Chapter 31

Animal Organization and Homeostasis

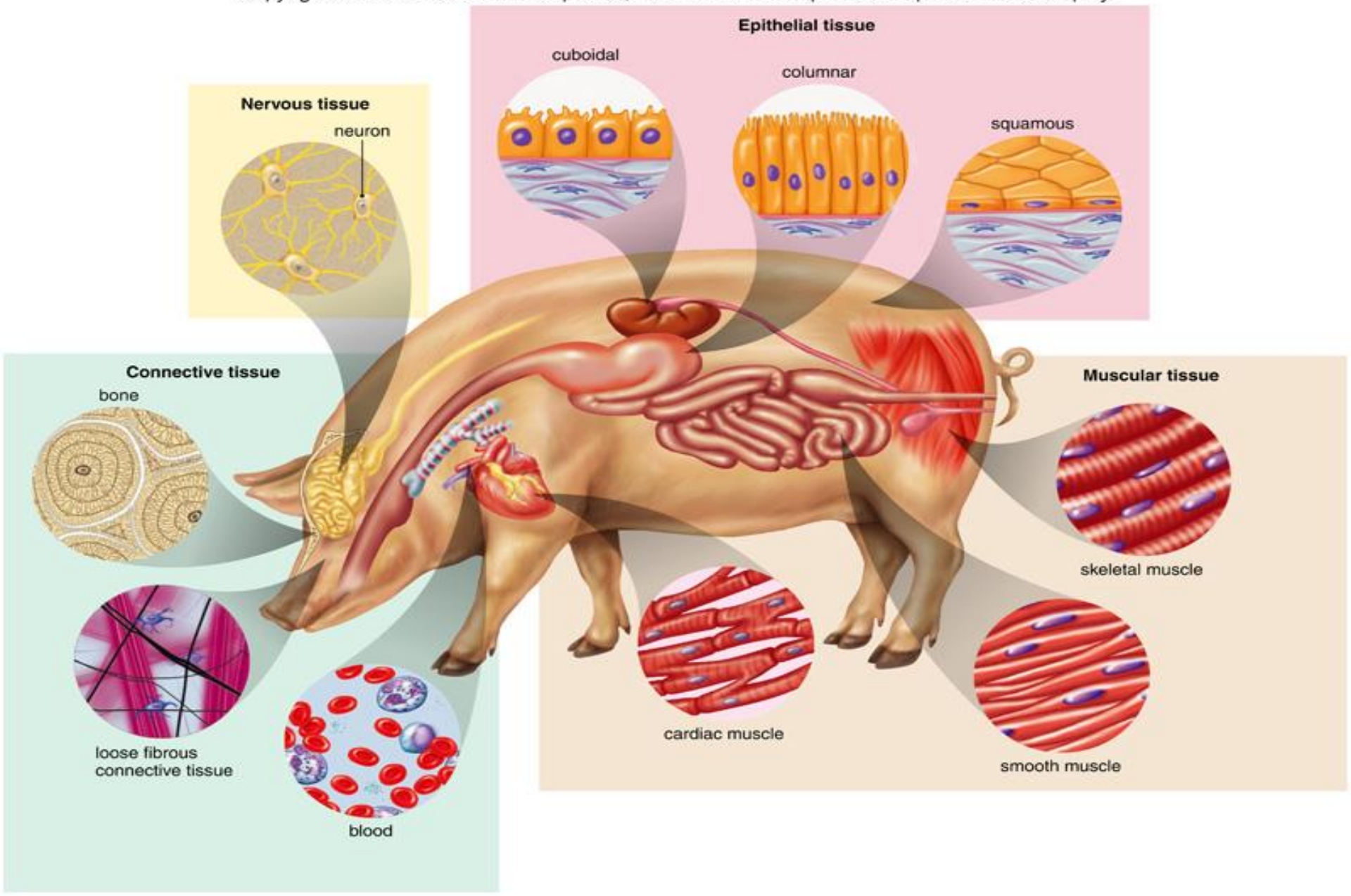
M.Mustafa Abu Omair

22.1 The Body's Organization

- The body of multicellular organisms has a hierarchical structure.
  - The body is composed of several organ systems.
  - An organ system is composed of one or more organs.
  - An organ is composed of tissues.
  - Tissues are composed of cells.

22.1 The Body's Organization (cont.)

- The bodies of animals are composed of four main tissue types:
  - Epithelial tissues covers the body surface and lines the body cavities.
  - Connective tissue binds and supports the part of the body.
  - Muscular tissue provides movement.
  - Nervous tissue conducts nerve impulses and interprets stimuli.



Epithelial Tissue

- Epithelial tissue, also called epithelium, consist of tightly packed cells that form a continuous layer.
- Substances that must enter or exit the body typically pass across the epithelial cell layer.
- This means that epithelial cells are widely distributed in animal bodies, it covers surfaces and lines body cavities.
- Epithelial cells are exposed to the environment on one side, but on the other side they have a basement membrane (protein layer).
- Cells of the epithelial layers differ in their shape and their function.

Classification of Epithelial Tissue

- Epithelial tissue is either simple or complex.
- Simple epithelia have single layer of cells and are classified into:

✓ Squamous: which is composed of flattened cells, is found lining blood vessels and air sacs of lungs.

✓ Cuboidal: contain cube-shaped cells and is found lining the kidney tubules and various glands.

✓ Columnar: has cells resembling rectangular pillars or columns, with nuclei usually located near the bottom of each cell.

✓ We have three subtypes:

1. Microvilli Columnar: Is found lining the digestive tract, where it efficiently absorbs nutrients from the small intestine because it has minute cellular extension called microvilli.
2. Ciliated columnar: is found lining the oviducts, to move the egg toward the uterus.
3. Peudostratified ciliated columnar: lining the windpipe or trachea.

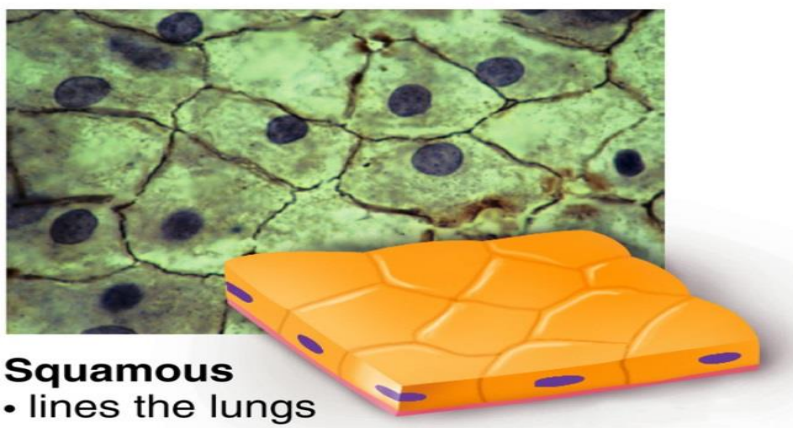
Epithelial Tissue Protects (cont.)

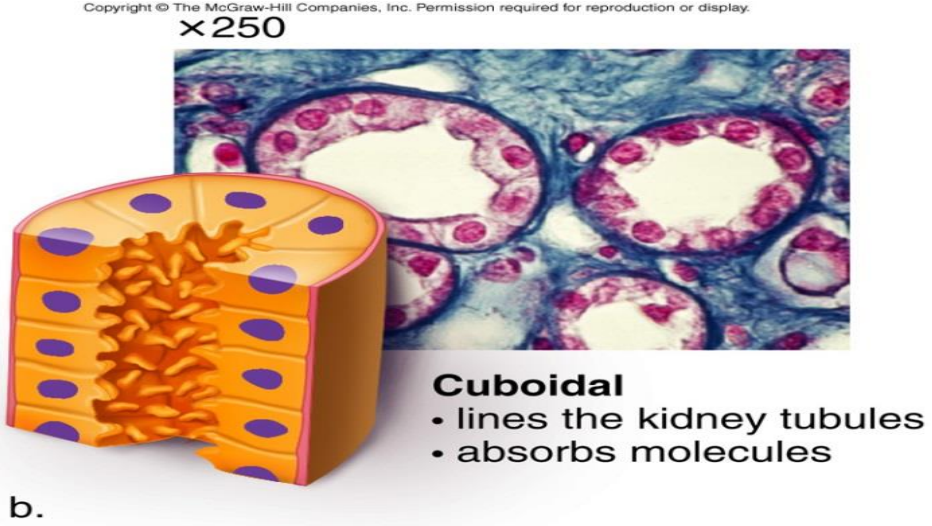
- The lining of the ureters, urethra, and urinary bladder is composed of transitional epithelium.
- Transitional epithelial cells are capable of stretching and sliding past each other while still maintaining a barrier.
- This barrier prevents urine from diffusing back into the body.

Epithelial Tissue Protects (cont.)

Simple Squamous epithelium consists of flattened cells that line the lungs and blood vessels.

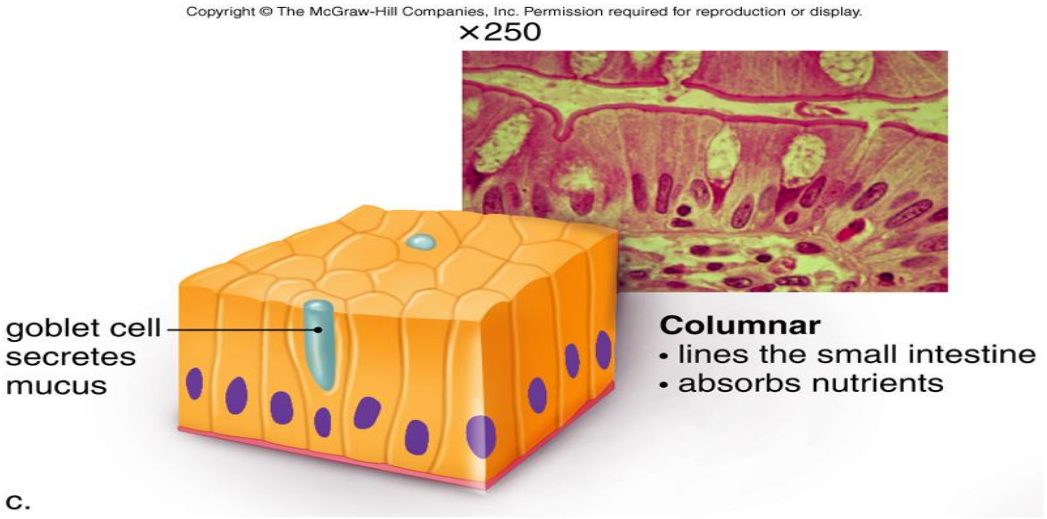
Simple Cuboidal epithelium consist of cuboidal cells that line the kidney tubules.



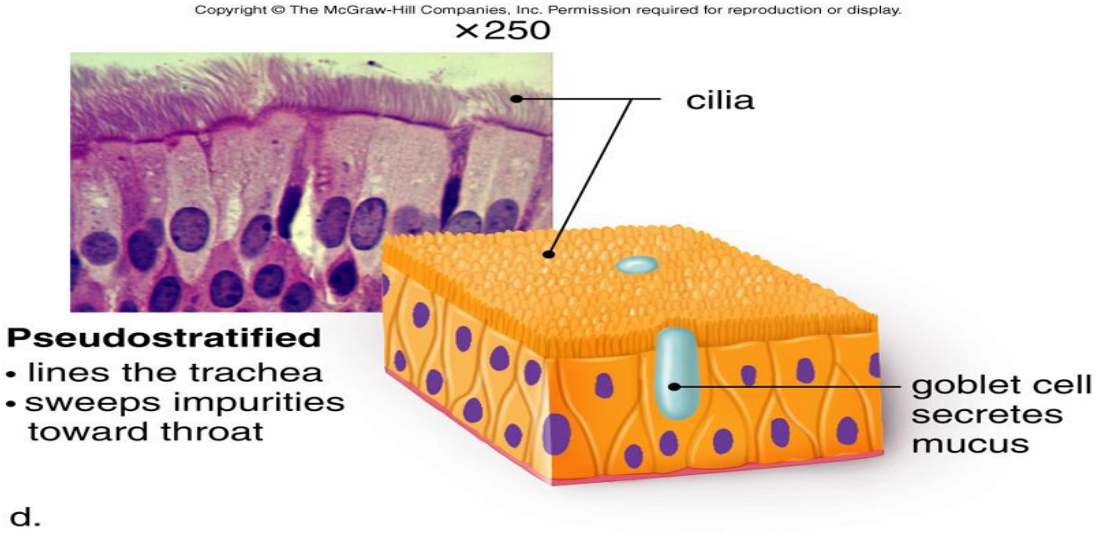


Epithelial Tissue Protects (cont.)

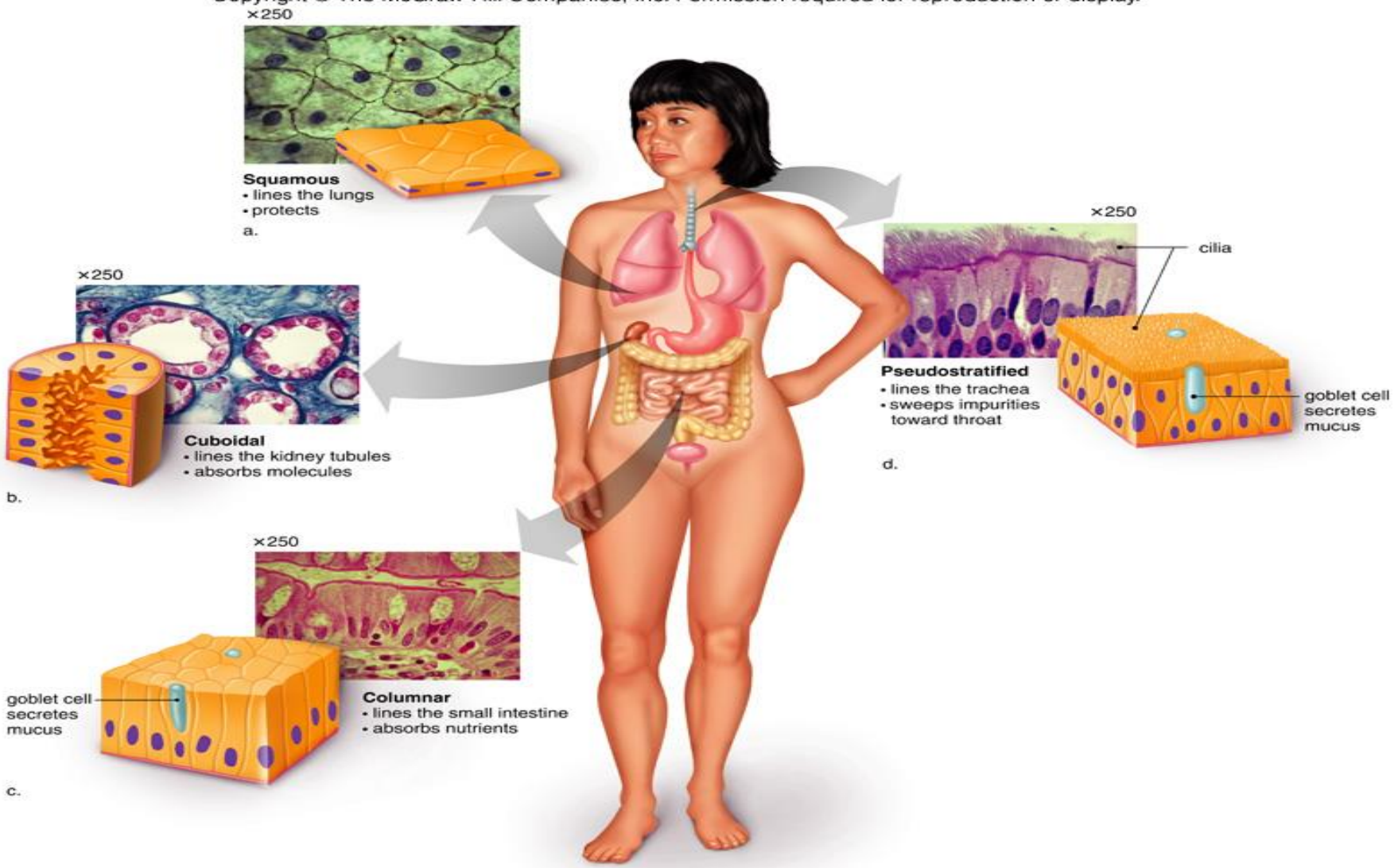
Simple Columnar epithelium consists of pillar-shaped cells that line the digestive tract.



Pseudostratified epithelium are mucus secreting cells that line the trachea.



Epithelial Tissue Protects (cont.)



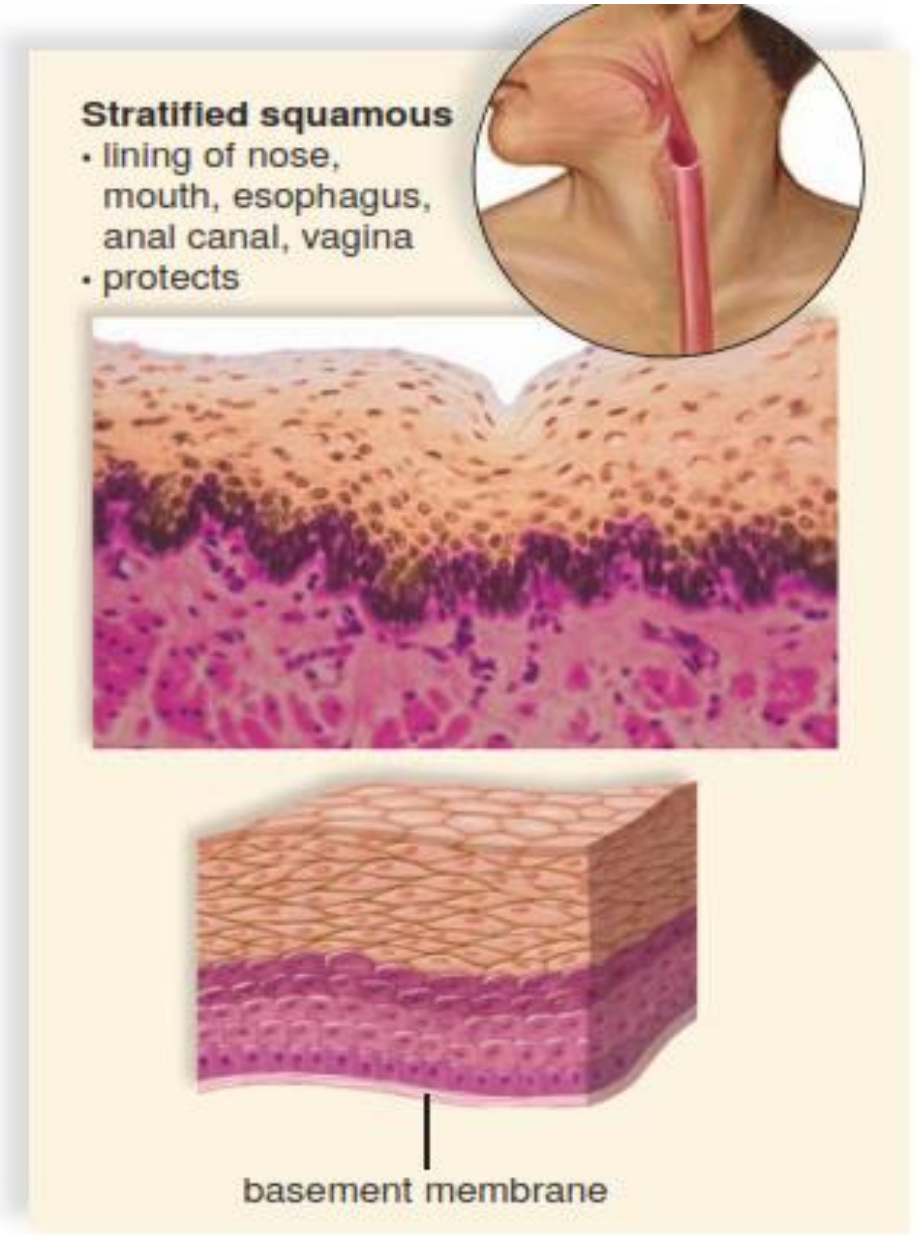
Stratified squamous epithelium

- Stratified epithelia: have layers of cells piled one on top of the other.

- Provide **protection.**

- <u>2 types</u>:

1. **Keratinized** (dry environment- **skin**)
2. **Nonkeratinized** (wet environment- **esophagus**).



Epithelial Tissue Protects (cont.)

- The skin of animals is comprised of stratified epithelium reinforced with keratin.

Epithelial Tissue Protects (cont.)

- Epithelial cells are constantly replaced by cell division.
- However, this extensive rate of cell division means that epithelial cells are more likely to become cancerous than other cell types.

Glandular epithelium

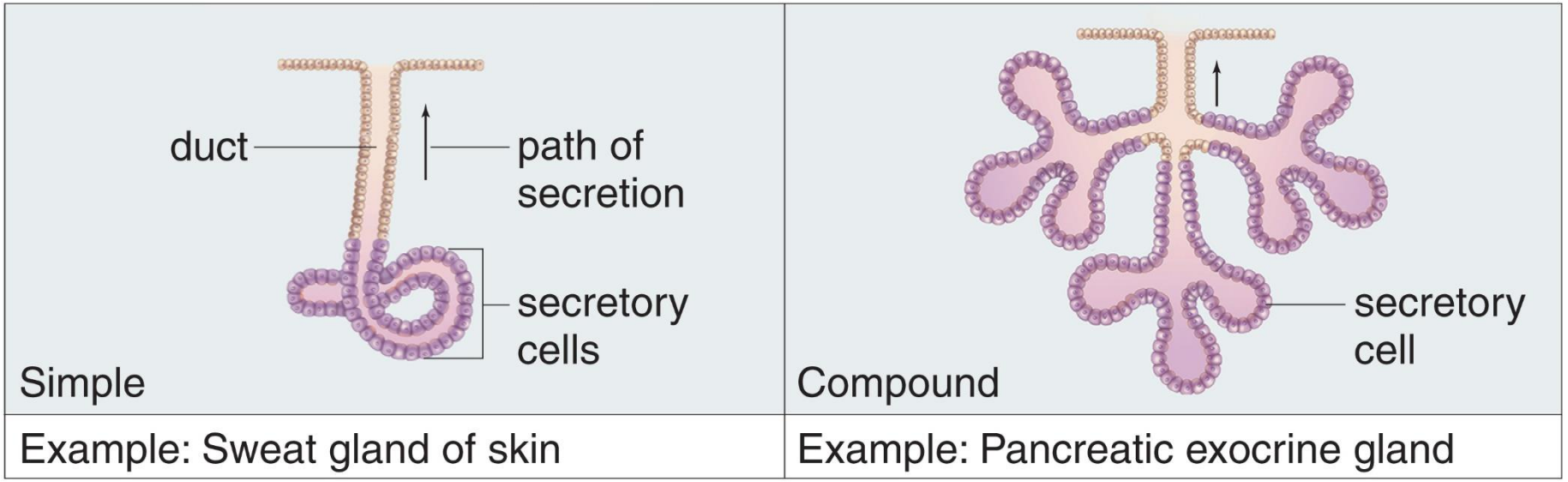
- Glandular epithelium: cells that are specialized to produce and secrete substances into ducts or into body fluids.
- gland = 1 or more epithelial cell.

✓ Simple: single epithelial cell- e.g.. mucus-secreting Goblet cell (lining the digestive tract).

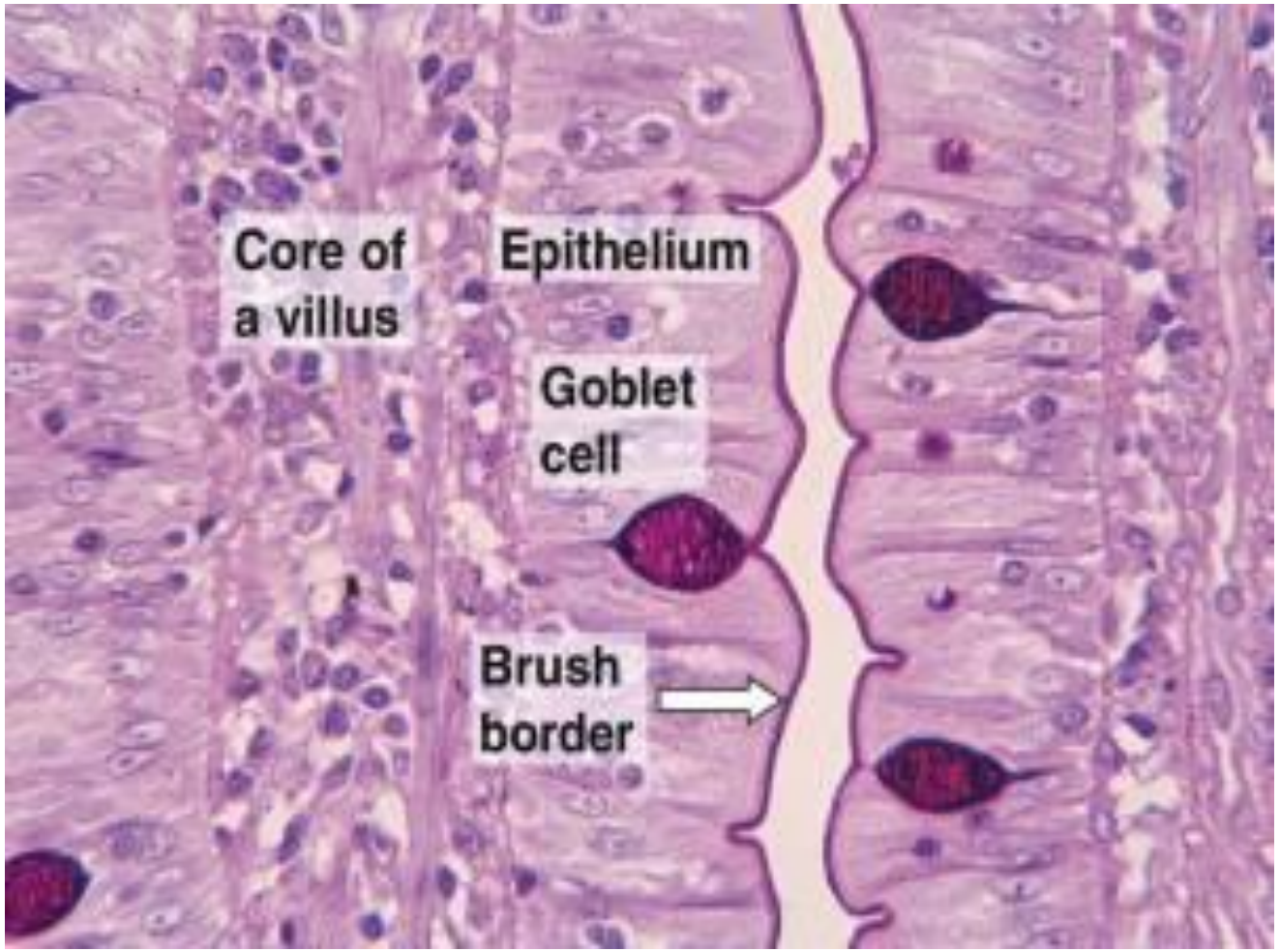
✓ Compound: many epithelial cells- Salivary glands.

✓ Two types of glands:

- Exocrine = secrete substances into ducts that open onto surfaces. e.g.. Salivary glands, Sweat glands.
- Endocrine = have no ducts secrete substances (hormones) into tissue fluid or blood. e.g. Pituitary gland, Thyroid gland



Example: Sweat gland of skin	Example: Pancreatic exocrine gland


Core of
a villus
Epithelium
Goblet
cell
Brush
border

Connective tissues (CT)

- **CT**: is the most abundant and widely distributed tissue.

- **CT** have 3 components:

1. cells (stem cells, WBCs, and adipose cells)

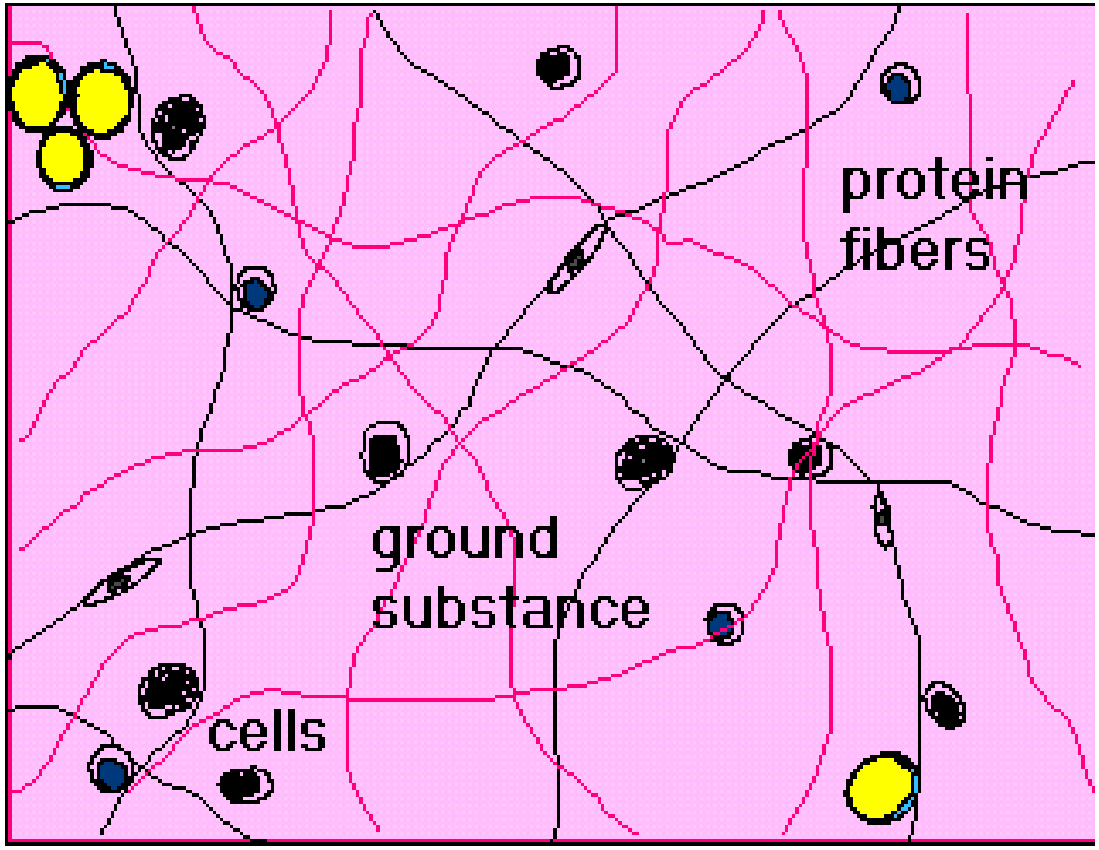
2. ground substance: is a noncellular material that separates the cells and varies in consistency from solid to semifluid to fluid.

3. Fibers: 3 types <u>collagen</u> fiber: contain collagen give flexibility and strength.

- **<u>Reticular fibers</u>**: thin highly branched fibers give supporting.
- **<u>Elastic fibers</u>**: contain elastin and give stretching.

- All types of connective tissue serve the same general function.
- - binds organs together.
  - provides support, protection

Connective tissues (CT)



Connective tissues (CT)

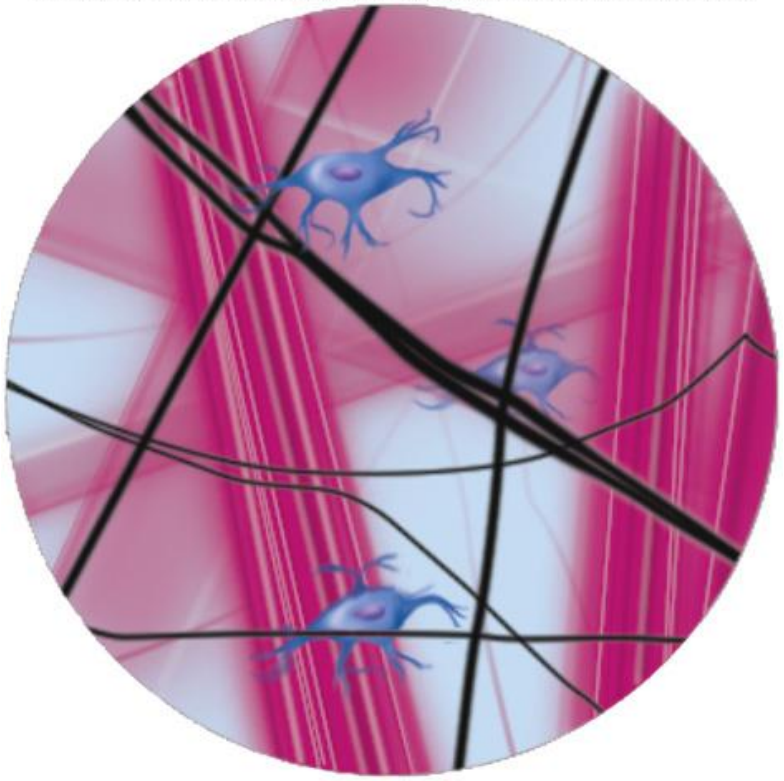
- **CT** is classified into:
- Fibrous CT
- Supportive CT
- Fluid CT

Loose Fibrous and Related Connective Tissues

Fibrous CT:

1. Loose fibrous connective tissue occurs below the epithelium.

- This tissue forms a protective covering over the organs (lungs, arteries, urinary bladder, muscles, nerves).
- The loose fibrous connective tissue is composed of cells called fibroblasts.
- They used in support and binds organs.

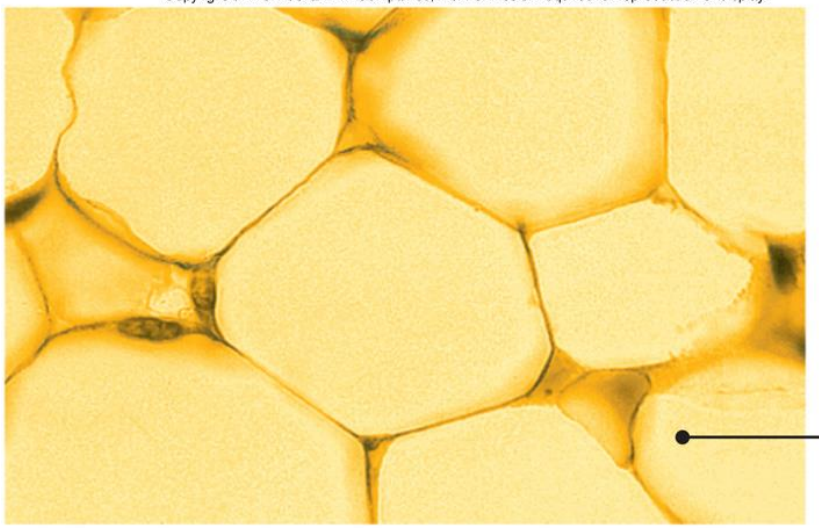


loose fibrous connective tissue

Loose Fibrous and Related Connective Tissues (cont.)

2. Adipose tissue is composed of adipose cells (adipocytes) that store fat.

- Adipose tissue lacks a matrix and is located beneath the skin and around the heart and kidneys.
- Insulate the body, serves as energy reservoir, and provides cushioning.



Adipose tissue ×250

Fibrous Connective Tissues (cont.)

3. Dense fibrous connective tissue contains many collagen fibers tightly packed together.

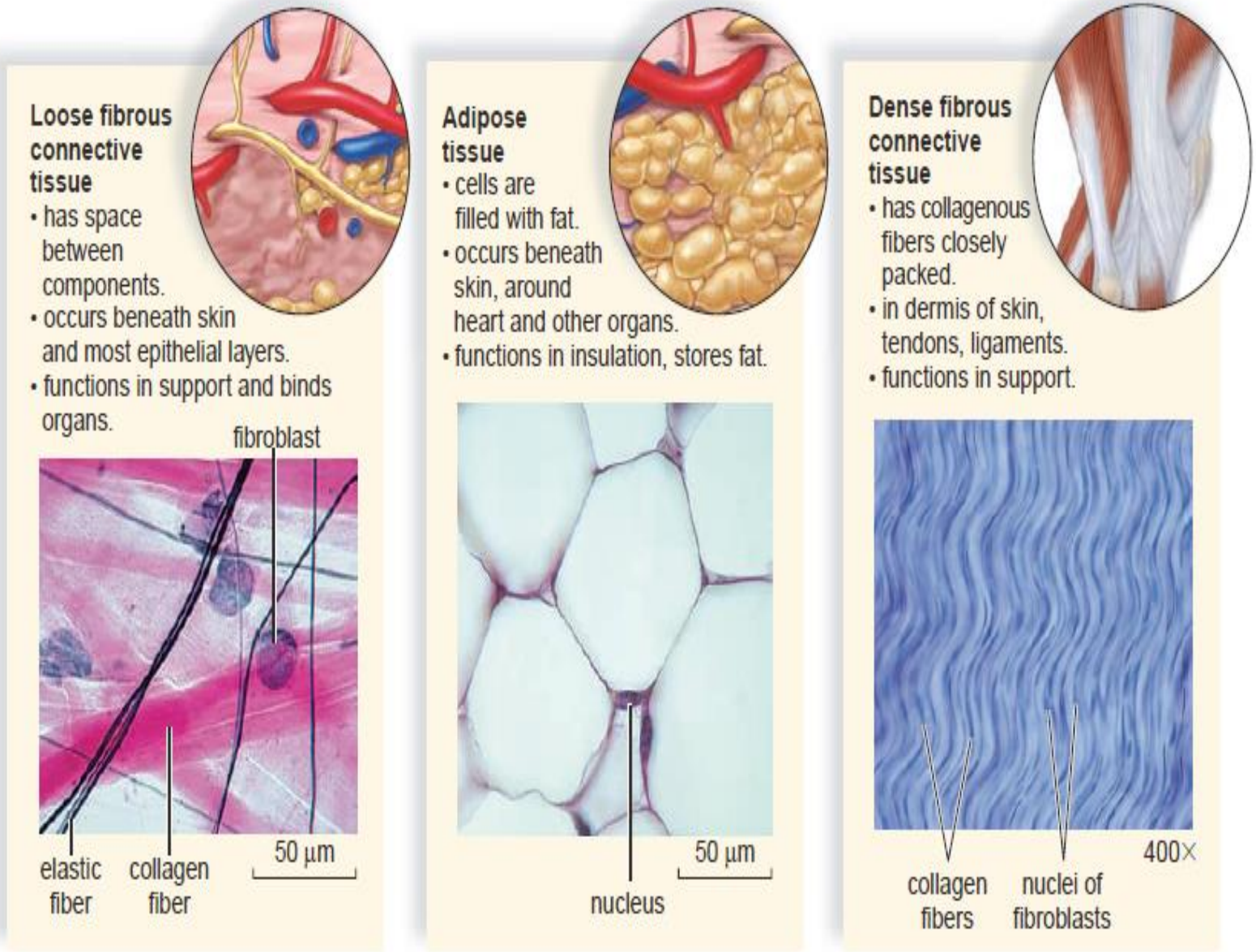
- Tendons, which connect muscles to bones, are one example.

- Ligaments are another example and connect bones together at the joints.

FIGURE 31.3

Types of connective tissue in vertebrates.

Pertinent information about each type of connective tissue is given.



Supportive Connective Tissue

- a. Cartilage and bone are rigid connective tissues.
- b. Structural proteins (cartilage) or calcium salts (bone) are deposited in an intercellular matrix.
- c. Cartilage cells or chondrocytes lie in small chambers or lacunae embedded in a strong, flexible matrix.

1) Hyaline cartilage
2) Elastic cartilage

- 3) Fibrocartilage

Supportive Connective Tissues (cont.)

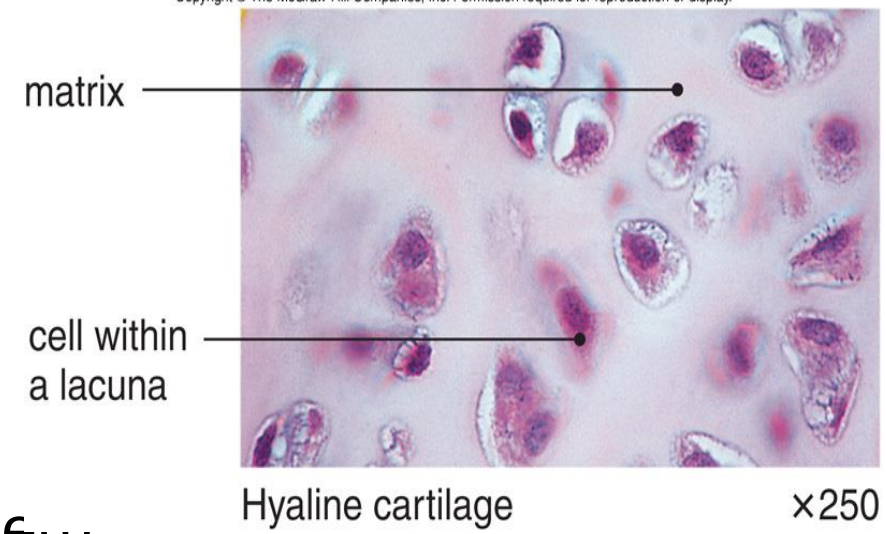
Supportive CT:

1. Cartilage

The cells of the cartilage lie in chambers called lacunae.

- The matrix of the cartilage is flexible yet solid.

- Hyaline cartilage (rich in collagen): nose, long bones, ribs, rings of respiratory passages.
- Elastic cartilage (more elastic): outer ear.
- Fibrocartilage (strong collagen fiber): pads between vertebrae and knee joint



Hyaline cartilage ×250

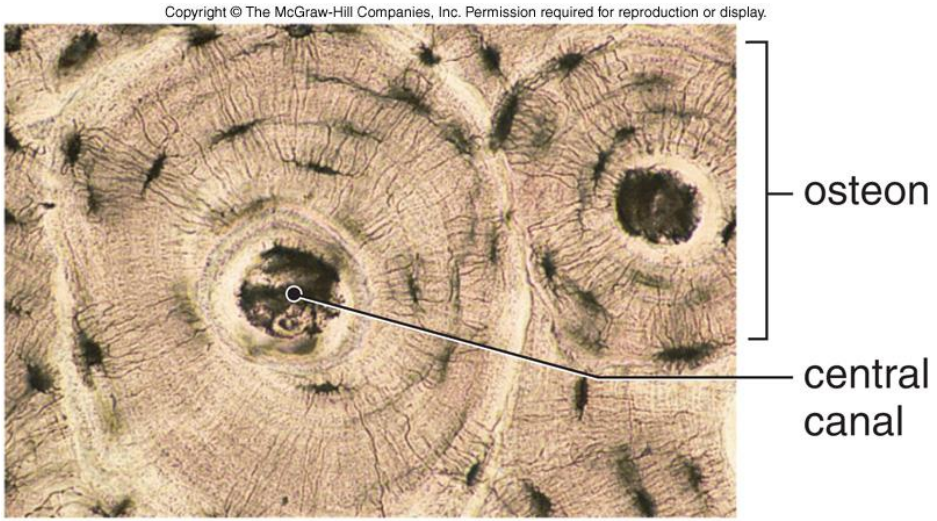
Supportive Connective Connective Tissues (cont.)

2. Bone:

- Bone is the most rigid connective tissue.
- The matrix is composed of inorganic salts deposited on collagen fibers.

a. Compact bone:

- Is the most common type of bone in the body.
- Make up the shaft of long bone
- Consists of cylindrical unites called osteons (haversian system)
- Bone cells located in lacunae.
- Central canal contains blood vessels and nerve cells.



Compact bone ×320

b. Spongy bone:

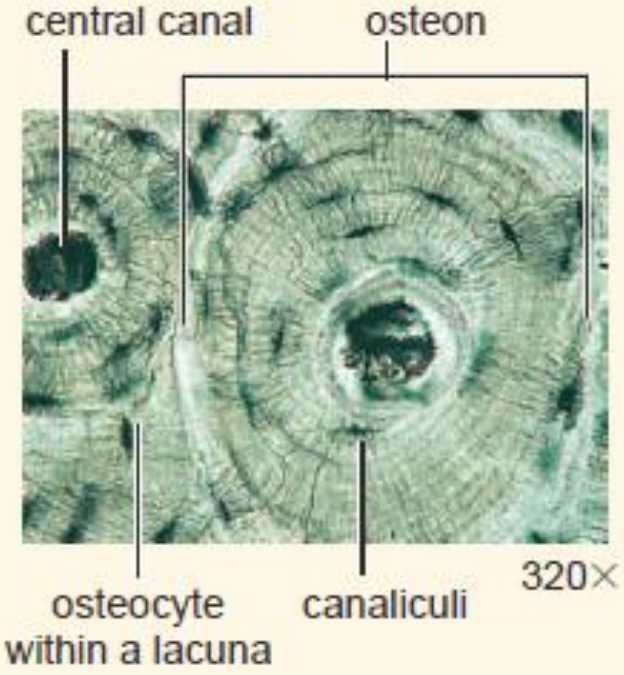
- Contains bars and plates that separated by space (filled with bone marrow).
- Makes up the interior of bones.

Hyaline cartilage

- has cells in lacunae.
- occurs in nose and walls of respiratory passages; at ends of bones, including ribs.
- functions in support and protection.

Compact bone

- has cells in concentric rings.
- occurs in bones of skeleton.
- functions in support and protection.



Fluid connective tissues

- Blood, considered to be a liquid connective tissue, consists of several cell types suspended in a liquid called plasma.
- The plasma can be considered to be the matrix for the blood.
- The production of blood cells known as hematopoiesis.
- There are three cell types in the blood.
  - Red blood cells
  - White blood cells
  - Platelets
  - **Lymph** : is fluid connective tissue located in lymph vessels.

Blood, a transporter medium

Blood function

1)Transports gases, nutrients, waste products, and hormones.
2)Helps destroy **pathogenic microorganism**
3)Distributes **antibodies** (immunity)
4)Aids in maintaining **water balance and pH**
5)Helps regulate body **temperature**
6)Carries platelets and factors that ensure **clotting and prevent blood loss.**

Blood has 2 main portions:

1.Cellular element portion: **RBCs, WBCs, platelets**
2.Plasma: liquid portion, contains **salts and proteins** maintain the blood pH (7.4),
✓ Blood proteins include: **albumin** and **globulins**.

Red blood cells

✓ Small, biconcave, lack nucleus, contain hemoglobin.

Hemoglobin:

✓ contains heme group (iron) that bind to O_2.
✓ Produced by red bone marrow and destroyed in the liver and spleen.

Blood, a transporter medium

White blood cells:

Larger than RBCs

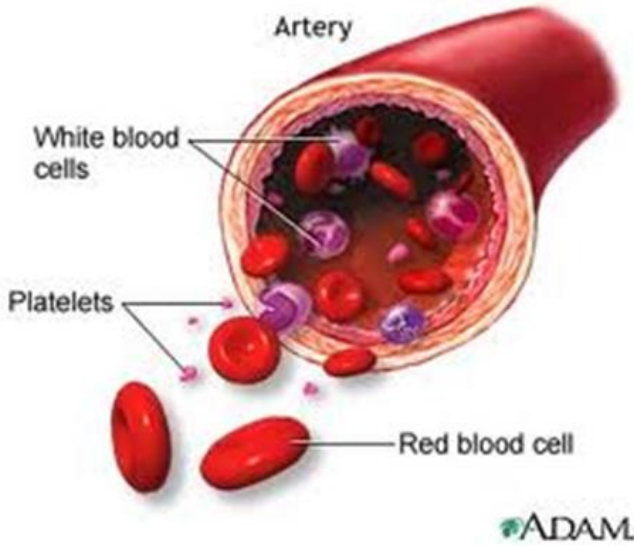
Have **nucleus** and lack **hemoglobin**.

Function: act as **phagocytosis**, production of **antibodies**.

2 types:

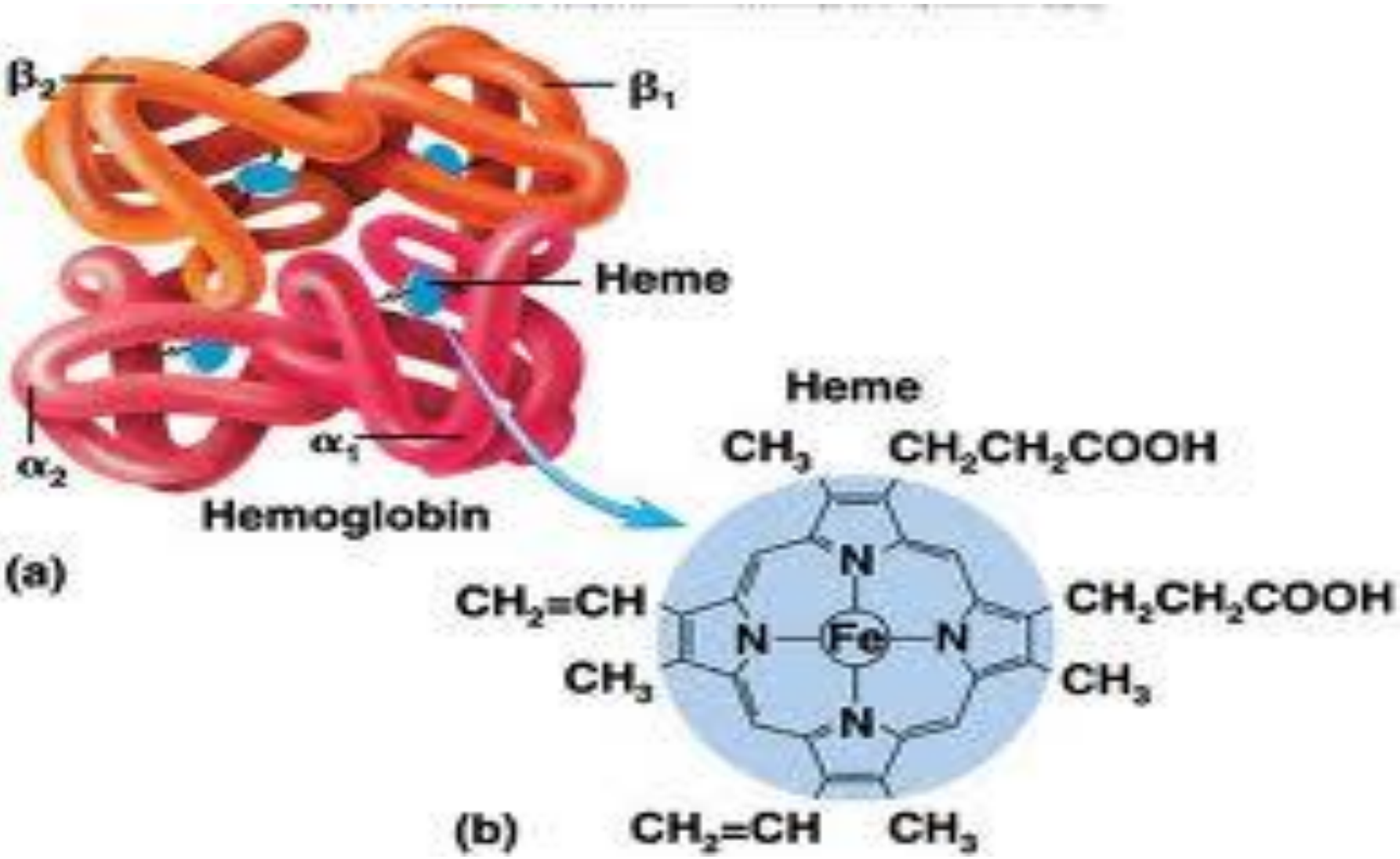
1.Granular: 3 types (**eosinophils-, neutrophils- , basophils-**).

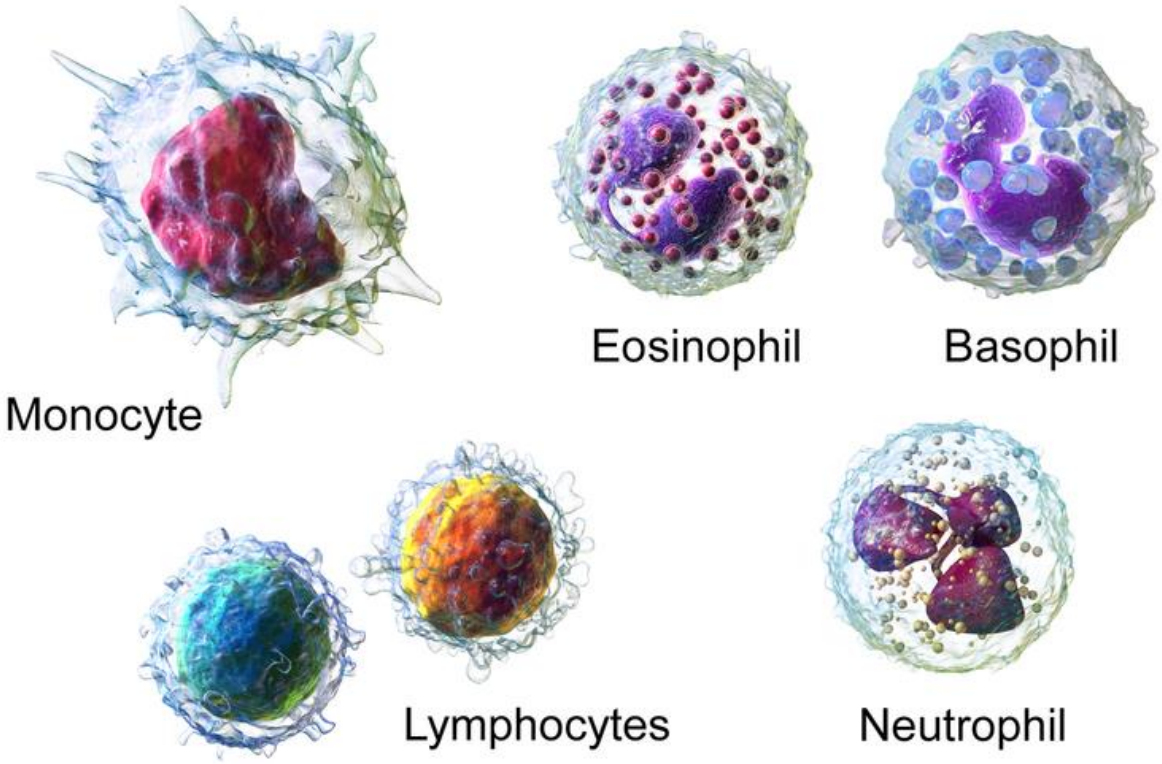
2.Agranular: 2 types (**lymphocytes, monocytes**).



Platelets:

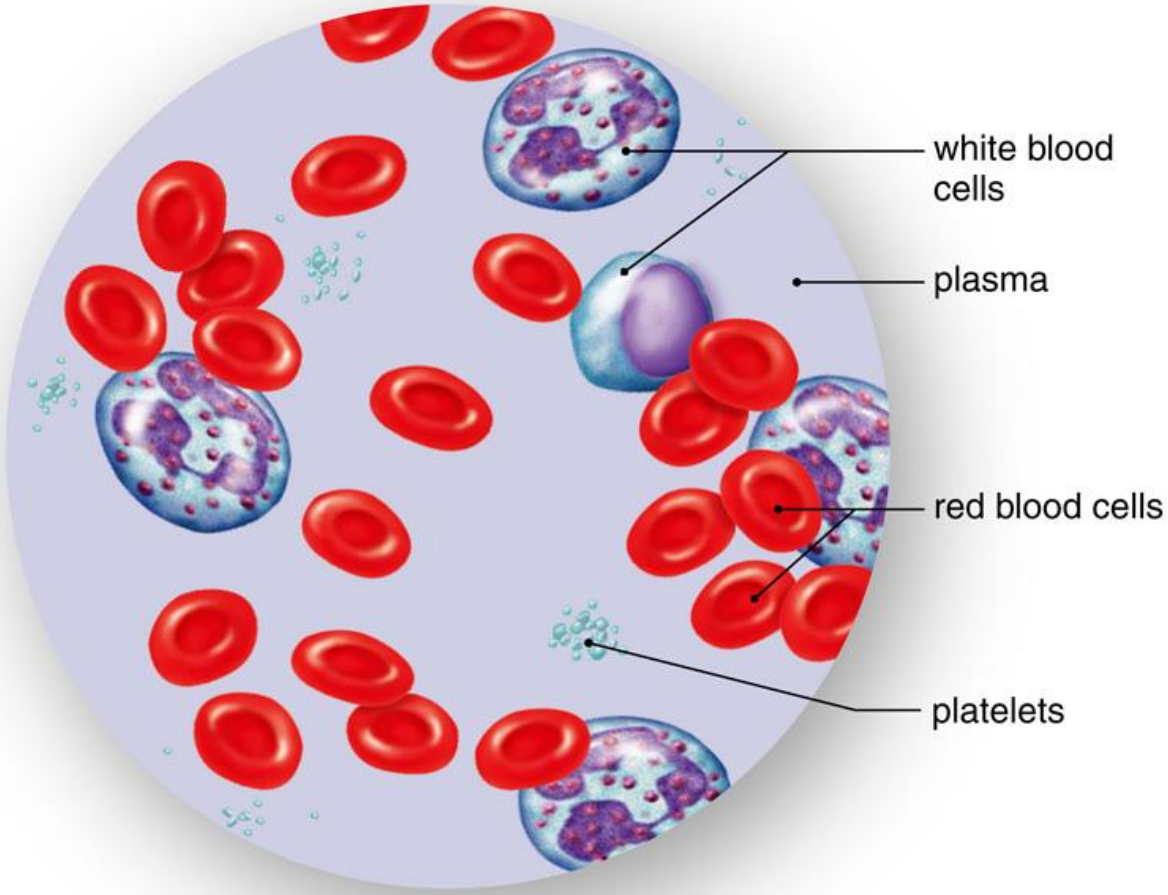
- Fragments of **large cells** called **megakaryocytes** found only in **bone marrow**.
- Are involved in **blood coagulation**.


β2
β1
Heme
α2
α1
Hemoglobin
(a)
Heme
CH3
CH2CH2COOH
CH2=CH
CH2CH2COOH
N
N
Fe
N
CH3
CH3
N
(b)
CH2=CH
CH3



White Blood Cells

Blood (cont.)



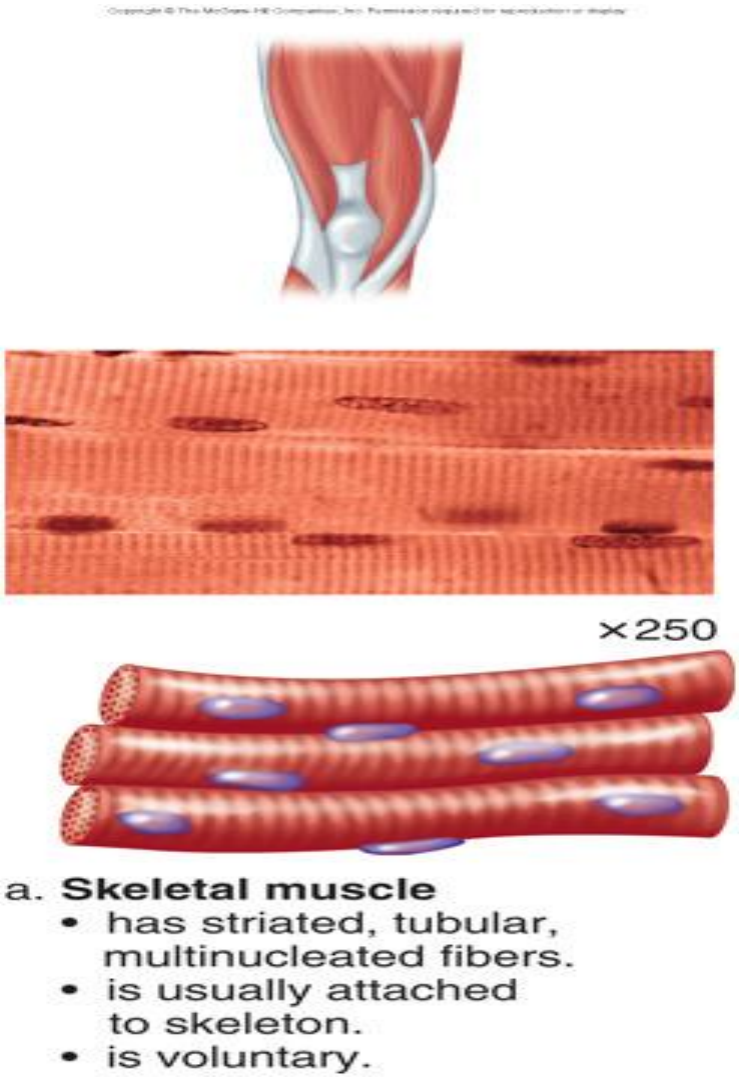
Muscular Tissues Move the Body

- Muscle tissues are frequently called contractile tissues because they contain contractile protein filaments such as actin and myosin.

- There are three types of muscle tissues.
  - Skeletal
  - Cardiac
  - Smooth

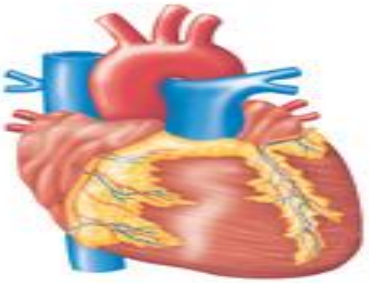
Muscular Tissues Move the Body (cont.)

- Skeletal muscle is voluntary muscle.
- Skeletal muscle is attached to bones to facilitate movement.
- Skeletal muscle cells are called fibers and are striated because of the actin and myosin bands.

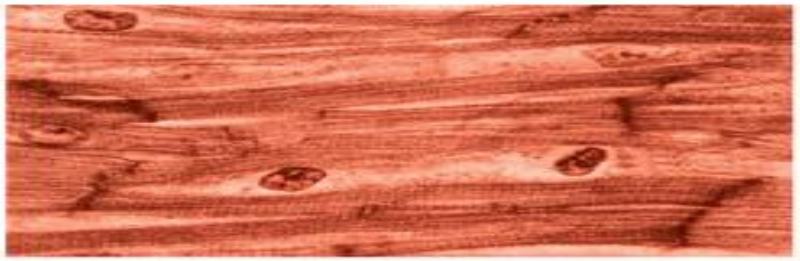


Muscular Tissues Move the Body (cont.)

- Cardiac muscle is found in the walls of the heart.

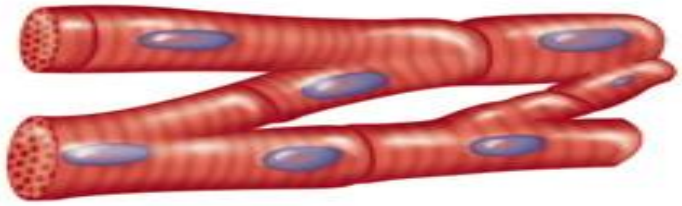


- Cardiac muscle is involuntary muscle.



- Cardiac muscle cells are highly branched, interconnected, and bounded on each end by intercalated disks.

×100

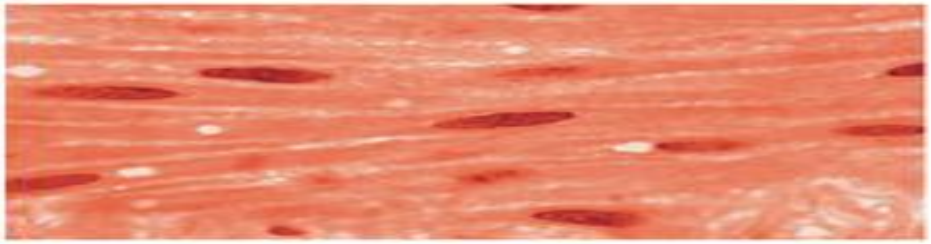


b. **Cardiac muscle**
- has striated, branched, uninucleated fibers.
- occurs in walls of heart.
- is involuntary.

Muscular Tissues Move the Body (cont.)

- Smooth muscle is involuntary muscle without striations.

- Smooth muscle is also called visceral muscle because it lines the walls of the organs and blood vessels.



×100

c. **Smooth muscle**
- has spindle-shaped, nonstriated, uninucleated fibers.
- occurs in walls of internal organs.
- is involuntary.

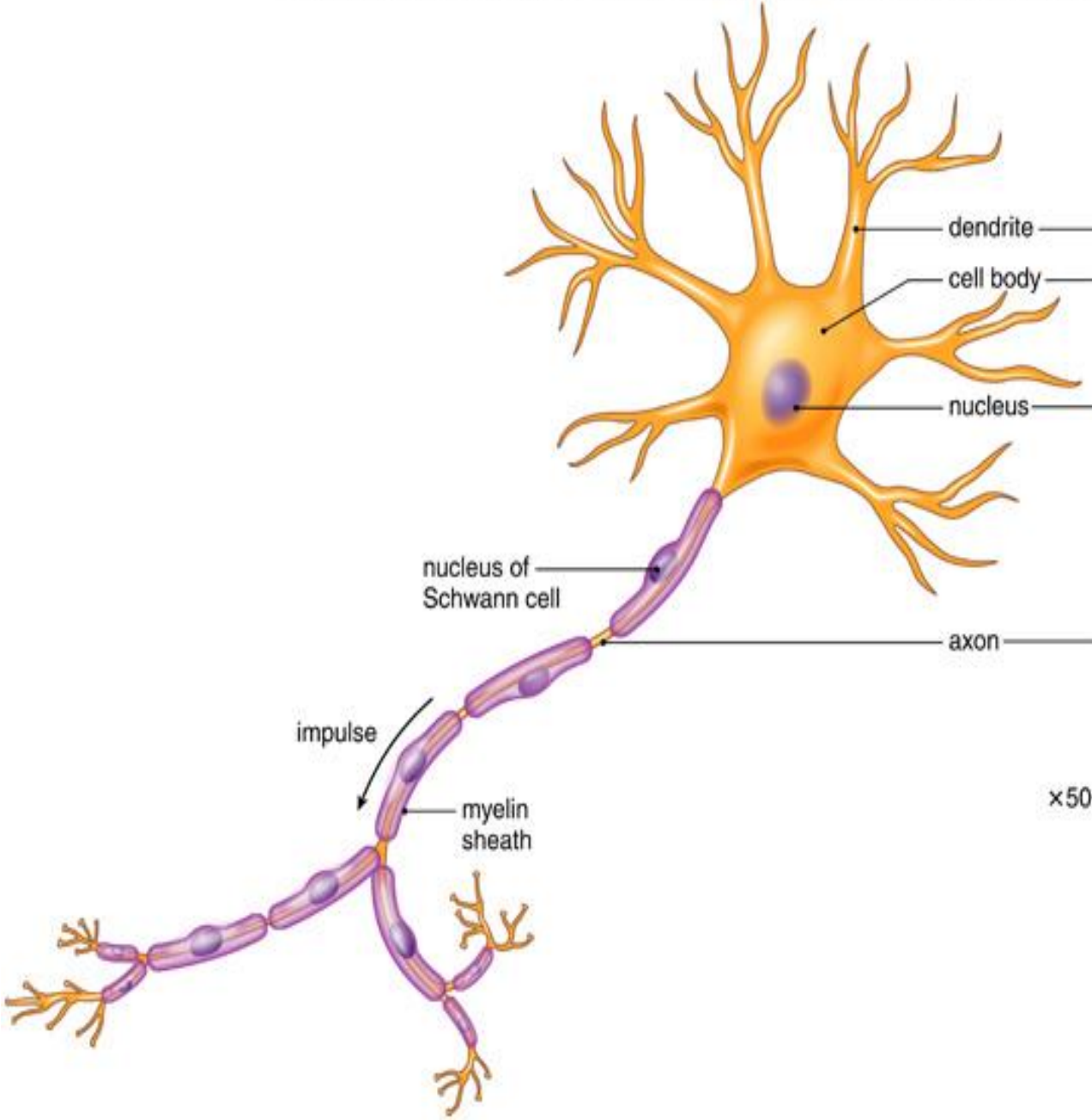
Nerve Tissue Communicates

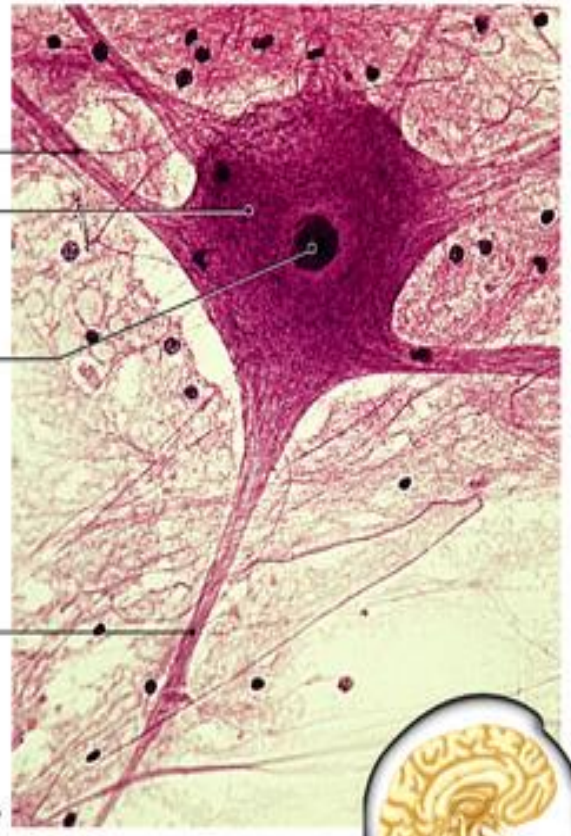
- Nervous tissues control body functions and responds to environmental stimuli.

- The function of the nervous tissues depends upon three factors.
  - Sensory input delivered by nerves to the brain and spinal cord.
  - Integration of data by the brain and spinal cord.
  - Motor output triggered by nerves carrying impulses from the brain and spinal cord

Nerve Tissue Communicates (cont.)

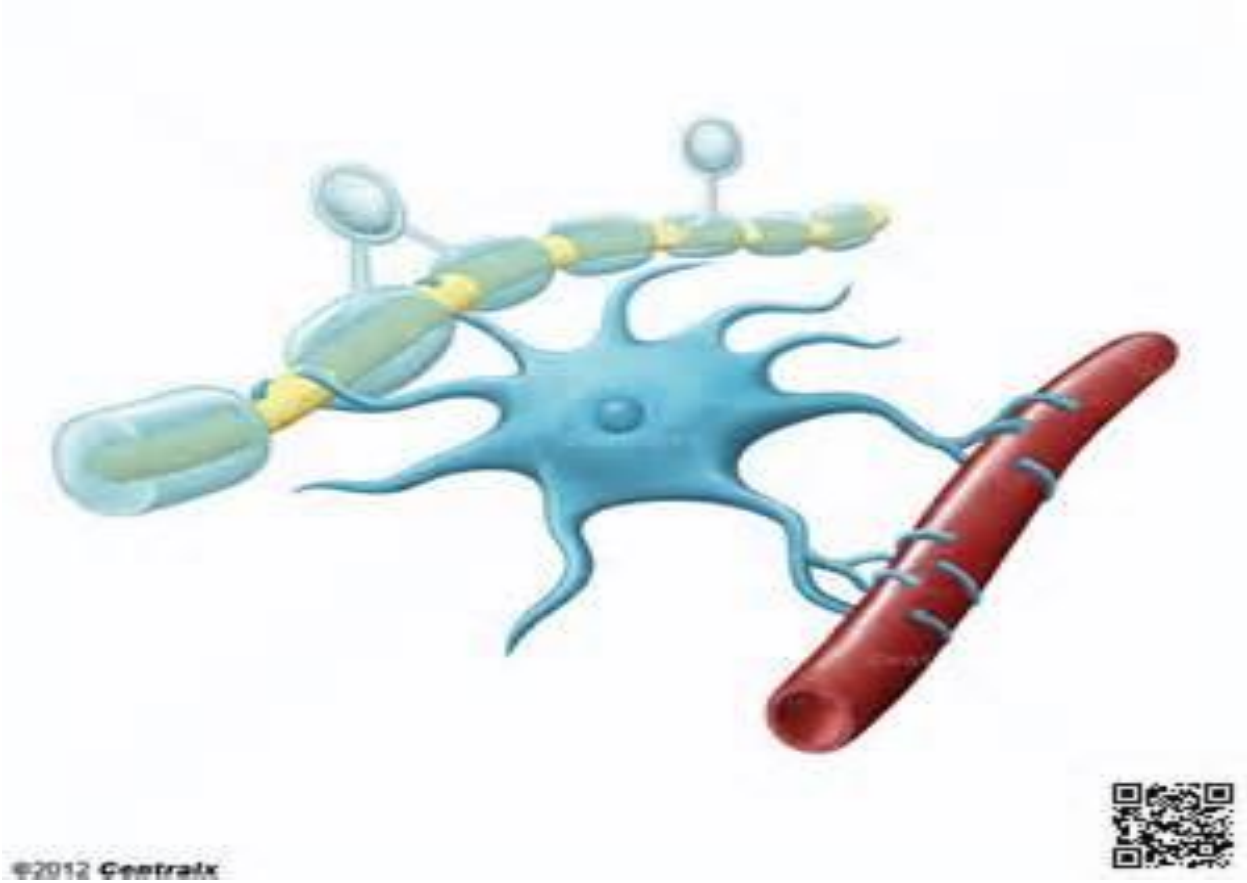
- The cells of the nervous tissue are called neurons , which are protected separated and supported by neuralgia.
- Neuron has three parts:
  - Dendrites conduct signals to the cell body.
  - The cell body is the main part of the cell.
  - Axons conduct signals away from the cell body.



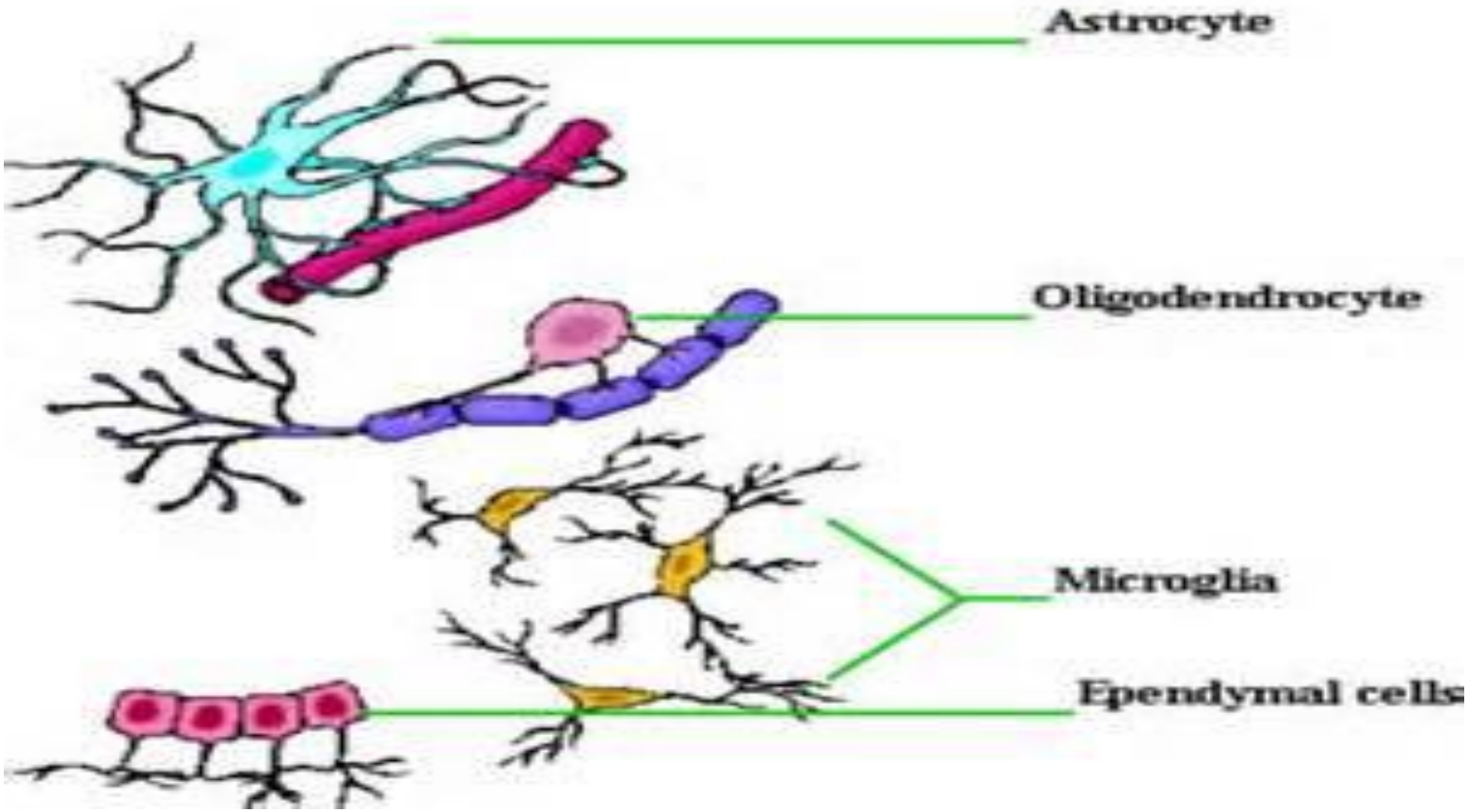


Nervous tissue

- Brain; spinal cord; nerves
- Conduction of nerve impulses



Neuroglial Cells of the CNS



Function of nervous tissue

- The cell body receives impulses from other cells through dendrites.
- The dendrites act as antennae that receive and transmit messages between the neuron and muscles, skin or other neurons.
- The cell body passes these messages to the axon which conducts electrical impulses away from the cell body.

Organs and Organ Systems

- Organ is composed of two or more types of tissues working together to perform particular functions.

- Organ system contains many different organs that cooperate to carry out a process, such as the digestion of food.

31.2 Organs and Organ Systems

Skin as an Organ

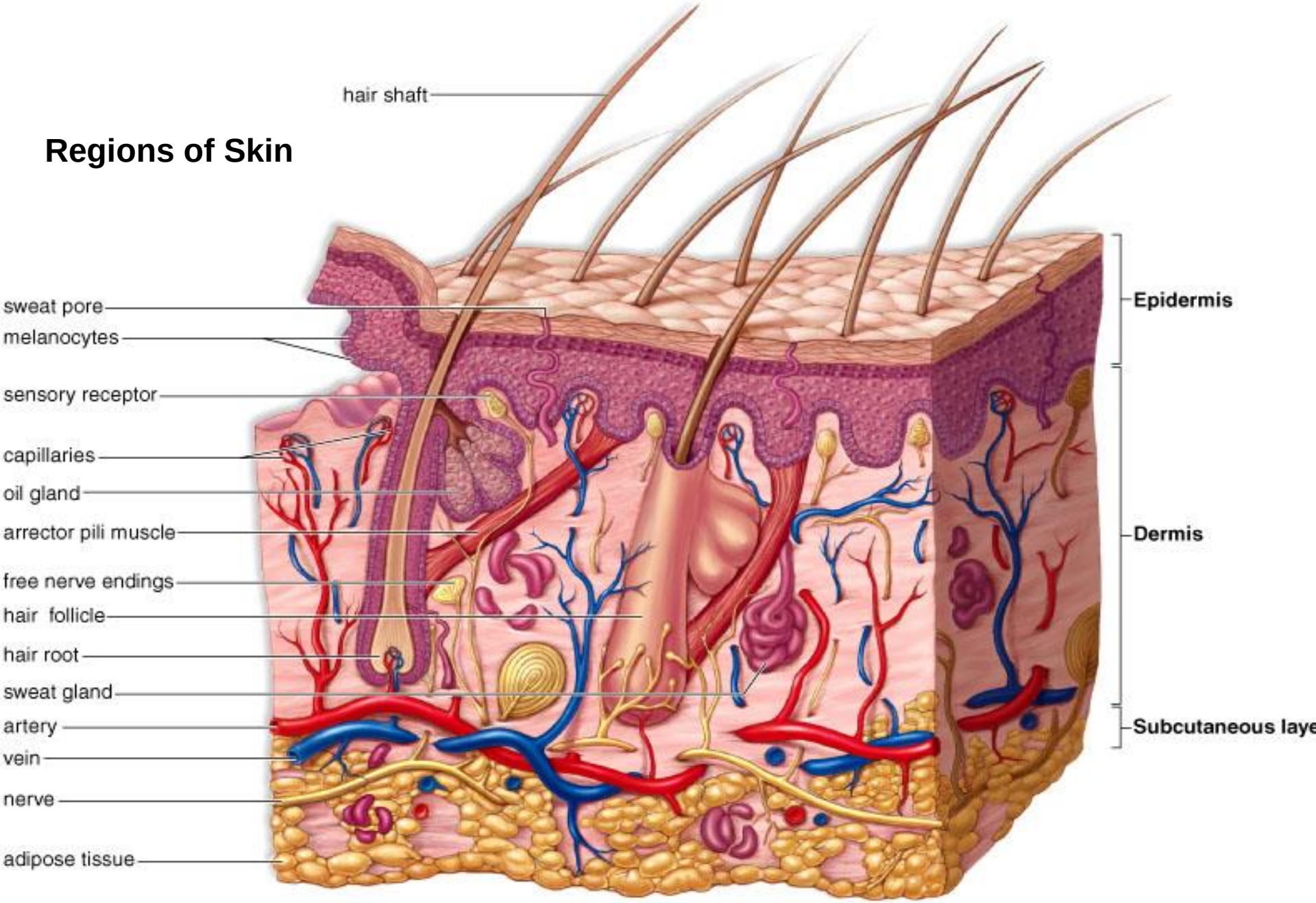
1. The **integumentary** system is composed of the **skin** and **accessory** organs (i.e., nails, hair).
2. Human skin **protects** the underlying tissues from **trauma**, **water loos**, and **microbial** invasion.
3. The skin produces a precursor molecule that is converted to **vitamin D** after exposure to **UV light**.
4. The skin also helps regulate **body temperature**.
5. Has variety of **sensory structure**, that monitor touch, pressure, temperature and pain.

Human Skin

- The skin has both an outer epidermal layer (epidermis) and a deeper layer (dermis).

- A subcutaneous layer (hypodermis) is found between the skin and underlying structures.

Regions of Skin



Epidermis

- The epidermis is the **outer**, thinner layer of skin, composed of **stratified squamous epithelium**.
- It does not contain blood vessels so they said to be avascular.
- It has specialized cells called **melanocytes** that produce melanin, the pigment responsible for skin color, and protect against sunlight.
- Epidermis cells accumulate **keratin**, which is **waterproof protein**.
- UV light is required for **vitamin D formation**, a chemical required for proper bone growth.
- Excessive exposure to **UV radiation** can convert cells in the basal layer of the epidermis into **cancer cells (basal cell carcinoma); melanoma** is skin cancer derived from melanocytes.

Dermis

- The dermis is **fibrous connective tissue** that forms a **thicker** and **deeper** layer of skin.
- The dermis contains both **elastic** fibers and **collagen** fibers.
- The dermis contains **blood vessels** and nerves.
- Also contains sebaceous glands (oil gland), sweat gland, hair follicles (produce hair).

Subcutaneous layer

- The subcutaneous layer is not technically a part of the skin; it is composed of **loose connective tissue** including **adipose cells**.
- Adipose tissue helps **insulate** the body by minimizing both heat gain and **heat** loss.
- This layer of adipose gives a **rounded appearance** to the body.
- The excessive development of adipose tissue occurs with many **diseases** like obesity.
- Nails and hairs both are **accessory** structure.

Fig. 31.9