# Fundamental Biology
# BI 1101

an interdisciplinary approach to introductory biology

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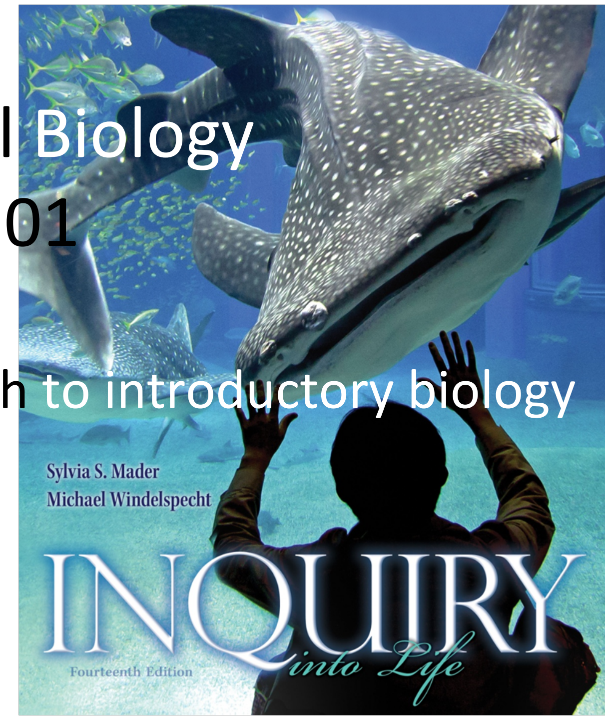
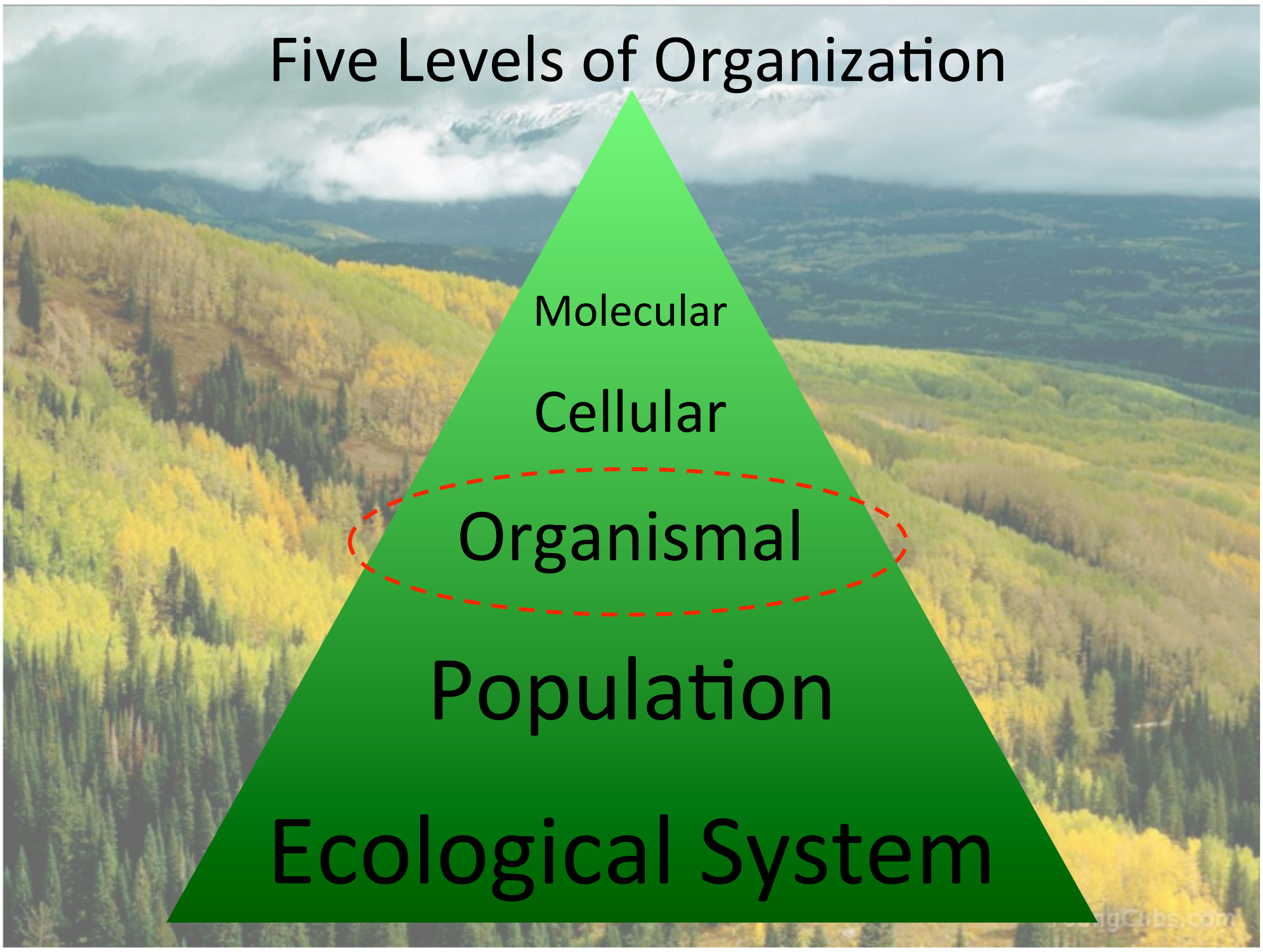



## Five Levels of Organization



ANIMAL STRUCTURE & FUNCTION

# BASIC TISSUE IN ANIMAL

## Learning outcomes

After this lecture, students should be able to:

- Describe the basic tissue of animal and the basic structure of the tissue
- Explain the type and example of epithelial tissue
- Explain the type and example of connective tissue
- Describe the type, structure and function of muscle
- Describe the type, structure and function of nerveous tissue

# THE HIERARCHY OF STRUCTURAL ORGANIZATION IN AN ANIMAL

Structure fits function in the animal body

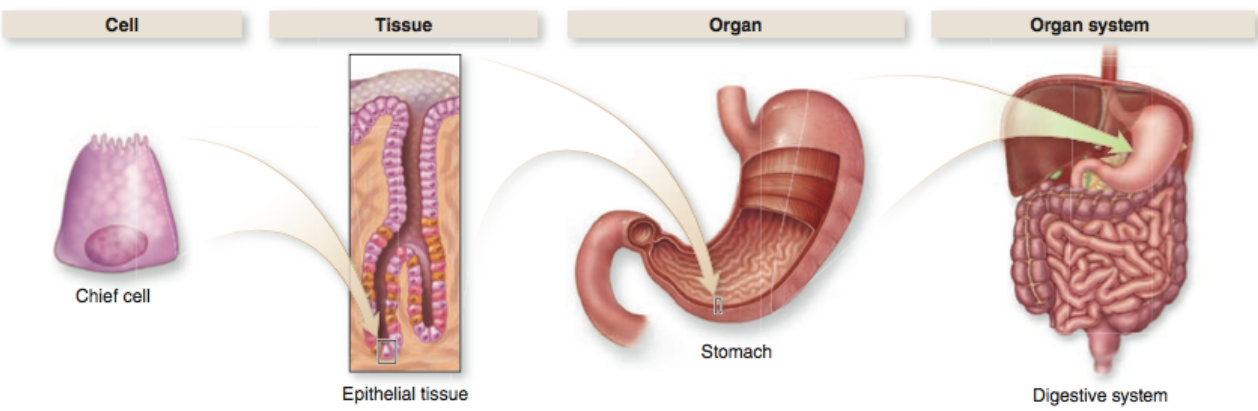
- Anatomy is the study of structure
- Physiology studies how structures function
- The functions of the various parts of the body result from their specific structures
  - Example: Flight apparatus of birds provides strength, support, insulation, stability, minimal weight



# Animal structure has a hierarchy

Structure in the living world is organized in a series of hierarchical levels

- Cell: smallest independent unit of life
- Tissue: integrated group of cells that perform a specific function
- Organ: two or more types of tissues that together perform a specific task
- Organ system: multiple organs that together perform a vital body function
- Organism: integrated unit made up of a number of organ systems functioning together



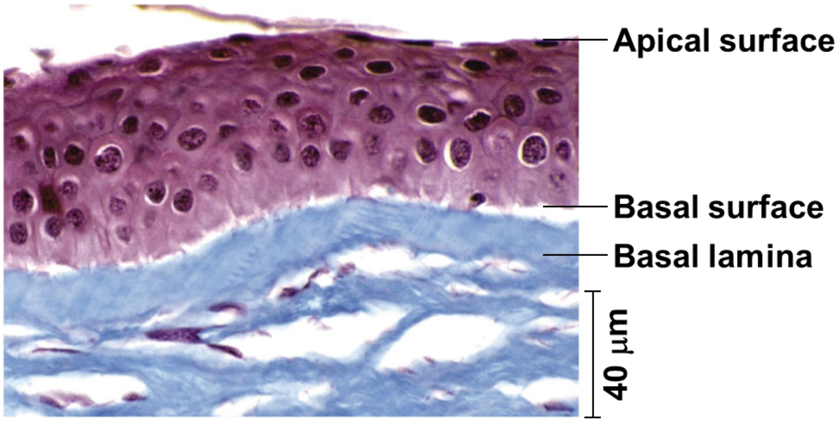
## An Overview

Tissues are groups of cells with a common structure and function

- The cells composing a tissue are specialized to perform a specific function
- In almost all animals, most body cells are organized into four main categories of tissues
  - Epithelial
  - Connective
  - Muscle
  - Nervous

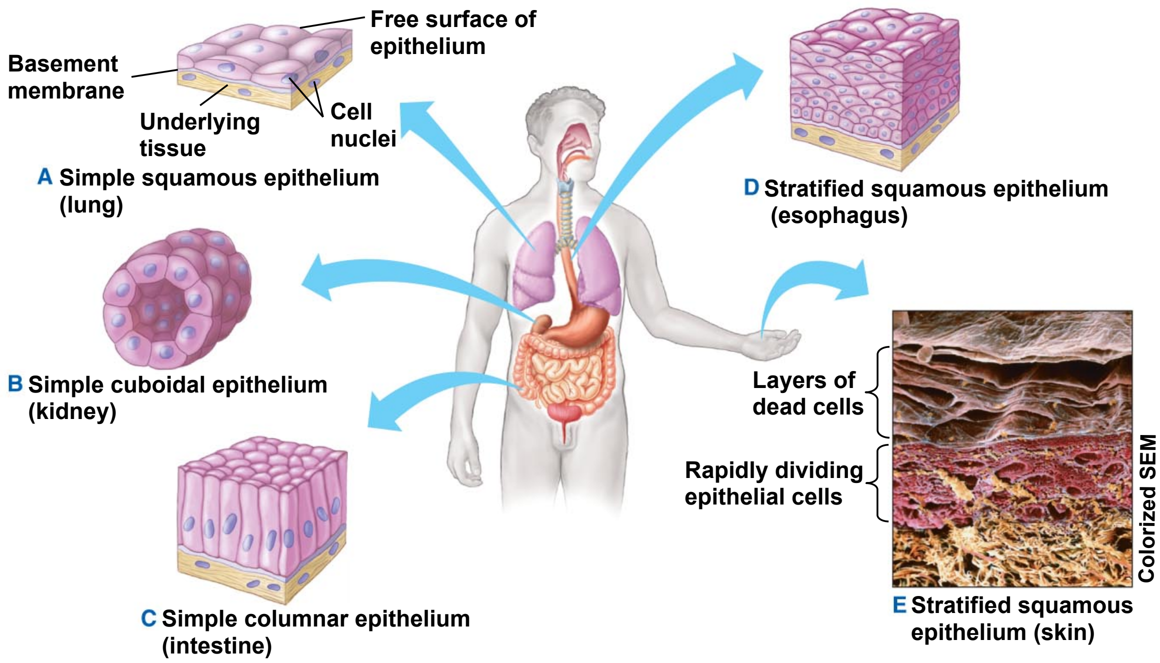
## Epithelial tissue covers the body and lines its organs and cavities

- Epithelial tissue occurs as sheets of closely packed cells anchored to underlying tissues by a basement membrane
- Epithelial tissue functions in protection, secretion, and exchange

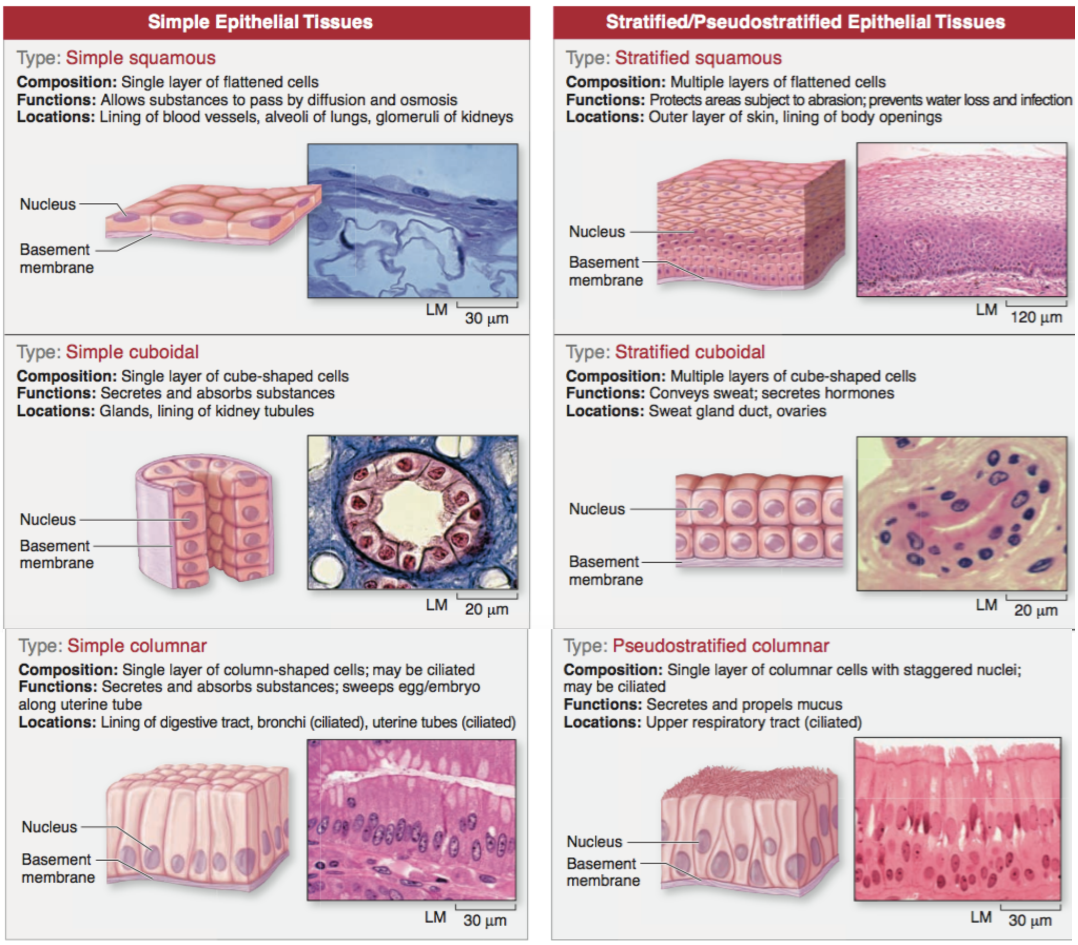



Polarity of epithelia

- Categories of epithelial tissues
    - Simple: single layer of cells
    - Stratified: multiple layers of cells
    - Shapes: squamous, cuboidal, or columnar



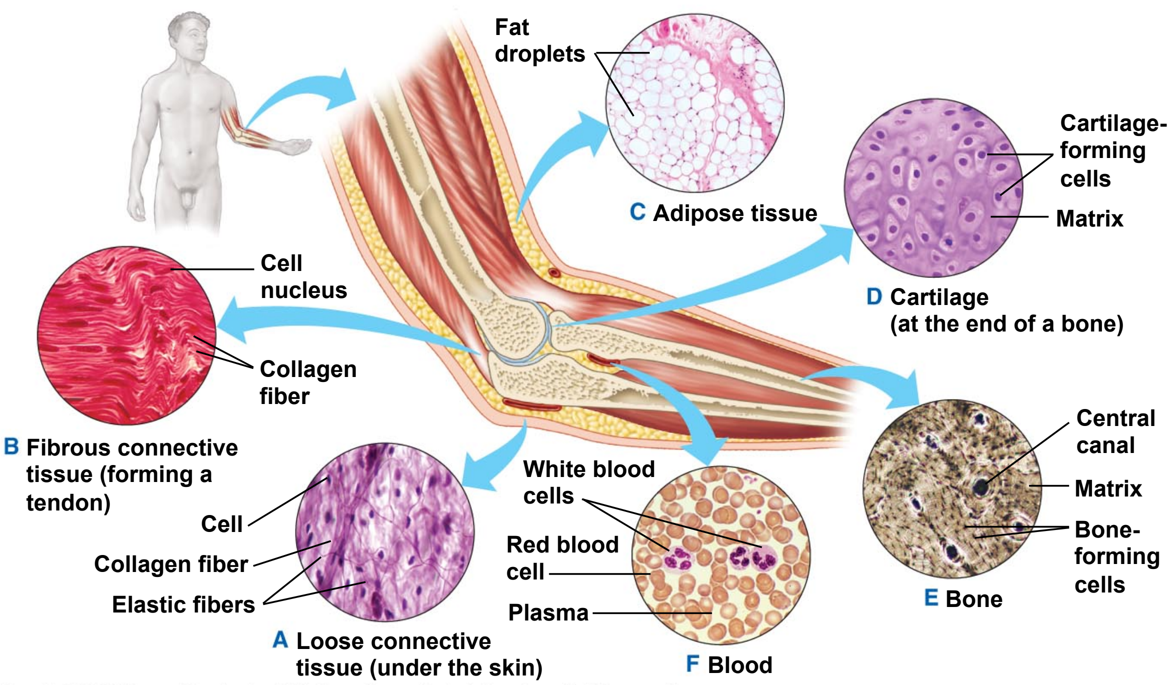


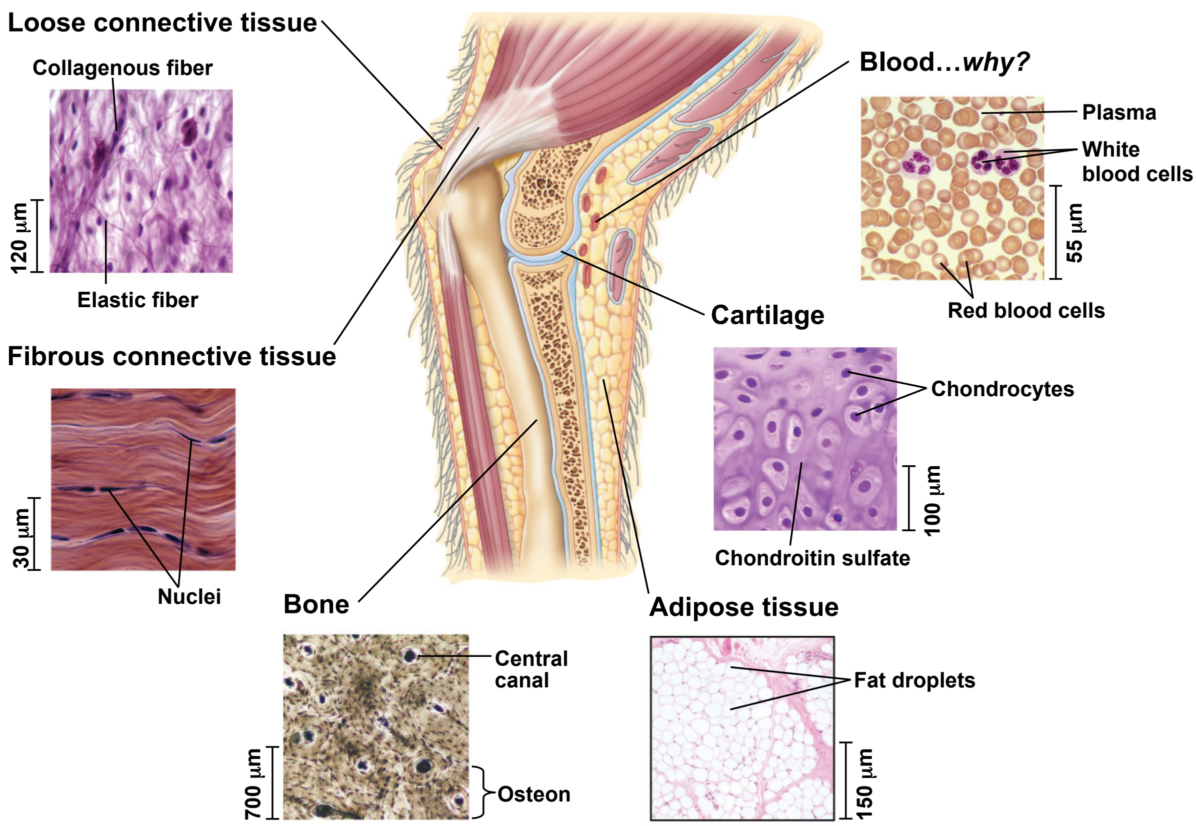
# Connective tissue binds and supports other tissues

The various types of connective tissue consist of sparse cells in an extracellular gel matrix

- Loose connective tissue
- Fibrous connective tissue
- Adipose tissue
- Cartilage
- Bone
- Blood



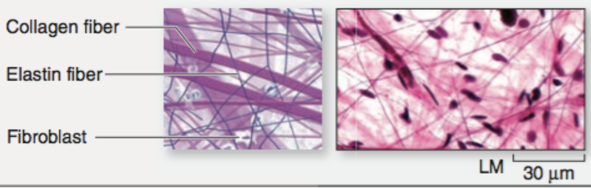
# Connective Tissue





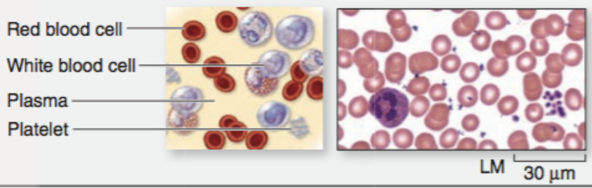

Type: Loose connective tissue

**Composition:** Fibroblast cells in loose matrix of elastin and collagen fibers
**Functions:** Holds organs in place; attaches epithelial tissue to underlying tissue
**Locations:** Under skin, between organs



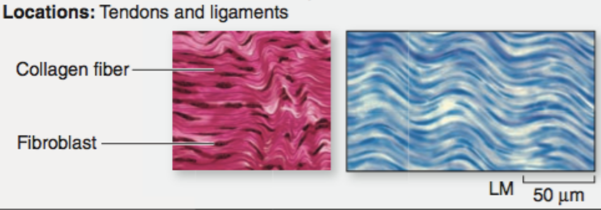

Type: Blood

**Composition:** Red blood cells, white blood cells, platelets in plasma matrix
**Functions:** Transports gases, nutrients, wastes, hormones
**Locations:** In arteries, veins, and capillaries




Type: Dense connective tissue

**Composition:** Fibroblast cells in dense matrix of elastin and collagen fibers
**Functions:** Connects muscle to bone; connects bone to bone
**Locations:** Tendons and ligaments

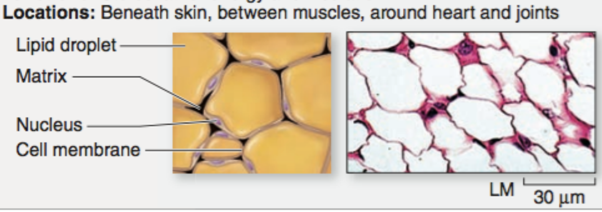



Type: Cartilage

**Composition:** Chondrocytes in matrix of fine collagen fibers
**Functions:** Flexible support
**Locations:** Ears, joints, bone ends, respiratory tract, embryonic skeleton

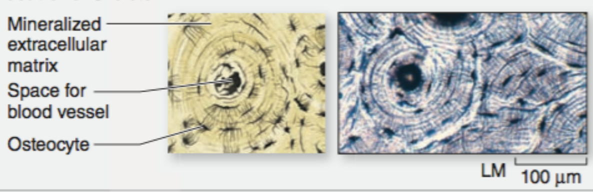

Type: Adipose tissue

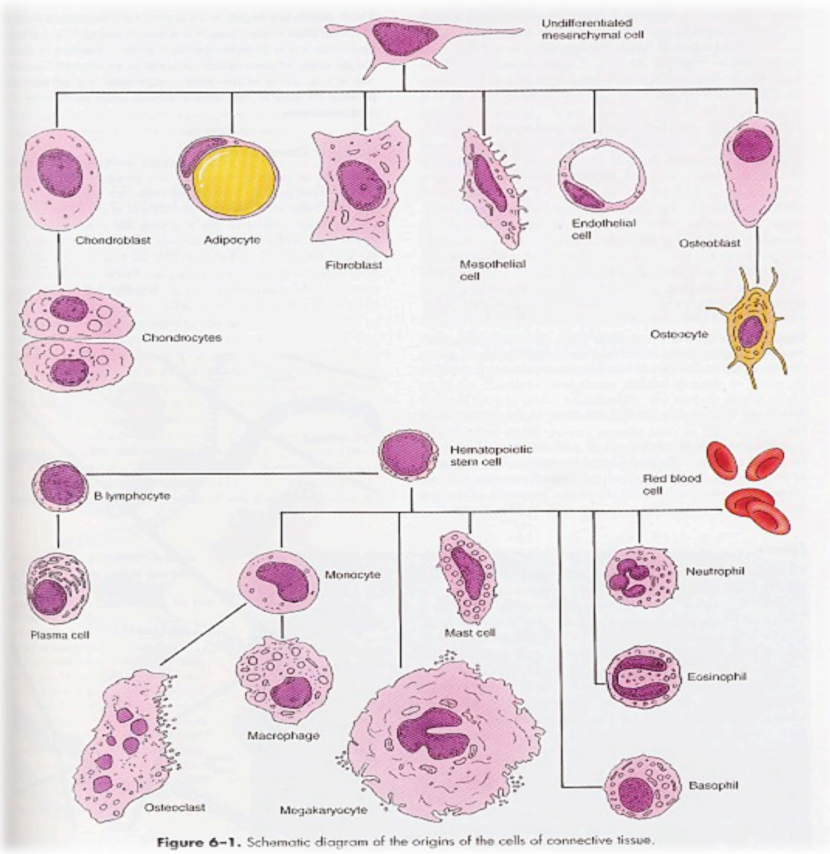
**Composition:** Fat cells (adipocytes) in minimal matrix
**Functions:** Stores fat for energy and insulation
**Locations:** Beneath skin, between muscles, around heart and joints




Type: Bone

**Composition:** Osteocytes and other cells in matrix of collagen and minerals
**Functions:** Firm support
**Locations:** Skeleton






**Asal mulanya sel-sel pada jar. ikat**

# JARINGAN IKAT

- Jar. Ikat : a. sejati : kendur dan kencang
- Jar ikat penunjang : rawan dan tulang
- Jar ikat khusus : lemak (dominasinya oleh sel lemak)
- Rawan: selnya dis. Kondrosit, yg menghuni suatu ruang dis. Lakuna
- Substansi dasar berupa gel, di dalam matriks ada serabut2

**Macam rawan**:

- R. hialin: transkulen, perikondrium padat, seluler: daerah kondrogenik, memiliki kemampuan utk membentuk rawan. Adanya tumbuh aposisional, adanya kel isogen (tumbuh interstisial dr kel isogen)
- R. elastin: dominan serabut elastin (fleksibel)
- R. serabut: banyak kolagen, sel2 rawan tersusun sejajar dg serabutnya

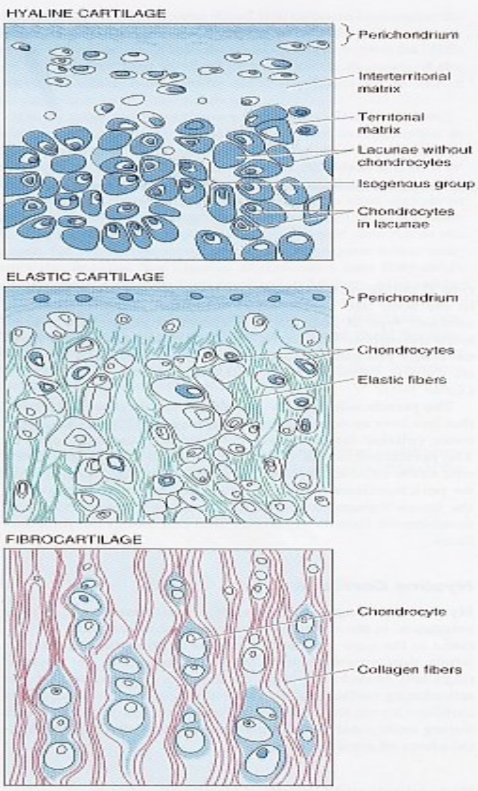
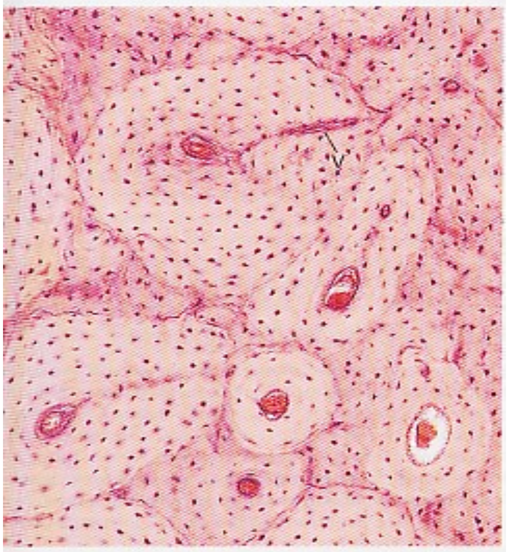



**Figure 7–1.** Diagram of the types of cartilage.


**Figure 7–2. Light micrograph of hyaline cartilage (× 270).** Observe the large ovoid chondrocytes (C) trapped in their lacunae. Directly above them are the elongated chondroblasts, and at the very top is the perichondrium (P) and the underlying chondrogenic cell layer.

- 3 jenis rawan : elastin, serabut, hialin

  R. Serabut : tidak ada perikondrium




**igure 7–11. Light micrograph of decalcified com- act bone (× 132).** Several osteons are displayed with ieir concentric lamellae. A Volkmann's canal (V) is also dis- layed.

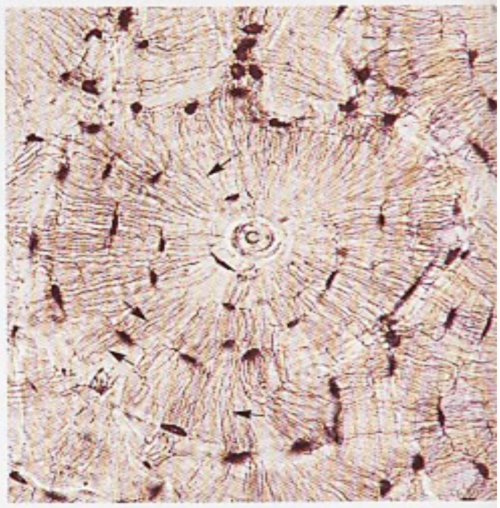
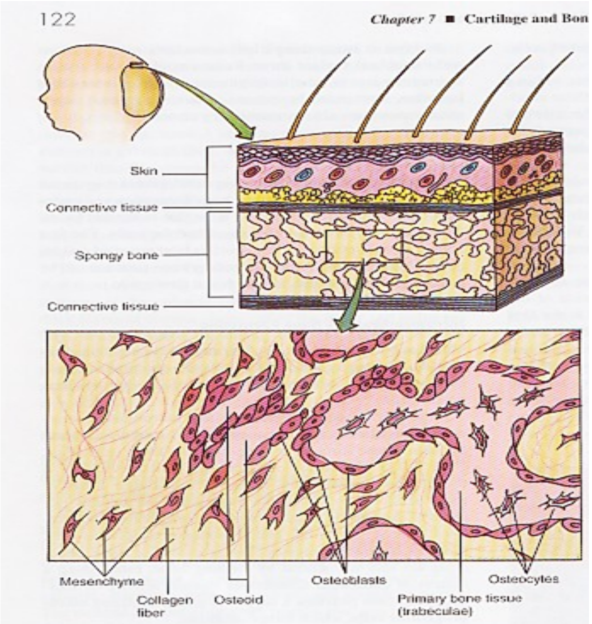



**Figure 7–10. Light micrograph of undecalcified ground bone (× 270).** Observe the haversian system containing the haversian canal (C) and concentric lamellae with lacunae with their canaliculi (arrows).

Sistem Havers pada tulang kompak



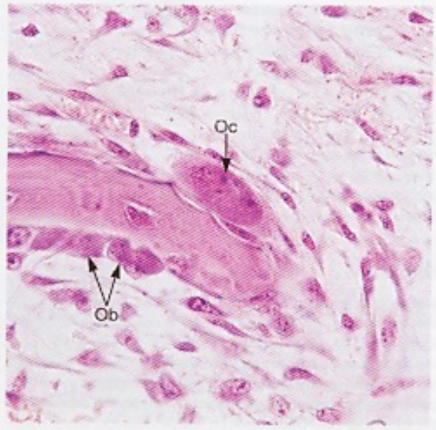




**Figure 7–6. Light micrograph of intramembranous ossification (× 540).** Osteoblasts (Ob) line the bony spicule where they are secreting osteoid onto the bone. Osteoclasts (Oc) may be observed housed in Howship's lacunae.

**Penulangan intramembran**: mesoderm kondensasi, jadi osteoblas, jadi osteoid, mengalami mineralisasi

Osteoblas: menghasilkan matriks tlg yg belum termineralisasi

Osteosit: lakuna, juluran2 sitoplasma, kanalikuli

Osteoklas:merombak tlg (remodelling), inti banyak, fusi dr sel2 osteogenik

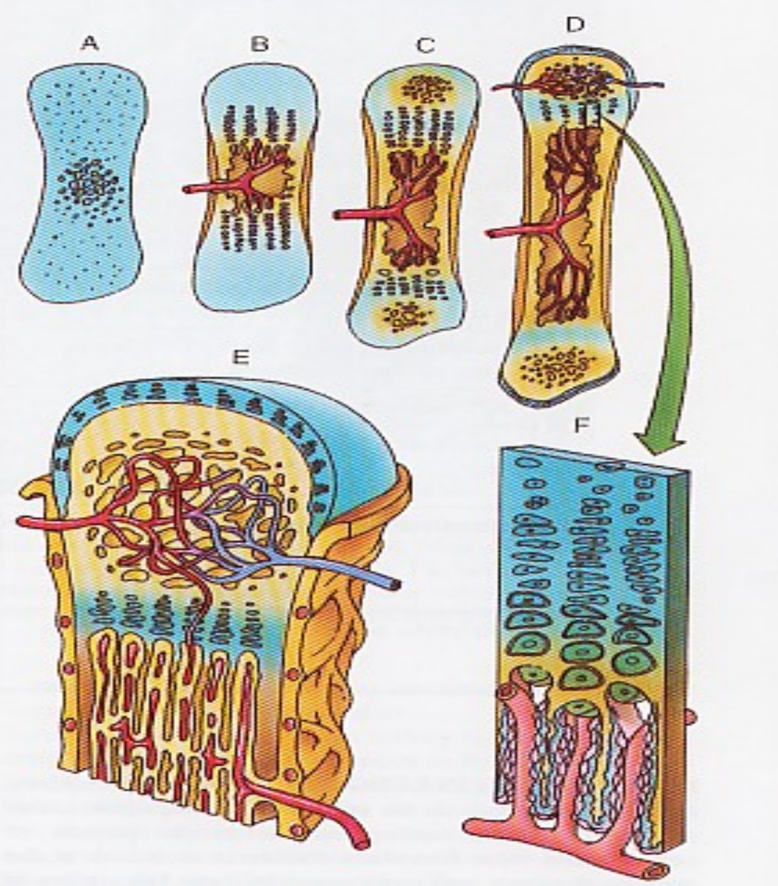
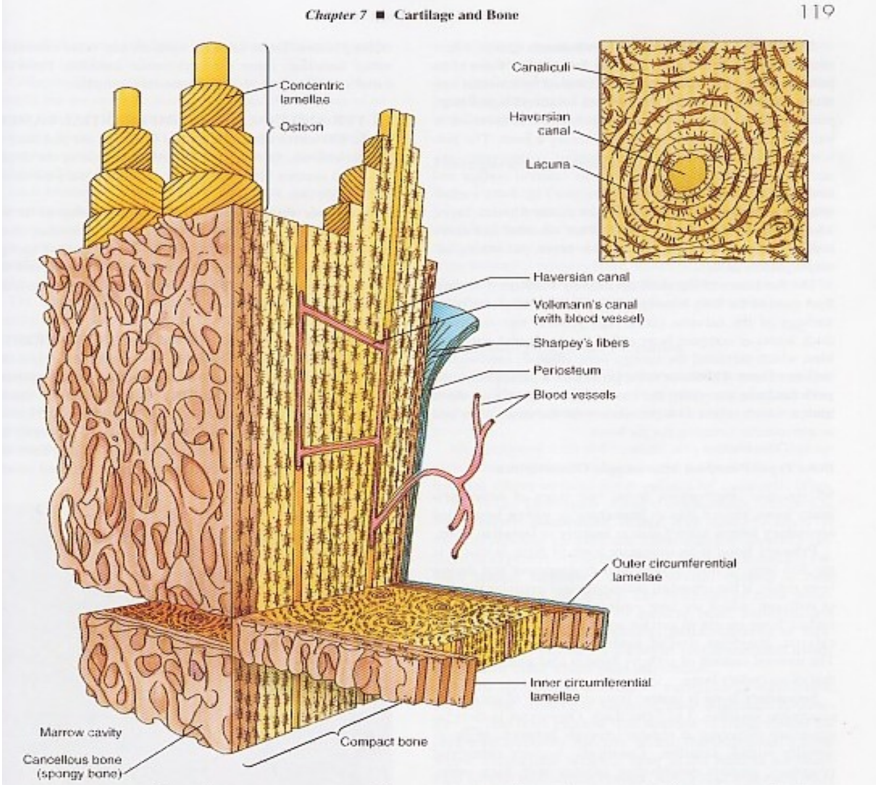



**Figure 7–14.** Diagram of endochondral bone formation.

**Penulangan endokondral: melalui rawan, rawan dirombak menjadi tulang**




igure 7–9. Diagram of bone illustrating compact cortical bone, osteons, lamellae, Volkmann's canals, haversian canals, lacu-
ie, canaliculi, and spongy bone.

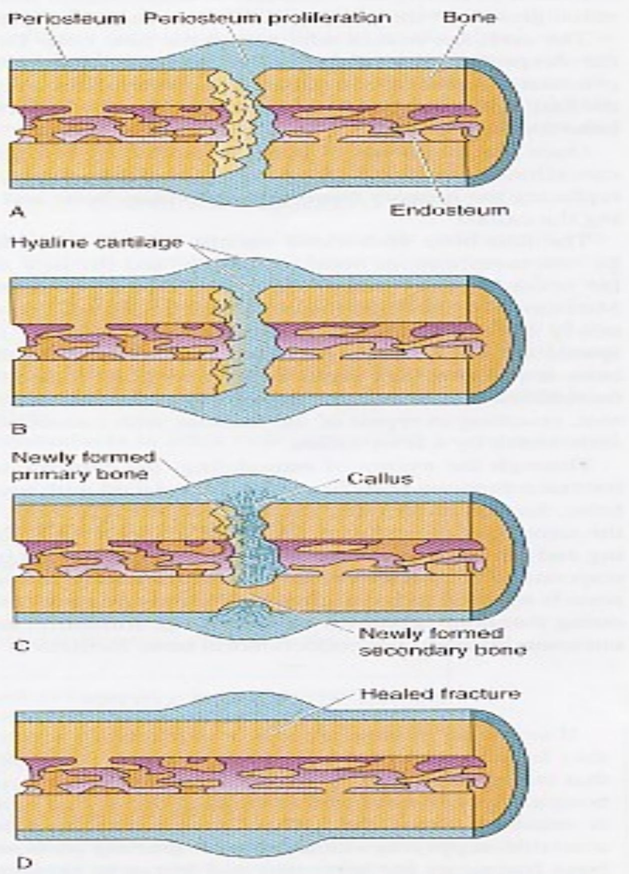


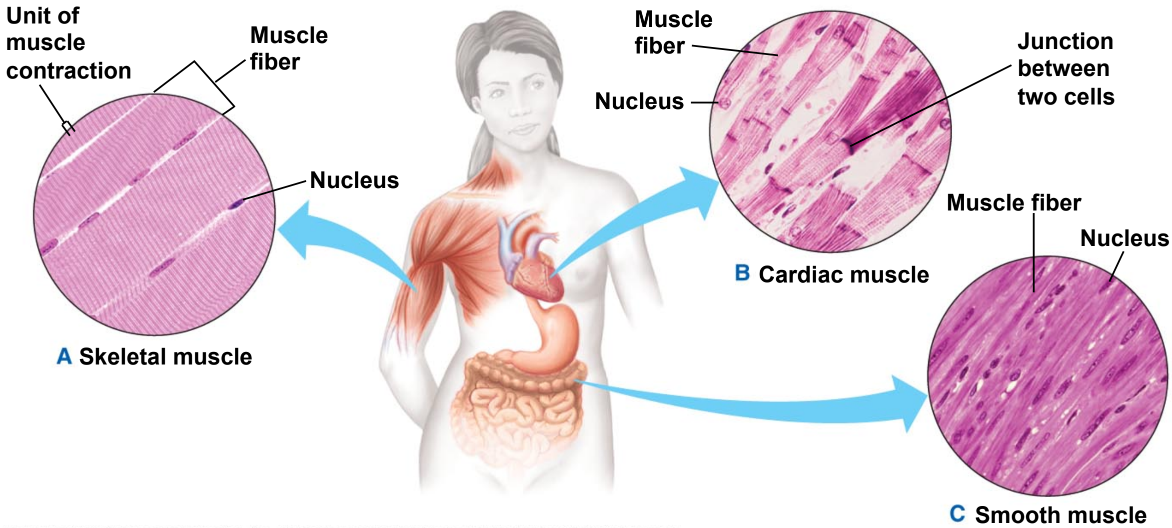

**Figure 7–17.** Diagram of the events in bone fracture repair.

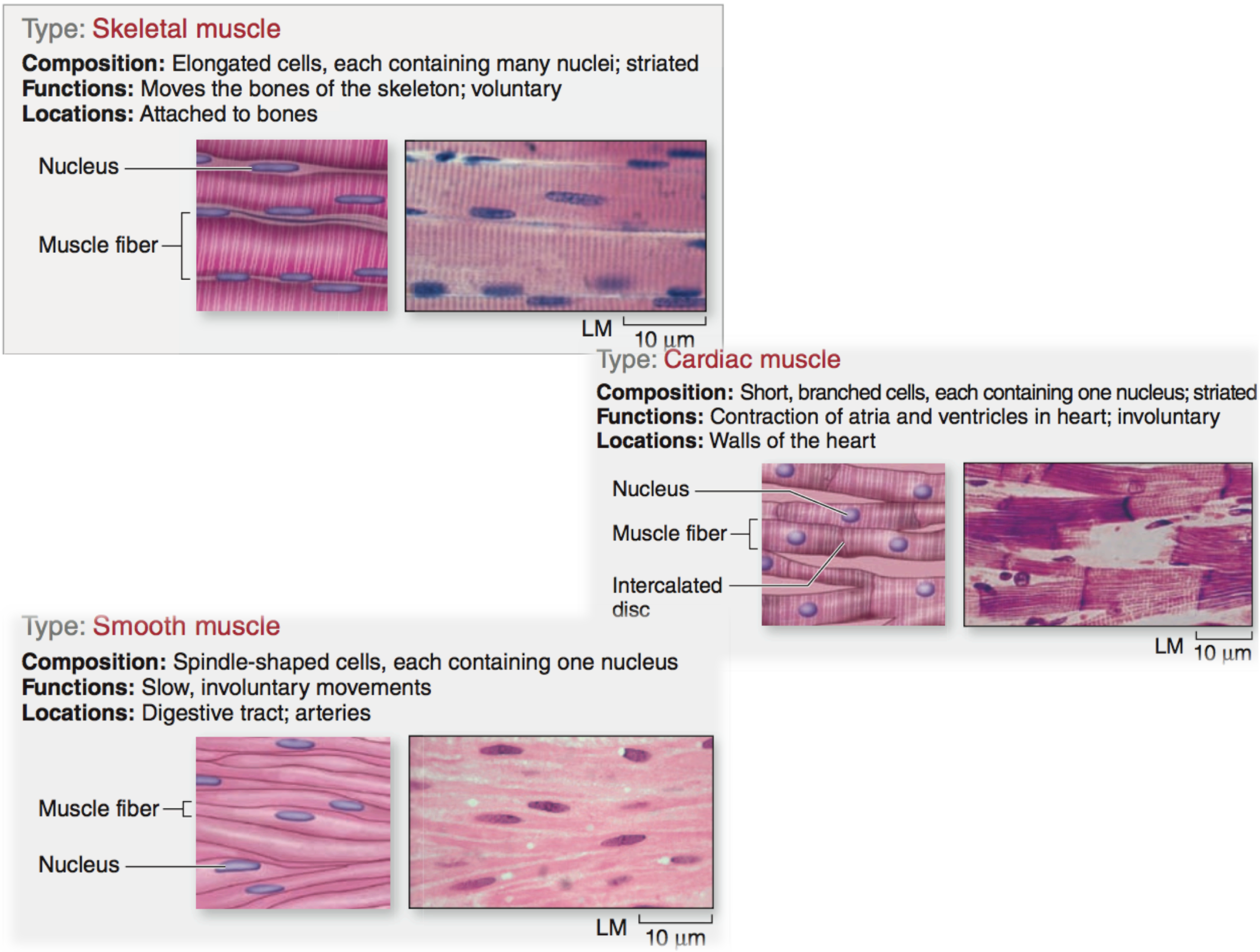
**Proses penyembuhan patah tulang**

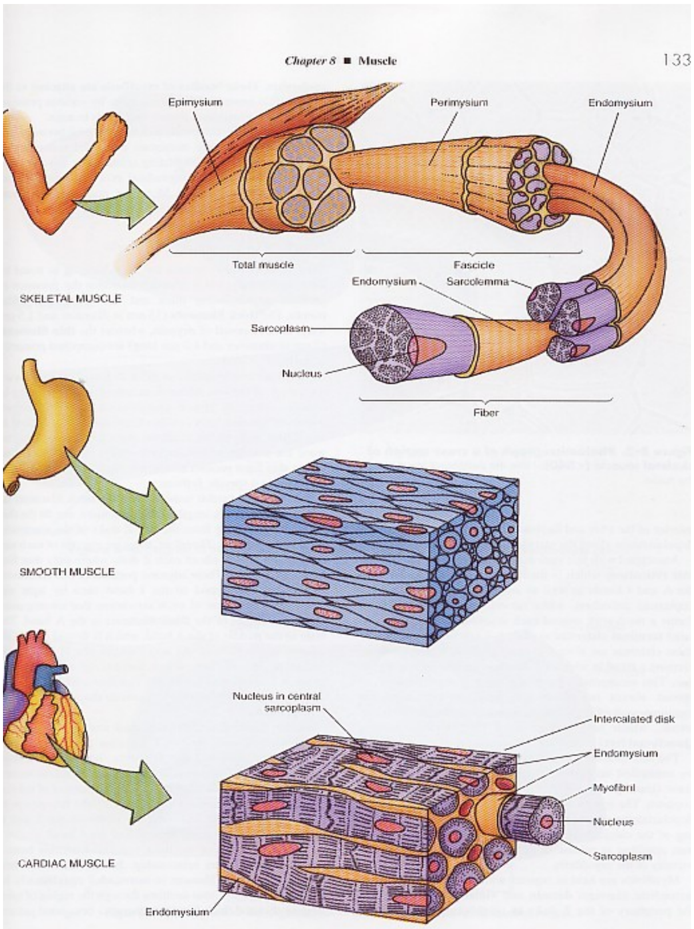
# Muscle tissue functions in movement

Muscle tissue consists of bundles of long cells called muscle fibers

- Skeletal muscle is responsible for voluntary body movements
- Cardiac muscle forms the contractile tissue of the heart
- Smooth muscle moves the walls of internal organs such as the stomach, bladder, and arteries






gure 8–2. Diagram of the three types of muscle. *Top*, Skeletal muscle; *center*, smooth muscle; *bottom*, cardiac muscle.

**3 jenis otot**:

1. Otot rangka: melekat pd komponen2 rangka, shg rangka bisa bergerak
2. Otot polos: dinding2 organ:sal penc.
3. Otot jantung: di jantung

Asal
usul :MESODERM

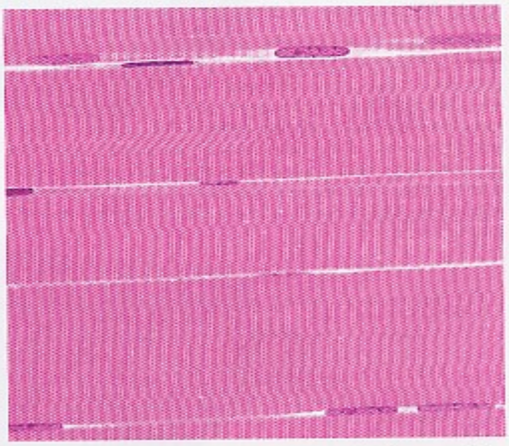


**Figure 8–1.** Photomicrograph of a longitudinal section of skeletal muscle (× 540).

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Otot rangka Inti di tepi

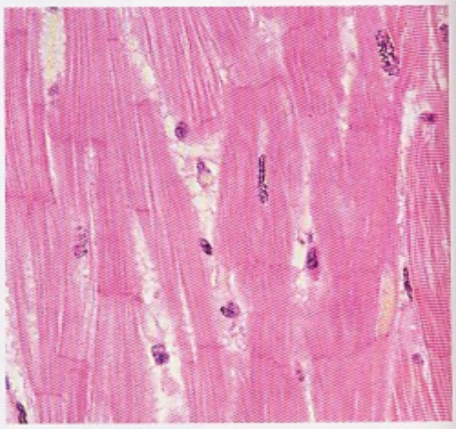


**Figure 8–16.** Photomicrograph of cardiac muscle in longitudinal section (× 540).

Otot jantung: inti di tengah

**Figure 8–22.** Photomicrograph of smooth muscle in longitudinal section (× 540).

Otot polos: memanjang

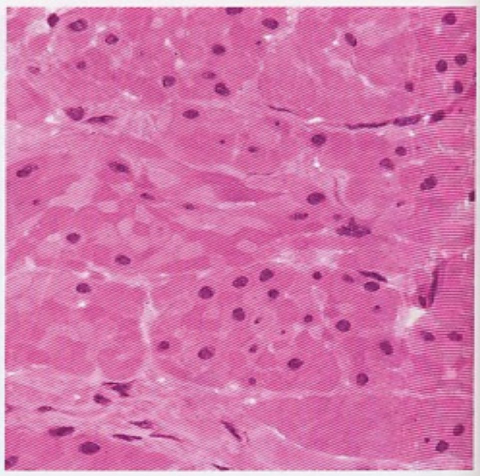
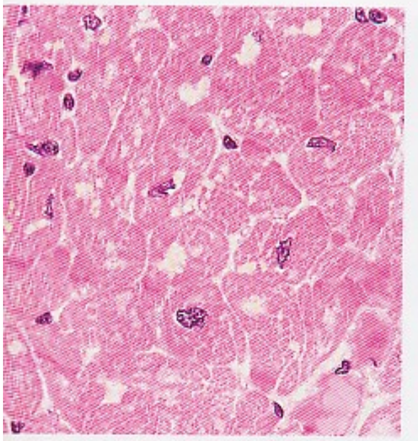


**Figure 8–23.** Photomicrograph of smooth muscle in cross-section (× 540).

Otot polos: melintang



...gure 8-17. Photomicrograph of cardiac muscle in cross-...ction.

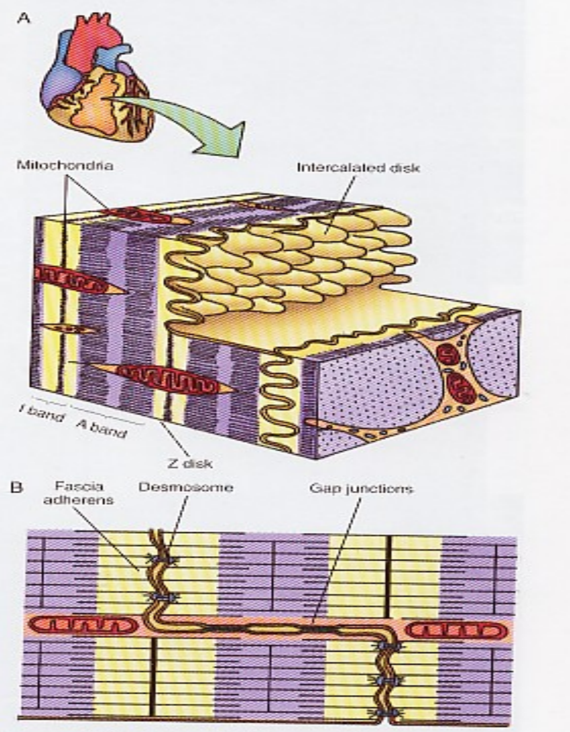



**Figure 8-18. Schematic diagram of cardiac muscle. A,** Three-dimensional view of the intercalated disk. **B,** Two-dimensional view of the intercated disk, displaying adhering and communicating junctions.



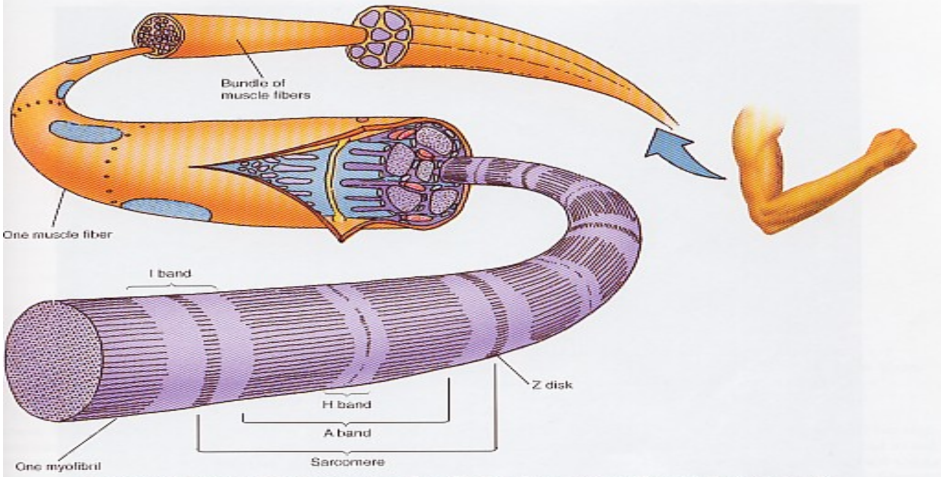



**Figure 8-4.** Diagram of the organization of myofibrils and sarcomeres within a skeletal muscle cell.

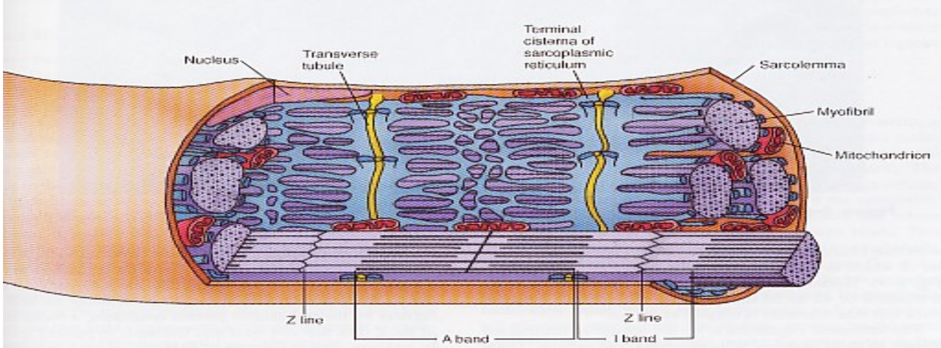



**Figure 8-5.** Diagram of the organization of triads and sarcomeres of skeletal muscle.

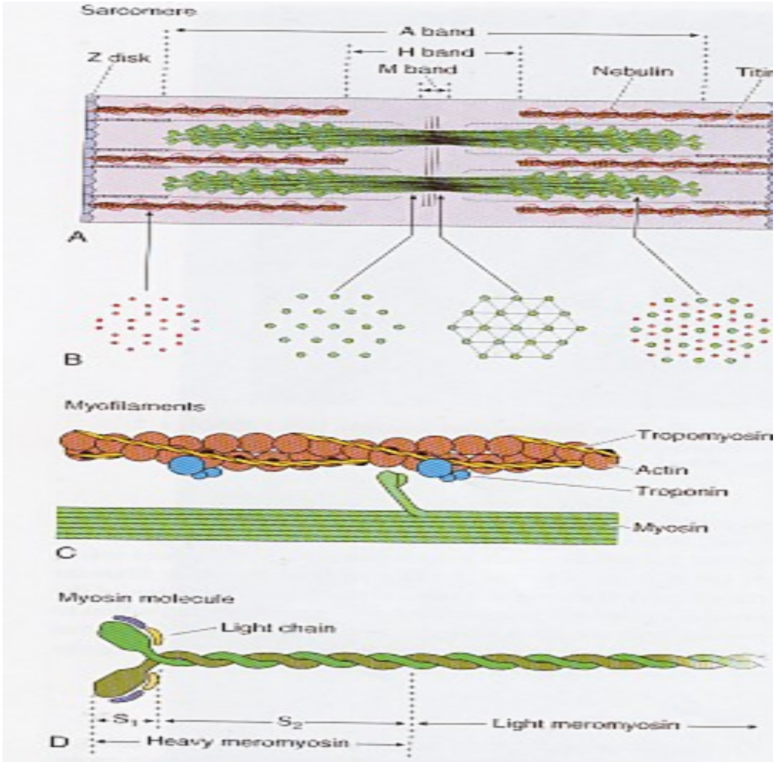
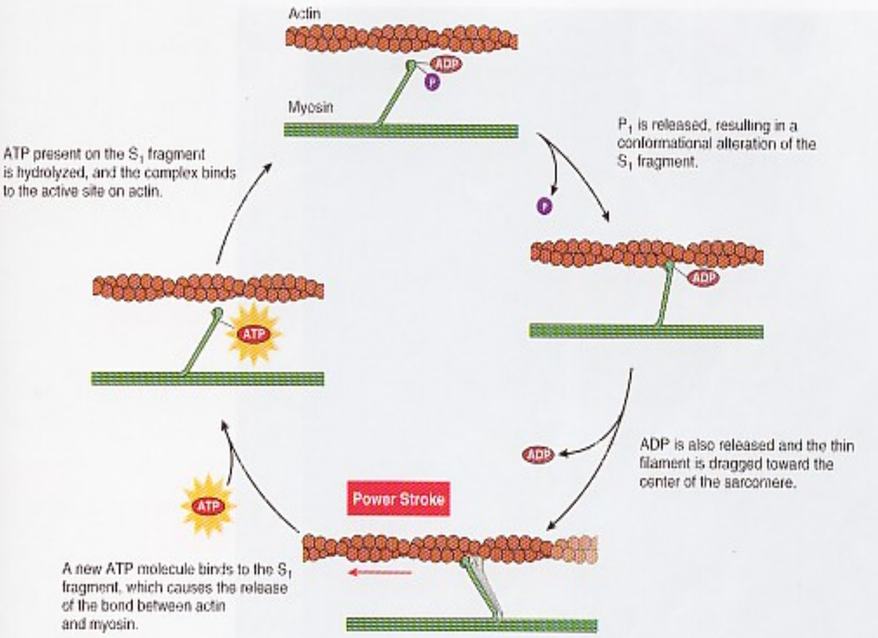



**Figure 8–8. Diagram of a sarcomere and its components. A,** Sarcomere; **B,** cross-sectional profiles of sarcomere at indicated regions; **C,** thick and thin filaments; **D,** myosin molecule.

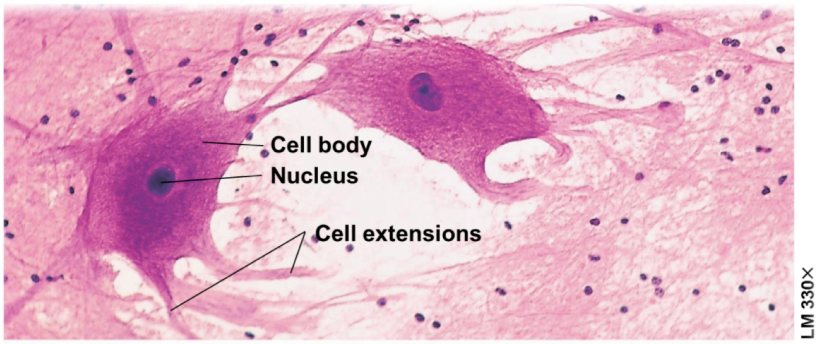




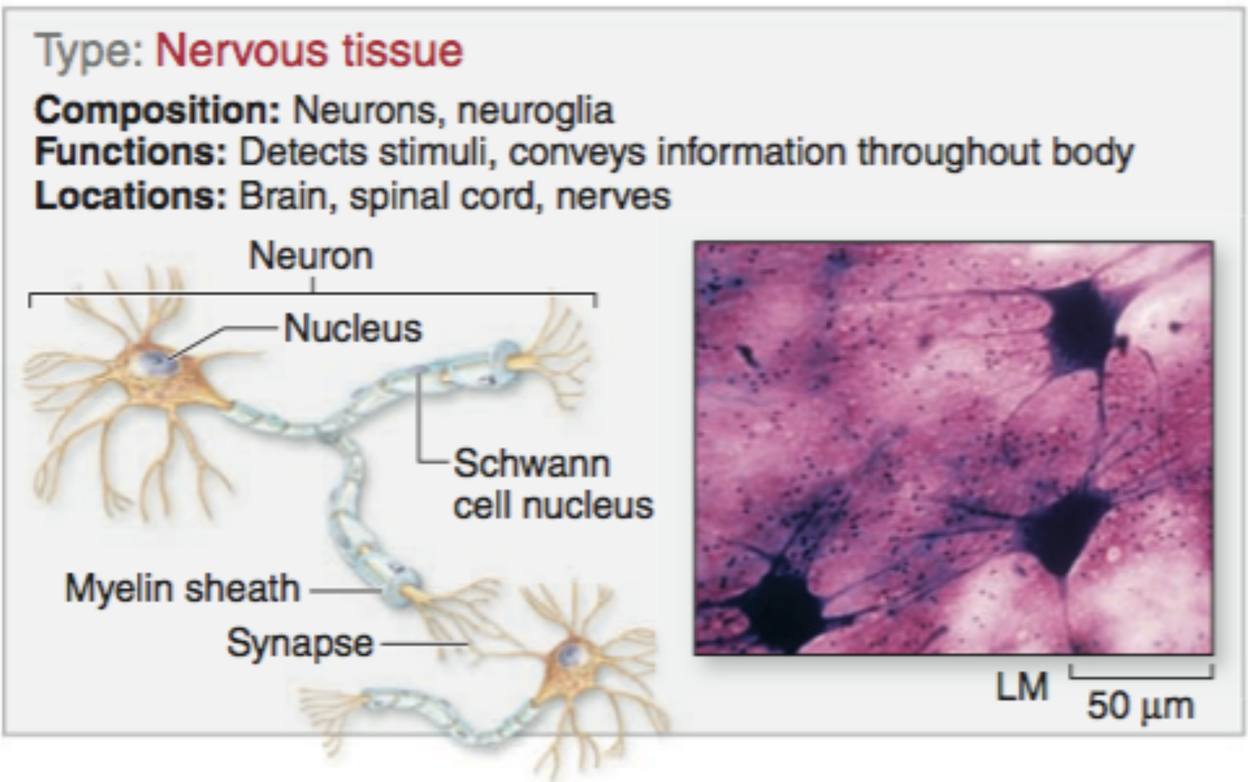

**gure 8–10.** Diagram of the role of ATP in muscle contraction. (Modified from Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, , and Watson, J.D.: Molecular Biology of the Cell. New York, Garland Publishing, 1994.)

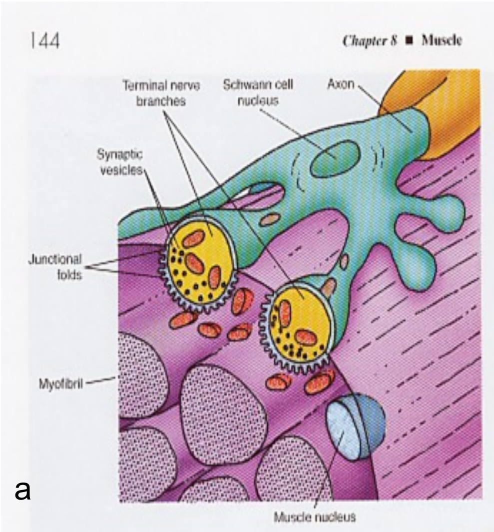
# Nervous tissue forms a communication network

- Nervous tissue senses stimuli and rapidly transmits information through the body
- The neuron is the structural and functional unit of nervous tissue
  - Specialized to conduct electrical impulses
  - Consists of cell body, axon, and dendrites
  - Nourished by supporting cells

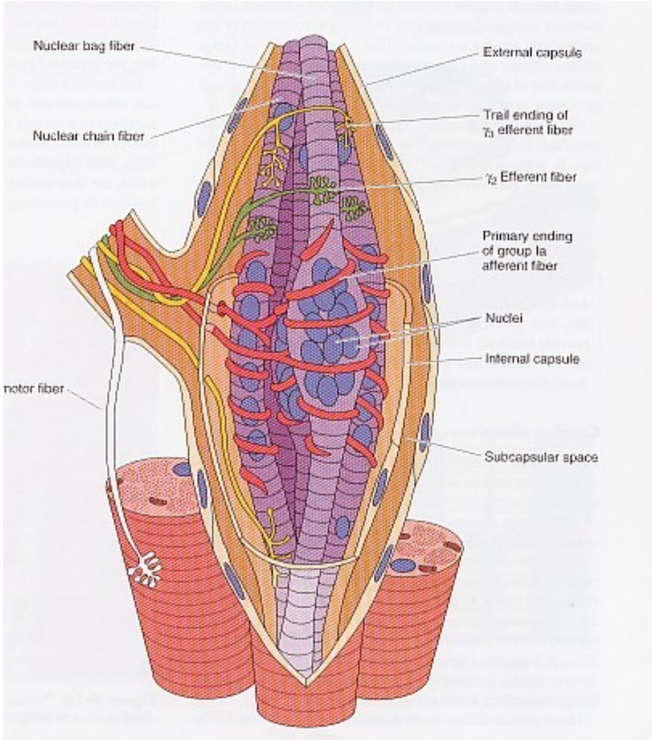




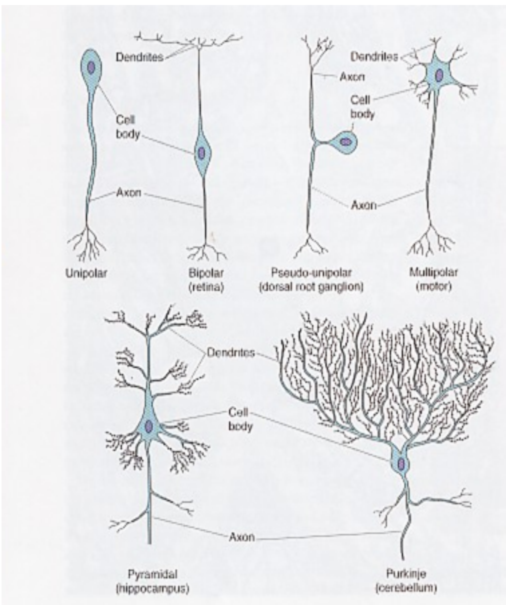






a. Myoneural junction
b. Diagram berkas otot




b




Macam-macam neuron

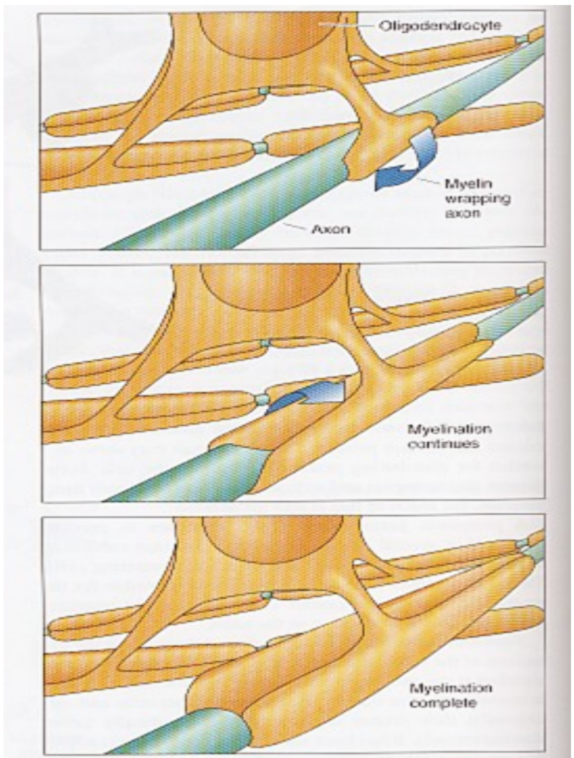



**Figure 9–6. Schematic diagram of the process of myelination in the central nervous system.** Note that unlike Schwann cells of the peripheral nervous system, each oligodendroglion is capable of myelinating several axons.

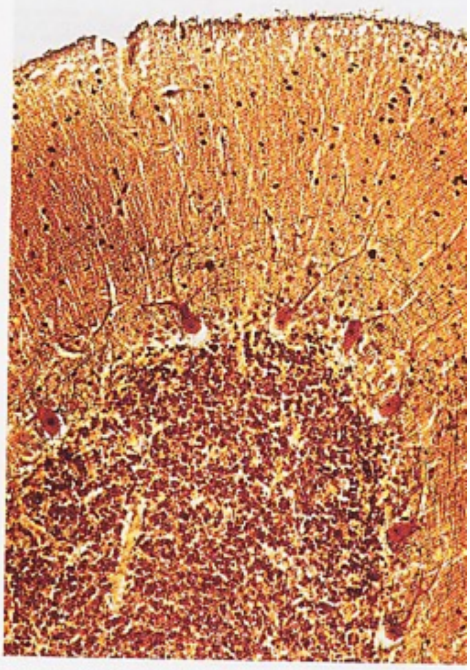
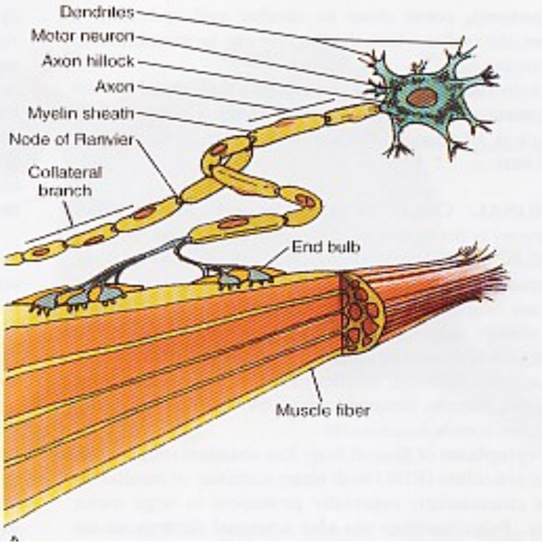
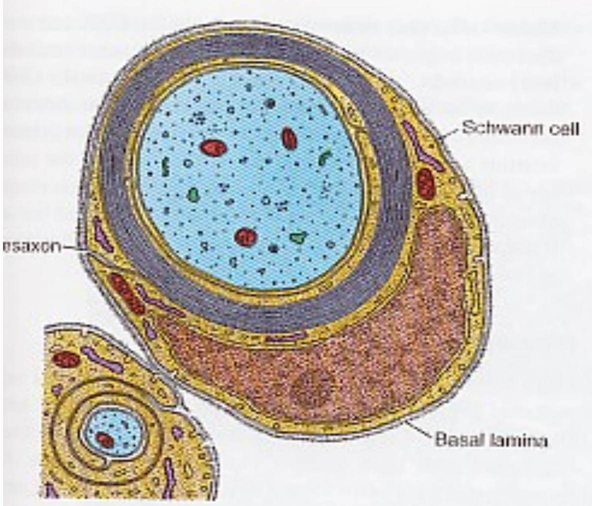


**Figure 9–29. Light micrograph of the cerebellum showing its layers (× 132).** Especially note the prominent Purkinje cells.






**gure 9–7.** Diagram of the fine structure of a myelinated rve fiber and its Schwann cell. (From Lentz, T.L.: Cell Fine ucture. An Atlas of Drawings of Whole-Cell Structure. iladelphia, W.B. Saunders Company, 1971.)

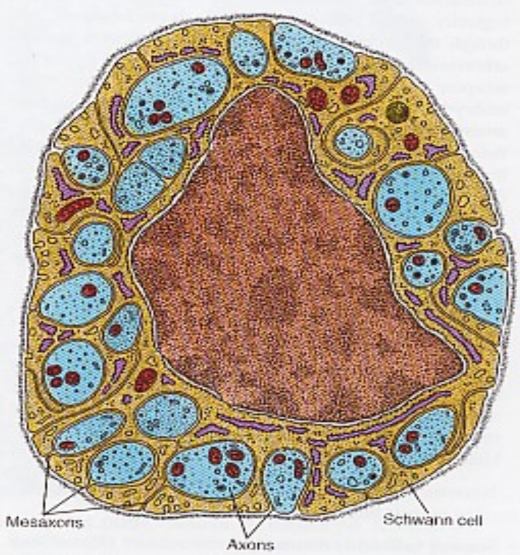



**Figure 9–8.** Diagram of the fine structure of an unmyelinated nerve fiber. (From Lentz, T.L.: Cell Fine Structure. An Atlas of Drawings of Whole-Cell Structure. Philadelphia, W.B. Saunders Company, 1971.)

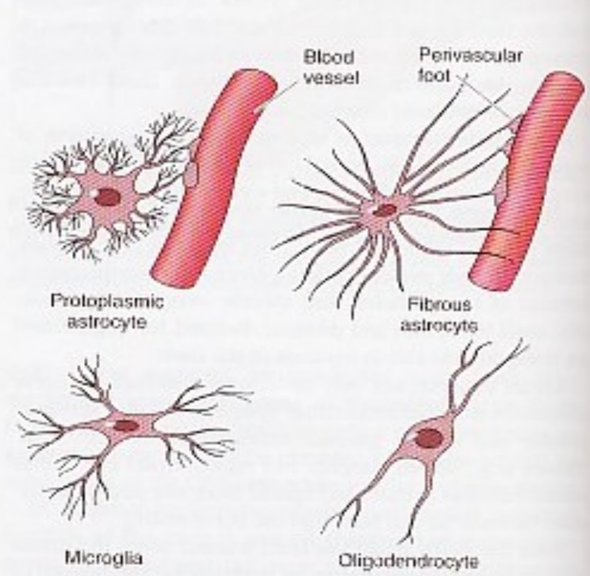



**Figure 9–9.** Diagram of the various types of neuroglial cells.

Macam-macam astrosit/glia sel

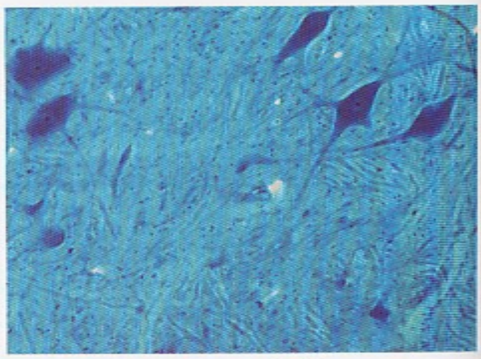


**Figure 9–1. Light micrograph of the gray matter of the spinal cord (× 270).** Observe the multipolar neuron cell bodies and their processes.

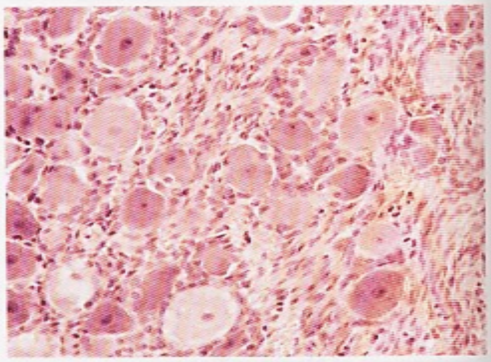
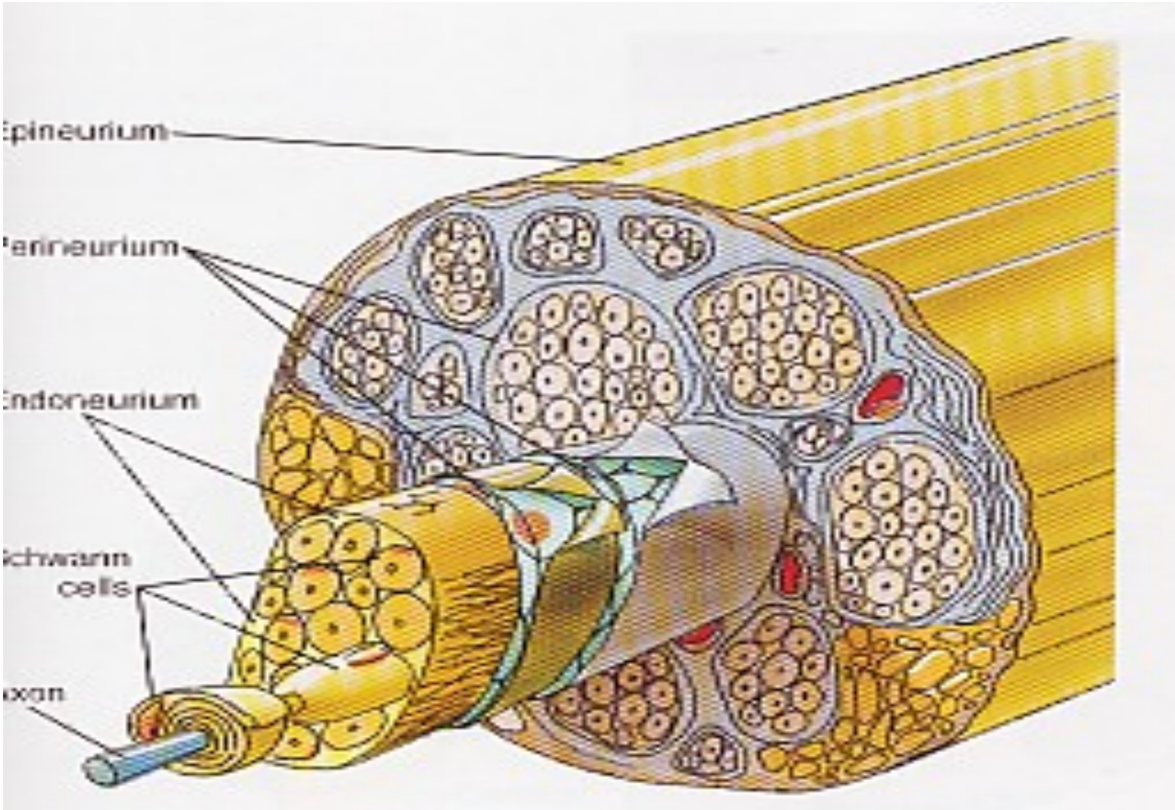
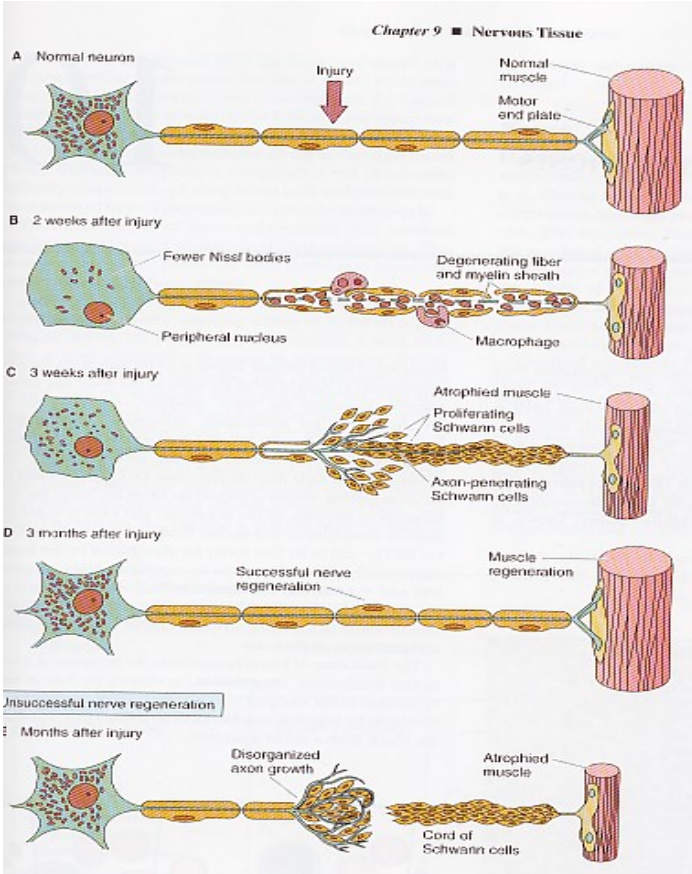


**Figure 9–2. Light micrograph of a sensory ganglion (× 270).** Observe the large neuronal cell bodies with singular nucleoli.




**igure 9–22.** Diagram of the structure of a nerve bundle.

Berkas saraf : epineurium, perineurium, endoneurium, fasikulum




Regenerasi saraf

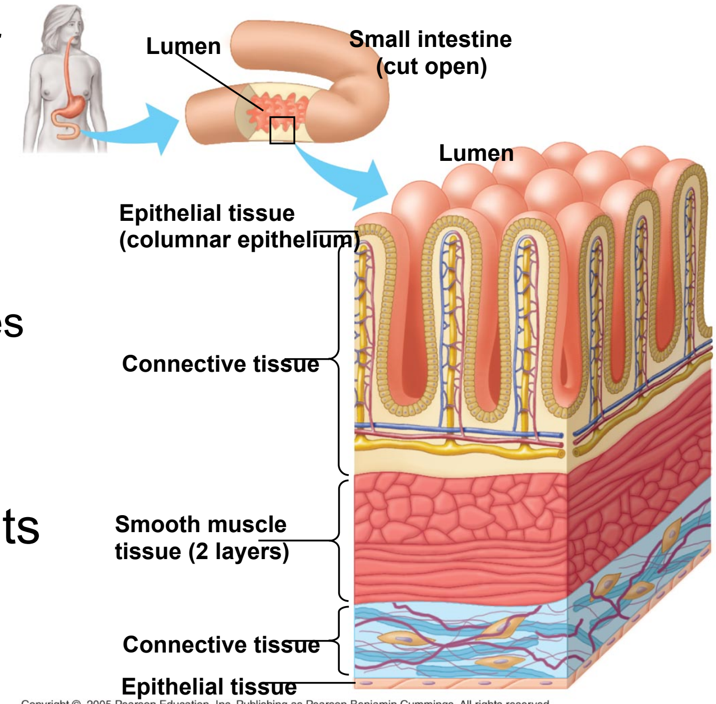
## CONNECTION

### Artificial tissues have medical uses

- Many, but not all, body tissues are self-repairing
- Artificial tissues can assist in the healing of tissues that cannot recover on their own
  - Skin
  - Cartilage, teeth (under study)

# Organs are made up of tissues

- Each organ is made of several tissues that collectively perform specific functions
  - In some organs, tissues are arranged in layers
- An organ performs functions that none of its component tissues could carry out alone

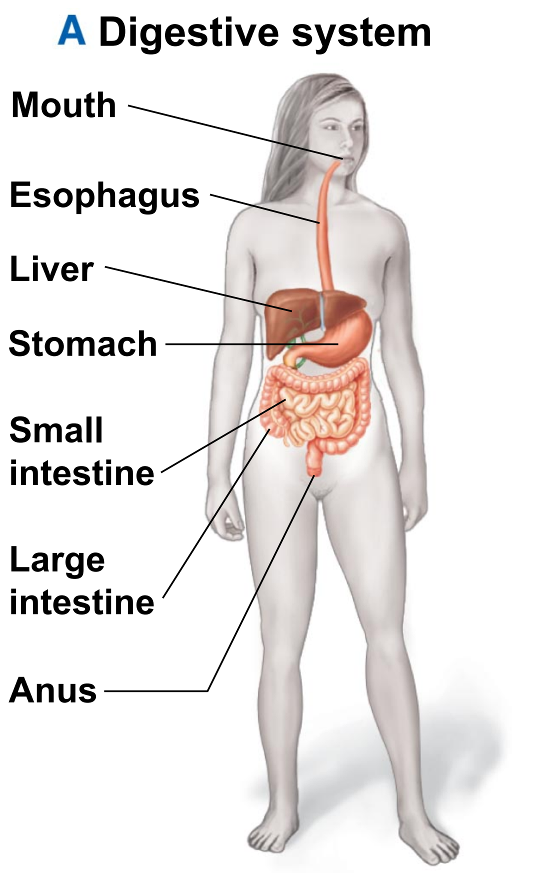




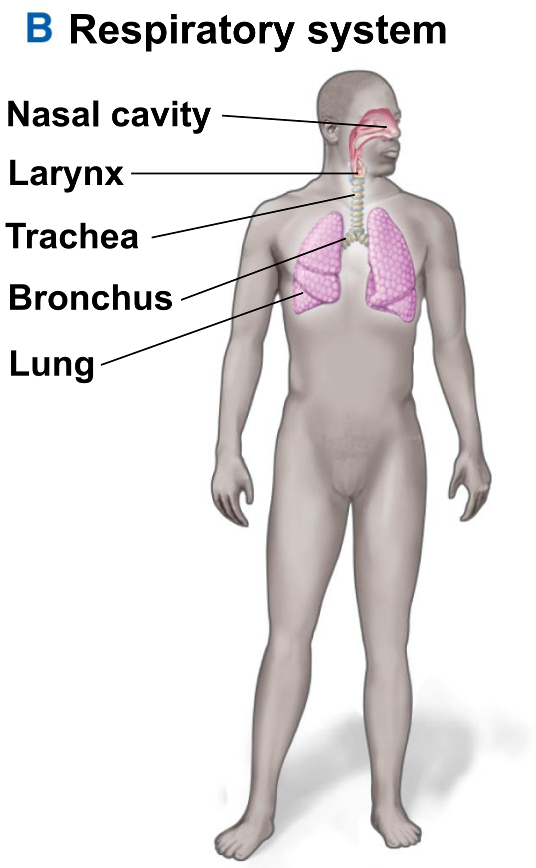

# Organ systems work together to perform life functions

There are twelve major organ systems in vertebrate animals

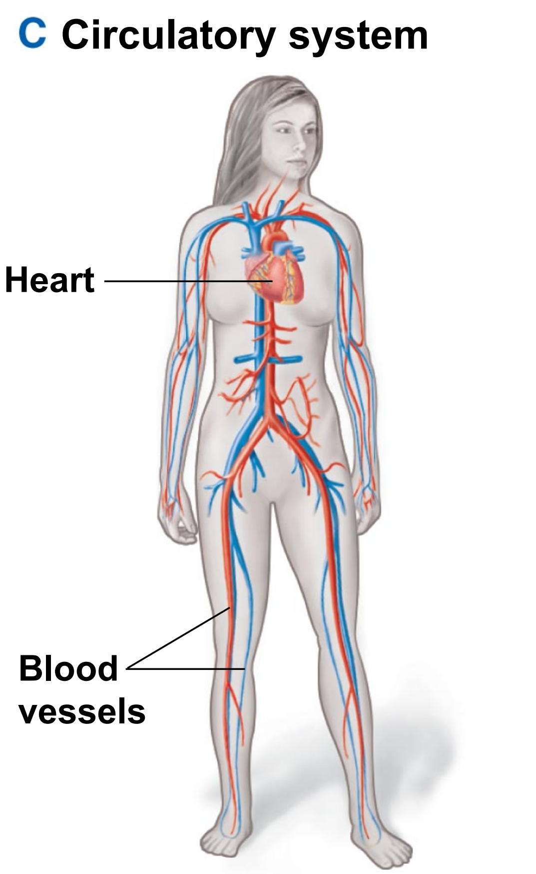
A. Digestive system
B. Respiratory system
C. Circulatory system
D. Immune system
E. Lymphatic system
F. Excretory system
G. Endocrine system
H. Nervous system
I. Integumentary system
J. Skeletal system
K. Muscular system
L. Reproductive systems


A Digestive system
Mouth
Esophagus
Liver
Stomach
Small intestine
Large intestine
Anus

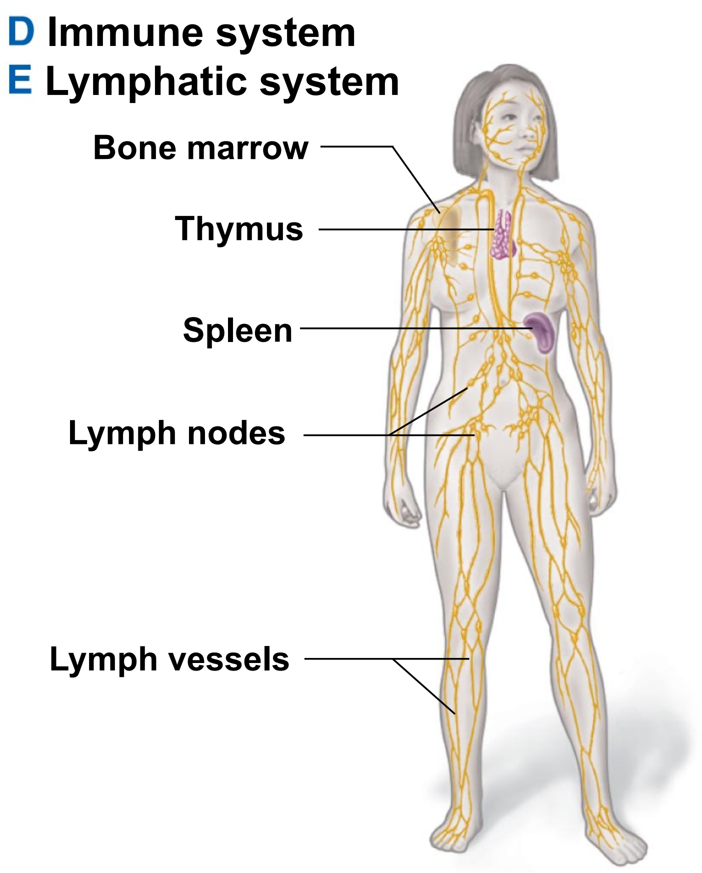



B Respiratory system
Nasal cavity
Larynx
Trachea
Bronchus
Lung

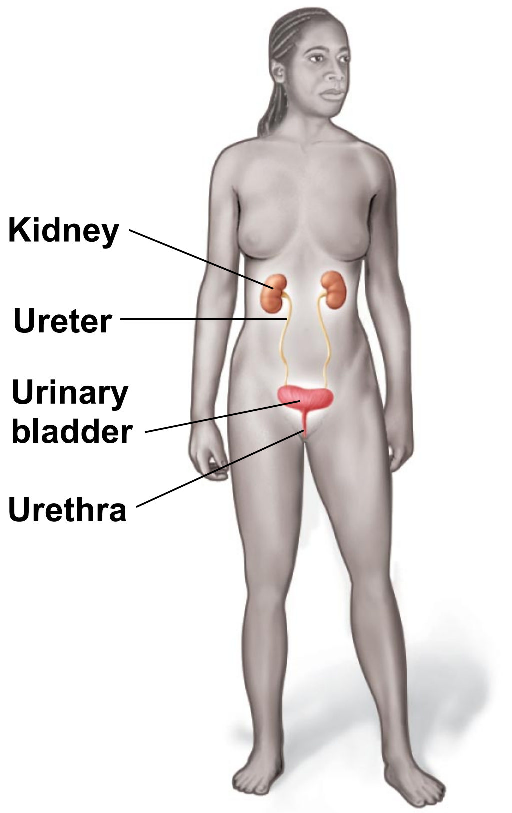



C Circulatory system
Heart
Blood vessels



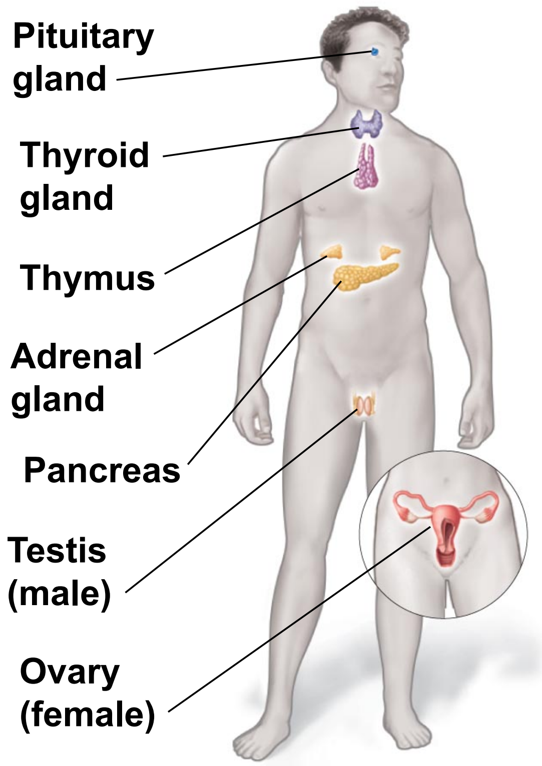

D Immune system
E Lymphatic system
Bone marrow
Thymus
Spleen
Lymph nodes
Lymph vessels

## F Excretory system



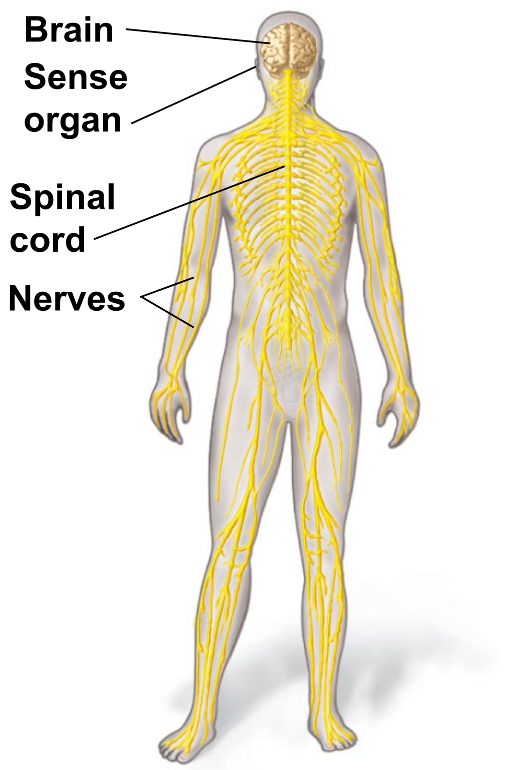



## G Endocrine system



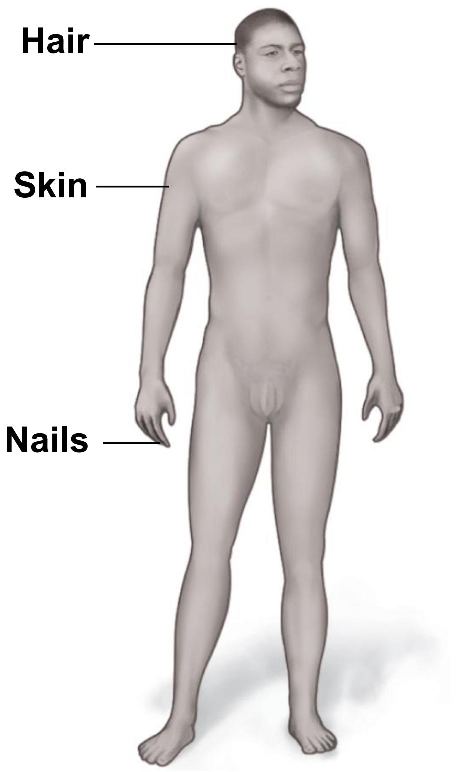



## H Nervous system

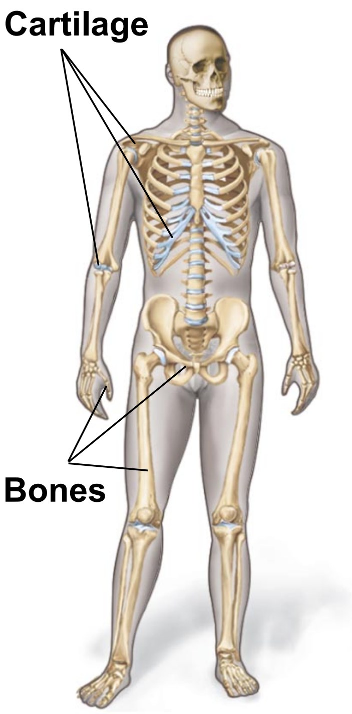





## I Integumentary system

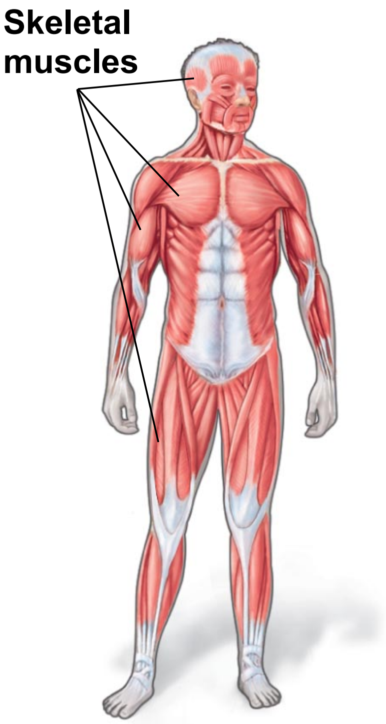


## J Skeletal system



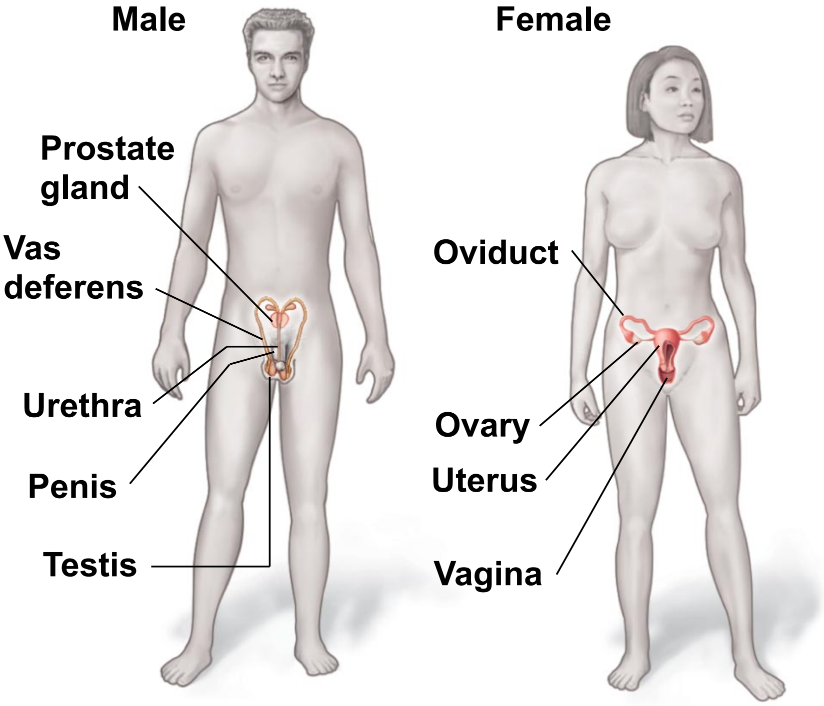



## K Muscular system






## L Reproductive system



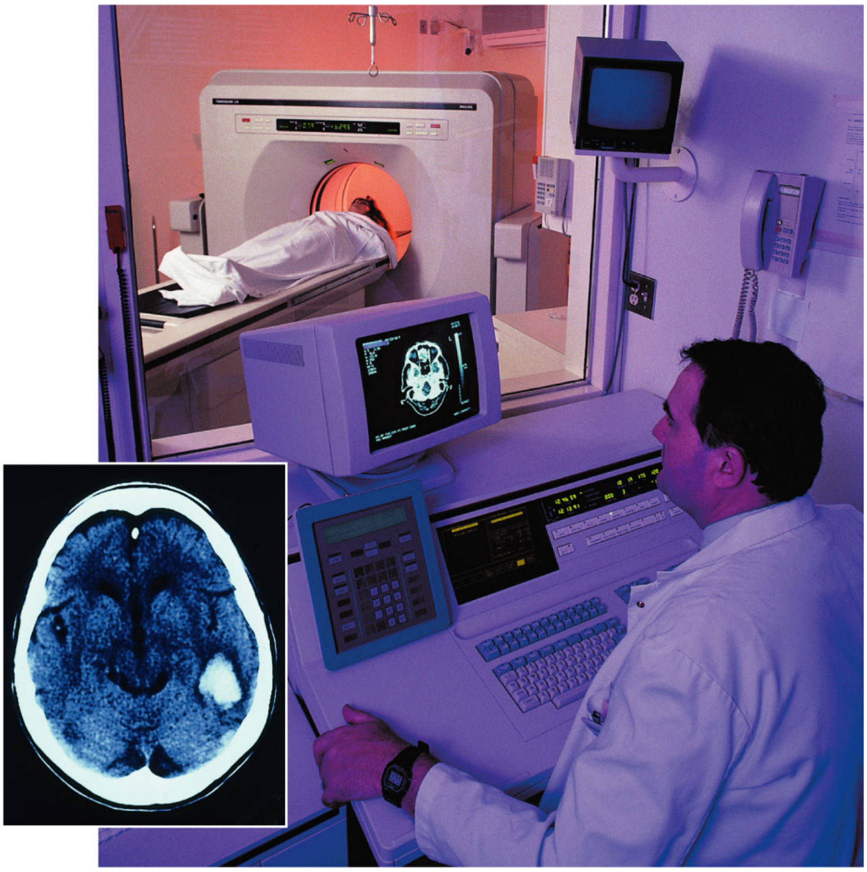
# CONNECTION
## New imaging technology reveals the inner body

X-Rays

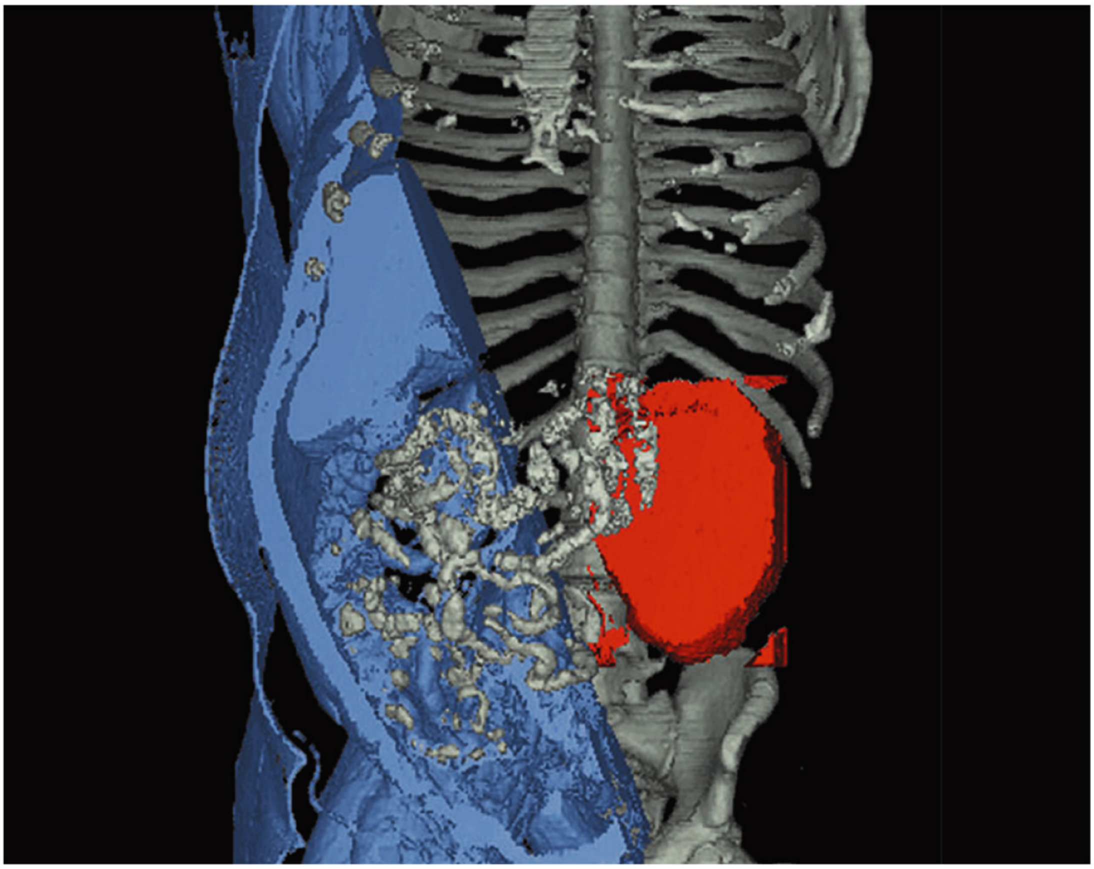
- High-energy radiation passes through soft tissue
- Hard structures (teeth, bones, tumors) show up most clearly on film
- Problems: don't show soft tissue, are only 2-D, can cause cancer in large doses

## Computed tomography (CT)

- Computer-assisted X-ray technique
- Produces images of a series of thin cross sections through the body
- Images can be studied individually or combined into 3-D views
- Excellent diagnostic tool, especially for abdomen and brain





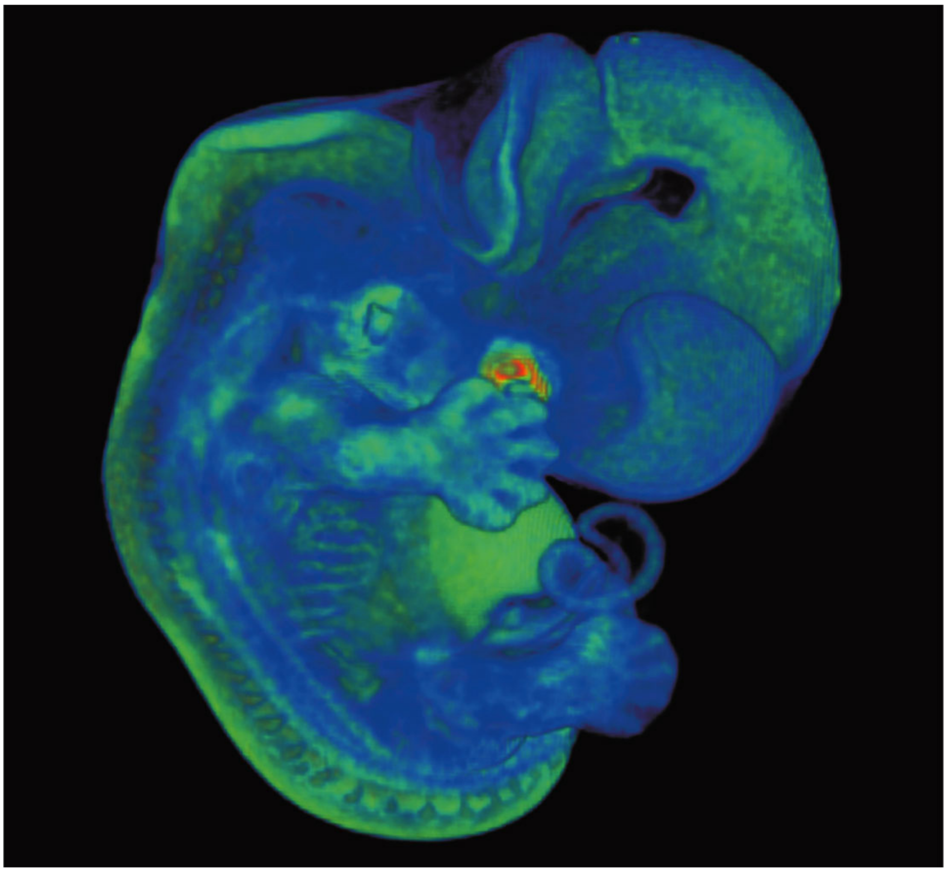


## Magnetic resonance imaging (MRI)

- Uses powerful magnets to align hydrogen atoms in water
- Allows visualization of soft tissues; dense structures nearly invisible
  - Particularly good for detecting problems in nervous tissue surrounded by bone

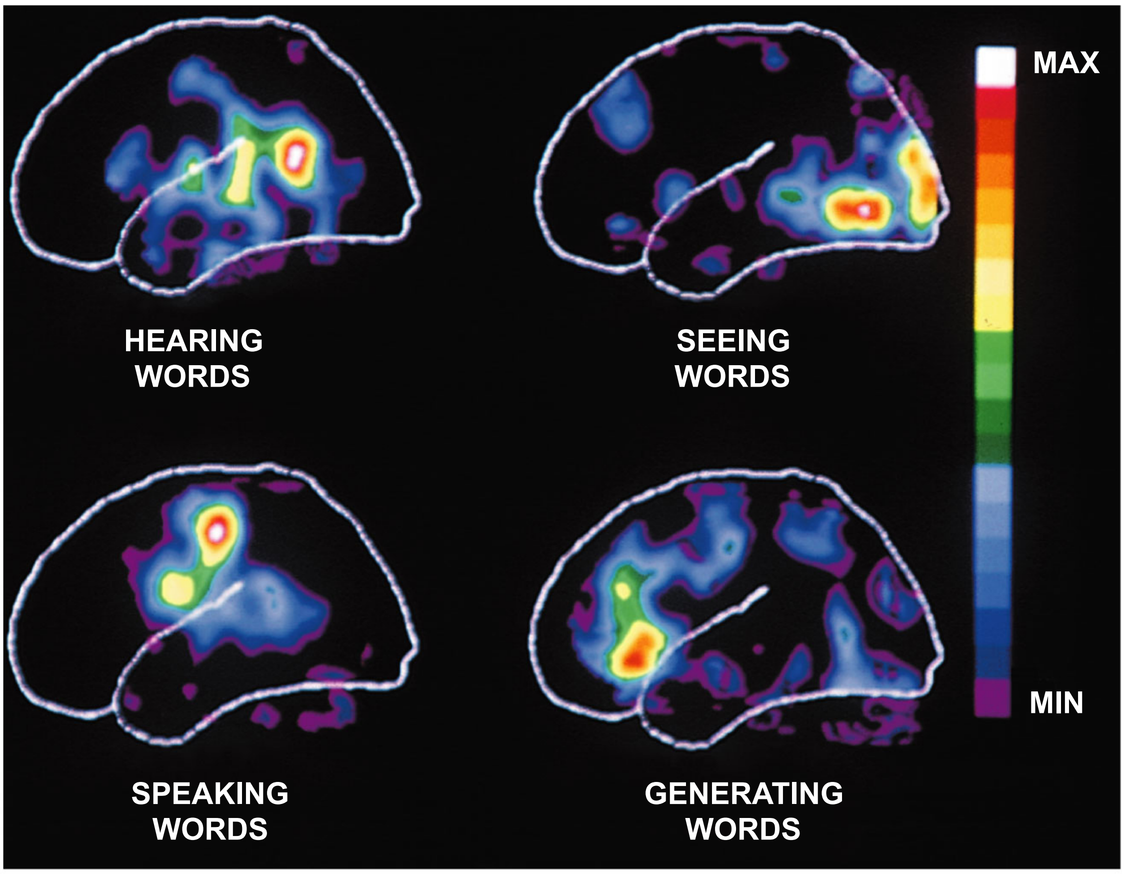
## Magnetic resonance microscopy (MRM)

- Provides three-dimensional images of very small structures



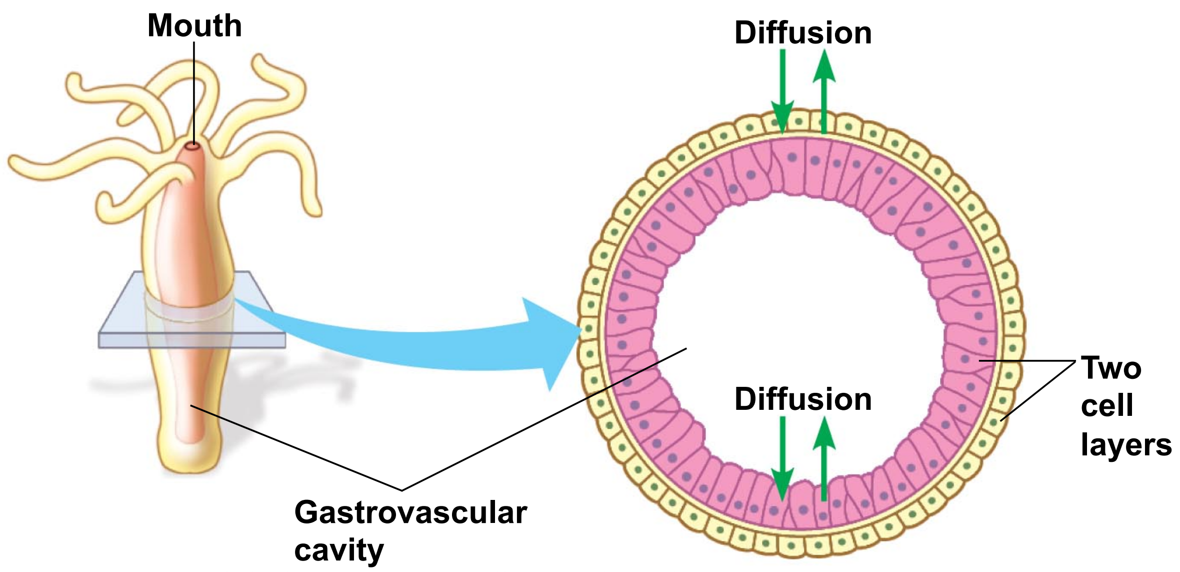
# Positron-emission tomography (PET)

- Scanner detects radiation taken up during metabolism
- Yields information about metabolic processes at specific locations in the body
- Most valuable for measuring brain activity
  - Alzheimer's disease, epilepsy, stroke



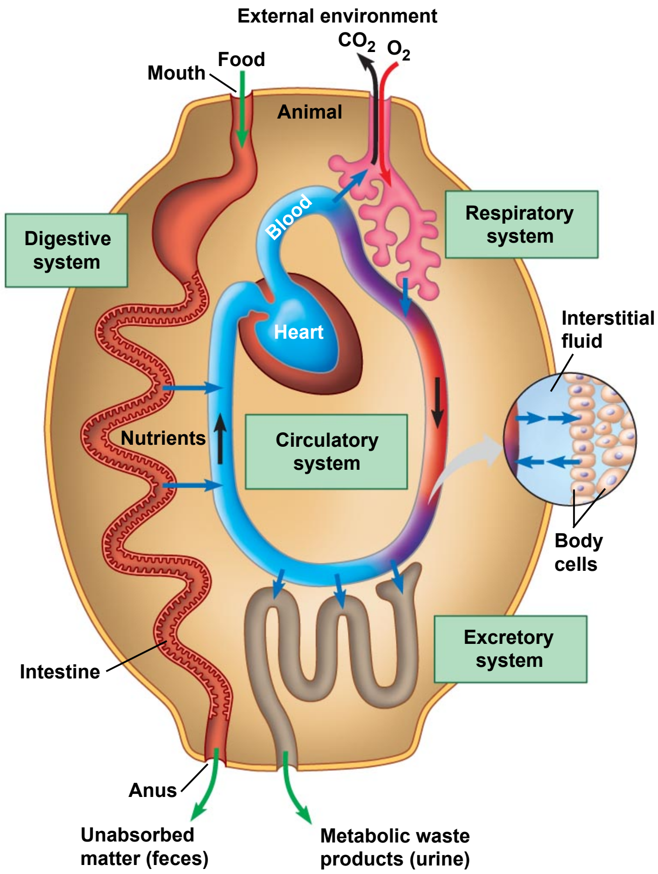
# EXCHANGES WITH THE EXTERNAL ENVIRONMENT

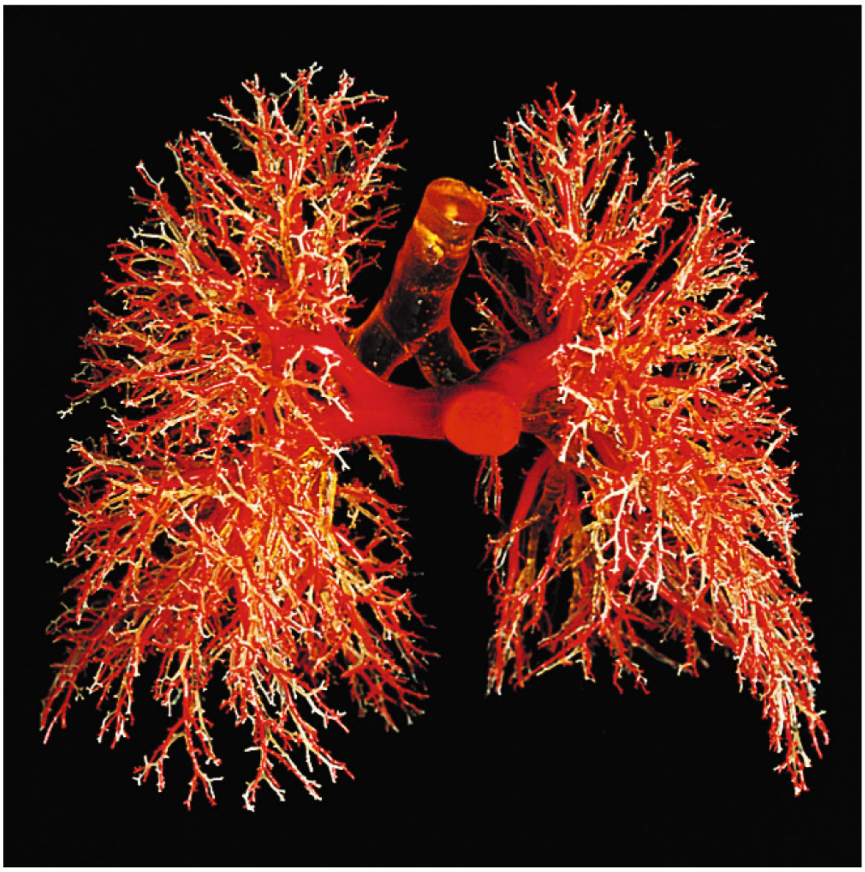
- Structural adaptations enhance exchange between animals and their environment
  - An animal must exchange materials with its environment
    - Oxygen and nutrients enter
    - $CO_2$ and metabolic wastes exit
    - Only molecules dissolved in water can move across the plasma membrane
  - In small, simple animals, each cell has enough surface area to meet its needs by direct diffusion and active transport



## Larger, complex animals have less surface area relative to volume

- Rely on specialized surfaces for exchanging materials with the environment
  - Interstitial fluid provides for indirect exchange between blood and body cells
  - Branching and folding increase surface area of the lungs, intestines, and kidneys



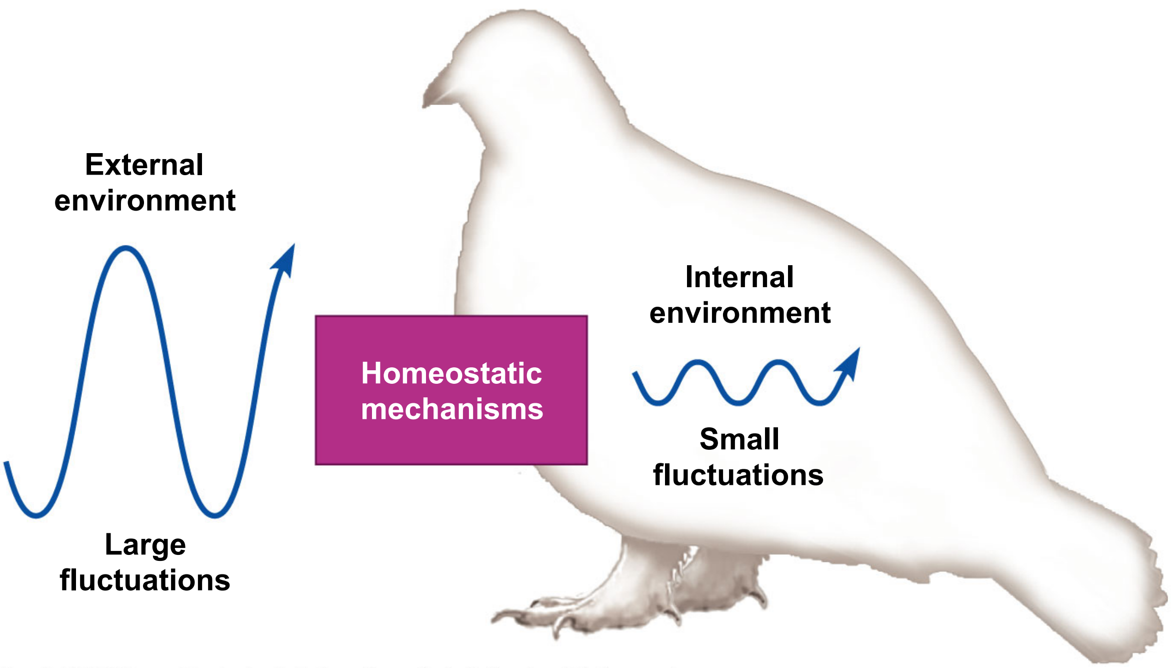




## Animals regulate their internal environment

- The internal environment of a vertebrate is the interstitial fluid surrounding the cells
- In response to changes in external conditions, animals regulate their internal environment to achieve homeostasis, an internal steady state
  - Homeostasis is a dynamic state with constant small fluctuations




External
environment
Large
fluctuations
Homeostatic
mechanisms
Internal
environment
Small
fluctuations

# Homeostasis depends on negative feedback

- In negative feedback, a change in a variable triggers mechanisms that reverse the change
- Negative feedback mechanisms keep internal variables fairly constant, with small fluctuations around set points
- In animals, most control centers that maintain homeostasis are located in the brain