

Animal Tissues and Organization

Tissues are groups of cells with a common structure and function.

Different types of tissue have different structures that are especially suited to their functions.

Tissues may be held together by a sticky extracellular matrix that coats the cells

tissue = weave

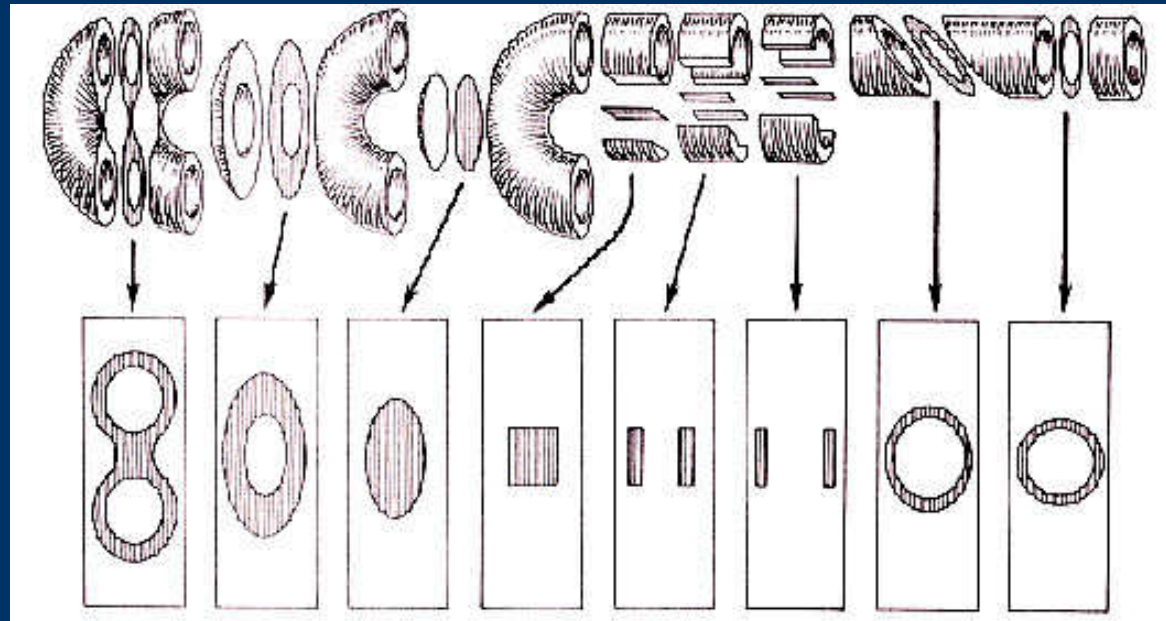
4 types of tissues:

epithelial tissue

connective tissue/supporting tissue
(including blood)

muscular tissue

nervous tissue



Note that even a simple three dimensional object can have a surprising number of appearances when viewed in different two dimensional perspectives. Knowing the plane of the section and the general arrangement of cells in a tissue is often critical to interpreting the view.

Epithelial tissues

- cover the outside of the body and lines organs and cavities
- cells of an epithelium are closely joined with little material between them
- in many epithelia, the cells are riveted together by tight junction

-the tight packing enable the epithelial to function as a barrier protecting against mechanical injury,

invasive microbes and fluid loss

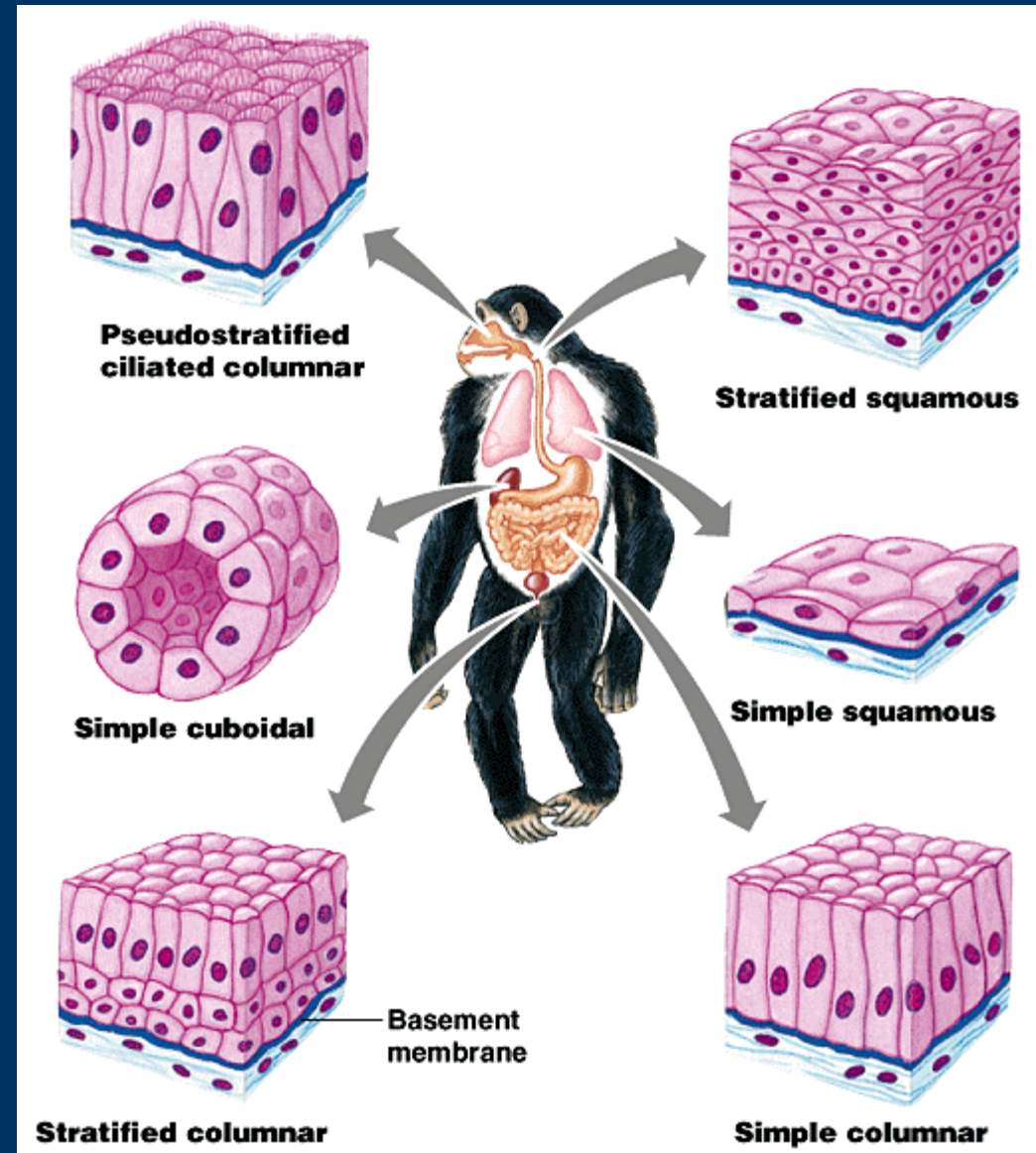
-free surface of the epithelium is exposed to air or fluid, whereas the cells at the base are attached to a basement membrane, a dense mat of extracellular matrix

Classification of epithelium:

- number of cell layer
- shape of the cells on the free surface

simple = single layer of cells

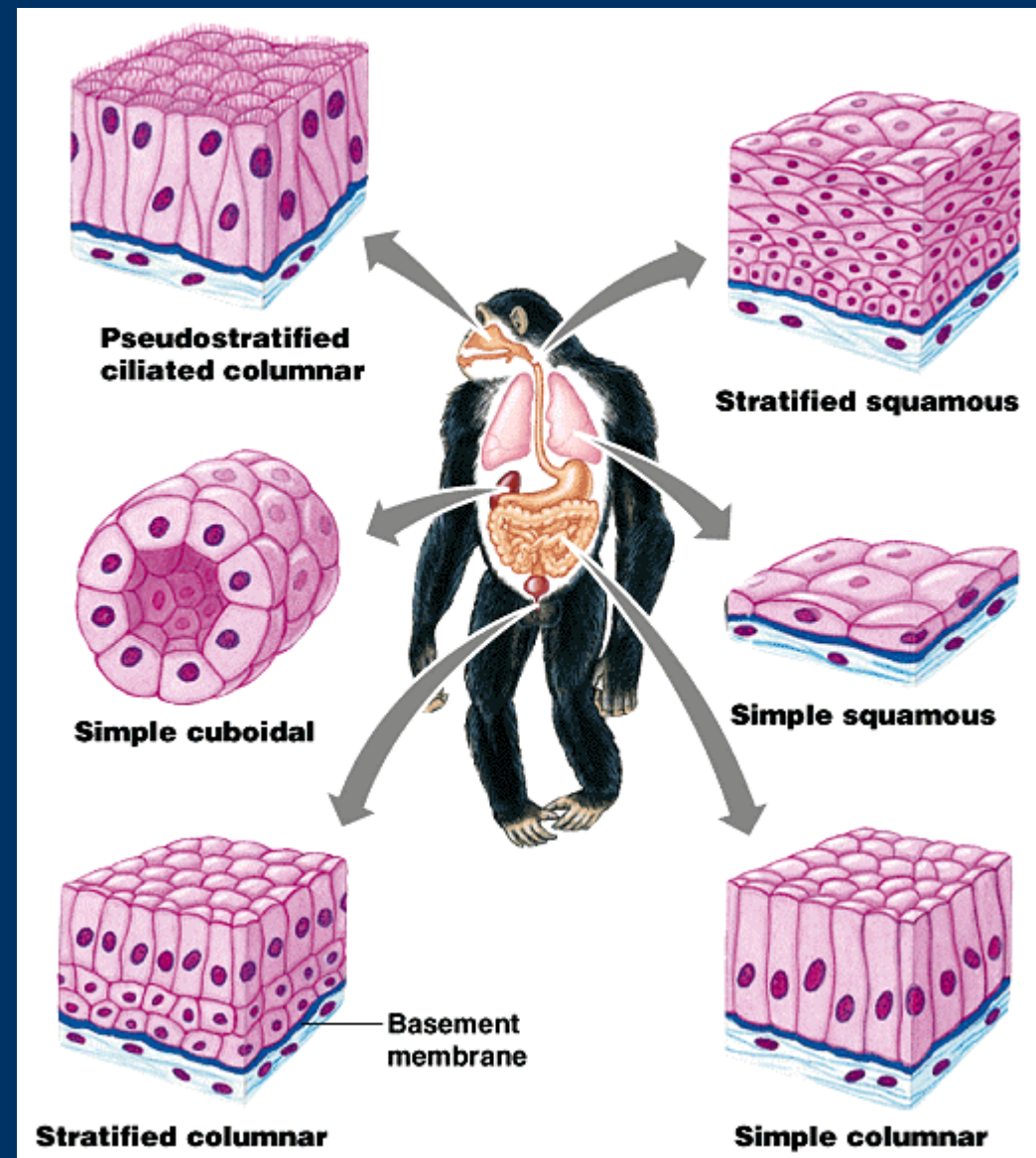
stratified = multiple tiers of cells



-cuboidal = cubic shape like dice

-columnar = column shape like brick

-squamous = flat shape like floor tiles



Epithelium can be categorized by function:

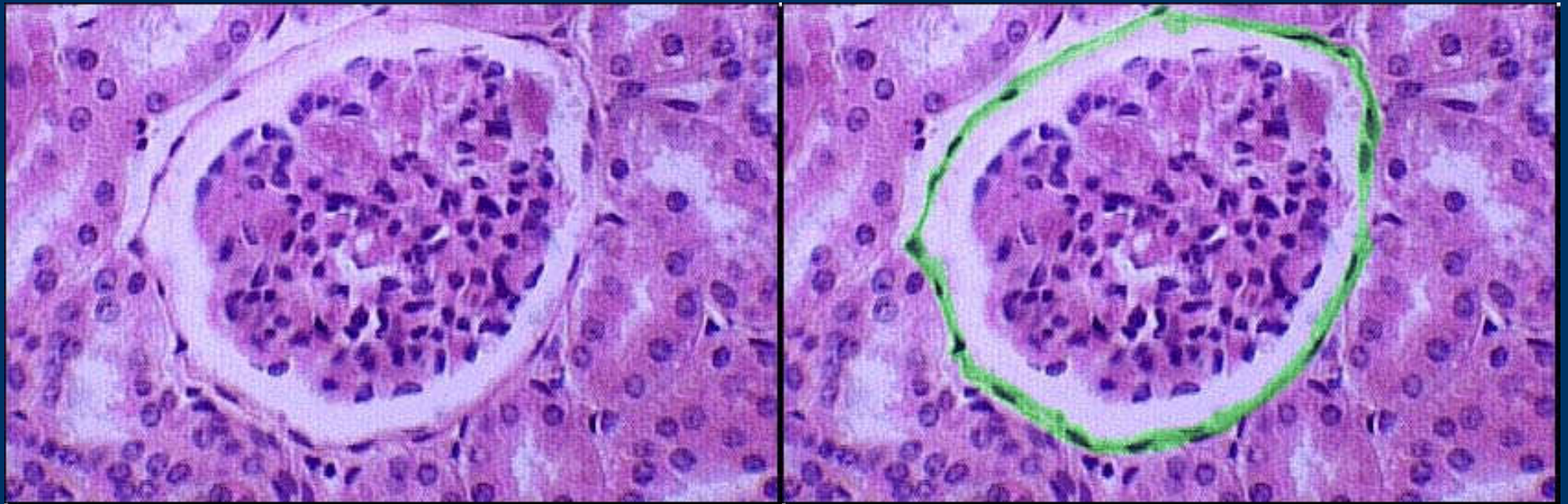
- lining epithelia

- glandular epithelia absorb or secrete chemical solution

e.g. glandular epithelia lining tubules in the thyroid gland secrete a hormone that regulates the body's rate of fuel consumption

Simple squamous epithelium

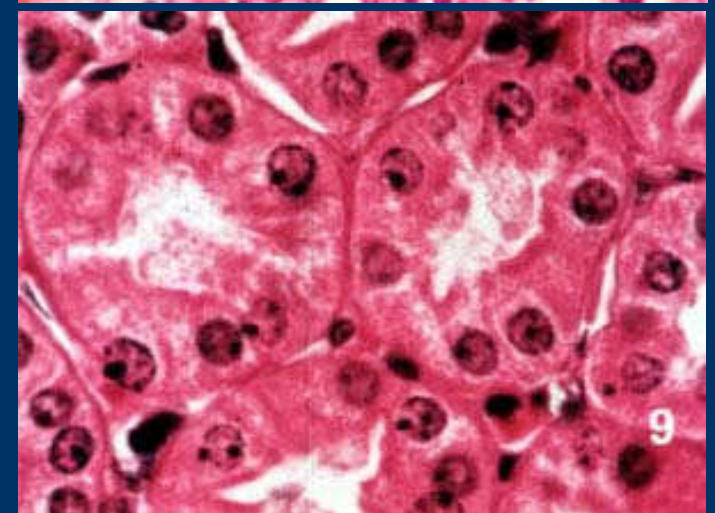
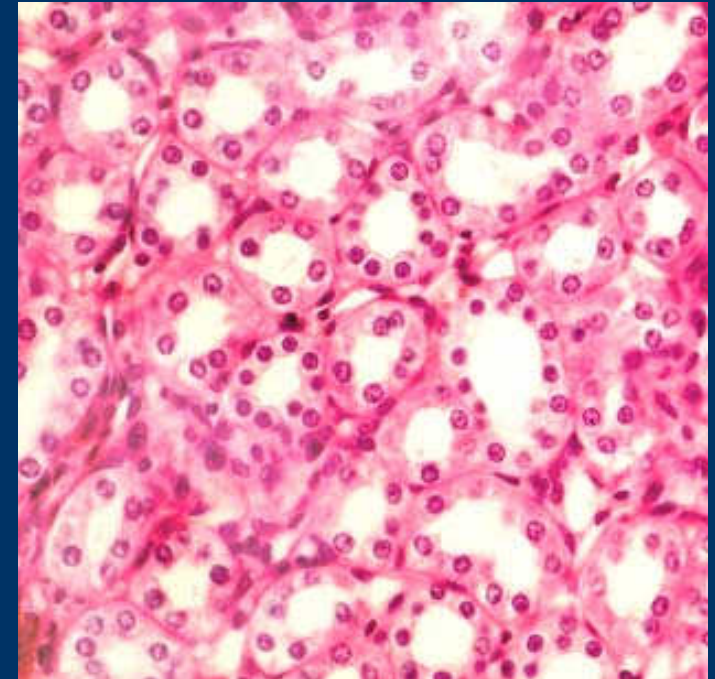
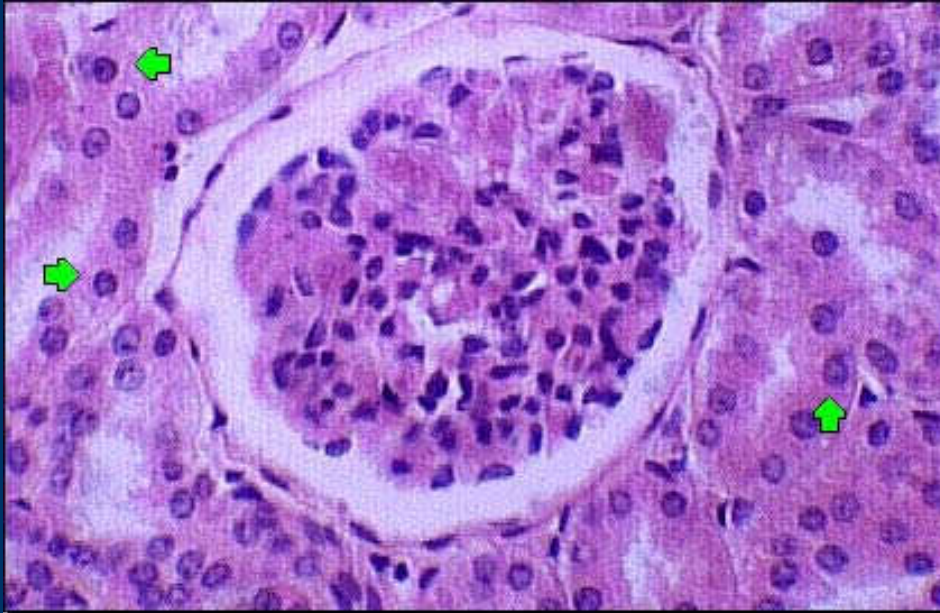
- consist of a single layer of flattened cells
- lining body cavity, cardiovascular and lymphatic systems, surface of lung and kidneys (gas and liquid exchange)
- function = diffusion and filtration

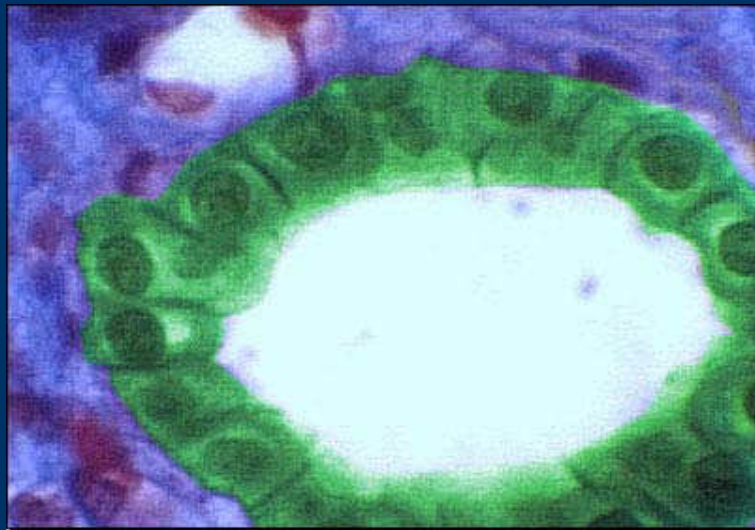
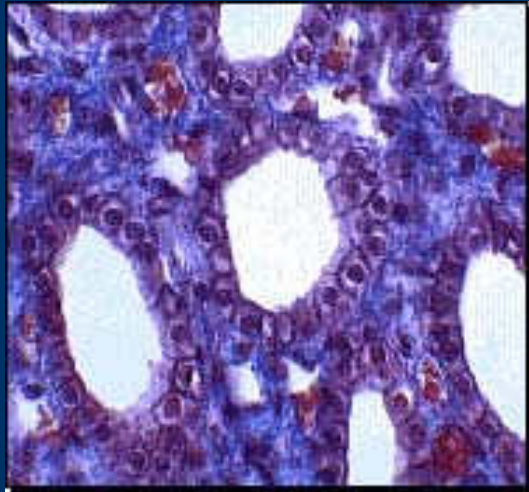


Simple squamous epithelium lining Bowman's space in the cortex of the kidney.

Simple cuboidal epithelium

- consists of a single layer of cells that are roughly square in shape when cut in cross-section.
- lining many ducts and tubules of the body.
- functions of secretion and absorption e.g. kidney



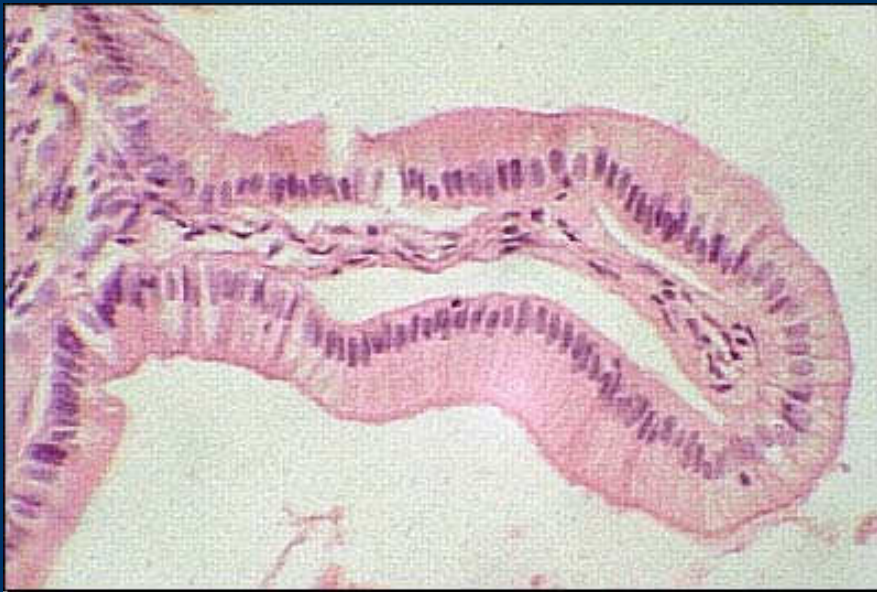


Simple cuboidal cells

Cell nuclei

Simple columnar epithelium

- consists of a single layer of cells that are taller than they are wide. - their nuclei typically lie in the basal portion of the cell and form a single line in cross section.
- found lining the stomach, intestines, and some large ducts in the body.
- often have surface modifications such as cilia and microvilli and function in secretion and absorption.



Epithelial Tissue Review

- Epithelium is one of the four basic tissues.
- Its cells are often arranged in sheets.
- Epithelia are classified according to the shape of the cells (squamous, cuboidal, or columnar) and the number of layers (simple, stratified, or pseudostratified).
- Depending on the epithelium type and its location it may serve protective, absorptive, or secretory functions.
- Epithelia cover all internal and external body surfaces.
- A special type of epithelium, endothelium, makes up the walls of blood and lymph vessels.

Connective/Supporting Tissue

- connective tissues consist of **cells** and **extracellular matrix** (a sparse population of cells scattered through an extracellular matrix)
- connective tissue may serve different functions:
 - structural support (e.g. bones)
 - connections (e.g. ligaments and tendons)
 - protection (e.g. fat pads).
- blood is considered to be connective tissue.

-**cells**: provide defense and produce the supportive structures.

fibroblast (secrete the protein ingredients of the extracellular matrix e.g. collagen and elastin)

adipocytes

macrophages (amoeboid cells that engulf bacteria and dead cell debris by phagocytosis)

mast cells (contain small granules to prevent blood clotting, increase permeability of capillaries and venules)

plasma cells

-extracellular matrix:

ground substance = matrix of organic materials: e.g. hyaluronic acid, chondroitin sulfate, heparain sulfate

function = as a medium through which nutrients can diffuse from blood vessels to nourish the cells

structural glycoproteins: e.g. fibrinin, fibronectin, laminin

fibers = proteins that give connective tissue its strength

collagenous fibers

- made of collagen

- the most abundant protein in the

animal kingdom

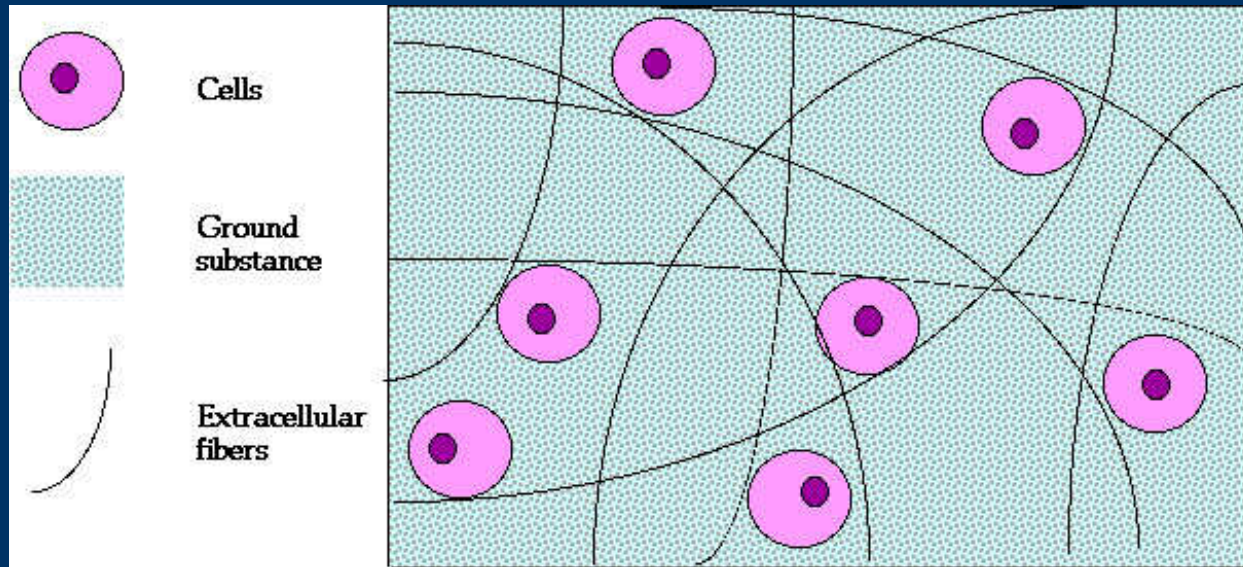
elastic fibers

- long threads made of elastin protein

reticular fibers

- very thin and branched

- join connective tissue to adjacent tissue



Types of connective tissues:

Loose connective tissue: containing cells and ground substance but relatively few fibers

Dense connective tissue: containing a greater proportion of fibers, fewer cells and less ground substance

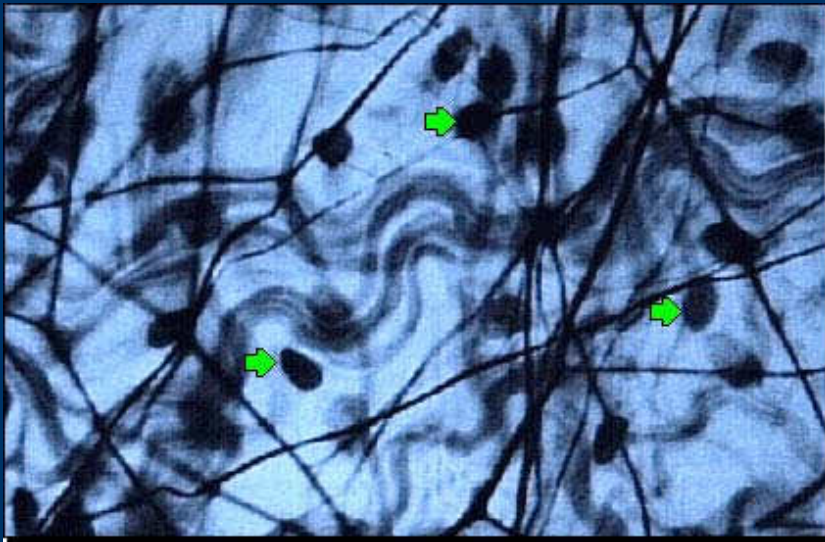
dense regular connective tissue or fibrous connective tissue: tendons (attach muscle to bone), ligaments (join bone together at joints)

dense irregular connective tissue: dermis of skin, sheath surrounding tendon and nerve

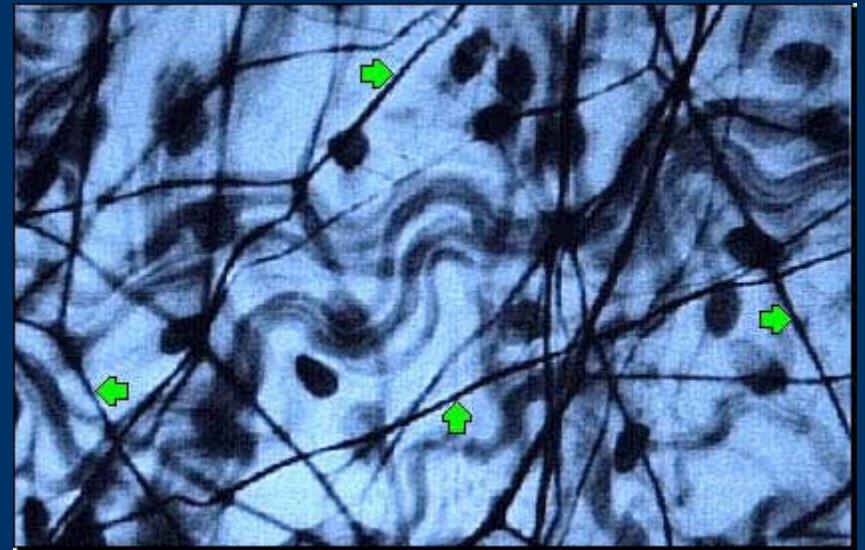
1. Loose Connective Tissue

- has an abundance of cells and ground substance, but relatively few fibers.
- It is soft and pliable and serves as a kind of packing material between other tissues and organs.
- It is found between muscles, allowing one to move freely over the other.
- It supports small blood vessels, lymphatic vessels and nerves.

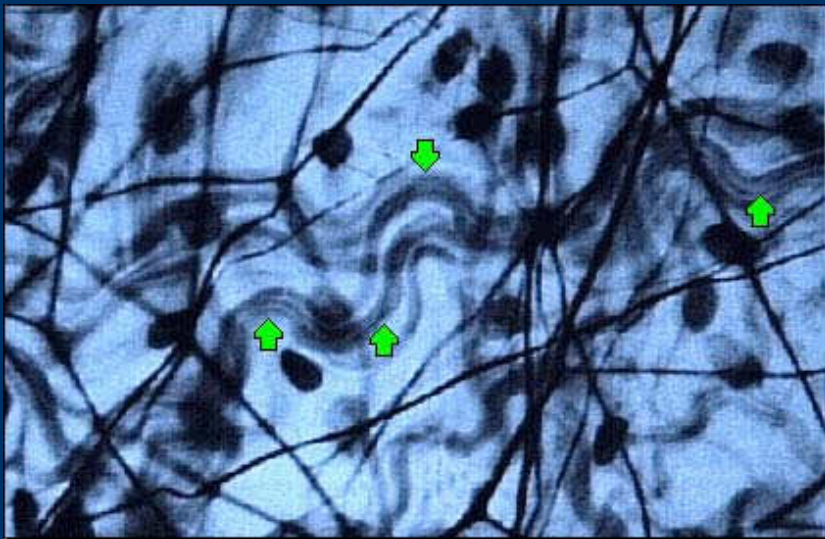




fibroblast



elastic fibers



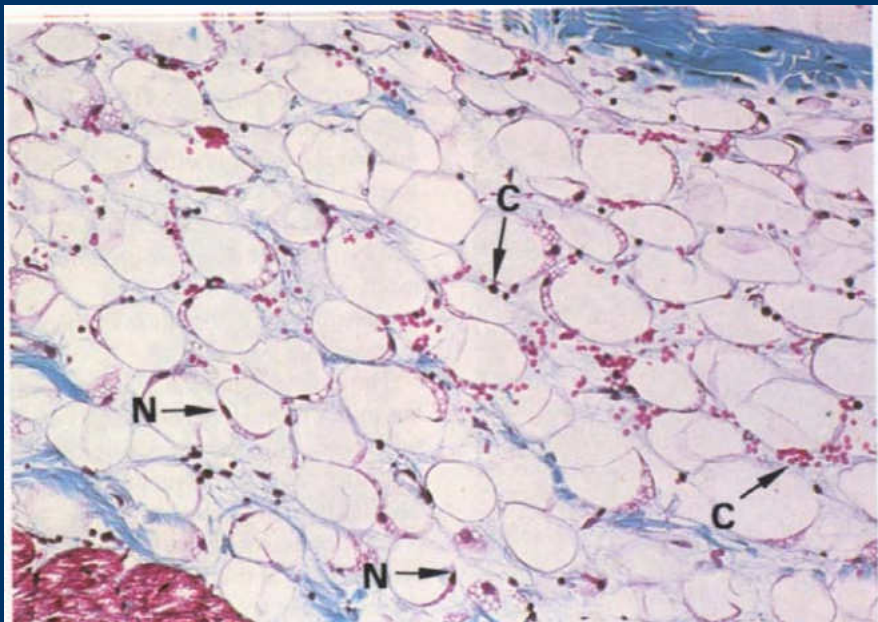
collagen fibers

Both fibers are formed by fibroblasts.

Loose connective tissue

Adipose tissue

- loose connective tissue with a high population of adipocytes
- has a honeycomb type appearance as the lipid stored by adipocytes is removed during tissue processing

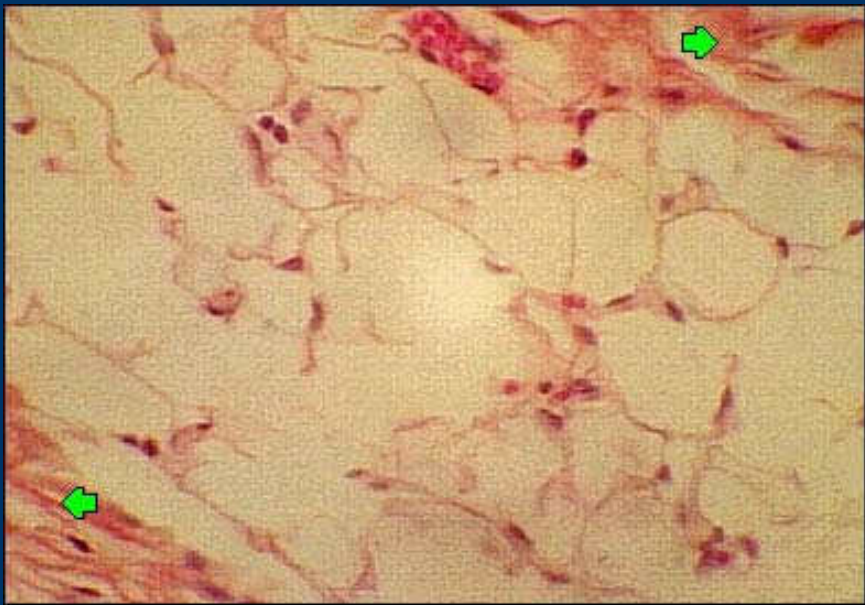
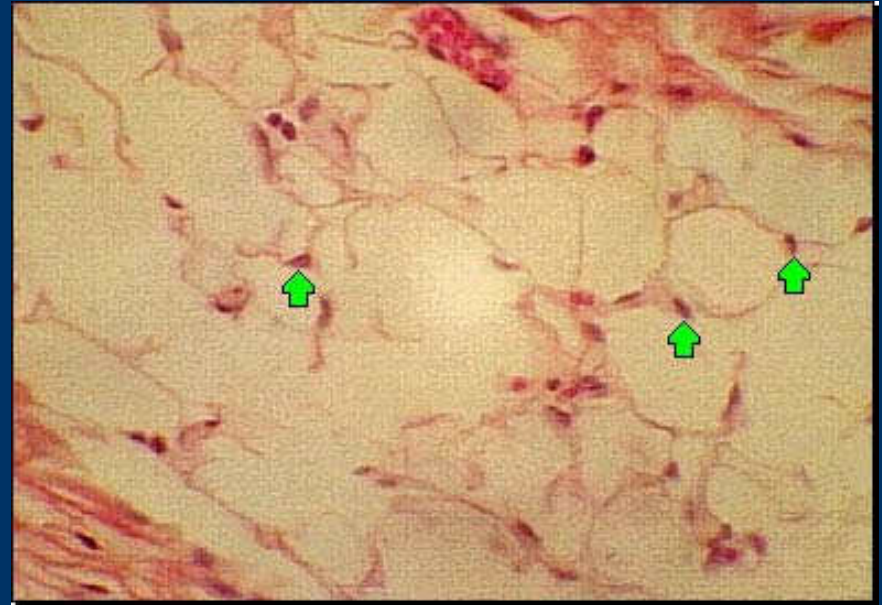


N = adipocyte nucleus C = blood capillary

Adipose cell

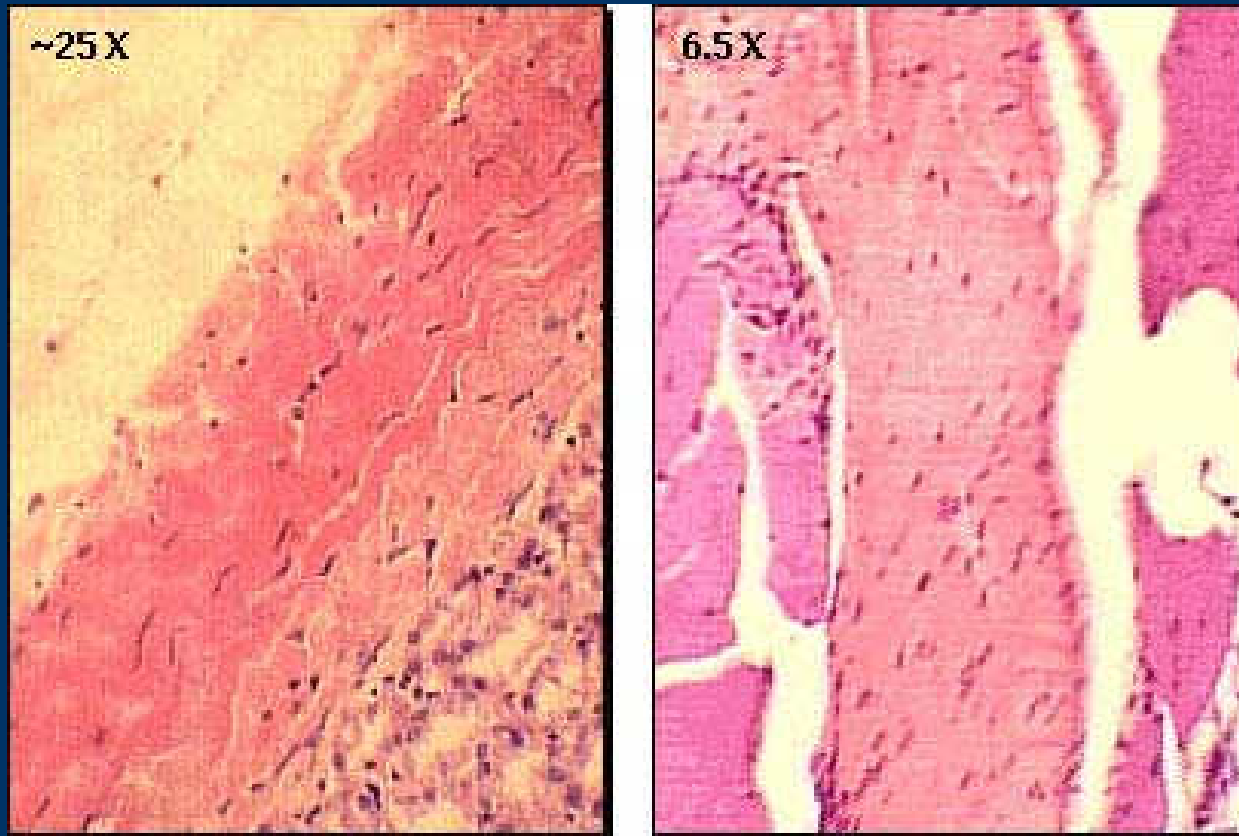


Adipose cell nuclei

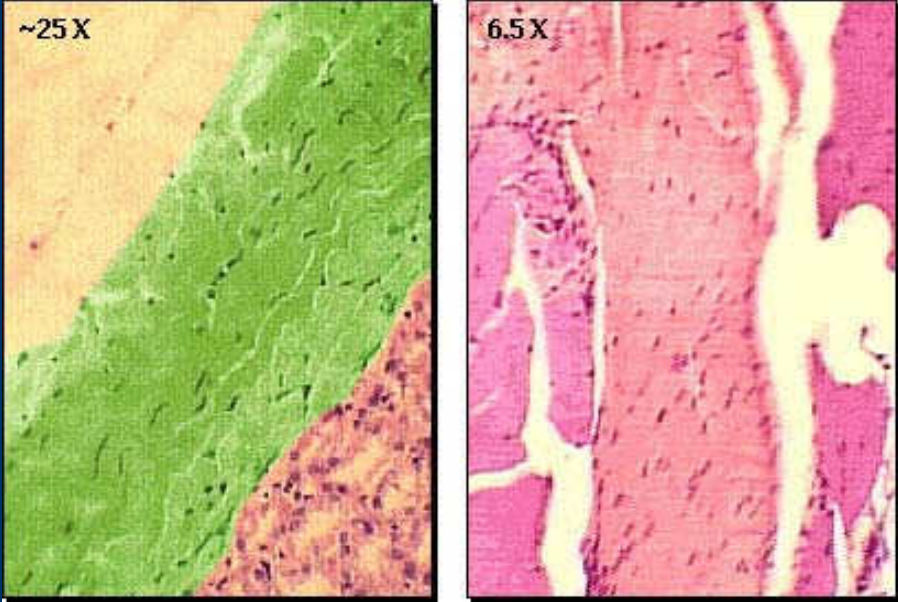
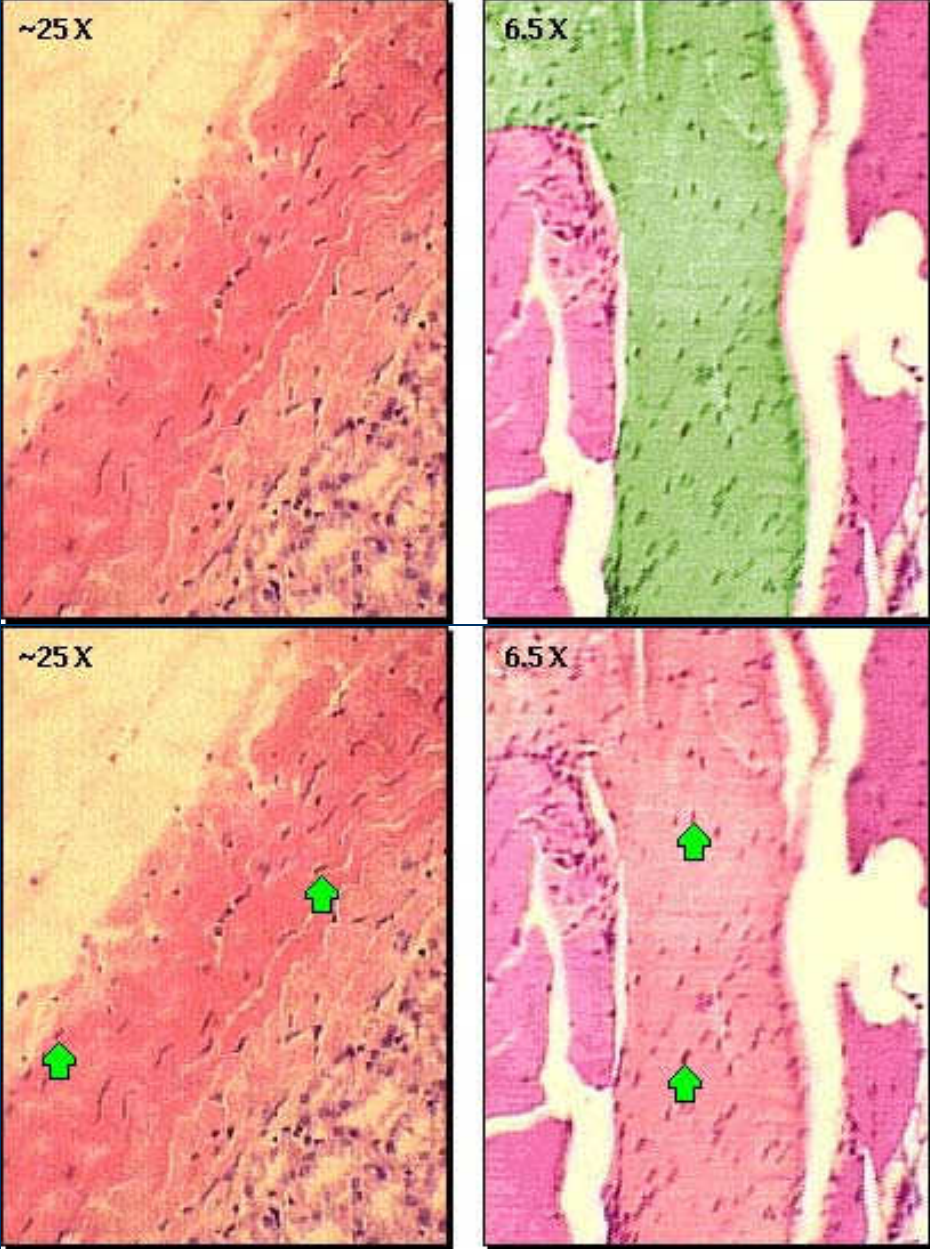


Collagen

2. Dense connective tissue has a greater proportion of fibers, fewer cells and less ground substance than loose connective tissue.



Regular dense connective tissue



Irregular dense connective tissue

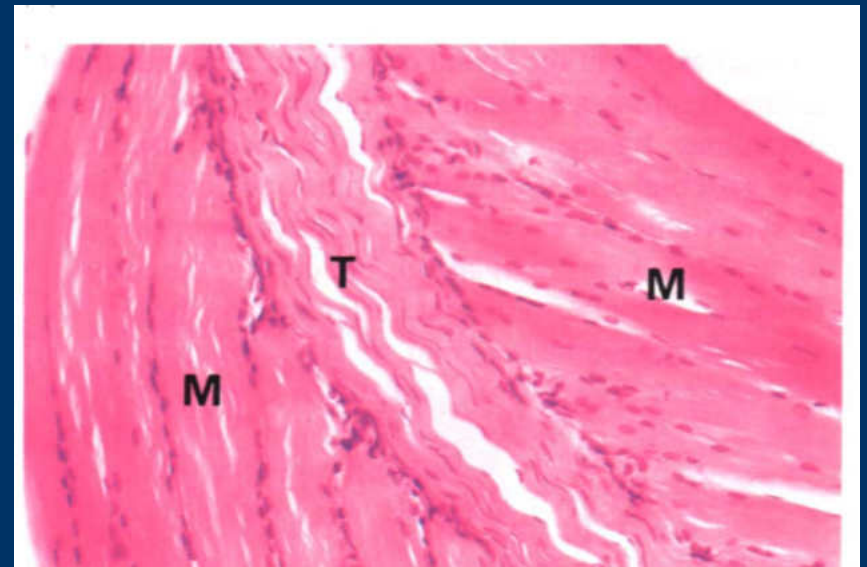
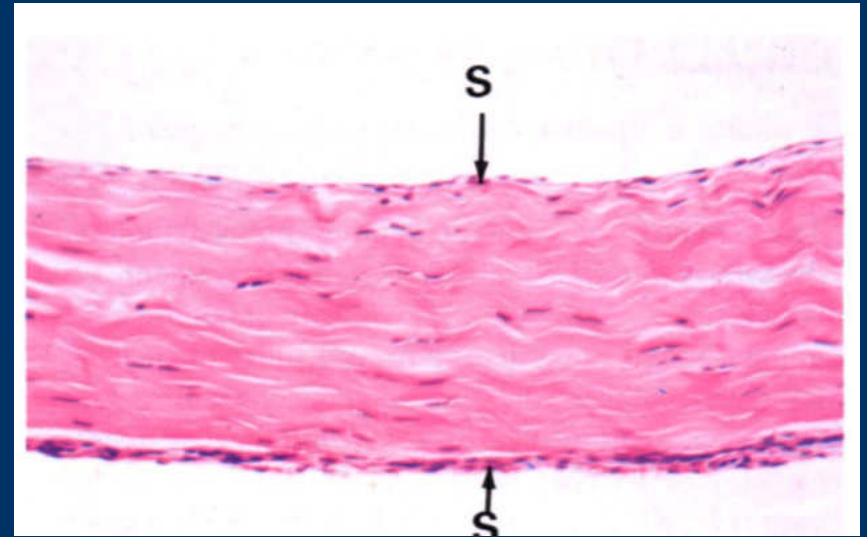
Fibroblast nuclei

Fibrous connective tissue: tendon & ligament

dense regular connective tissue

Tendon:

- densest form of collagenous supporting tissue
- consist of bundles of coarse collagen fibres and fibroblast



M = muscle

3. Cartilage

- a form of connective tissue that is much firmer than dense connective tissue.
- consists of a dense network of fibers embedded in a gel-like intercellular material which confers firmness but also permits flexibility.
- cells of cartilage are called chondrocytes (produce collagen and chondroitin sulfate)
- cartilage has no blood vessels and the cells are entirely dependent on diffusion as the source of their nutrients and oxygen.

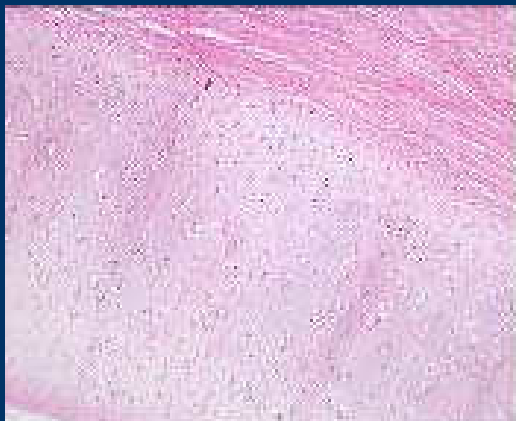
-There are various types of cartilage: hyaline, elastic and fibrocartilage

-3.1 hyaline cartilage is the most widely distributed type of cartilage found in the body.

-has an amorphous matrix of ground substance reinforced by collagen

-found at the end of bones where they articulate with one another (articular surfaces)

-and found in the nose, larynx, trachea and bronchi of the respiratory system.



trachea

-3.2 elastic cartilage

- similar architecture to hyaline cartilage
- has a collagen-containing matrix with an abundant network of elastic fibers. This allows it to be very flexible and when deformed, it immediately returns to normal position.
- found in the external ear, epiglottis and auditory tube



epiglottis

-3.3 fibrocartilage

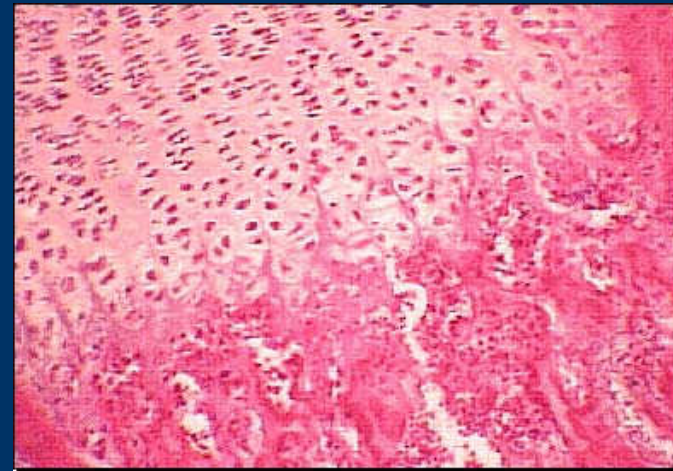
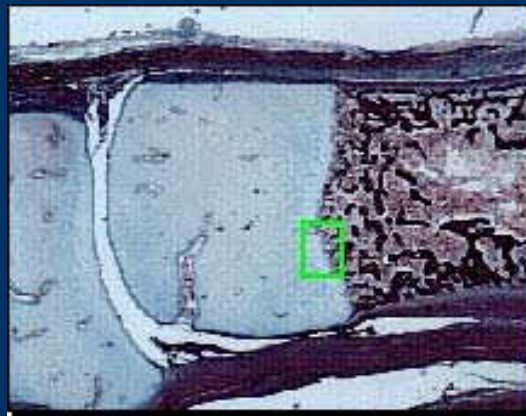
- a hybrid tissue between dense fibrocollagenous tissue and hyaline cartilage
- found in intervertebral disks and associated with dense fibrous tissue in tendons and ligaments



intervertebral
disc

Hyaline cartilage: strength and flexibility

- smooth, glassy bluish-white appearance when fresh
(*hyalos* = glass)
- precursor of the vertebrate skeleton (replaced by bone)

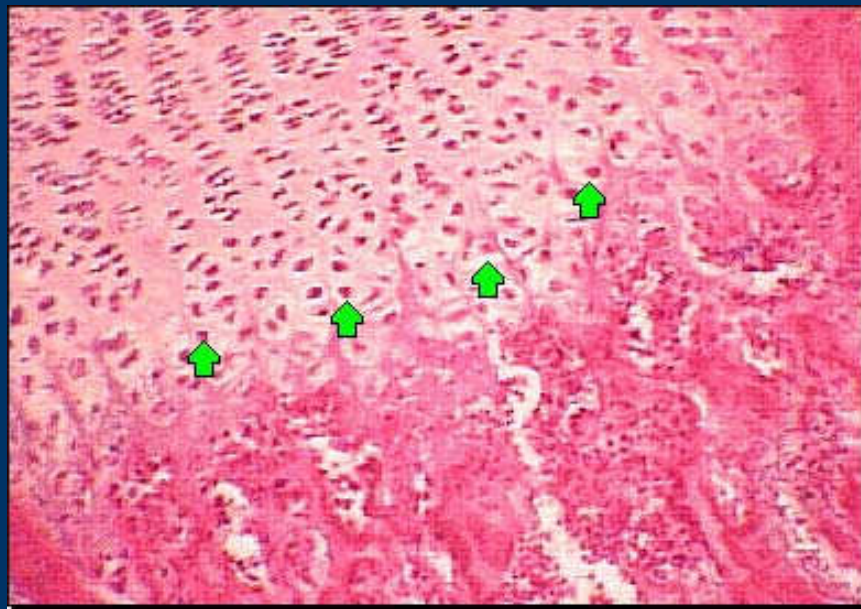
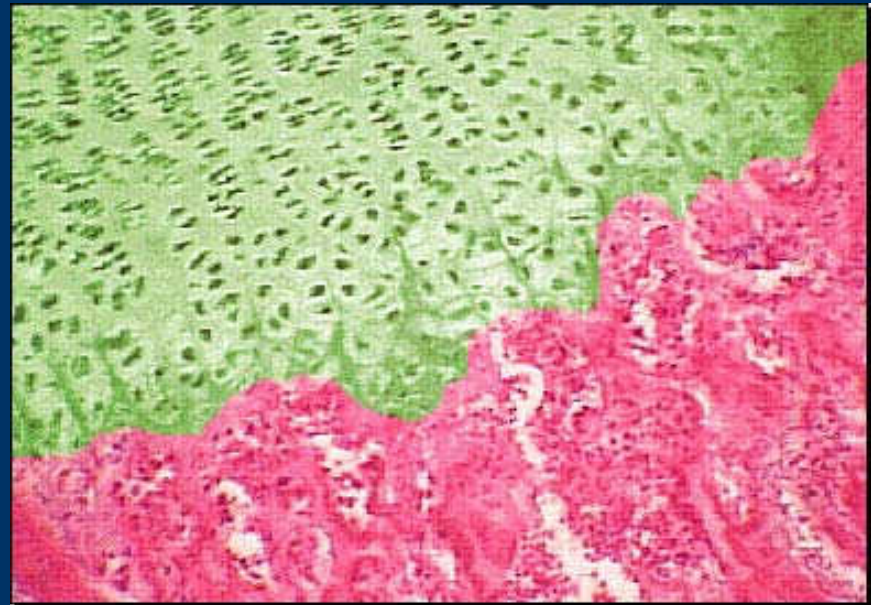


Hyaline cartilage at the articular surface of bone

bone

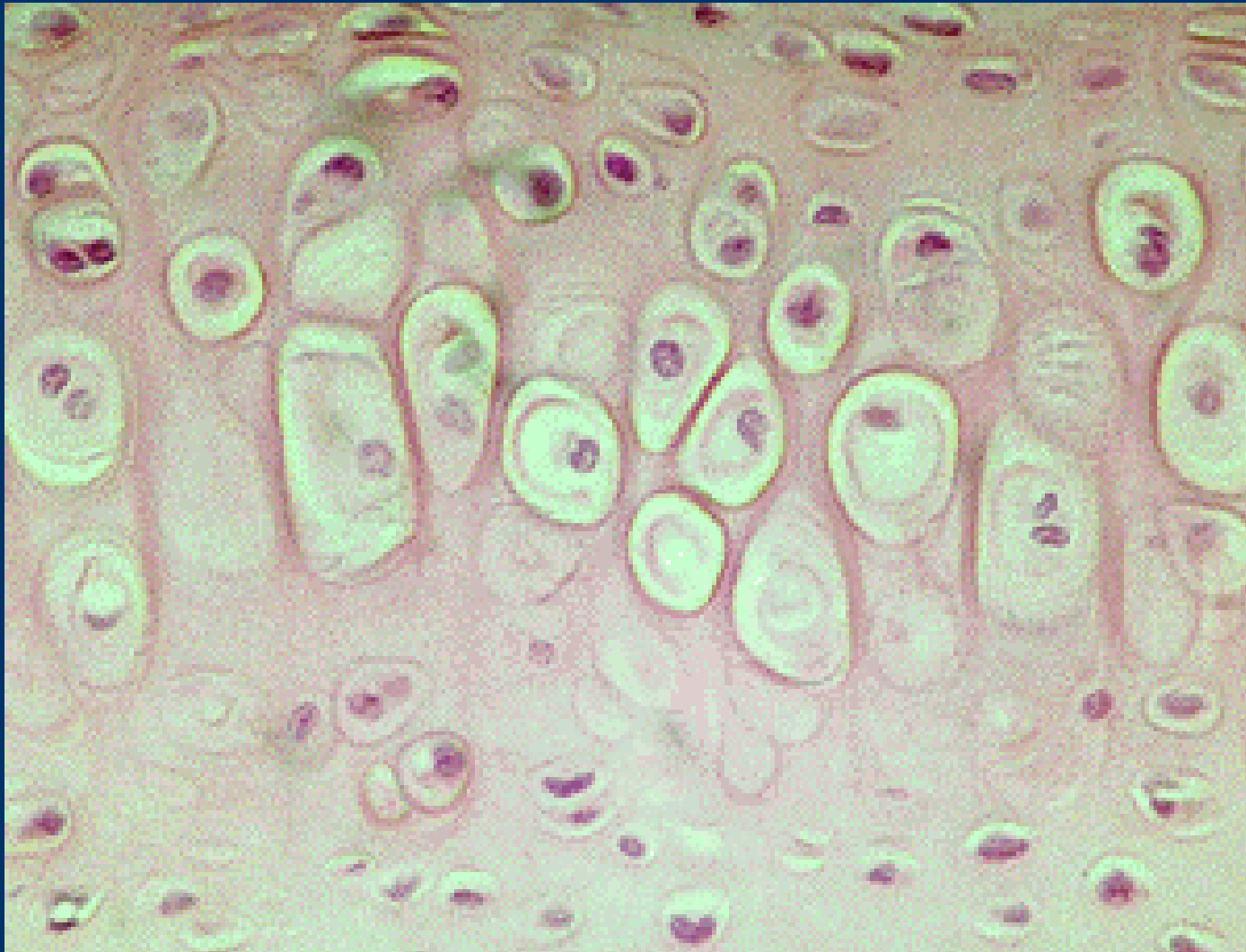


cartilage



Chondrocytes within the lacunae (cells of cartilage) -differentiate from the fibroblast surrounding cartilaginous area.

Cartilage



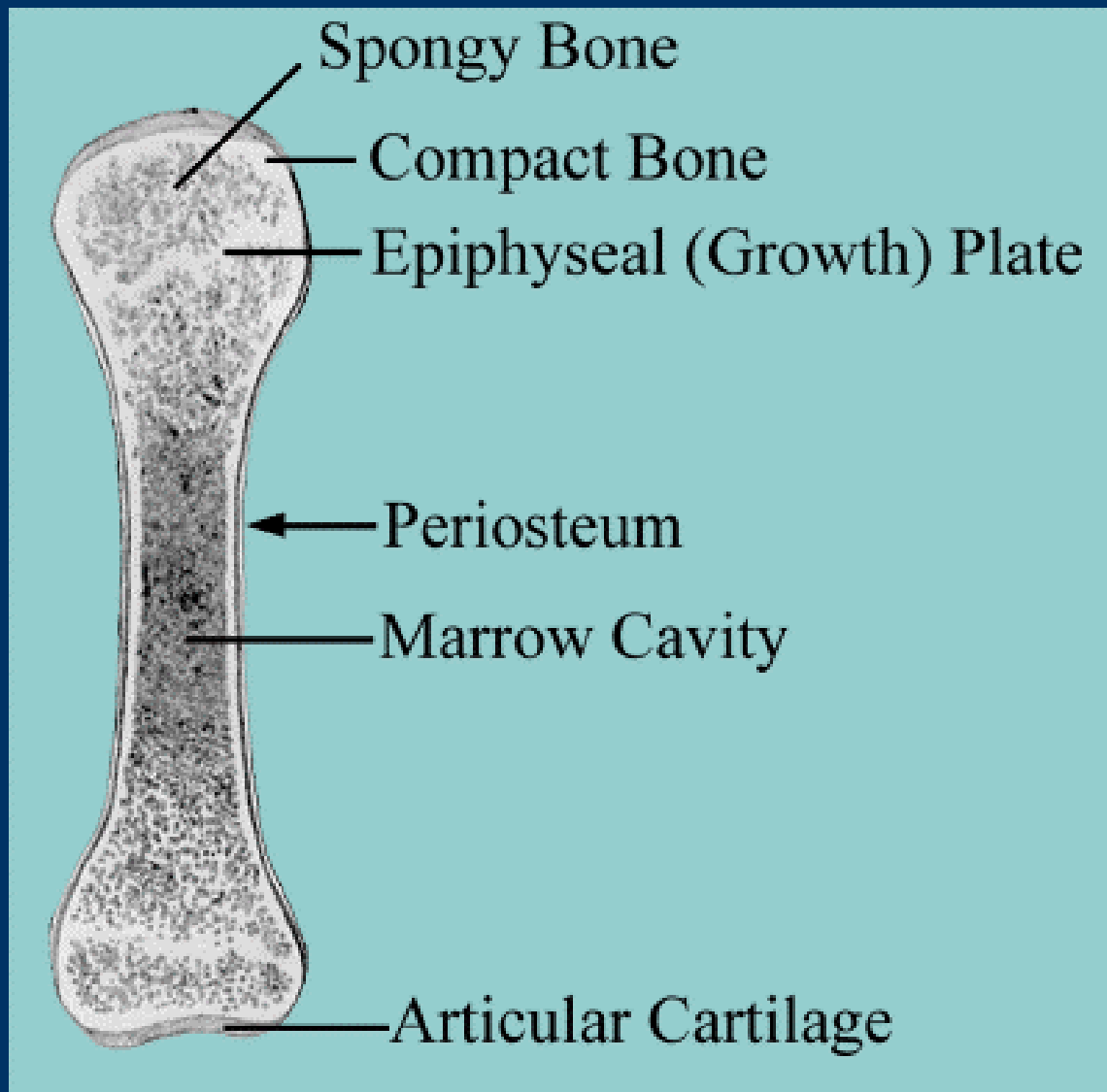
Elastic cartilage

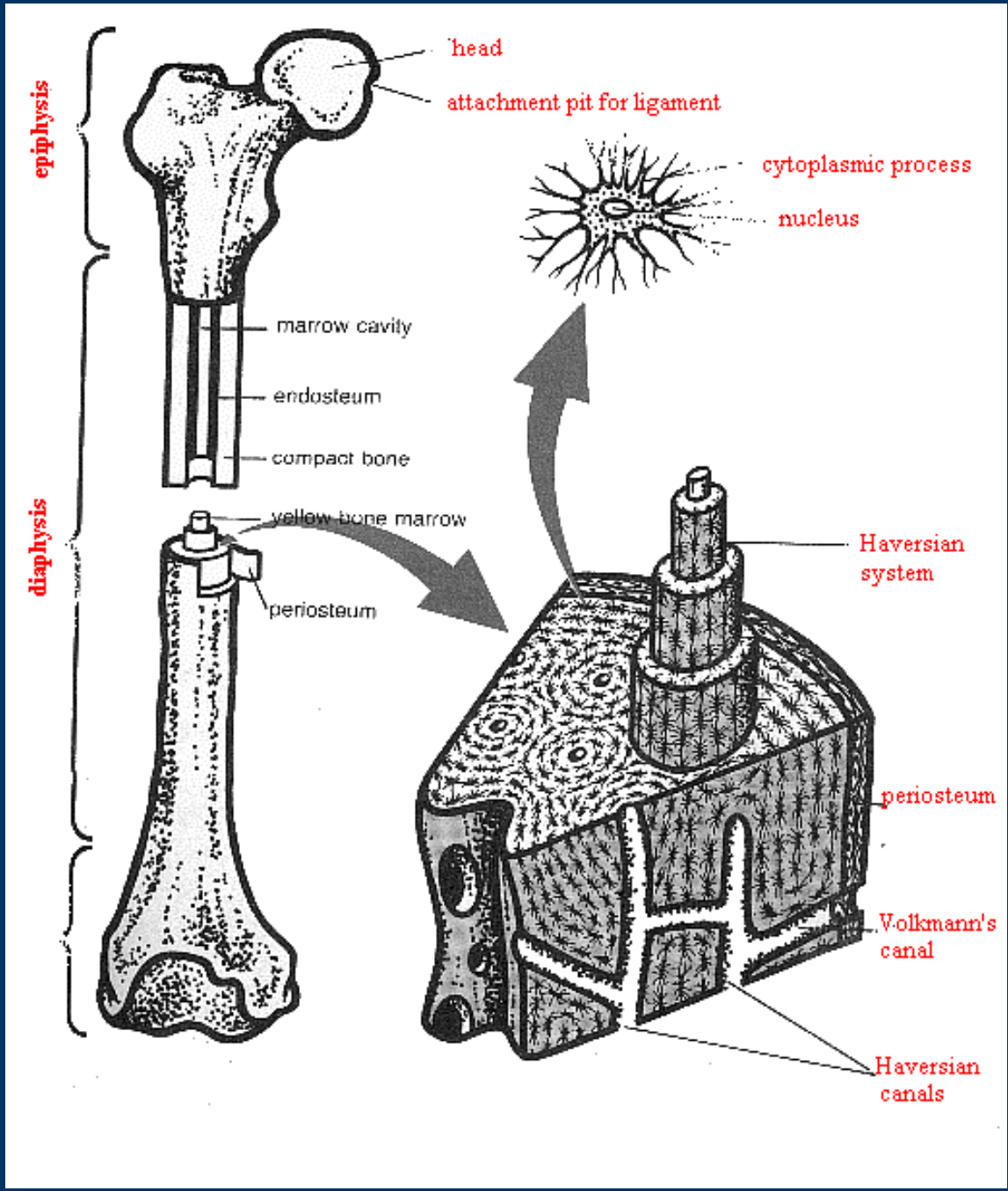
Blue = matrix containing elastic fibers
green = chondrocyte in lacunae



4. Bone

- a mineralized connective tissue = hydroxyapatite
- osteoblasts = bone-forming cells deposited in a matrix of collagen
- once osteoblasts are trapped in their secretion, they are called osteocytes
- compact bone consists of repeating unit called osteon or Haversian system





Bone is a rigid form of connective tissue and is much firmer than cartilage. The hardness of a bone (equal to that of cast iron!) is caused by the presence of calcium phosphate; the small degree of elasticity possessed by bone is caused by the presence of organic collagen fibers. The cells of bone are called osteocytes. Unlike cartilage, bone contains small tubular canals through which the cells are nourished. Bone exists in two forms: compact and spongy.



spongy bone



muscle



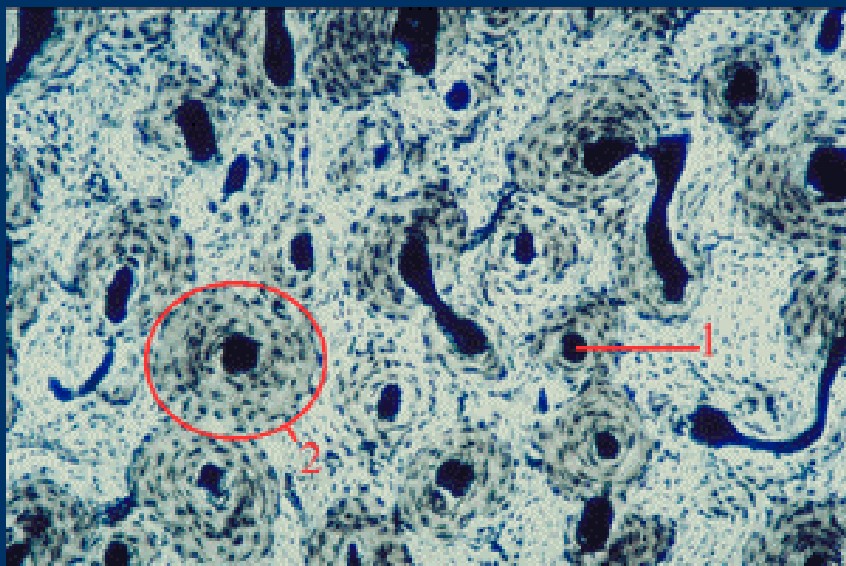
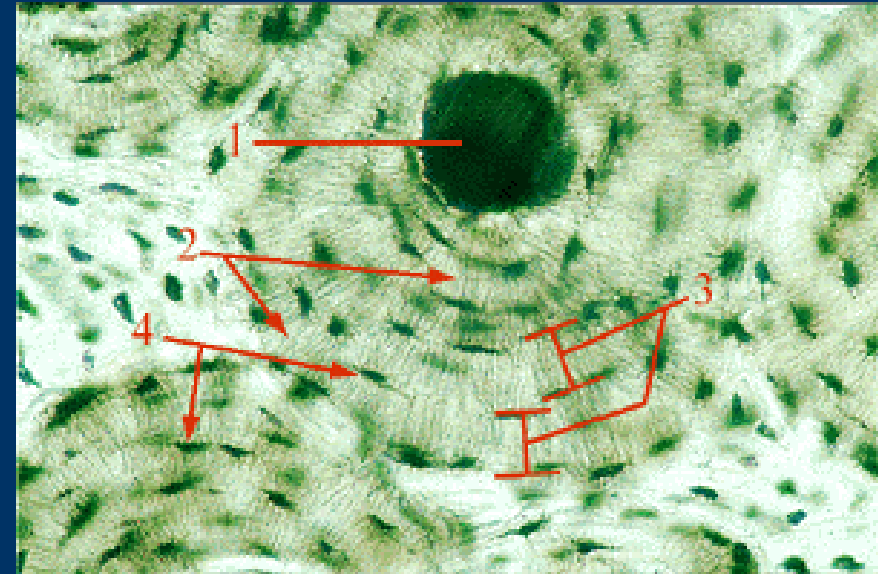
compact bone



marrow

Composition of compact bone:

- the Haversian canal (1)
- canaliculi (2)
- lamellae (3) -lacunae (4)

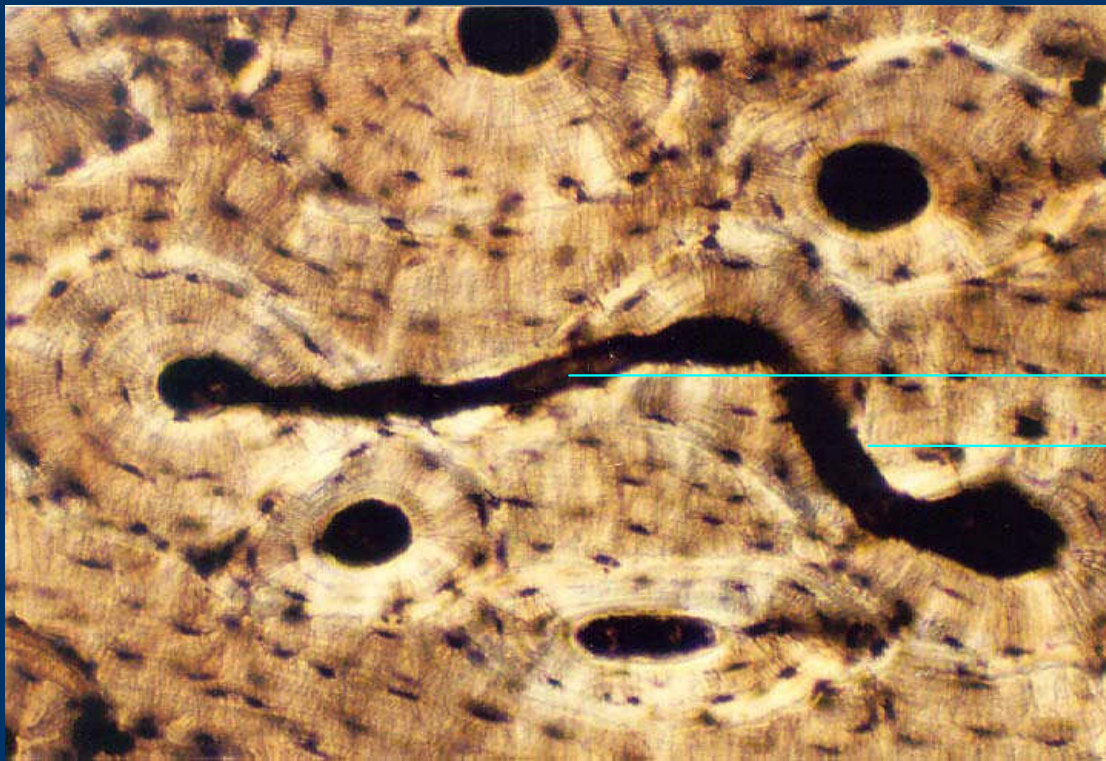


- 1 = Haversian canal
- 2 = Haversian system

-The lamellae form the bone matrix surrounding the Haversian canal which carry blood vessels and nerve to and from the bone.

-The lacunae are spaces in the bone where the osteocytes are located.

-Canaliculi is a system of small tubes in the bone which connect lacunae.



▶ Volkmann's canal

On this slide, all the living tissue has been removed in the preparation, so the lacunae, canaliculi and Harvesian canals all appear only as black spaces within the inorganic matrix (lamellae) of the bone.

5. Blood

-matrix = plasma consisting water, salts and dissolved proteins

-blood cells

1. erythrocytes = red blood cells

2. leucocytes = white blood cells

granulocytes

neutrophile

basophile

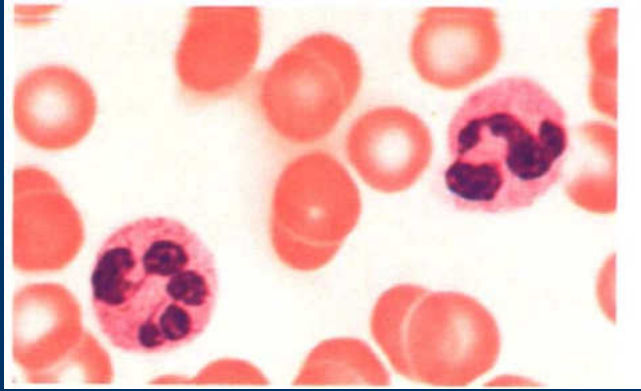
eosinophile

agranulocytes

monocytes

lymphocytes

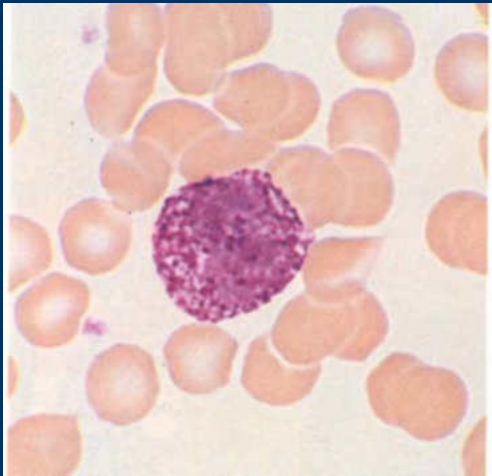
3. blood platelet



neutrophile



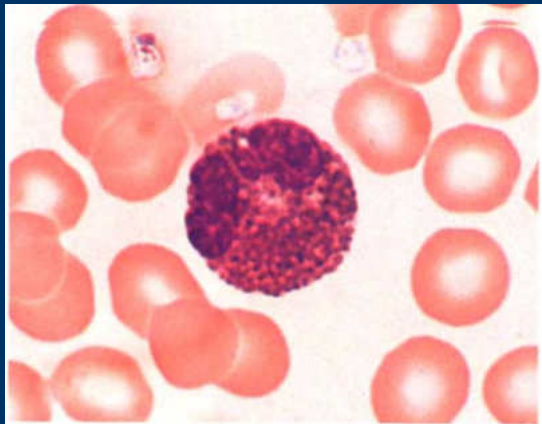
lymphocytes



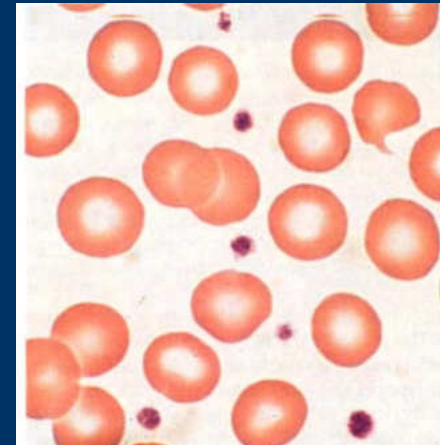
basophile



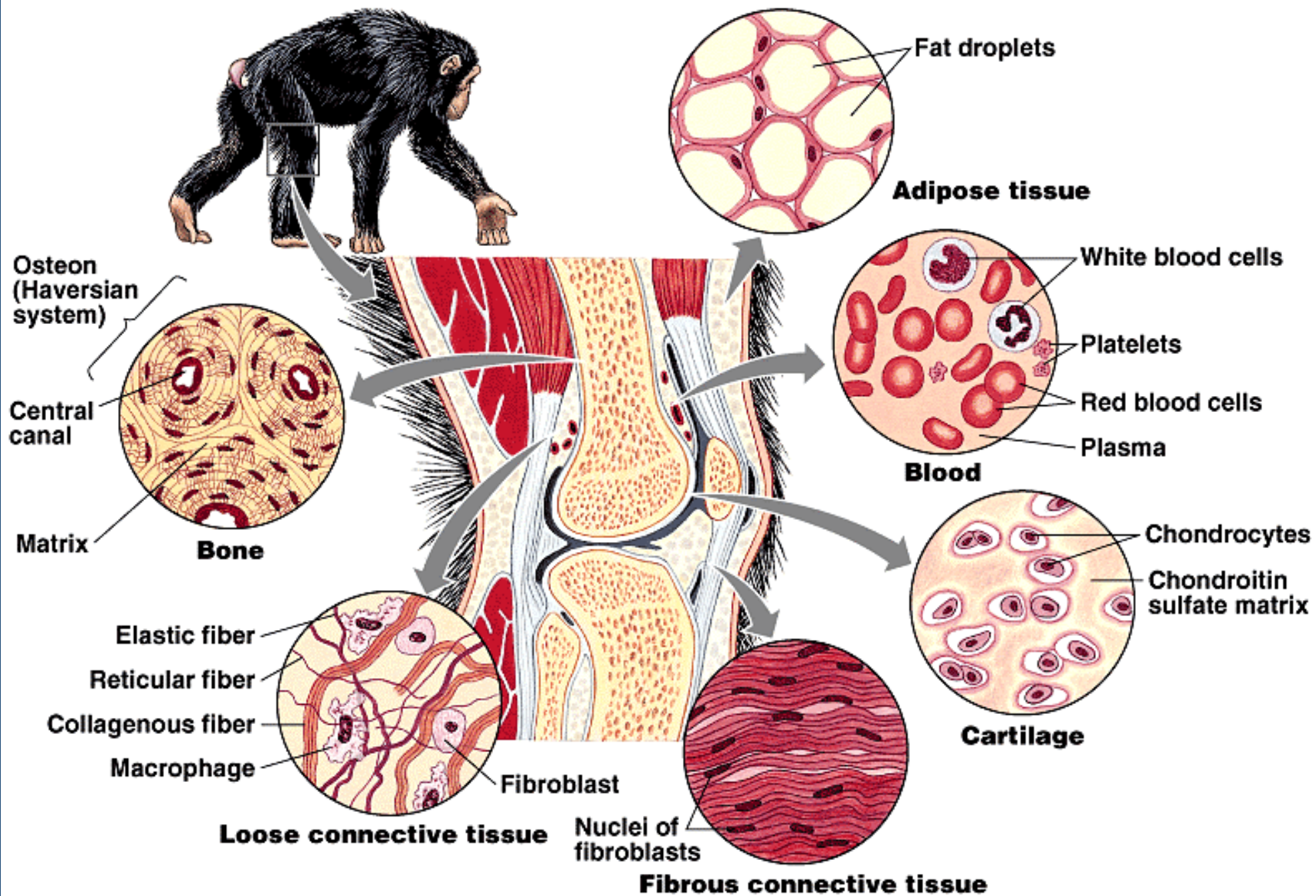
monocytes



eosinophile



platelet



Connective Tissue Review

- Connective tissue is one of the four basic tissues.
- It is made of of **cells**,(e.g. fibroblasts, chondrocytes and osteocytes); **extracellular fibers** (e.g. reticular, elastic and collagen); and **ground substance**.
- Small amounts of connective tissue are found intermingled with other tissues throughout all organs of the body.
- Depending on the type (e.g. loose, dense), connective tissue may serve different functions; including structural support, connections, elasticity and protection.
- Blood cells (erythrocytes and leukocytes) and platelets are considered to be connective tissue.

Muscle tissue

Muscle tissue is one of the four basic tissues. Muscle cells are contractile cells. Specialized proteins allow the cells to shorten. Their ability to contract provides a mechanism for movement of the internal organs and locomotion of the entire organism.

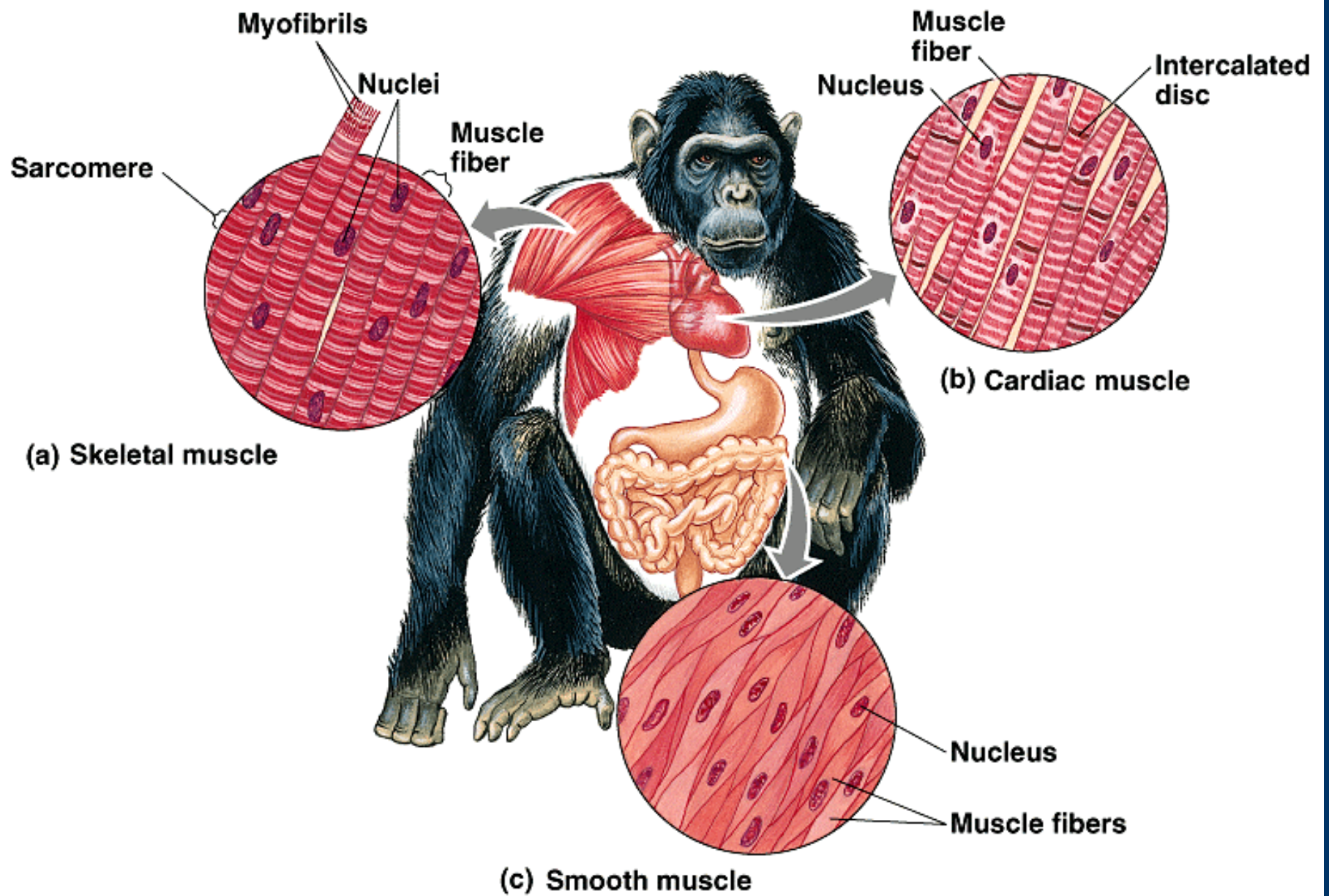
Muscle tissue can be divided into 3 major types: Skeletal, Cardiac and Smooth.

Skeletal muscle is attached to bones.

Cardiac muscle is found in the heart.

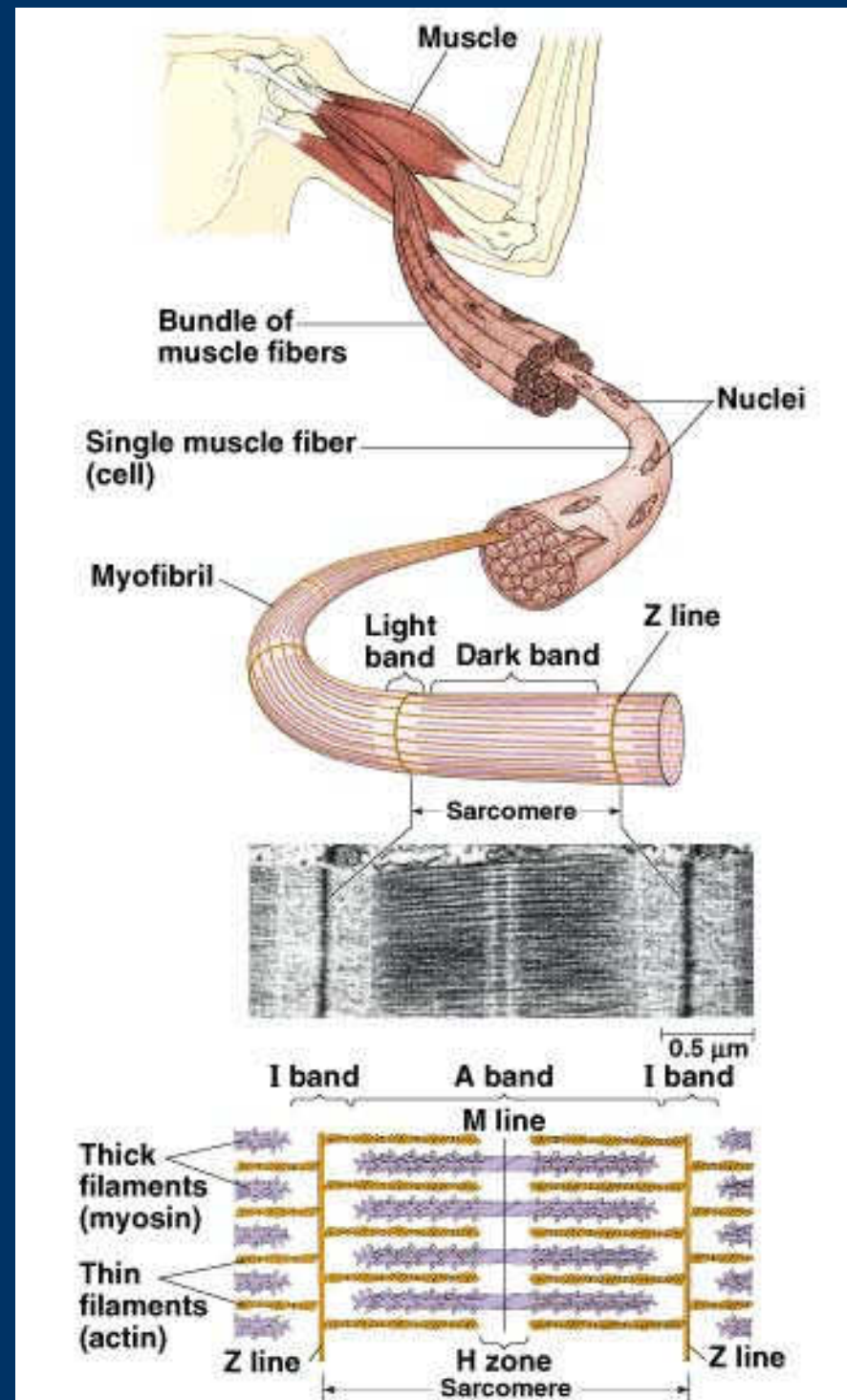
Smooth muscle is found in vessels, ducts, skin, and internal organs.

Muscle tissue is may be controlled by nerves, hormones, local chemicals, or itself depending on the type and location.



Skeletal muscle

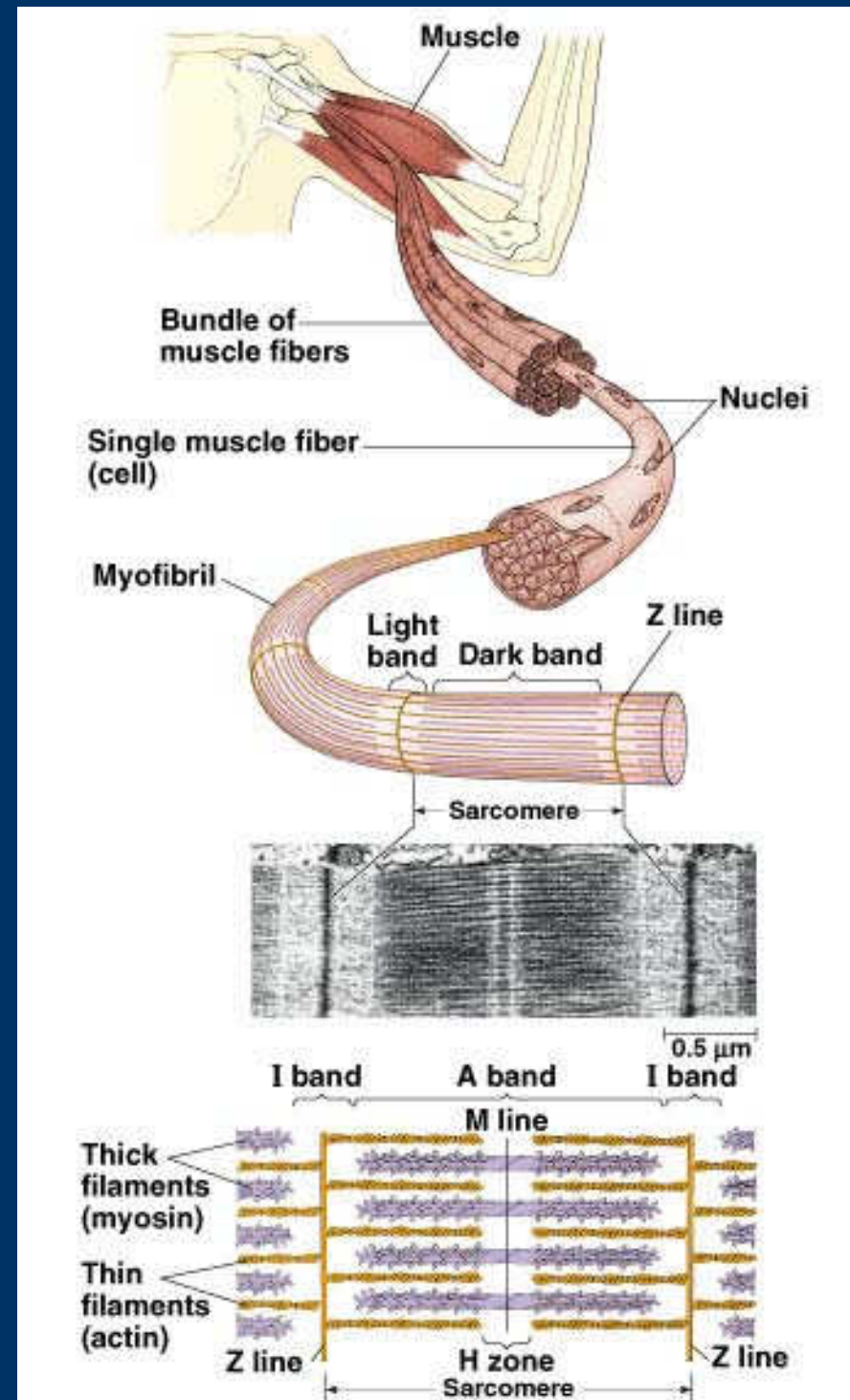
- under voluntary control.
- attaches to bones or fascia and constitutes the flesh of the limbs and body wall.
- the muscle cells (myofibers) are long, multinucleated and arranged in parallel bundles.
- unlike smooth and cardiac muscle, each skeletal myofiber is innervated by a neuron.

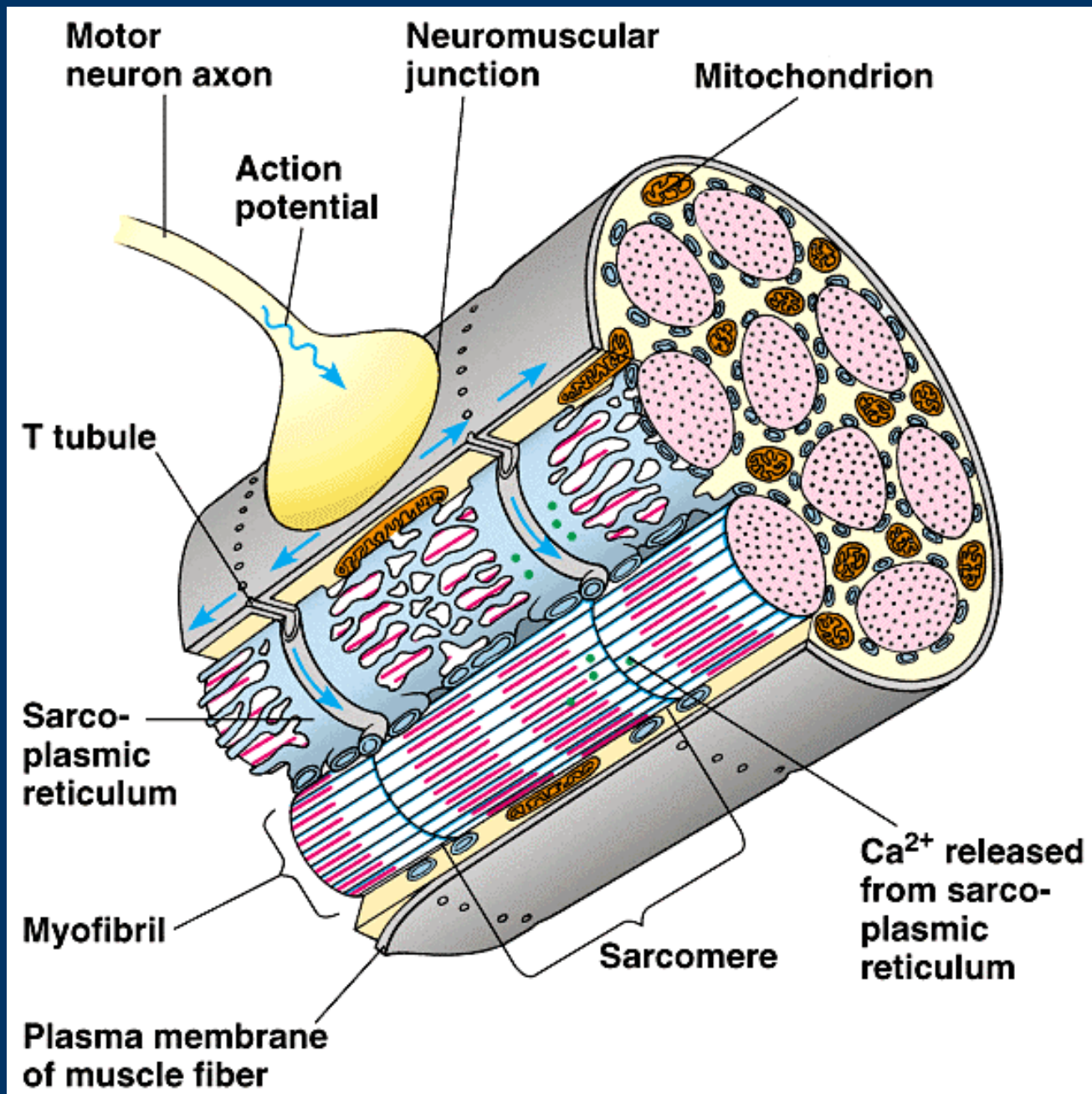


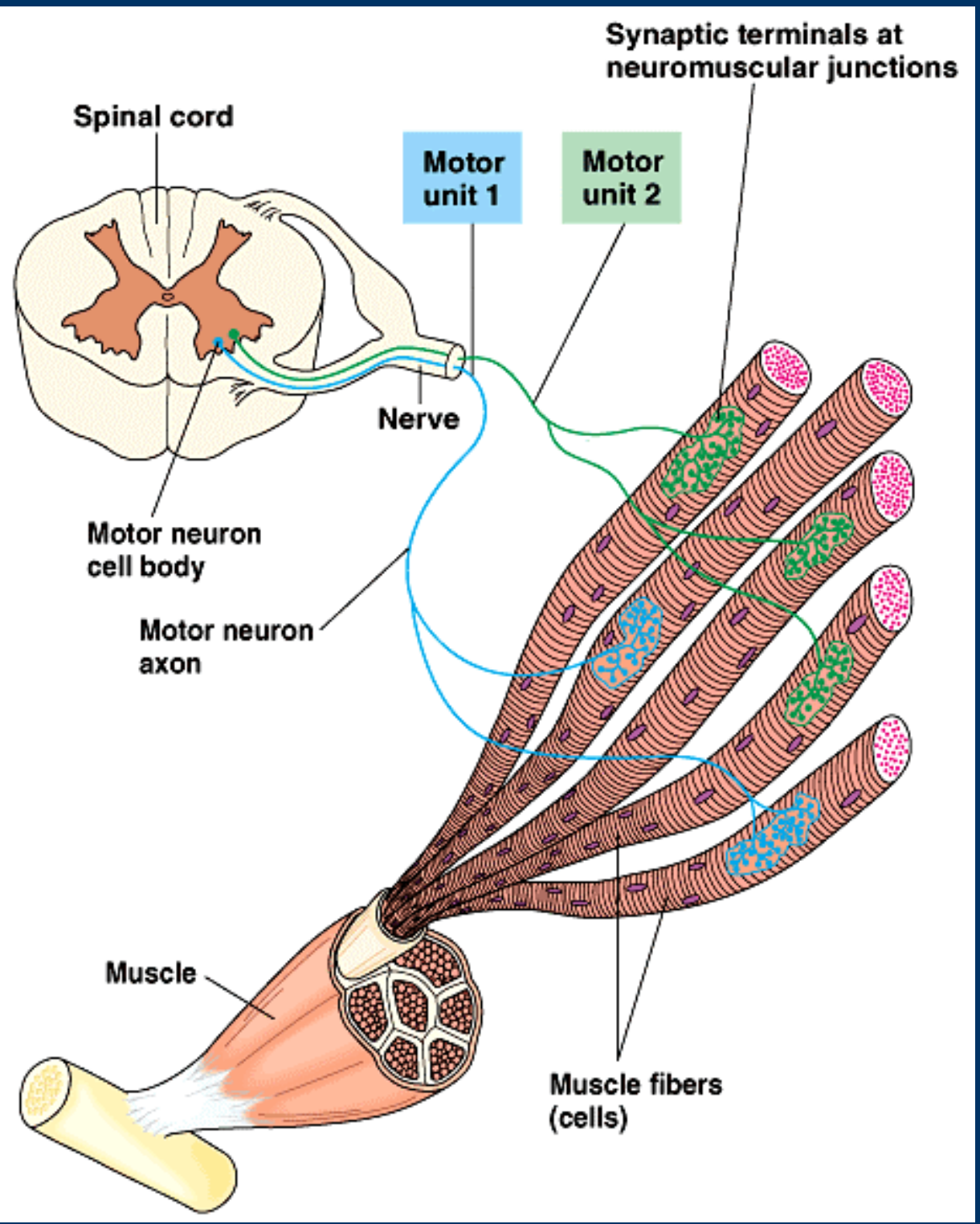
-By light microscopy, the cells of both cardiac and skeletal muscle show the presence of transverse striations.

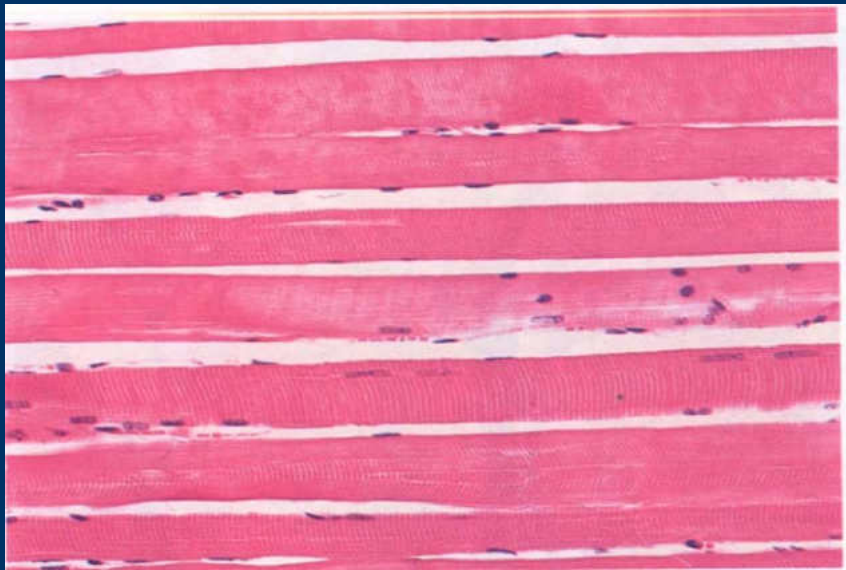
-For this reason, both of these muscle types are referred to as "striated"

-The striated appearance results from the presence of a highly organized network of actin and myosin protein filaments which utilize cellular energy and function in muscle contraction

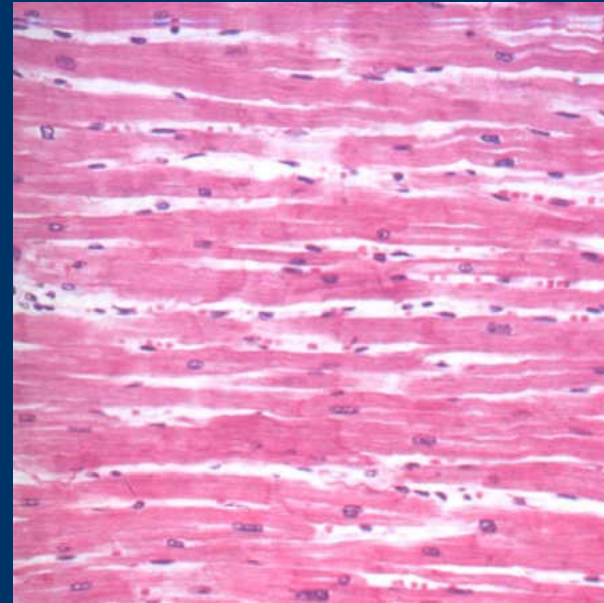








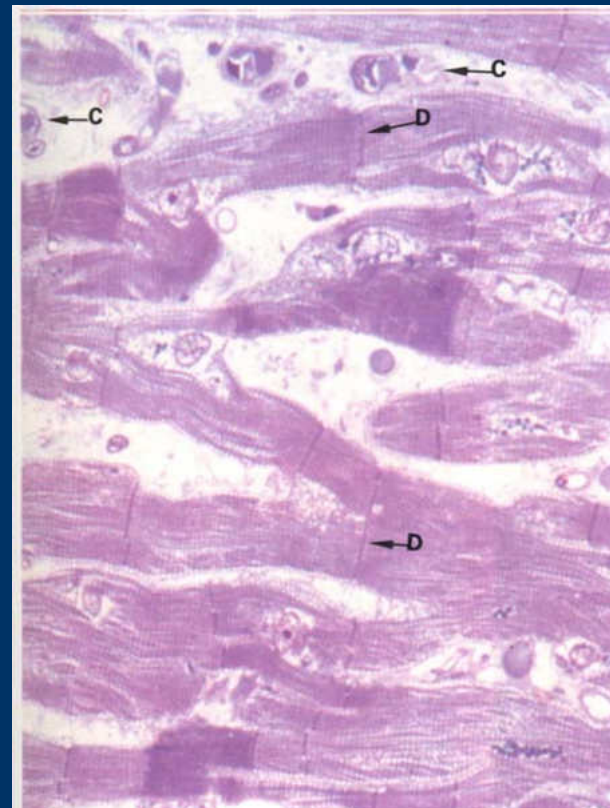
Skeletal muscle



Cardiac muscle



Smooth muscle



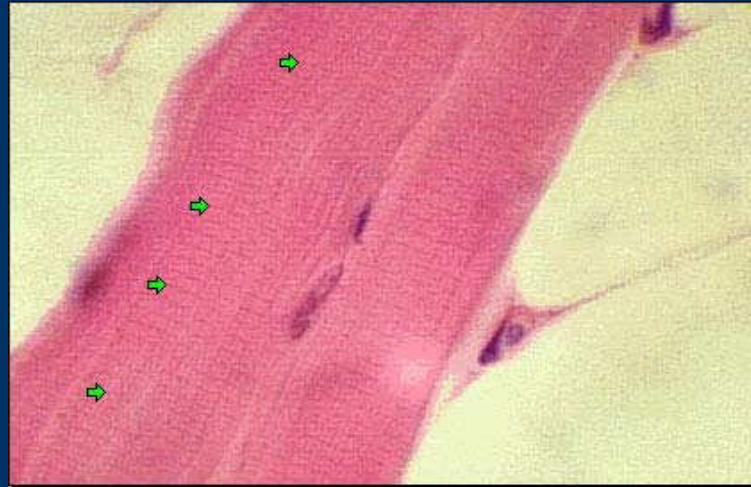
D
=intercalated
discs
C = blood
capillary

Skeletal muscle

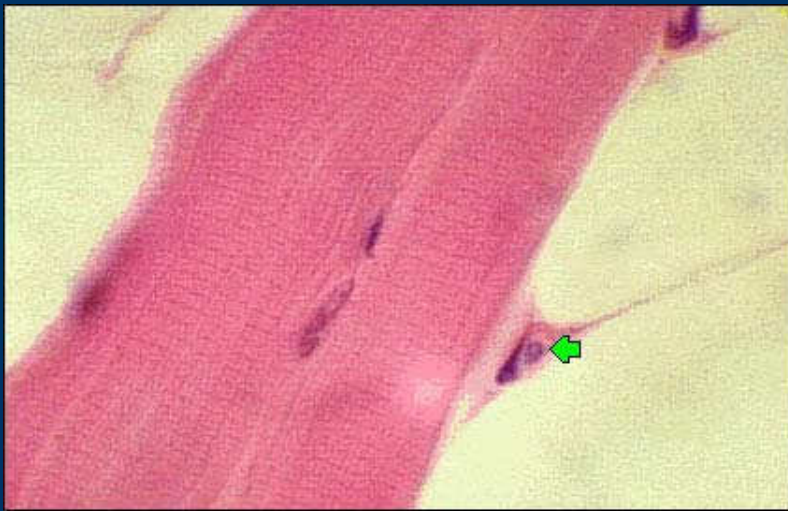
By light microscopy, the cells of both cardiac and skeletal muscle show the presence of transverse striations. For this reason, both of these muscle types are referred to as "striated." The striated appearance results from the presence of a highly organized network of actin and myosin protein filaments which utilize cellular energy and function in muscle contraction.



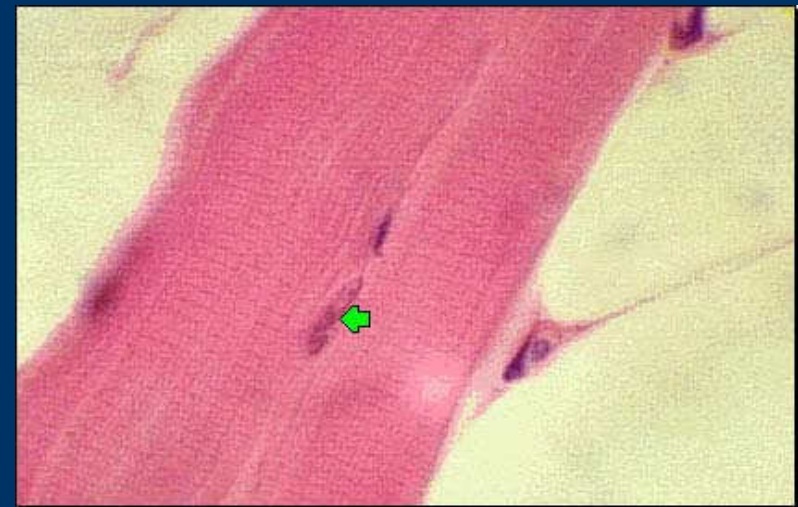
Skeletal muscle



striation

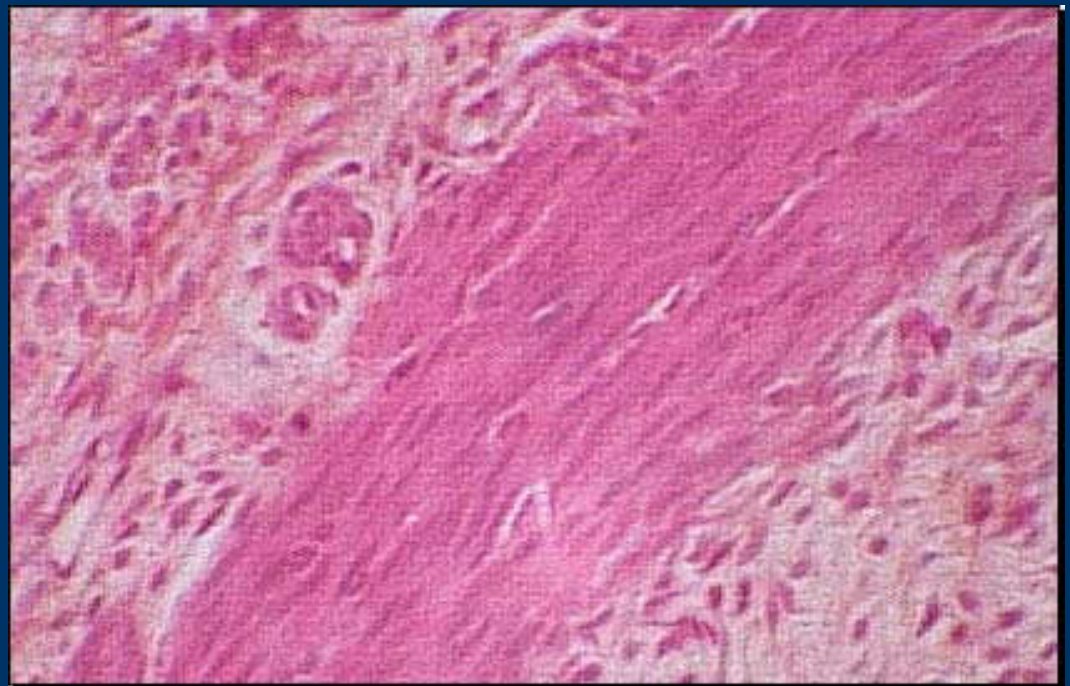
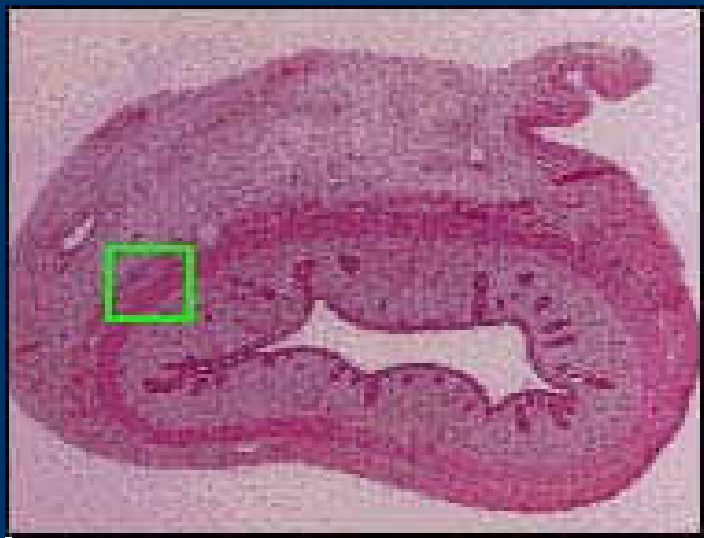


Connective tissue
nucleus



Skeletal muscle cell
nucleus

Smooth muscle is not under voluntary control and comprises the walls of most of the viscera and blood vessels of the body. There is one centrally placed nucleus per cell. Unlike skeletal muscle, smooth muscle cells (myofibers) are not generally individually innervated. Instead, adjacent smooth myofibers may form junctions with one another which permits the spread of excitation and contraction to pass from one cell to another.

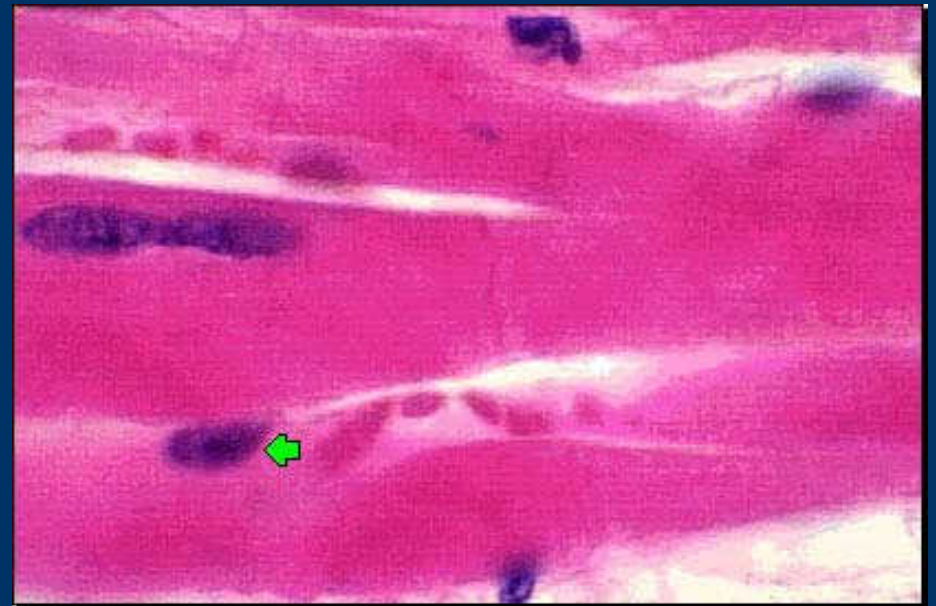
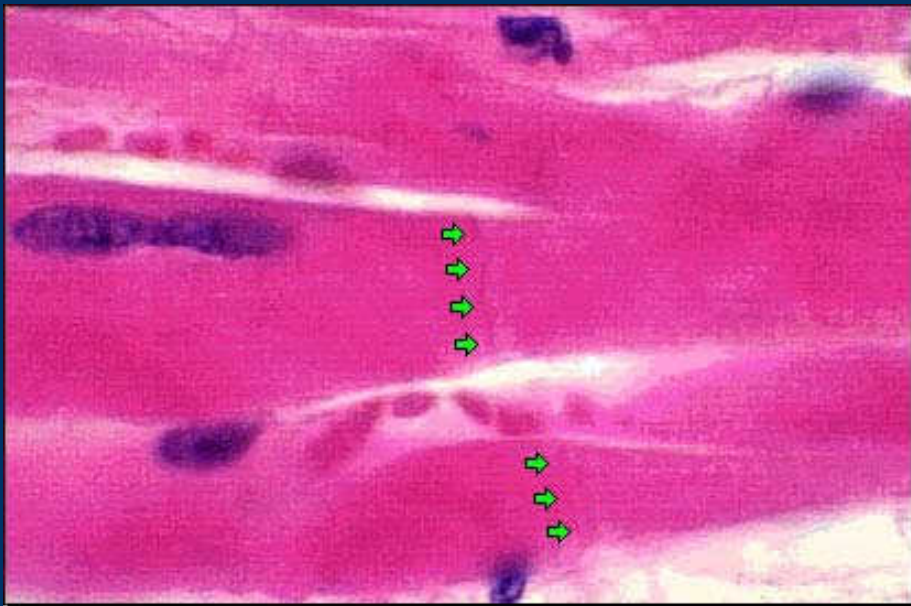


Cardiac muscle is involuntary, striated in appearance and contracts rhythmically and automatically. It is found only in the myocardium (the muscle layer of the heart). Each cell has a single, centrally located nucleus and joins end to end with other cardiac muscle cells at specialized junctional zones called intercalated discs. These junctions allow the spread of excitation to pass from one fiber to another and harness the contraction of individual cells so that overall muscle shortening can occur.



Intercalated disc

These junctions allow the spread of excitation to pass from one fiber to another and harness the contraction of individual cells so that overall muscle shortening can occur.



Muscle cell nucleus

Each cell has a single, centrally located nucleus.

Muscle Tissue Review

- Muscle tissue is one of the four basic tissues.
- It contains contractile proteins actin and myosin.
- Skeletal muscle is attached to bones, is under voluntary control, has long multinucleate cells (myofibers), and appears striated.
- Cardiac muscle is found only in the heart, is self activating, and has single nucleate cells that are electrically connected via special junctions. It appears striated.
- Smooth muscle is in the vessels and viscera. It is non-striated, involuntary, single nucleate, & may have special junctions between the cells .

Nervous Tissue

- It is composed of two major types of cells: **neurons** and **support cells (glia)**.
- Neurons are specialized for sending signals (=electrical impulse) rapidly over long distances to other cells.
- Neurons have a wide variety of shapes depending on their location and function.
- Different parts of the neuron are specialized for different tasks.
- Nervous tissue can be considered either central (brain and spinal cord) or peripheral (nerves).

-Glial (glue) cells or neuroglia are supportive cells, providing nourishment and other aids to neuron function.

-They too have a wide variety of shapes and sizes depending on the particular type.

-astrocytes (astroglia)

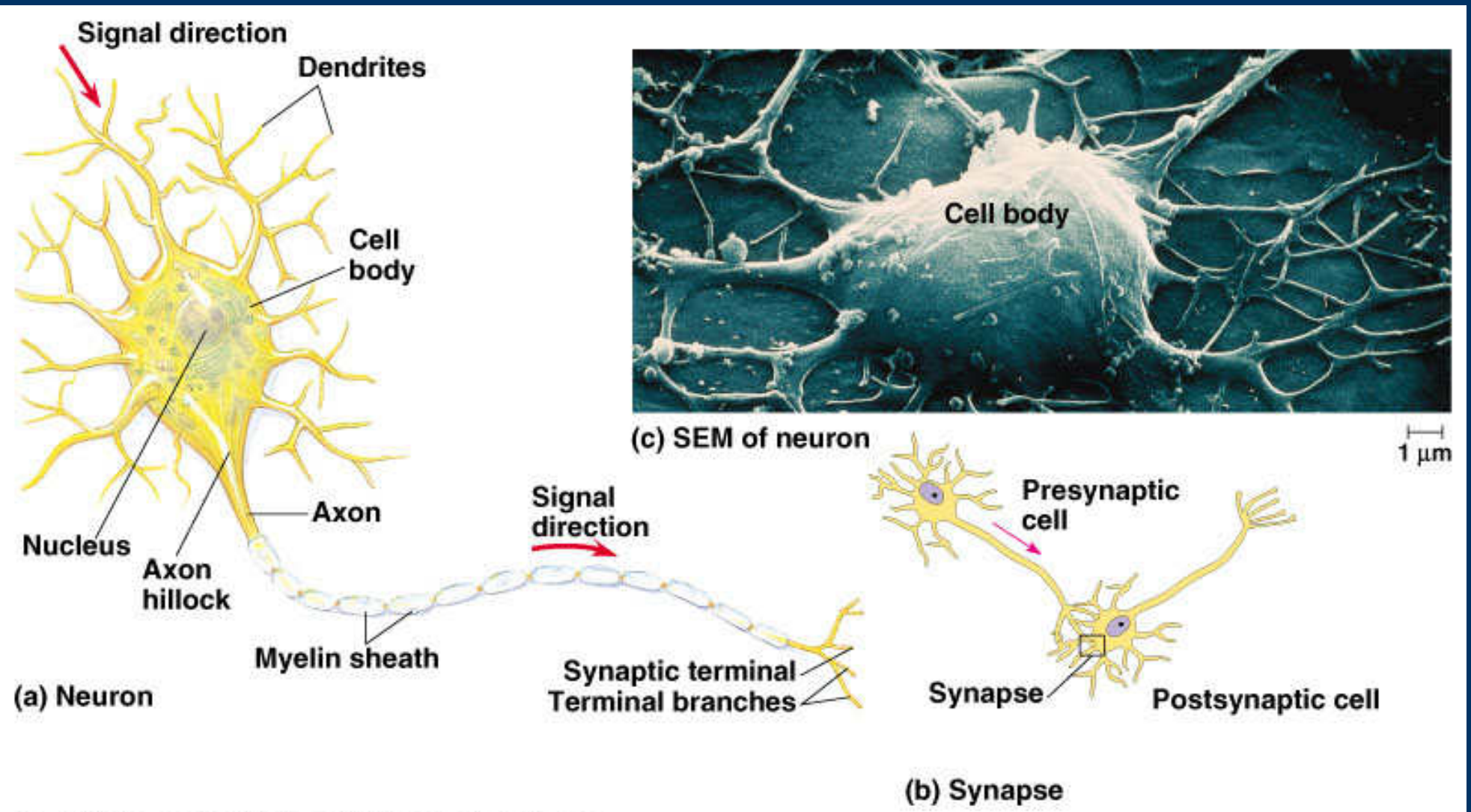
provide physical support to neurons

clear up debris

surround capillaries in the brain (=blood brain barrier)

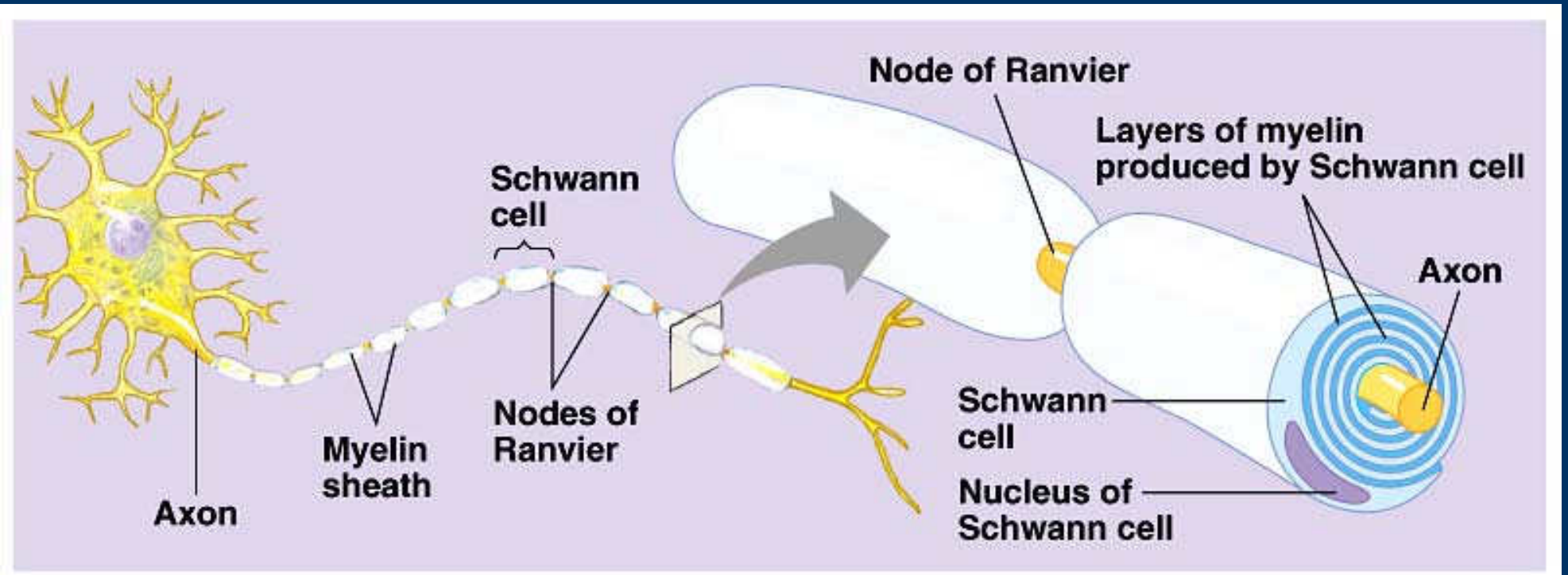
-oligodendrocytes produce myelin sheaths around axon in the central nervous system (CNS)

-Schwann cells produce myelin sheaths around axon in the peripheral nervous system



Vertebrate motor neuron

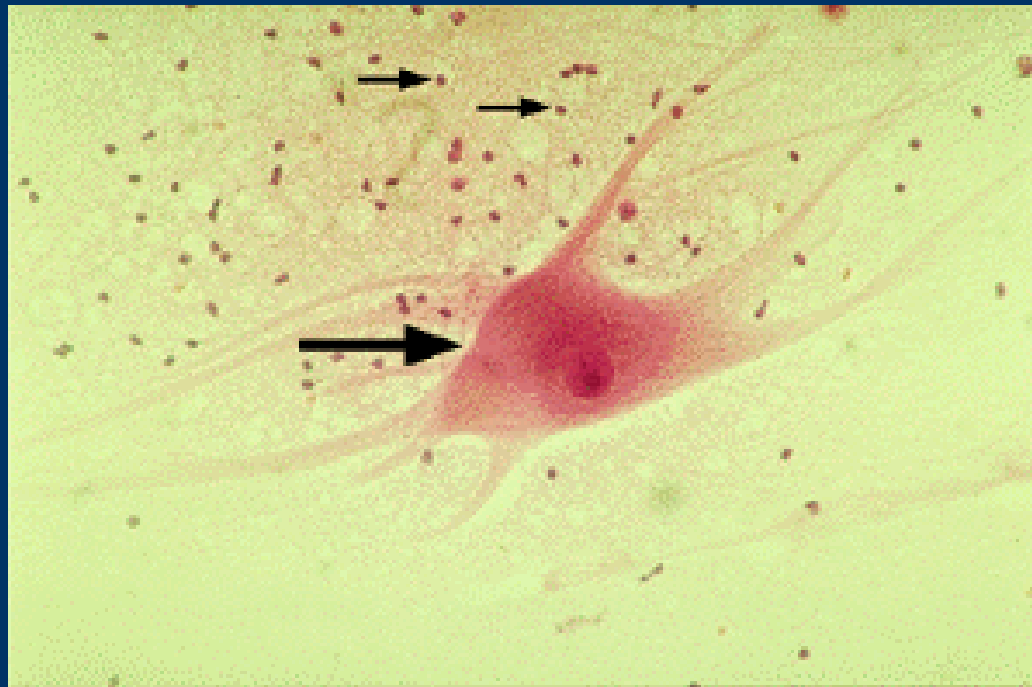
In general, neurone impulses are conveyed along **dendrites toward the nerve cell body** whilst **axons** usually convey impulses **away from the nerve cell body**.

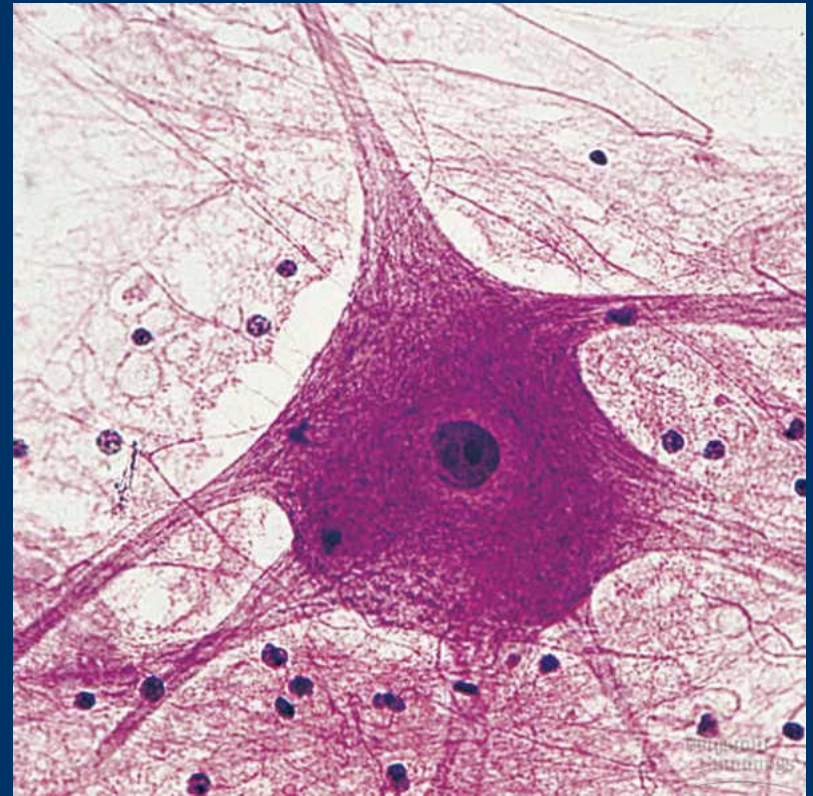
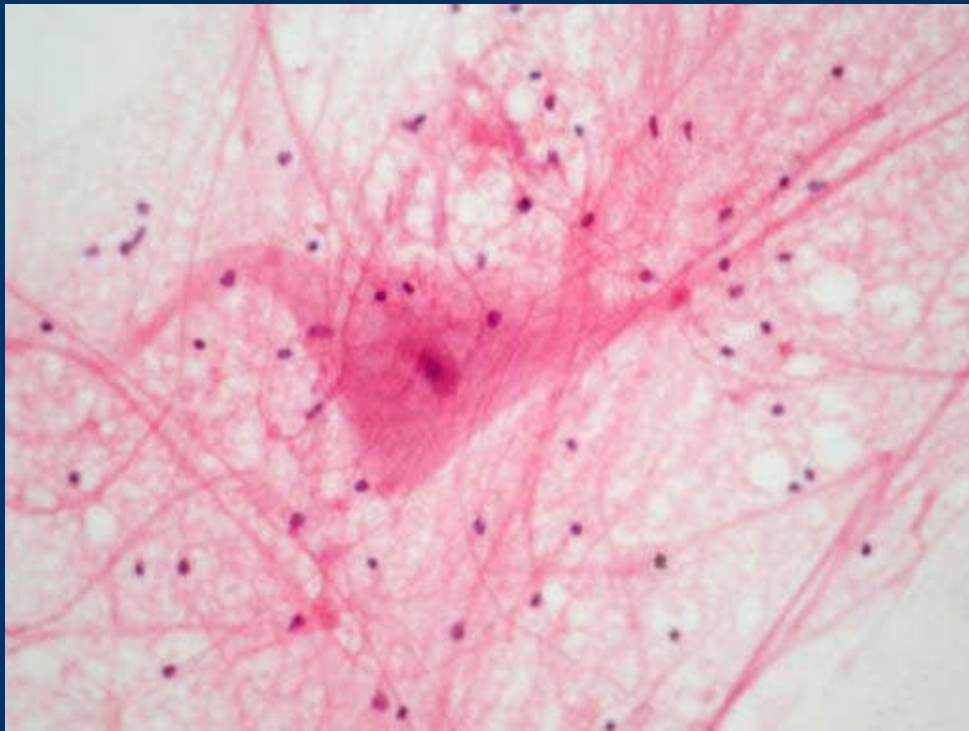


In the PNS, Schwann cells form an insulating myelin sheath around axons.

Node of Ranvier = gap between successive Schwann's cell.

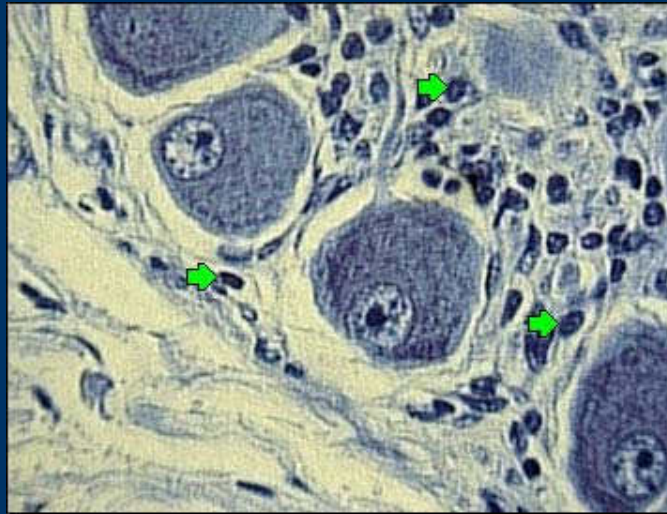
This slide is a smear from a mammalian spinal cord showing an isolated neuron (large arrow) and the nuclei of the surrounding neuroglial cells (small arrows). Note the numerous cytoplasmic extensions emanating from the neuronal cell body and the size of the neuron compared with the neuroglial cells.







Cell bodies of neuron

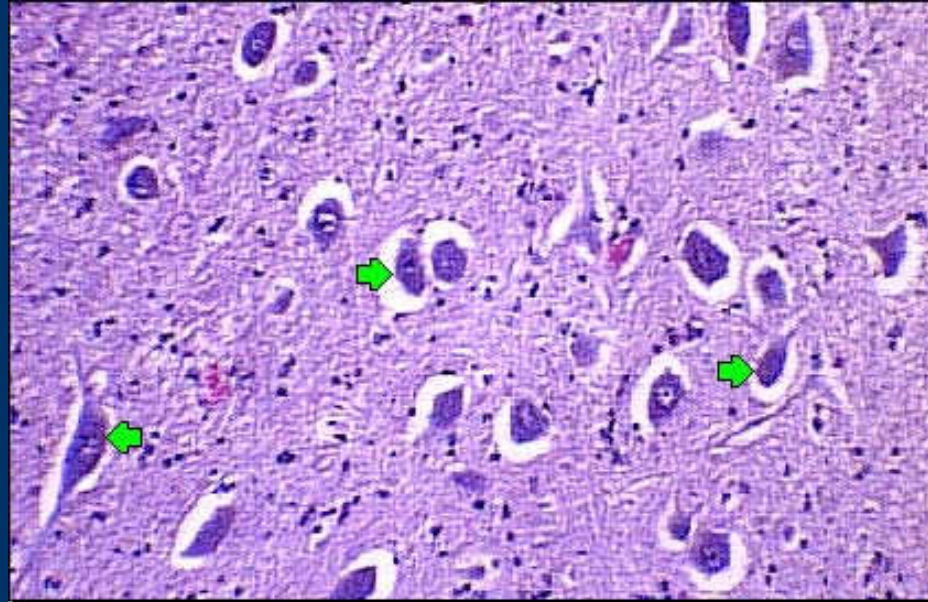


Nuclei of support cells

axon

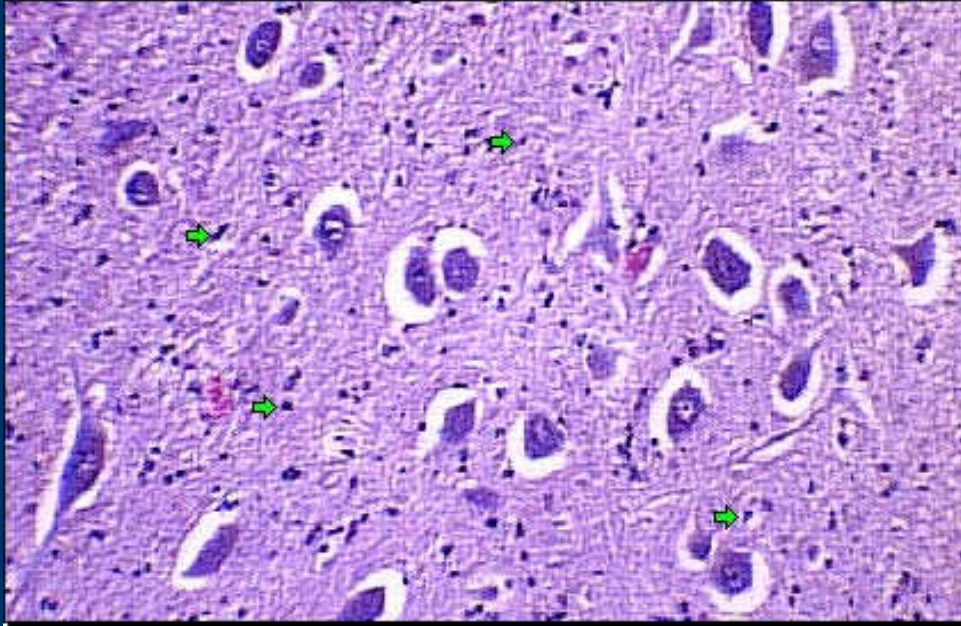


Neuron cell body



The cell body contains the nucleus and metabolic machinery of the cell. Proteins and neurotransmitter substances that carry signals between cells are synthesized here.

Neuroglial cell nuclei



These cells serve several important functions:

- Provide nutritional support for the neurons.
- Surround blood vessels to regulate what type of substances are allowed to pass to the neurons. This function is referred to as the blood brain barrier.

-Form myelin sheaths around axons to speed impulse transmission.

-Engulf foreign invaders such as bacteria.

Nervous Tissue Review

-Nervous tissue is one of the four basic tissues

-It is composed of two major types of cells: neurons and support cells (glia).

-Neurons have specialized dendrites for receiving signals, a cell body for cell maintenance and integration, an axon for sending signals rapidly over long distances, and many terminals to make synapses with other cells.

-The cell bodies of neurons in the peripheral nervous system are located in groups called ganglia.

-Glial (glue) cells are supportive cells, providing nourishment and other aids to neuron function.

-Nerves are bundles of axons surrounded by glial (Schwann) cells and some connective tissue. Individual axons may be either sensory or motor in function.