axon and 2 or more dendrites
  - motor- and interneurons
- **bipolar** neurons:
  - 1 axon and 1 dendrite
  - transmission of special senses



4. Nervous tissue



II. Supporting cells/Glia cells

- non-neuronal cells
- „glue of the nervous system"
- they form myelin and provide support and protection for neurons
- no conduction!

Function

- surround neurons and hold them in place
- nutrition of nerve cells
- insulate one neuron from another;
- cleaning up waste and breaking down dead neurons