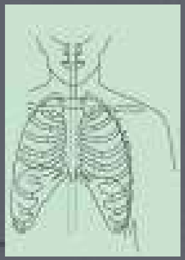

INTRODUCTION TO ANATOMY AND PHYSIOLOGY

BY
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An Introduction to the Human Body

- Anatomy
  - science of structure
  - relationships revealed by dissection (cutting apart)
  - imaging techniques
- Physiology
  - science of body functions
  - normal adult physiology is studied in this class
  - some genetic variations occur

ANATOMY AND PHYSIOLOGY DEFINED

- **Anatomy**
  - the study of structure and the relationships among structures.
- Subdivisions
  - surface anatomy, gross anatomy, systemic anatomy, regional anatomy, radiographic anatomy, developmental anatomy, embryology, cytology, and pathological anatomy

ANATOMY AND PHYSIOLOGY DEFINED

- **Physiology**
  - the study of how body structures function
- Subdivisions of physiology include
  - cell physiology, systems physiology, pathophysiology, exercise physiology, neurophysiology, endocrinology, cardiovascular physiology, immunophysiology, respiratory physiology, renal physiology, and reproductive physiology

Structural Organization of Matter

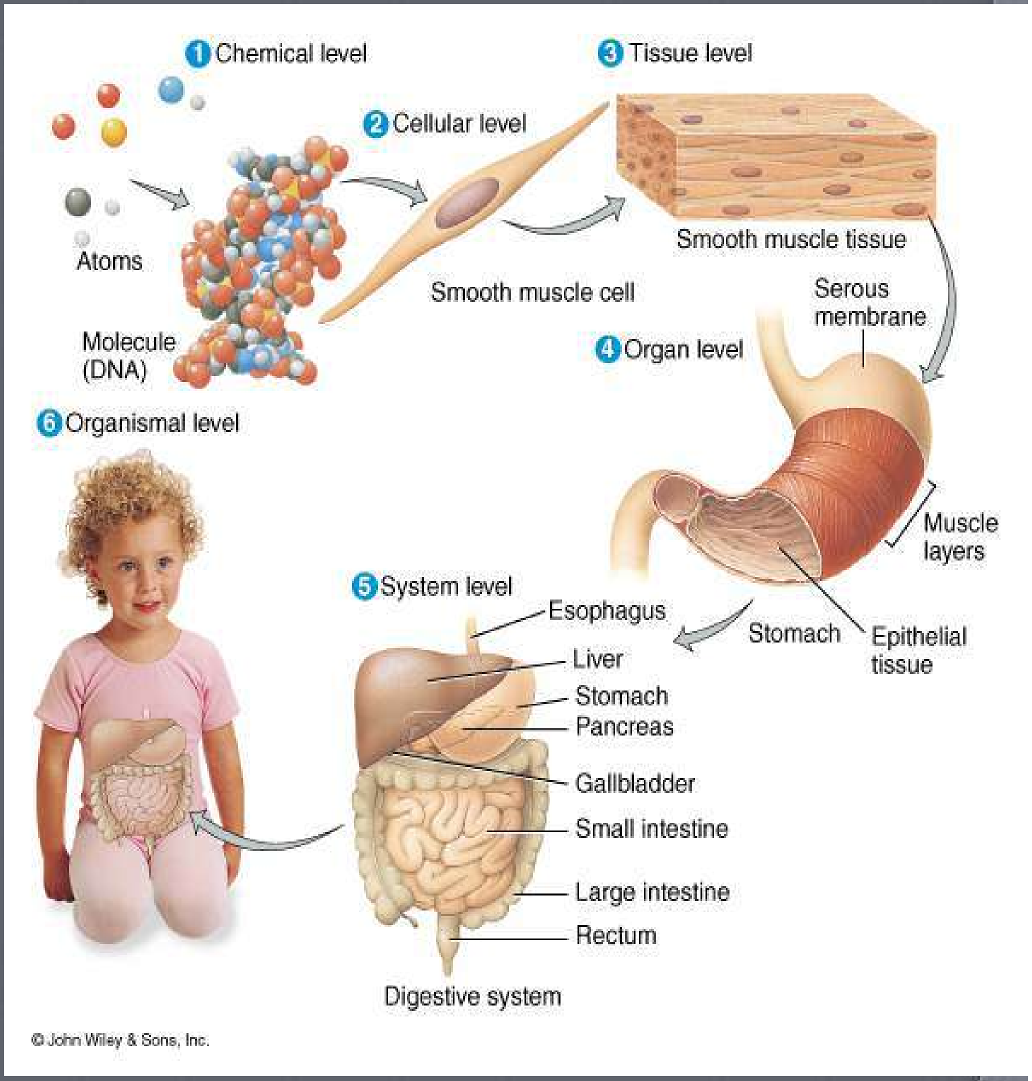
1. **Chemical Level**

a. Atoms

(Proton, Neutron, electrons)

b. Molecules

(Two or more atoms joined together by either covalent or ionic bonds)
Four biologically important organic molecules in the human body
a. Proteins which are made from 20 different Amino Acids



Structural Organization of Matter

Four Biologically-Important Organic molecules:

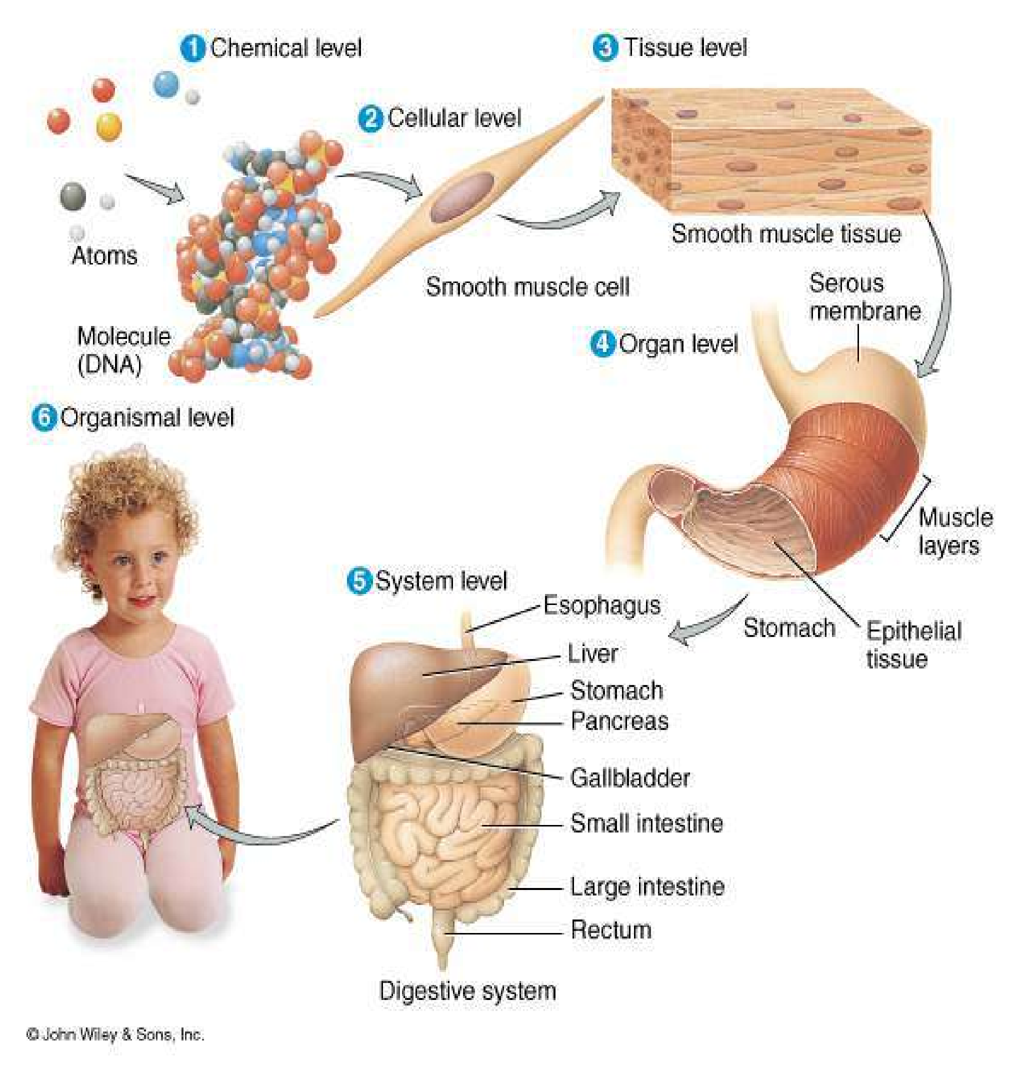
b. Complex Carbohydrates made from simple sugars

c. Nucleic Acids made for nucleotides

d. Lipids made from fatty acids and glycerol

2. Cells

(Smallest structural and functional units of the human body)



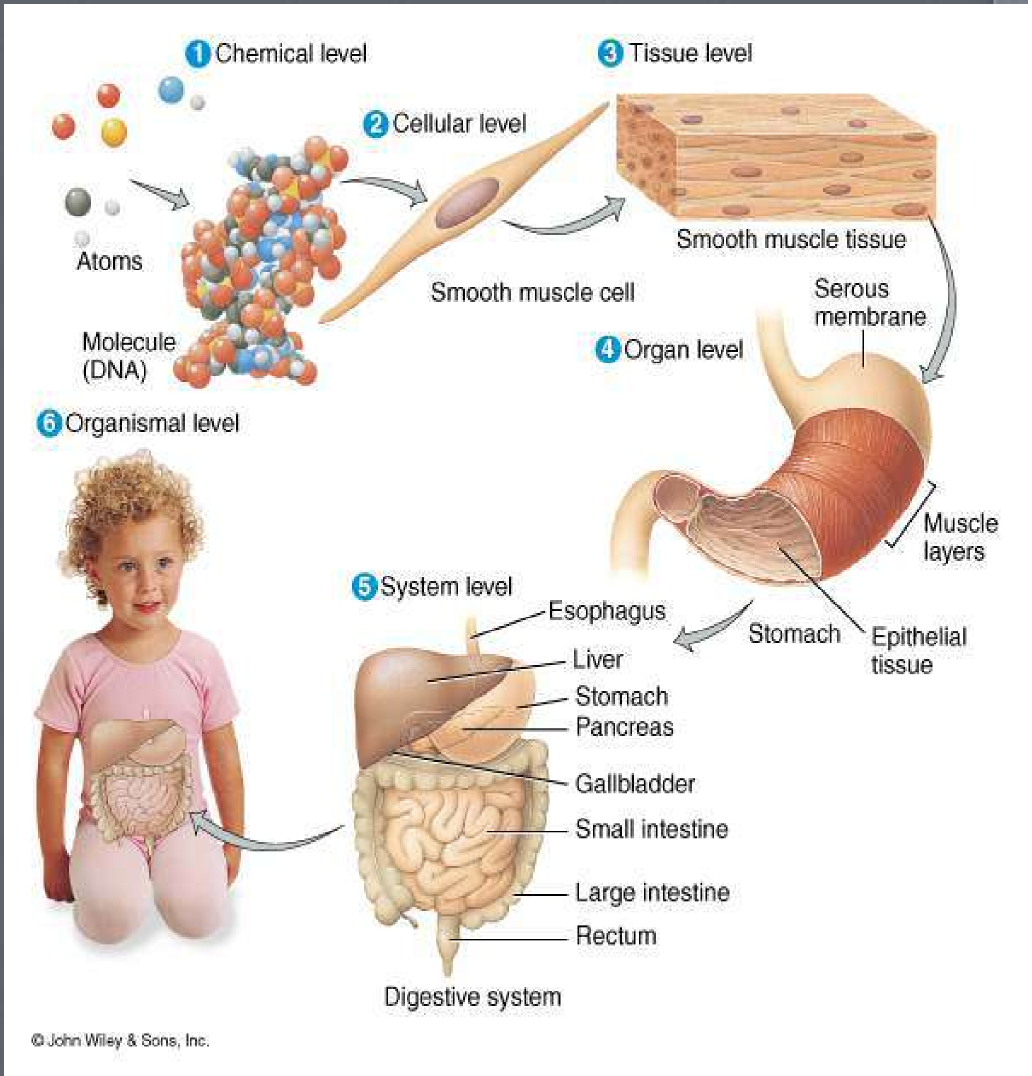
Structural Organization of Matter

3. **Tissues**

   (group of cells and the materials surrounding them that work together to perform a particular function)

4. **Organs**

   (composed of two or more tissues work together to provide specific functions and they usually have specific shapes)

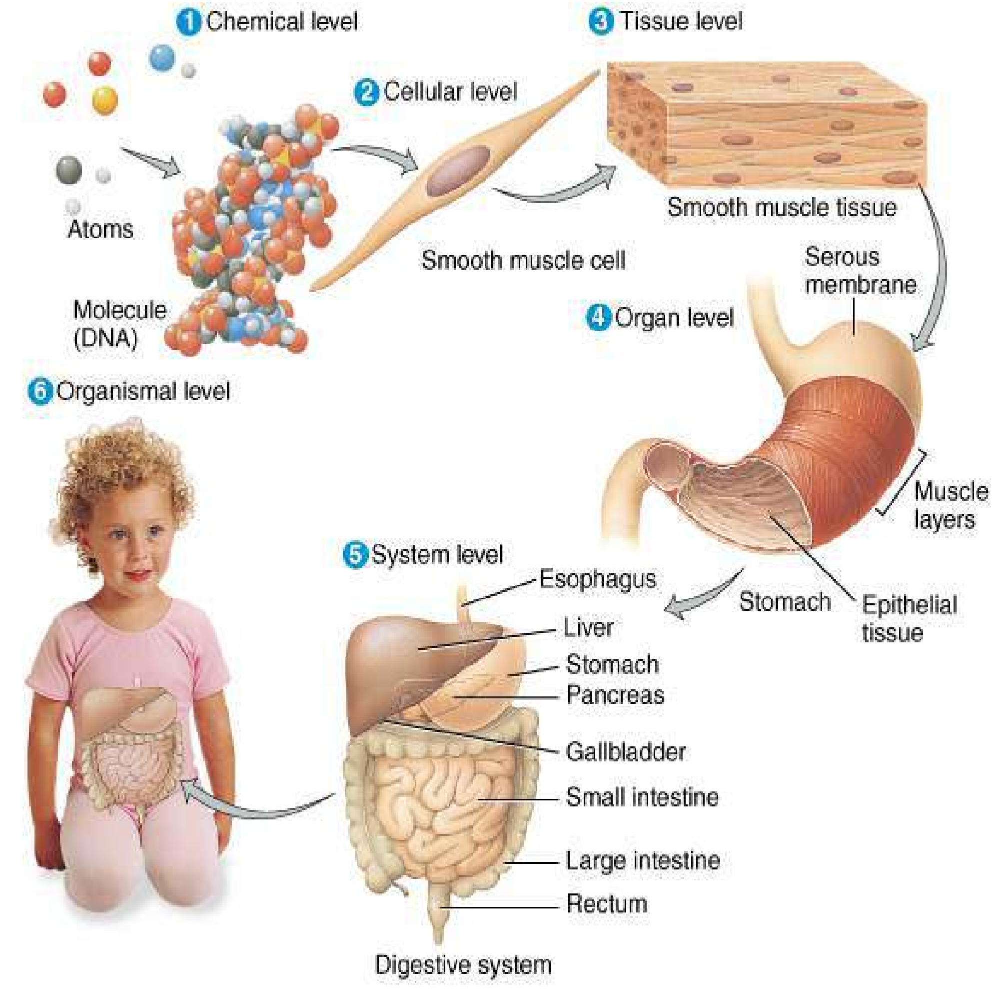


Structural Organization of Matter

5. **Organ systems**

(consist of one or more organs that provide a common function) Examples covered in Anatomy & Physiology 242:

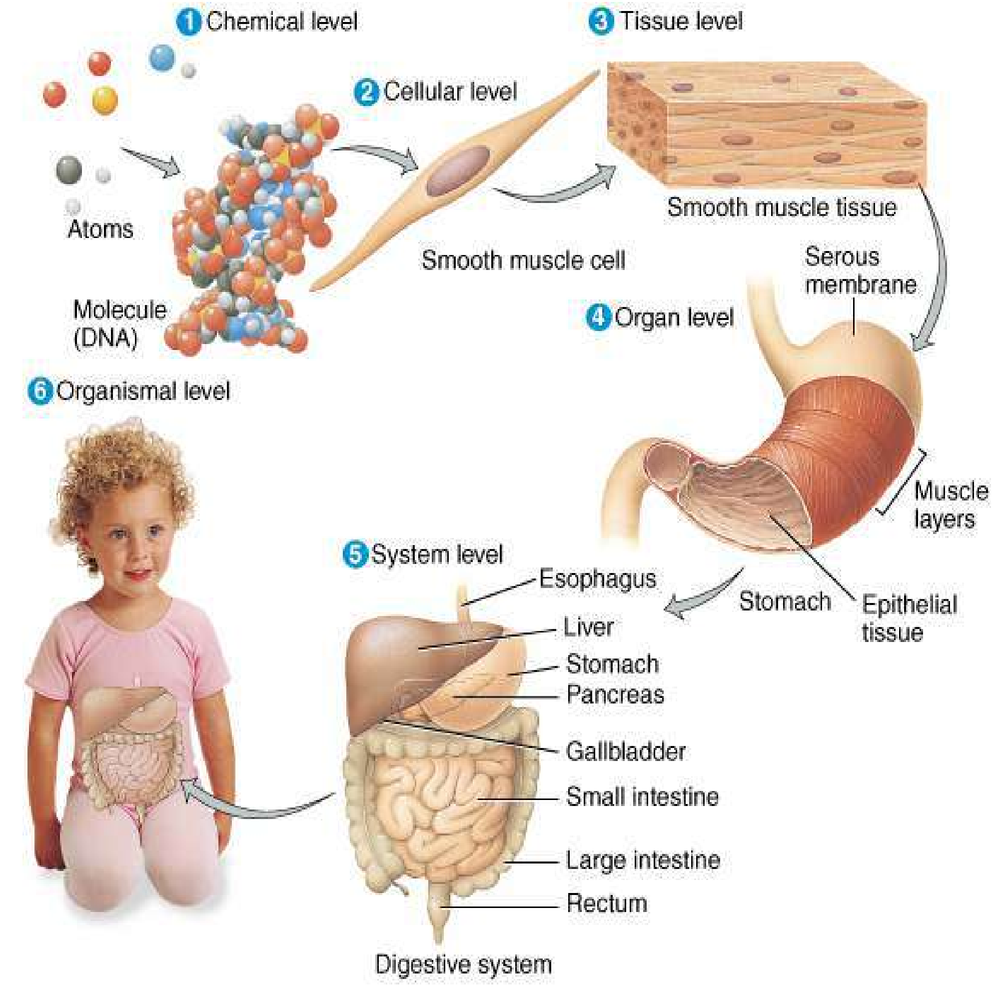
a. Integumentary system
b. Skeletal system
c. Muscular system
d. Nervous system



Structural Organization of Matter

Anatomy & Physiology

e. Endocrine system
f. Cardiovascular system
g. Lymphatic system
h. Respiratory system
I. Digestive system
j. Urinary system
k. Reproductive system



Basic Life Processes

1. **Metabolism**
   Sum of all biochemical processes of cells, tissues, organs, and organ systems
2. **Responsiveness**
   Ability to detect and respond to changes in the internal and external environment
3. **Movement**
   Occurs at the intracellular, cellular, organ levels

Basic Life Processes

4. **Growth**

   Increase in number of cells, size of cells, tissues, organs, and the body. Single cell to multicellular complex organism

5. **Differentiation**

   Process a cell undergoes to develop from a unspecialized to a specialized cell

6. **Reproduction**

   Formation of new cells for growth, repair, or replacement, or the production of a new individual.

Basic Life Processes

- **Homeostasis**

  Equilibrium of the body's internal environment produced by the interaction of organ systems and regulatory processes (feedback systems). Homeostasis is a dynamic condition in response to changing conditions.
  The two body systems that largely control the body's homeostatic state:
  1. Nervous system
  2. Endocrine system

Control of Homeostasis

- **Homeostasis** is continually being disrupted by
  - external stimuli
    - intense heat, cold , and lack of oxygen
  - internal stimuli
    - psychological stresses
    - exercise
- Disruptions are usually mild & temporary
- If homeostasis is not maintained, death may result

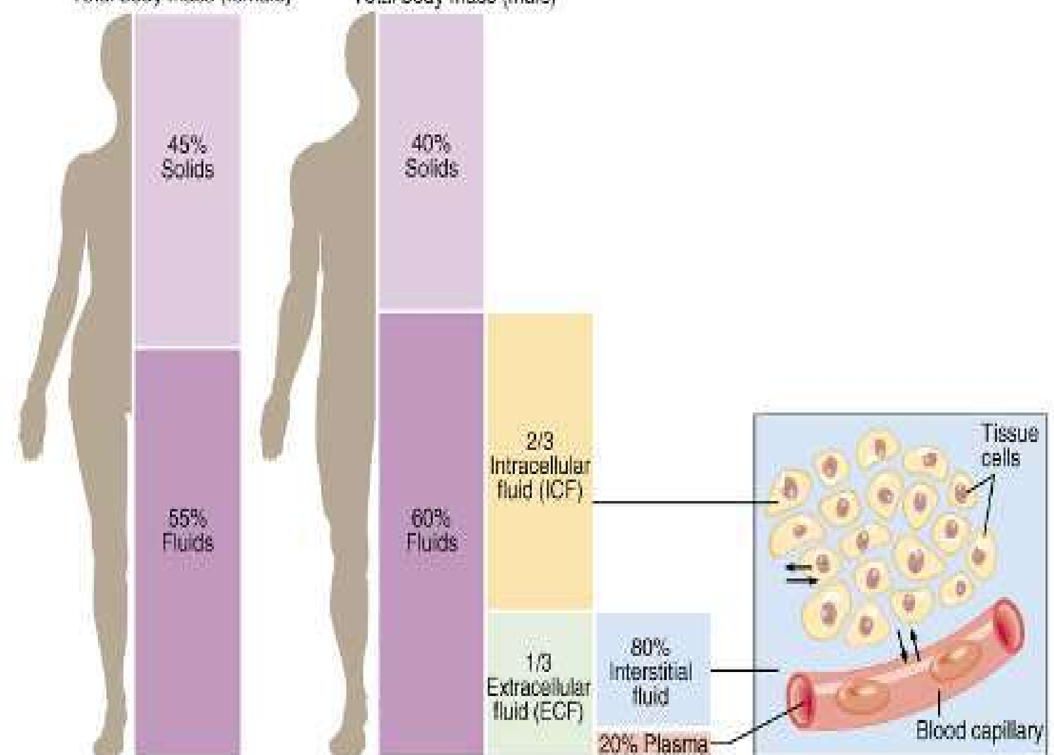
CONTROL OF HOMEOSTASIS

- **Homeostatic** imbalances occur because of disruptions from the external or internal environments.
  - Homeostasis is regulated by the nervous system and endocrine system, acting together or independently.
  - The nervous system detects changes and sends nerve impulses to counteract the disruption.
  - The endocrine system regulates homeostasis by secreting hormones.
- Whereas nerve impulses cause rapid changes, hormones usually work more slowly.
- Examples: CO_2, O_2, temperature, pH, blood pressure, …

Example of Homeostasis
Fluid balance in the Body

- **Compartments for Body Fluids**

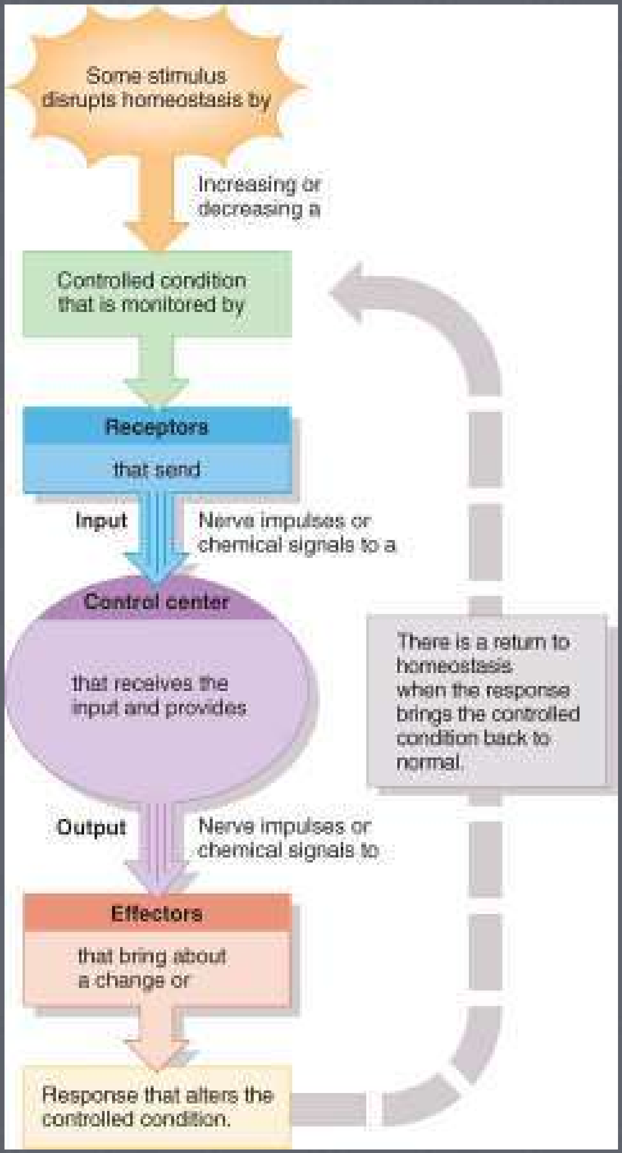
1. **Intracellular**
2. **Extracellular**
   a. Interstitial
   b. Plasma



(a) Distribution of body water in an average lean, adult female and male

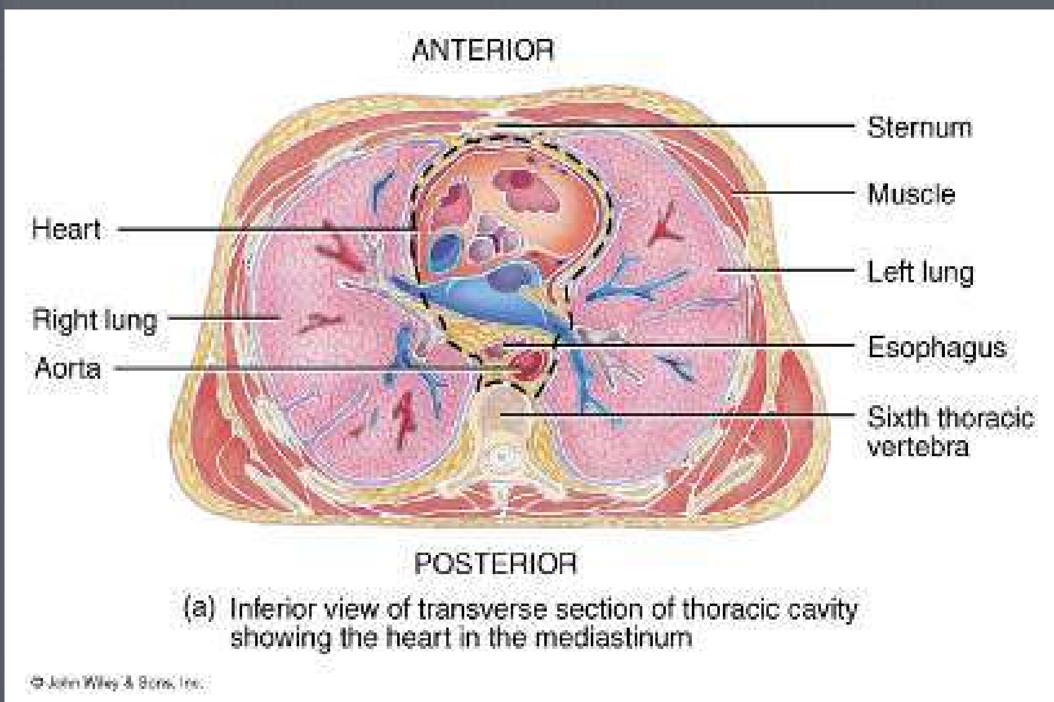
(b) Exchange of water among body fluid compartments

Components of Feedback Loo

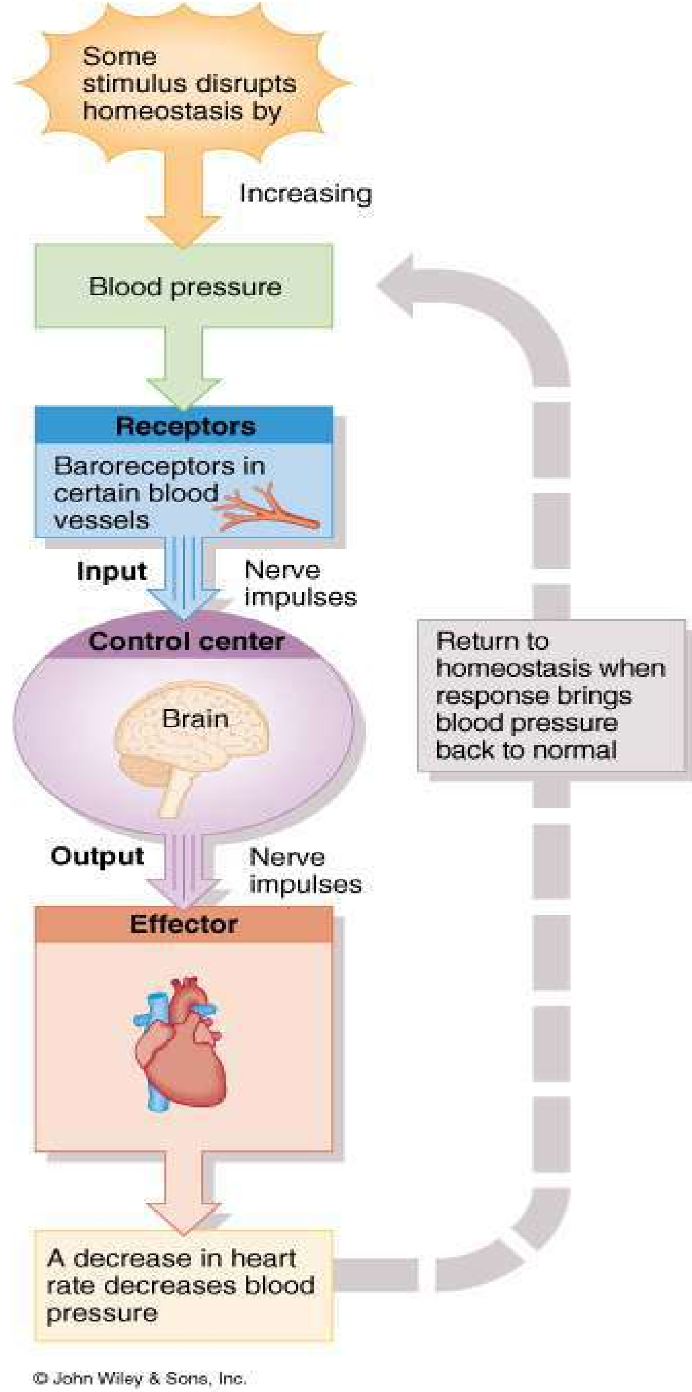


- **Receptor**
  - monitors a controlled condition
- **Control center**
  - determines next action
- **Effector**
  - receives directions from the control center
  - produces a response that changes the controlled condition

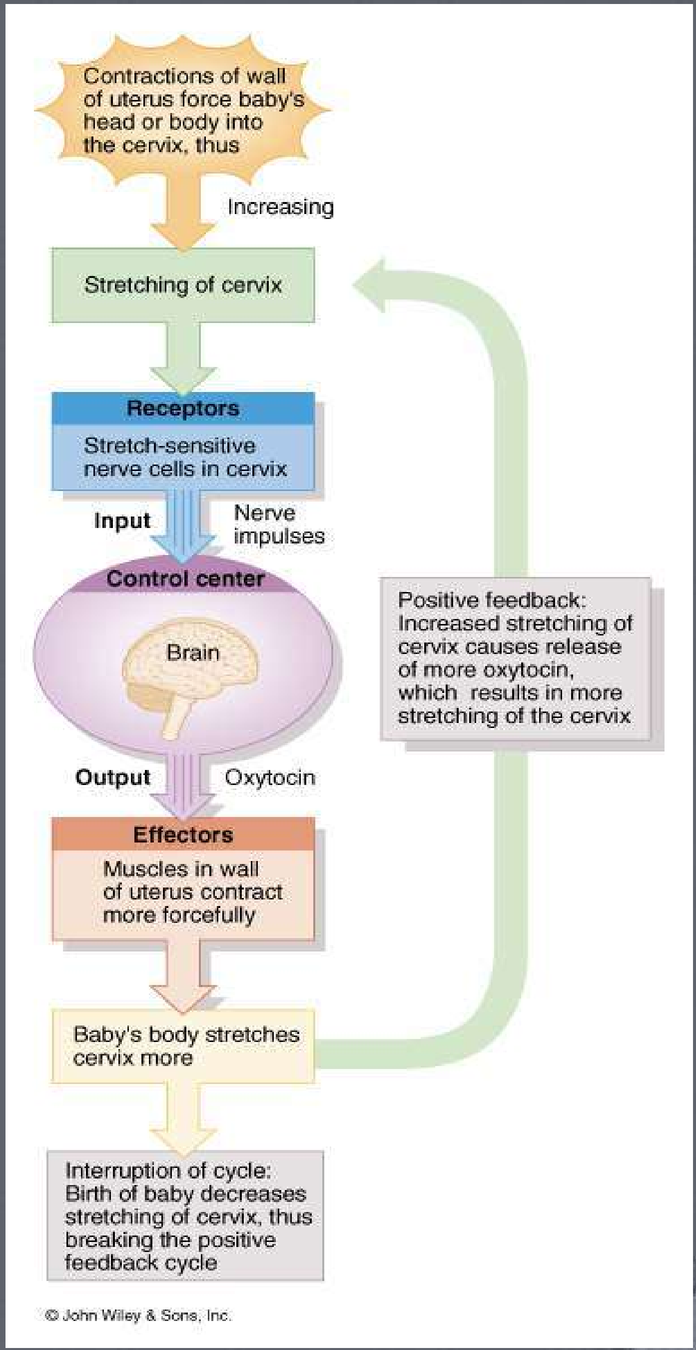
Basic Components of a Negative Feedback System



(a) Inferior view of transverse section of thoracic cavity showing the heart in the mediastinum



Basic Components of a Positive Feedback System



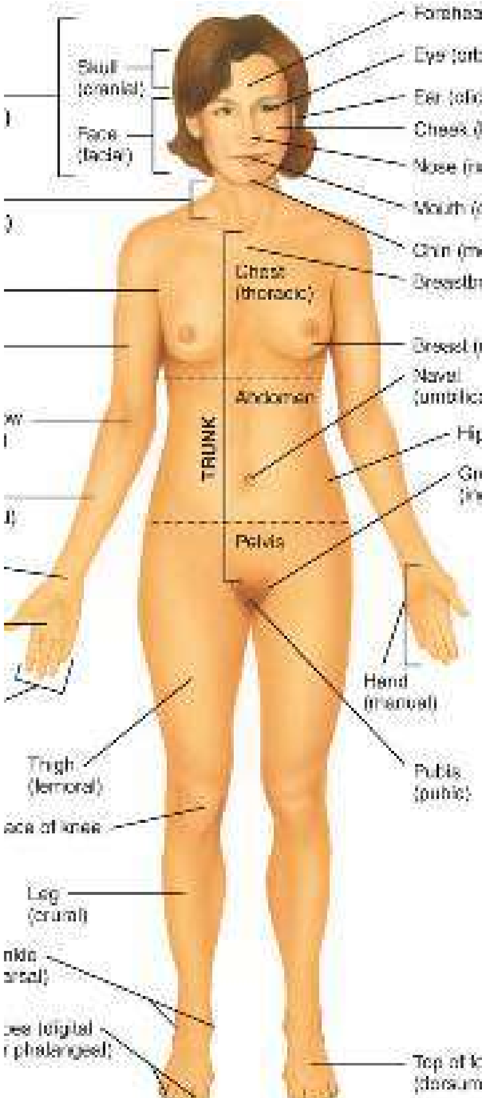
Homeostatic Imbalances

- Disruption of homeostasis can lead to disease and death.

- ***Disorder*** is a general term for any change or abnormality of function.
- ***Disease*** is a more specific term for an illness characterized by a recognizable set of signs and symptoms.
  - A local disease is one that affects one part or a limited region of the body.
  - A systemic disease affects either the entire body or several parts.

Homeostatic Imbalances

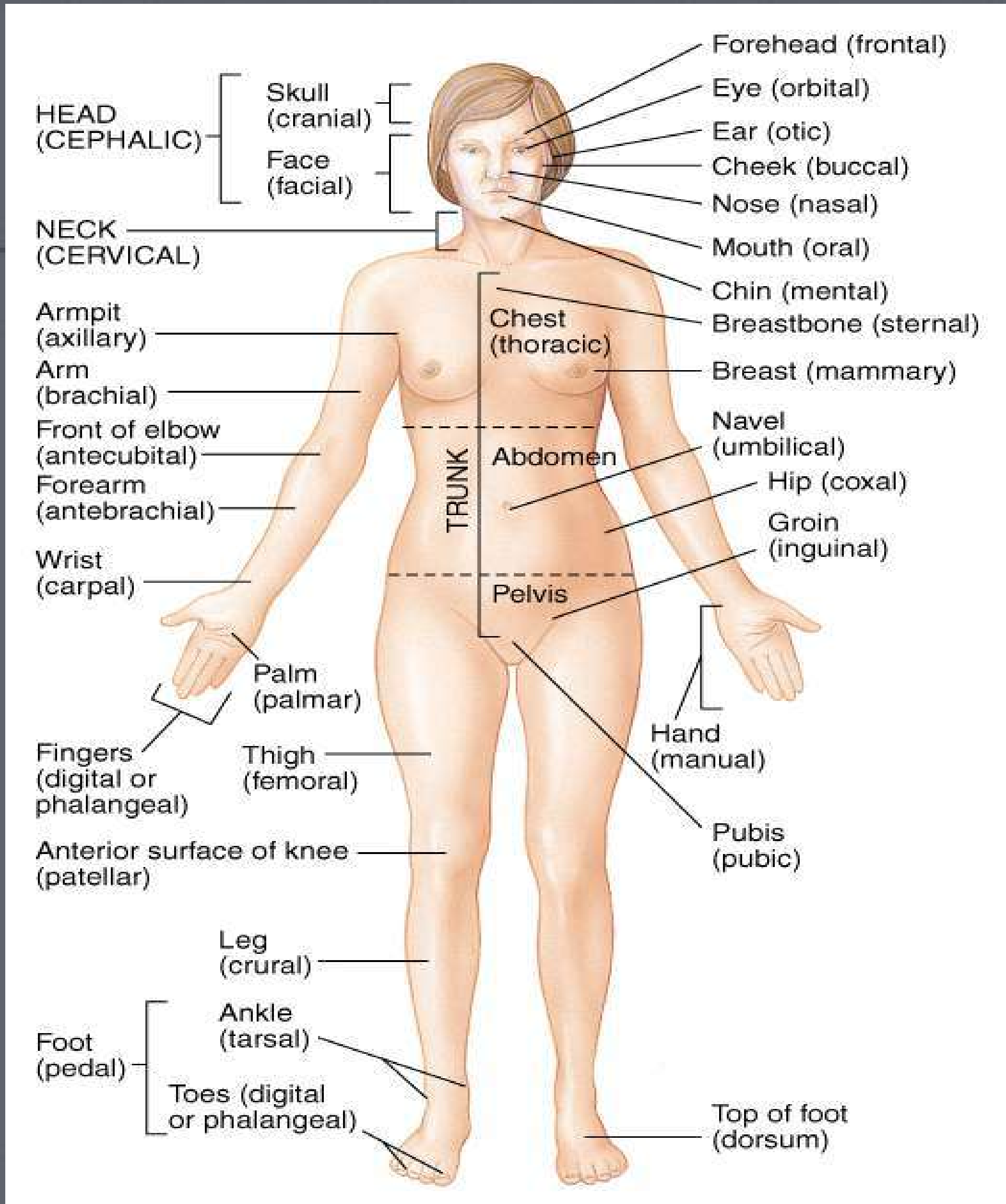
- ***Disease*** is a more specific term for an illness characterized by a recognizable set of signs and symptoms.
  - Signs are objective changes that a clinician can observe and measure; e.g., fever or rash.
  - Symptoms are subjective changes in body functions that are not apparent to an observer; e.g., headache or nausea.
- **Diagnosis** is the art of distinguishing one disease from another or determining the nature of a disease; a diagnosis is generally arrived at after the taking of a medical history and the administration of a physical examination.



Anatomical Position

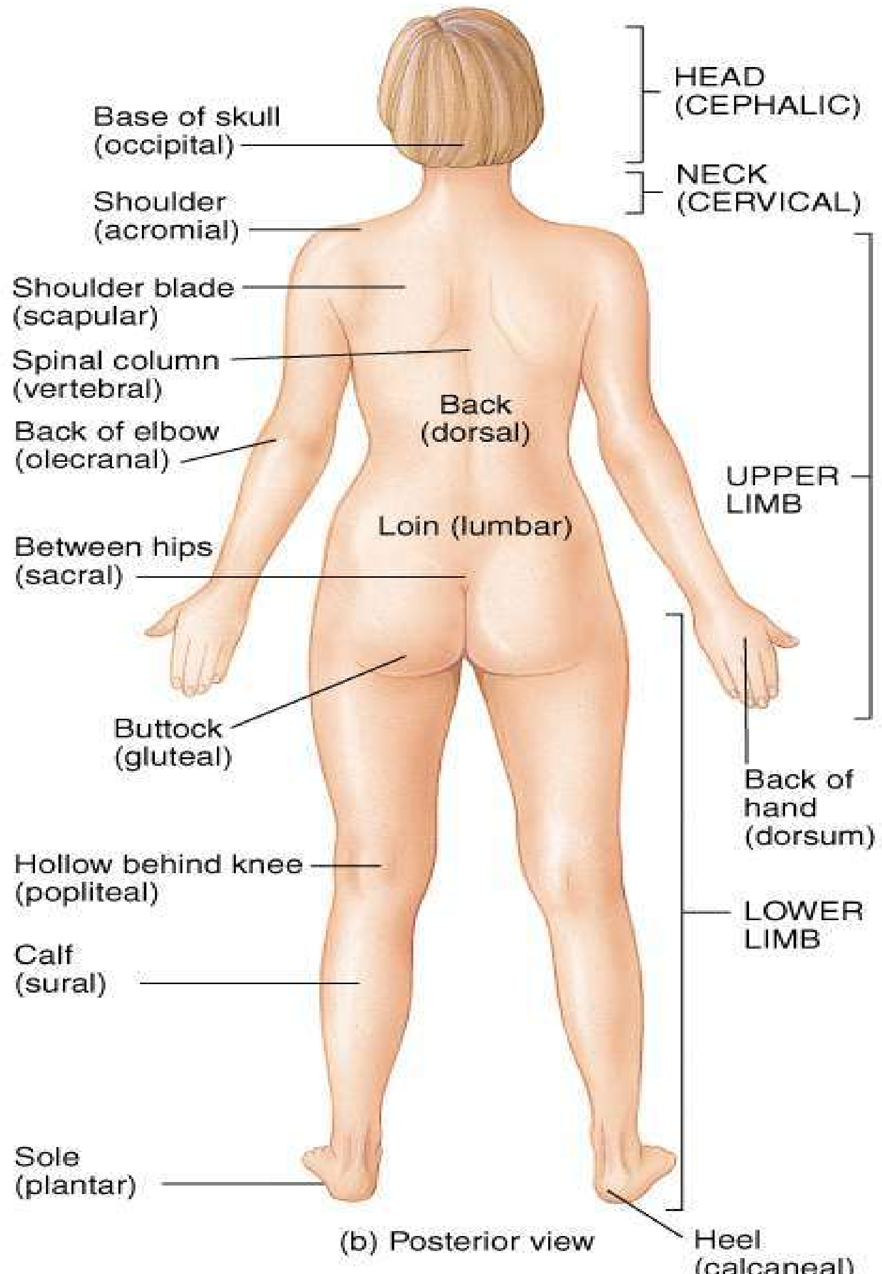
- The ***anatomical position*** is a standardized method of observing or imaging the body that allows precise and consistent anatomical references.
- When in the anatomical position, the subject stands (Figure 1.5).
  - **standing upright**
  - **facing the observer, head level**
  - **eyes facing forward**
  - **feet flat on the floor**
  - **arms at the sides**
  - **palms turned forward** (ventral)

Basic Anatomical Terminology



(a) Anterior view

Basic Anatomical Terminology



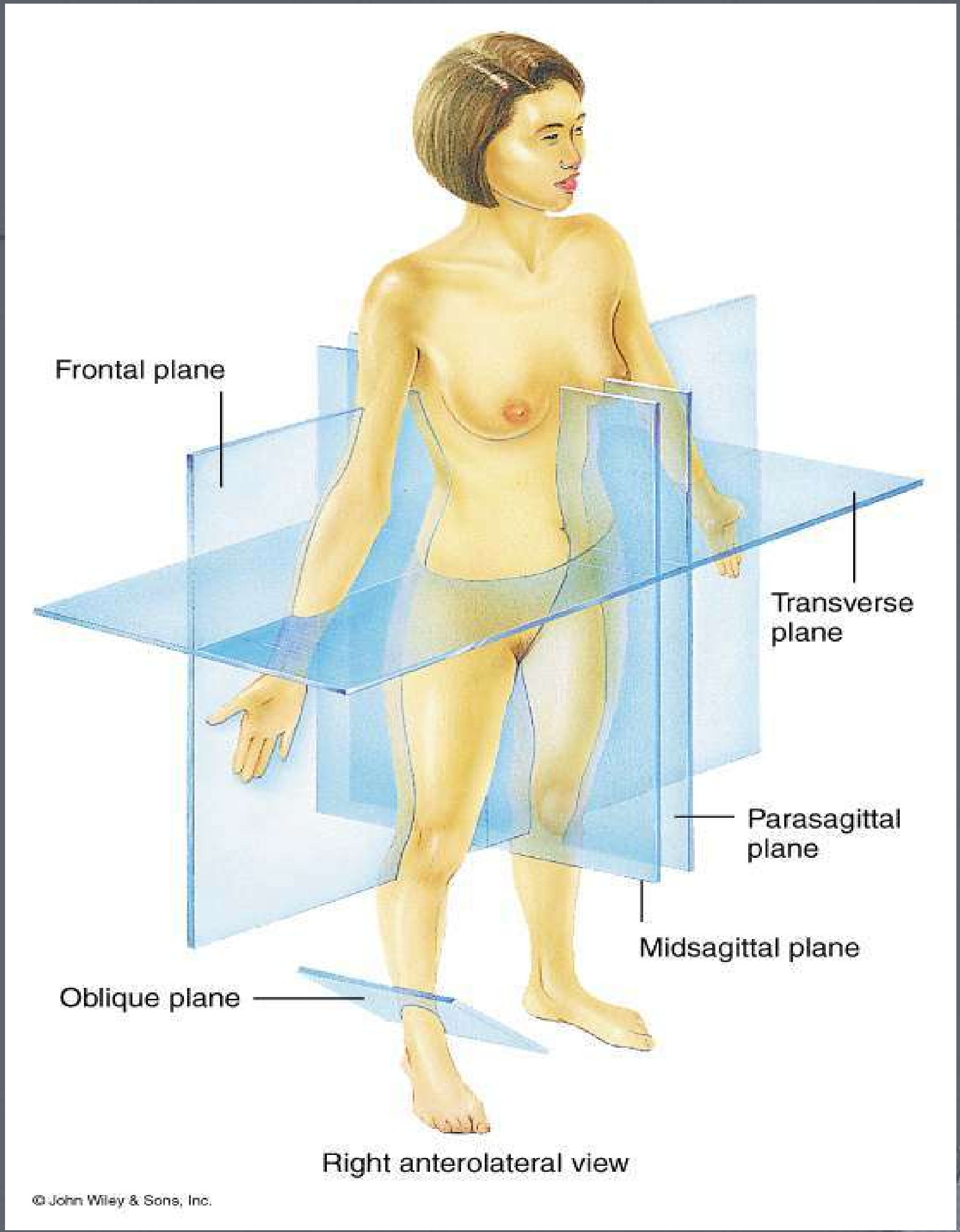
(b) Posterior view

Reclining Position

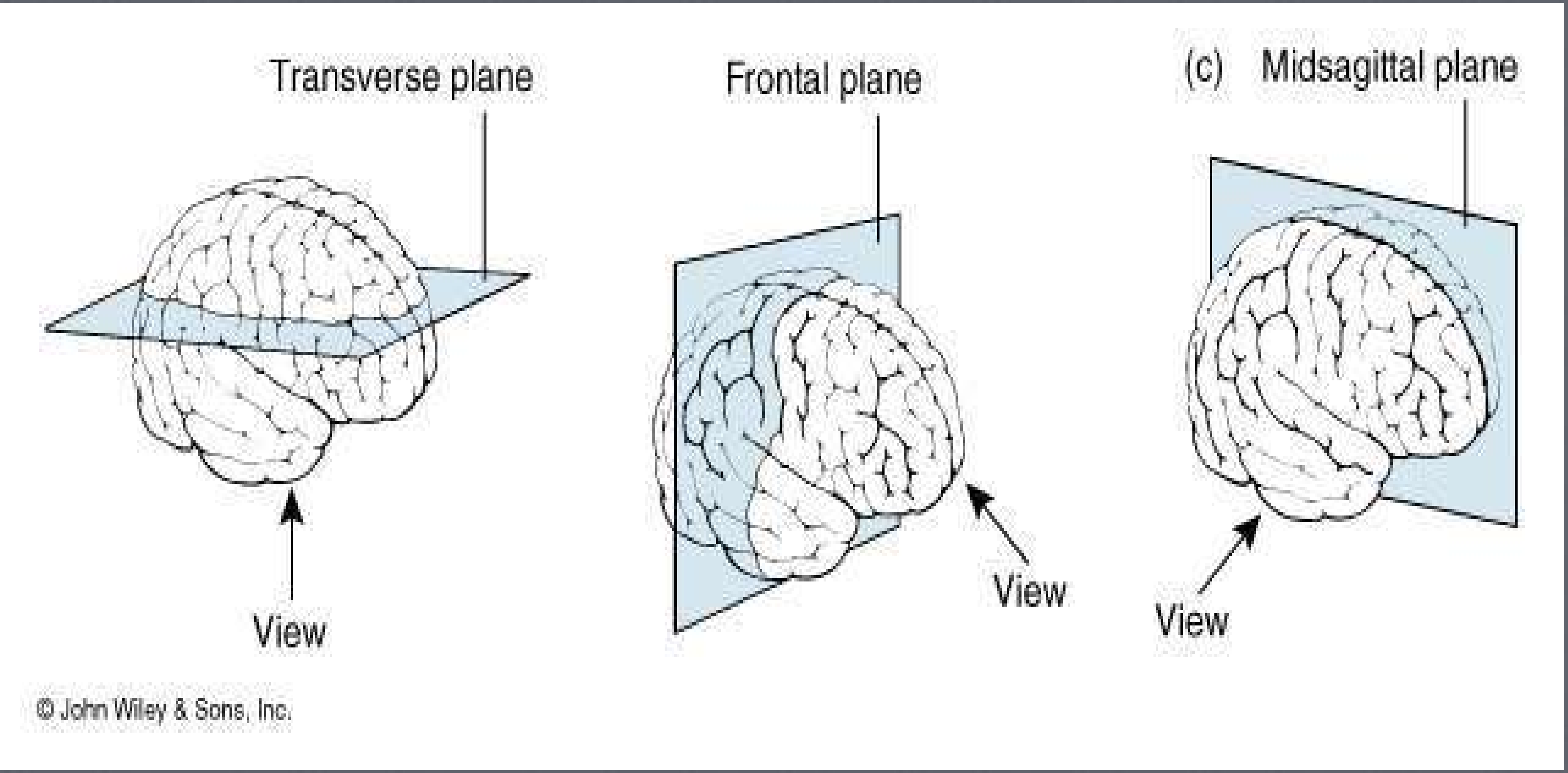
- If the body is lying face down, it is in the ***prone*** position.
- If the body is lying face up, it is in the ***supine*** position.

Basic body planes or sections

These terms are used for planes or sections that cut the body, organs, tissues, or cells



planes


Transverse plane
View
Frontal plane
View
(c) Midsagittal plane
View
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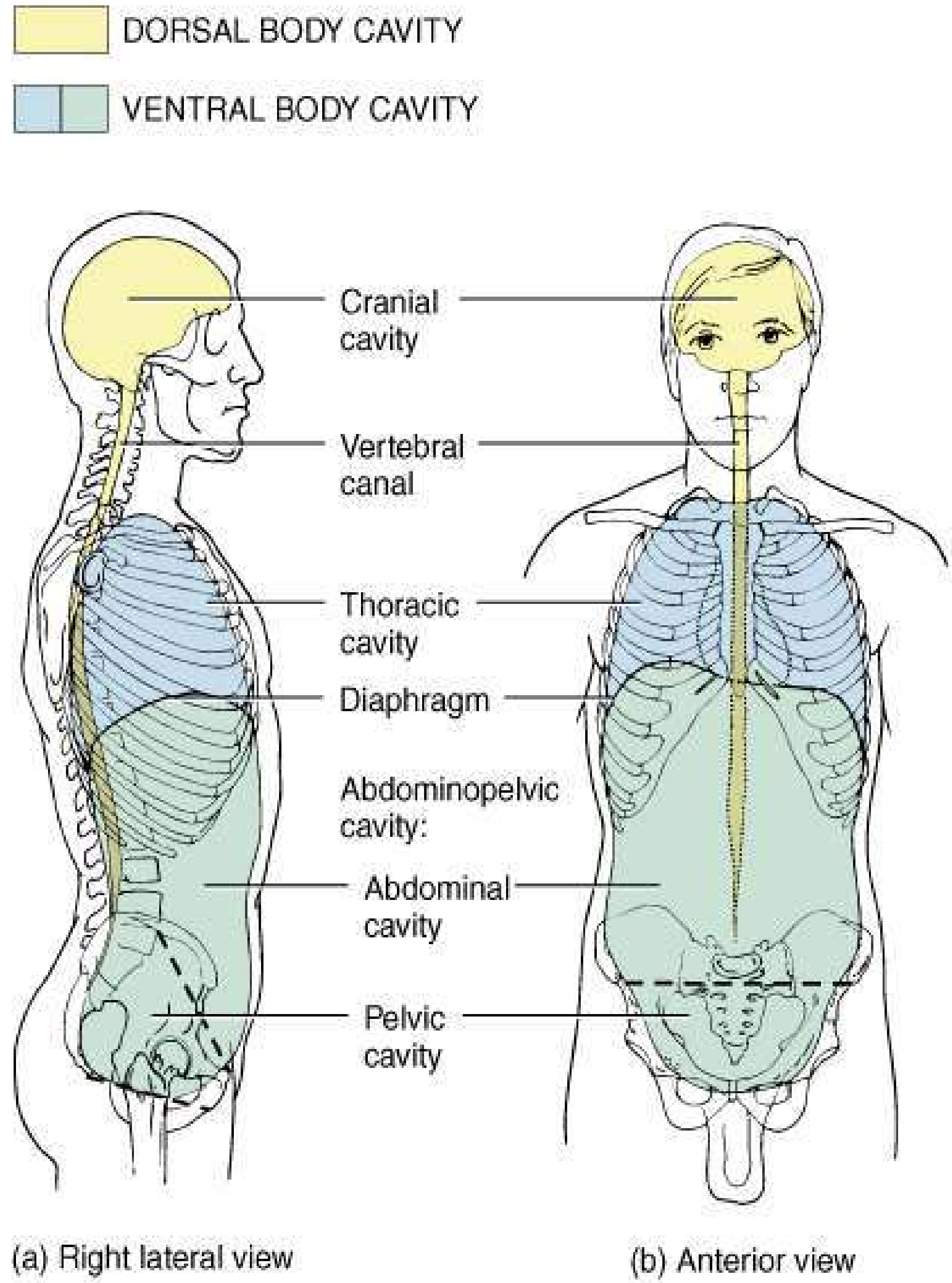
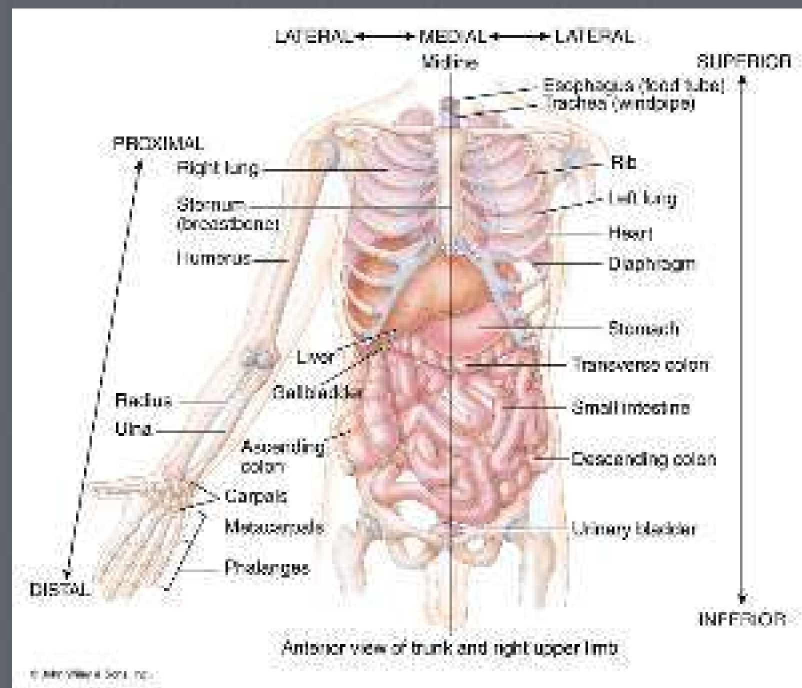
Two Principal Body Cavities and their Subdivisions

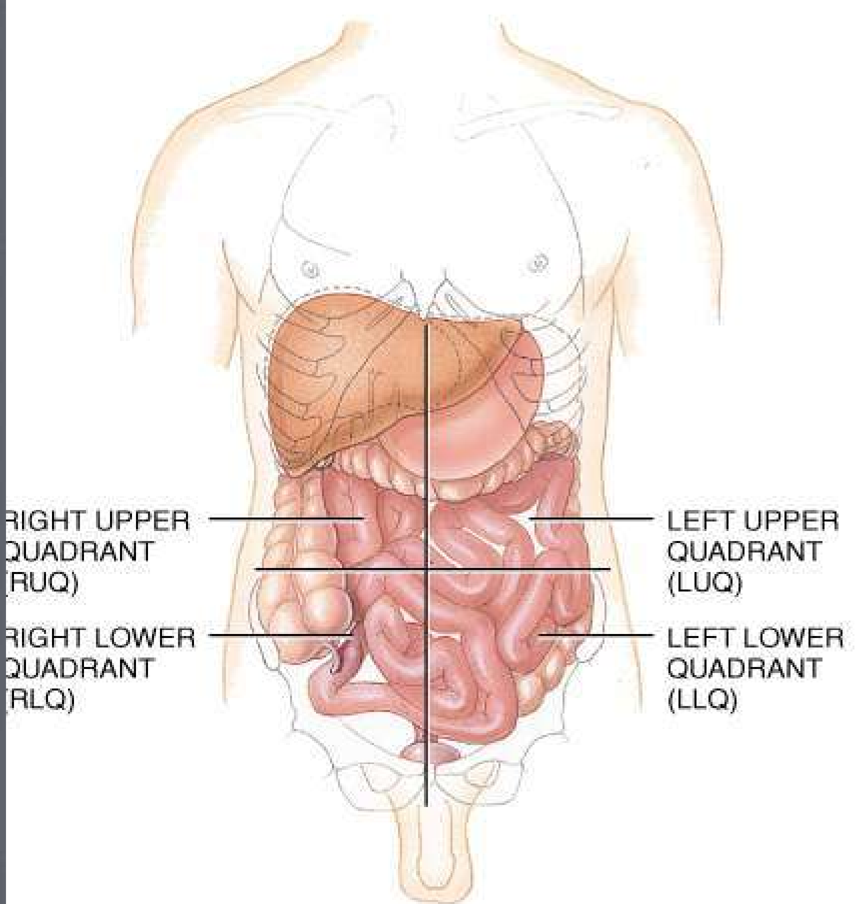


Directional Terms Used to Describe the Position of one Structure to Another

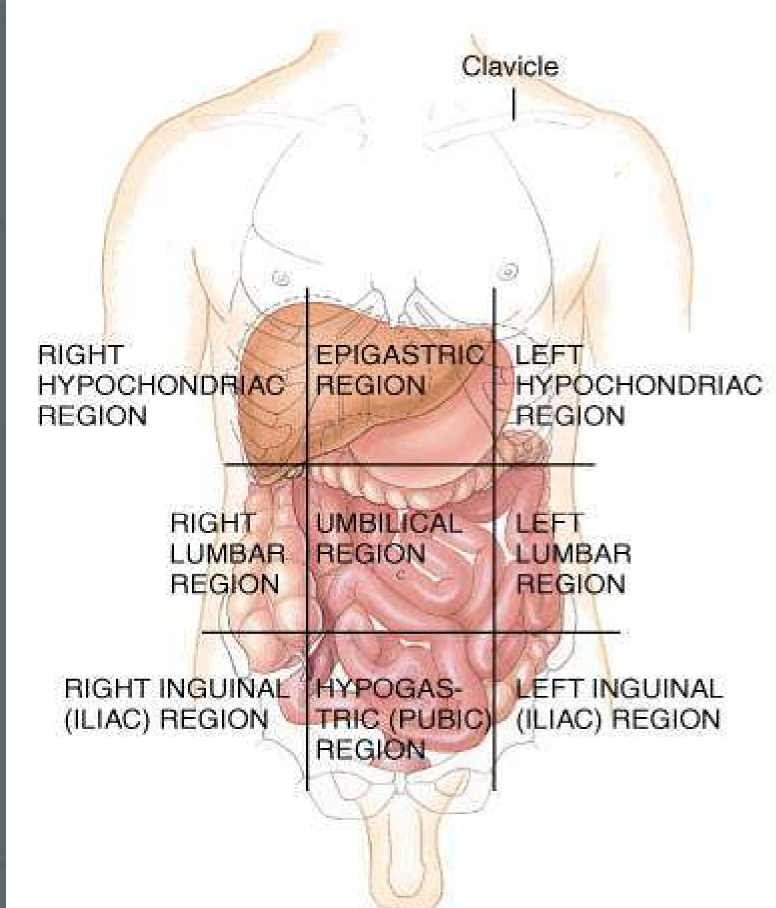
Superior/Inferior (Cephalic/Caudal)
Anterior/Posterior (Ventral/Dorsal)
Medial/Lateral
Intermediate: Between
Ipsilateral/Contralateral
Proximal/Distal
Superficial/Deep



Methods of dividing the Abdominopelvic cavity



(b) Anterior view showing abdominopelvic quadrants



(a) Anterior view showing nine abdominopelvic regions

THANK YOU

Blood

- **Blood:** A liquid connective tissue composed of extracellular matrix called as blood plasma that dissolves & suspends various cells & cell fragments.

- **Hematology:** The branch of science that deals with the study of blood, blood-forming tissues & blood disorders.

Functions

- Transport medium
  - **Oxygen, nutrients & waste material**
  - **Hormones to their target glands**
  - **Protective antibodies to the site of infection**
- Protection against infection
- Regulation of pH
- Maintenance of body temperature
- Clot formation

Physical properties

- **Denser** & **viscous** than water and **sticky**
- Temperature is **38°**
- Slightly alkaline pH **(7.35 to 7.45)**
- Color of blood varies with its oxygen content

❖ When it has a high oxygen content, it is **bright red**

❖ When it has a low oxygen content, it is **dark red**

- Blood volume is **5 to 6 liters** in an average adult male & **4 to 5 liters** in an average adult female.

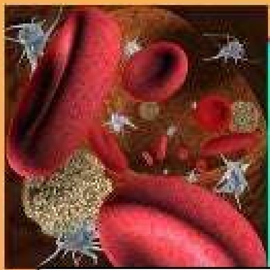
Components of Blood

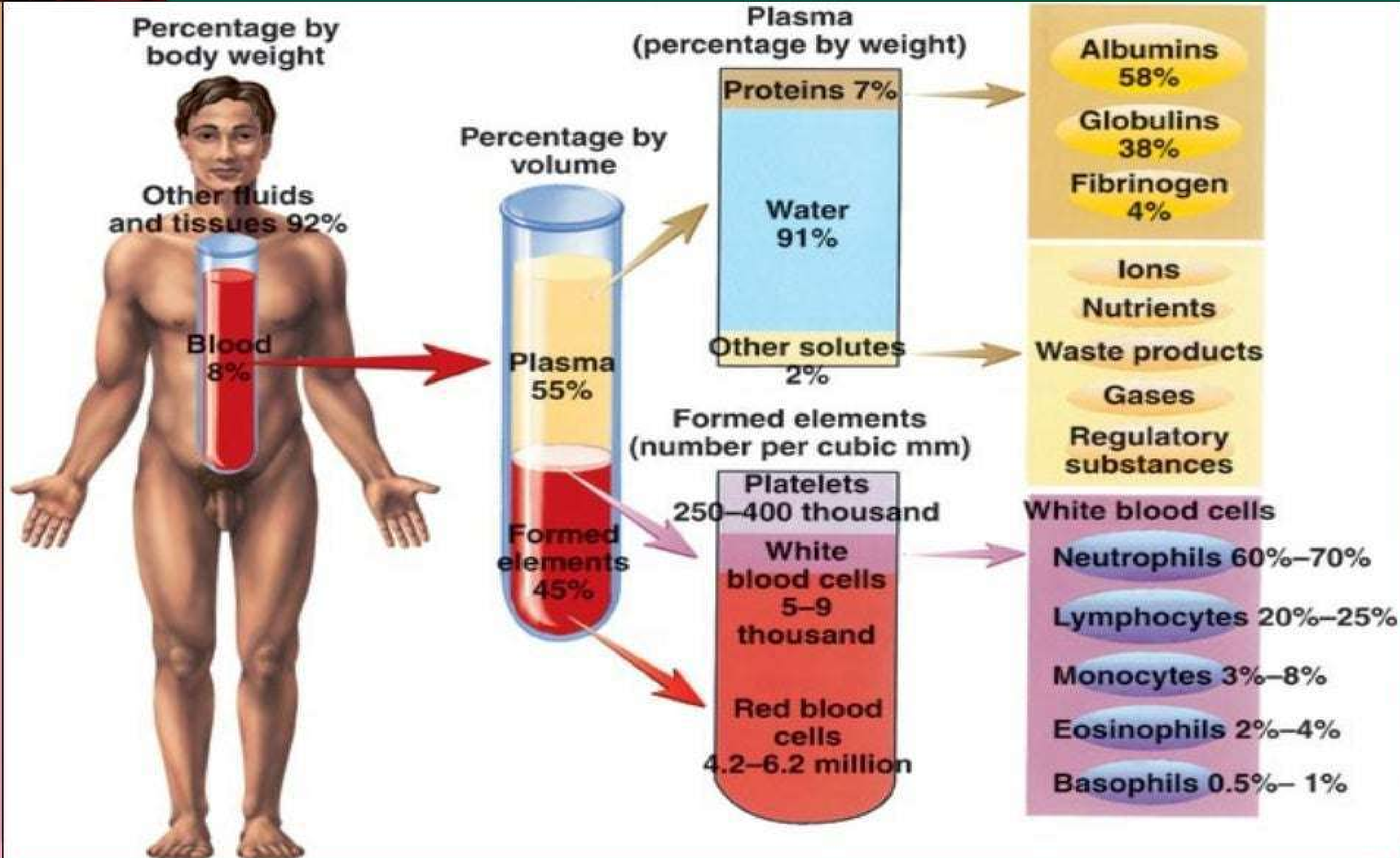
- **Two components of blood:**

1) **Blood plasma** (55%): Watery liquid extracellular matrix contains dissolved substances

2) **Formed elements** (45%): Cells & cell fragments

Composition of Blood



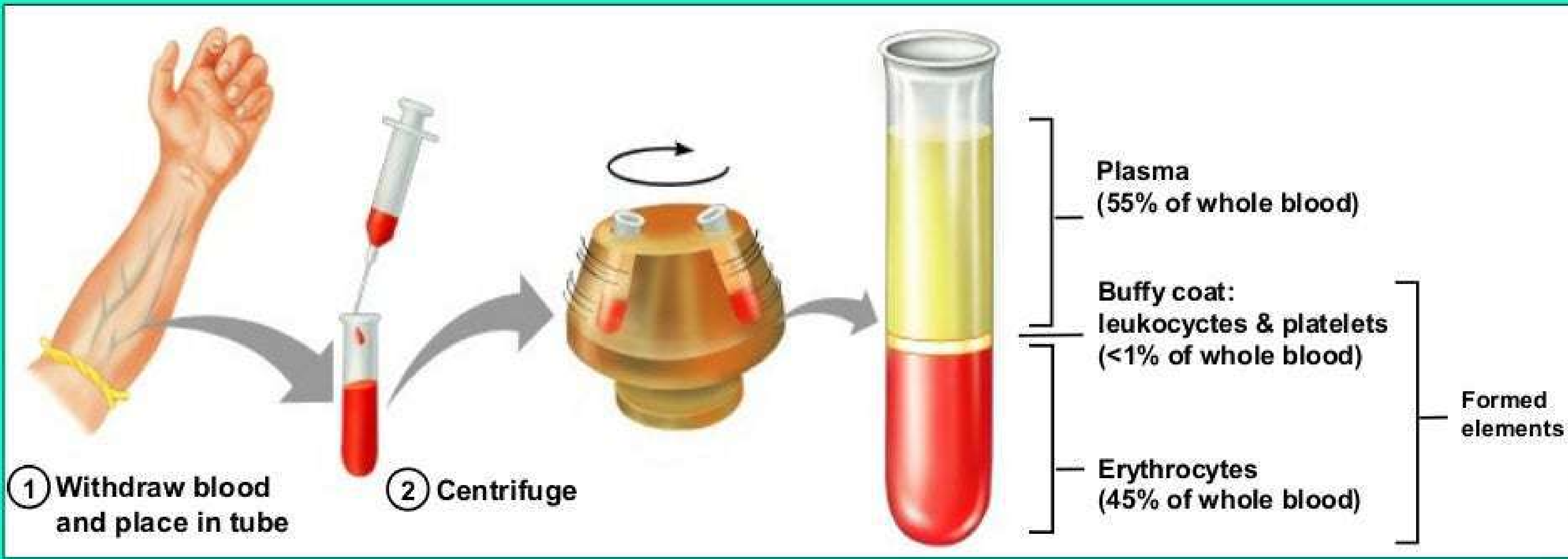


Blood Plasma

- When the formed elements are removed from blood, a straw colored liquid is called as **blood plasma.**
  - Pale yellow color (91% water, 7% Proteins & 1.5% other solutes)
  - Albumin: Responsible for maintaining osmotic pressure of blood
  - Globulins: Responsible for Immune system
  - Fibrinogen: Responsible for formation of blood clots

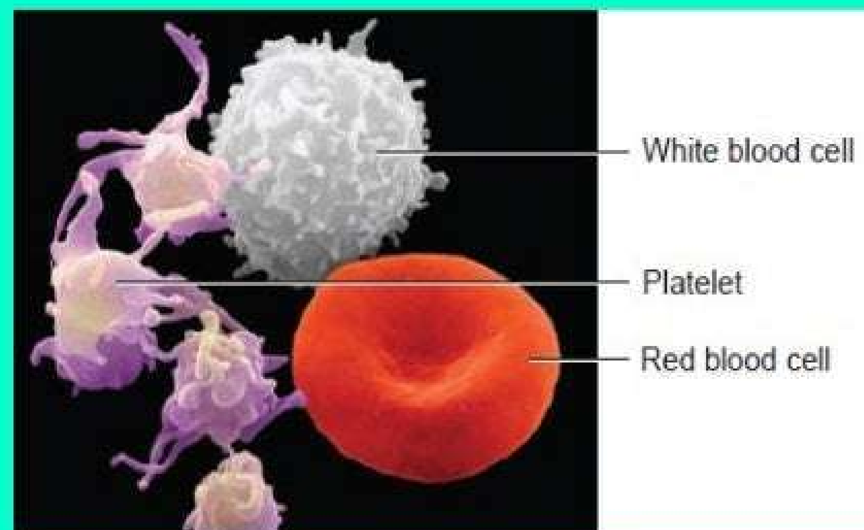
- Other regulatory substances are electrolytes, nutrients, enzymes, hormones, gases, & waste products (urea, uric acid, creatinine, ammonia, & bilirubin).

Components of Whole Blood



Formed Elements

- Red blood cells (Erythrocytes)
- White blood cells (Leukocytes)
  - Granulocytes
    - ❖ Neutrophils
    - ❖ Eosinophils
    - ❖ Basophils
  - Agranulocytes
    - ❖ Lymphocytes
    - ❖ Monocytes
- Platelets (Thrombocytes)



Haemopoiesis

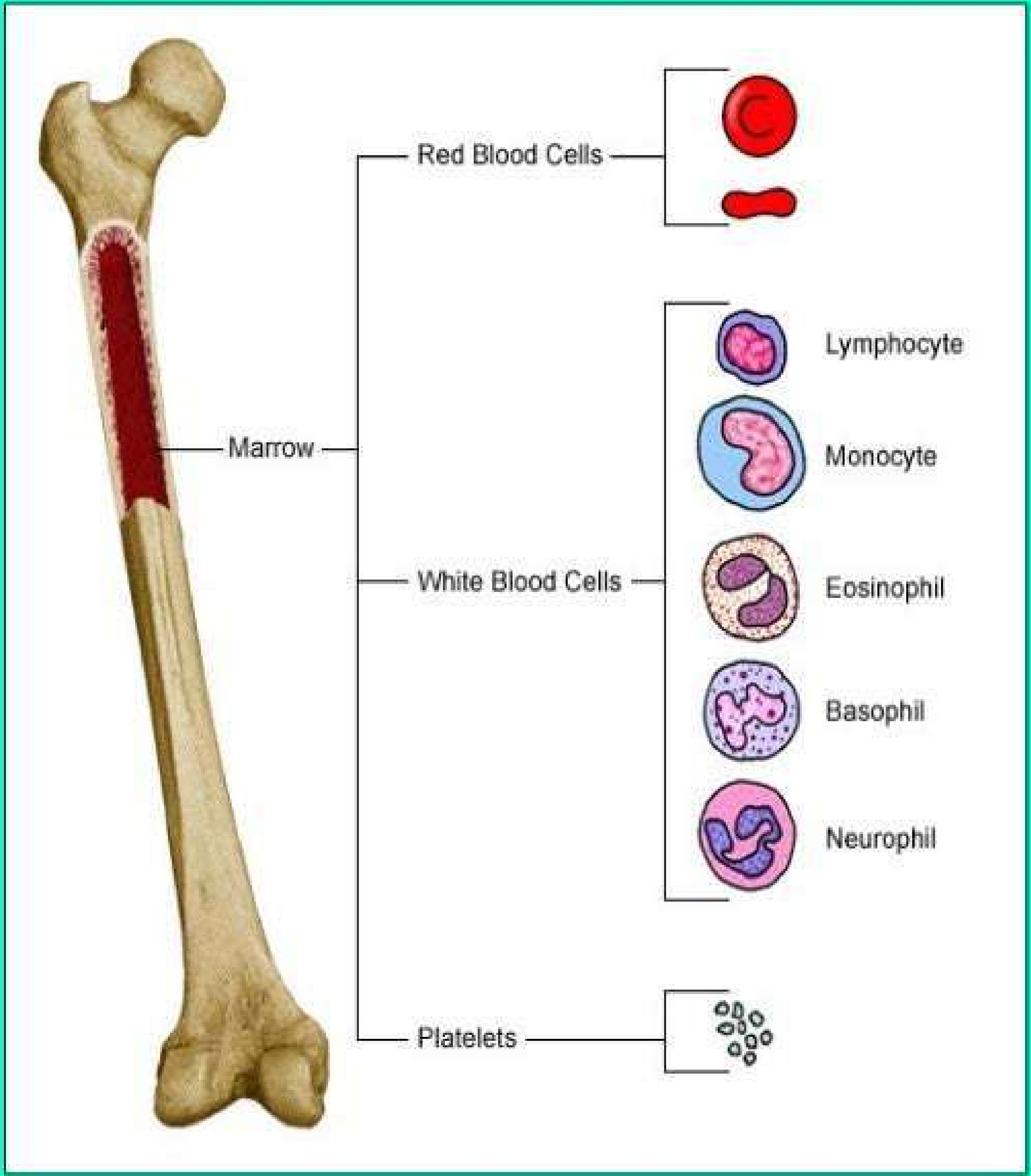
- The process of **formation of blood cells** called as hemopoiesis or hematopoiesis.
- **Red bone marrow** is the primary site of haemopoiesis.
- It is highly vascularized connective tissue located in the bone.
- Present mainly in bones of

✓ **Axial skeleton**

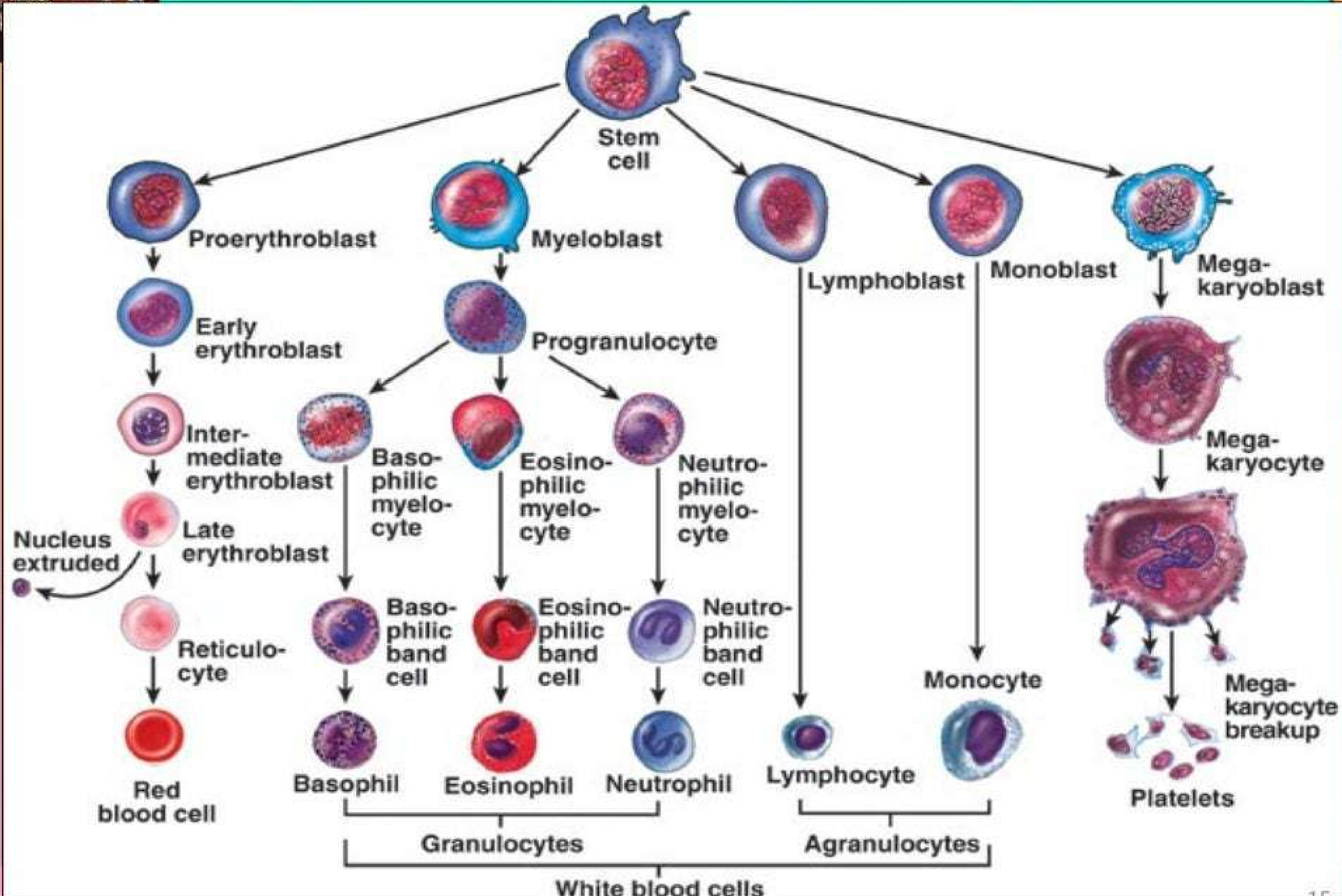
✓ **Pectoral & pelvic girdles**

✓ **Humerus & femur**

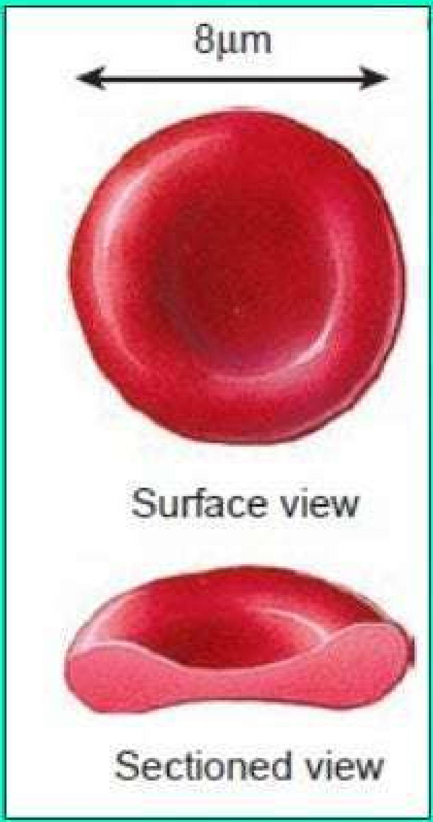
Red bone Marrow



Haemopoiesis



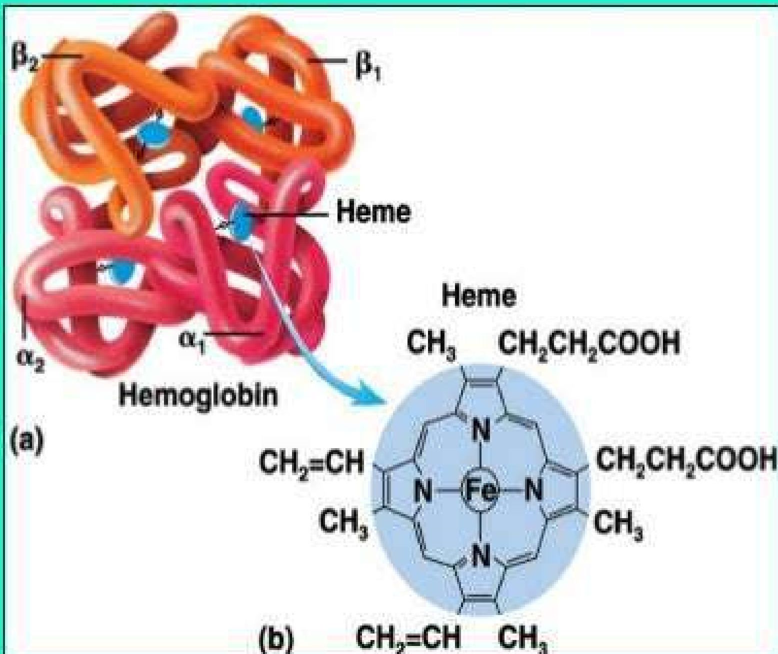
Red Blood Cells (RBCs)



- Biconcave disc shaped
- **Male: 5.4 M/ mm^3 of blood**
- **Female: 4.8 M/ mm^3 of blood**
- Have no nuclei
- Functional for about 120 days
- Production occurs in the red bone marrow
  - Erythropoiesis
  - Controlled by erythropoietin
- Contains Hemoglobin (280 M/RBCs)

- **Function:** Transport of oxygen from lungs to tissues & carbon dioxide from tissues to lungs

Hemoglobin



- Consists of:
  - 4 globin molecules: Colorless protein (96%)
  - 4 heme molecules (4%): Transport of oxygen
    - Iron is required for oxygen transport

Normal values:

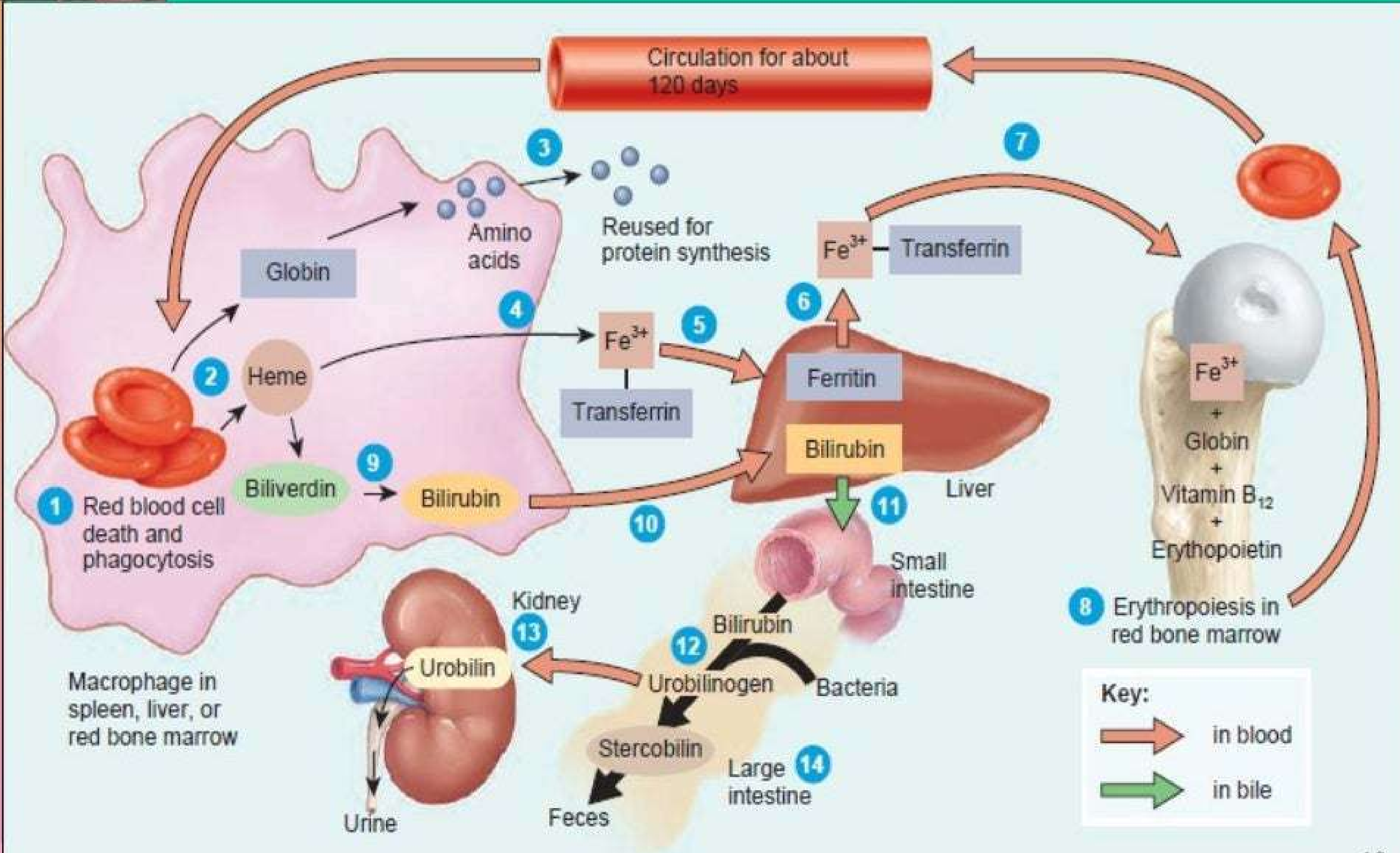
- ➢**Female: 12 to 16 gm/100 ml of blood**
- ➢**Male: 14 to 18 gm/100 ml of blood**
- ➢**Infants: 14 to 20 gm/100 ml of blood**

Hemoglobin

- **Lower hemoglobin values may be due to:**
- Anemia
- Bleeding
- Destruction of red blood cells
- Leukemia
- Malnutrition
- Nutritional deficiencies of iron, folate, vitamin B_{12}, vitamin B_6
- Overhydration

- **Higher hemoglobin values may be due to:**
- Congenital heart disease
- Dehydration
- Erythrocytosis (Increase in RBCs)
- Low blood oxygen levels (Hypoxia)
- Pulmonary fibrosis
- Polycythemia vera (Disorder of the bone marrow)

Formation & Destruction of RBCs



Formation & Destruction of RBCs

- Red blood cells live only about 120 days.
- Without a nucleus and other organelles, RBCs cannot synthesize new components to replace damaged ones.
- Ruptured red blood cells are removed from circulation & destroyed by macrophages in the spleen and liver, and breakdown products are recycled.

1 Macrophages in spleen, liver, or red bone marrow phagocytize ruptured and worn-out red blood cells.

2 The globin and heme portions of hemoglobin are split apart.

3 Globin is broken down into amino acids, which can be reused to synthesize other proteins.

Formation & Destruction of RBCs

4 Iron is removed in the form of Fe3, which associates with the plasma protein transferrin.

5 In muscle fibers, liver cells, and macrophages of the spleen and liver, Fe3 detaches from transferrin and attaches to an iron-storage protein called ferritin.

6 Upon release from a storage site or absorption from the gastrointestinal tract, Fe3 reattaches to transferrin.

7 The Fe3–transferrin complex is then carried to red bone marrow, where RBC precursor cells use it in hemoglobin synthesis.

8 Erythropoiesis in red bone marrow results in the production of red blood cells, which enter the circulation.

Formation & Destruction of RBCs

9 When iron is removed from heme, the non-iron portion of heme is converted to biliverdin, a green pigment, and then into bilirubin, a yellow orange pigment.

10 Bilirubin enters the blood and is transported to the liver.

11 Within the liver, bilirubin is released by liver cells into bile which passes into the small intestine and then into the large intestine.

12 In the large intestine, bacteria convert bilirubin into urobilinogen

13 Some urobilinogen is absorbed back into the blood, converted to a yellow pigment called urobilin and excreted in urine.

14 Most urobilinogen is eliminated in feces in the form of a brown pigment called stercobilin, which gives feces its characteristic color.

Definition of Anemia

- Deficiency in the oxygen-carrying capacity of blood due to a decrease in erythrocyte number.

- May be due to:
  - **Erythrocyte loss** (bleeding)
  - **Decreased Erythrocyte production**
    - low erythropoietin
    - Decreased bone marrow response to erythropoietin
  - **Increased Erythrocyte destruction** (hemolysis)

Symptoms of Anemia

- **Decreased oxygenation**
  - Exertional dyspnea
  - Dyspnea at rest
  - Fatigue
  - Lethargy, confusion

- **Decreased volume**
  - Fatigue
  - Muscle cramps
  - Postural dizziness
  - Syncope

Types of Anemia

- Iron deficiency anemia
- Megaloblastic anemia
- Pernicious anemia
- Hemolytic anemia
- Aplastic anemia
- Sickle-cell anemia

Anemia

Iron Deficiency Anemia: Inadequate absorption or excessive loss of iron

Megaloblastic Anemia: Due to deficiency of folic acid & vitamin B_{12}

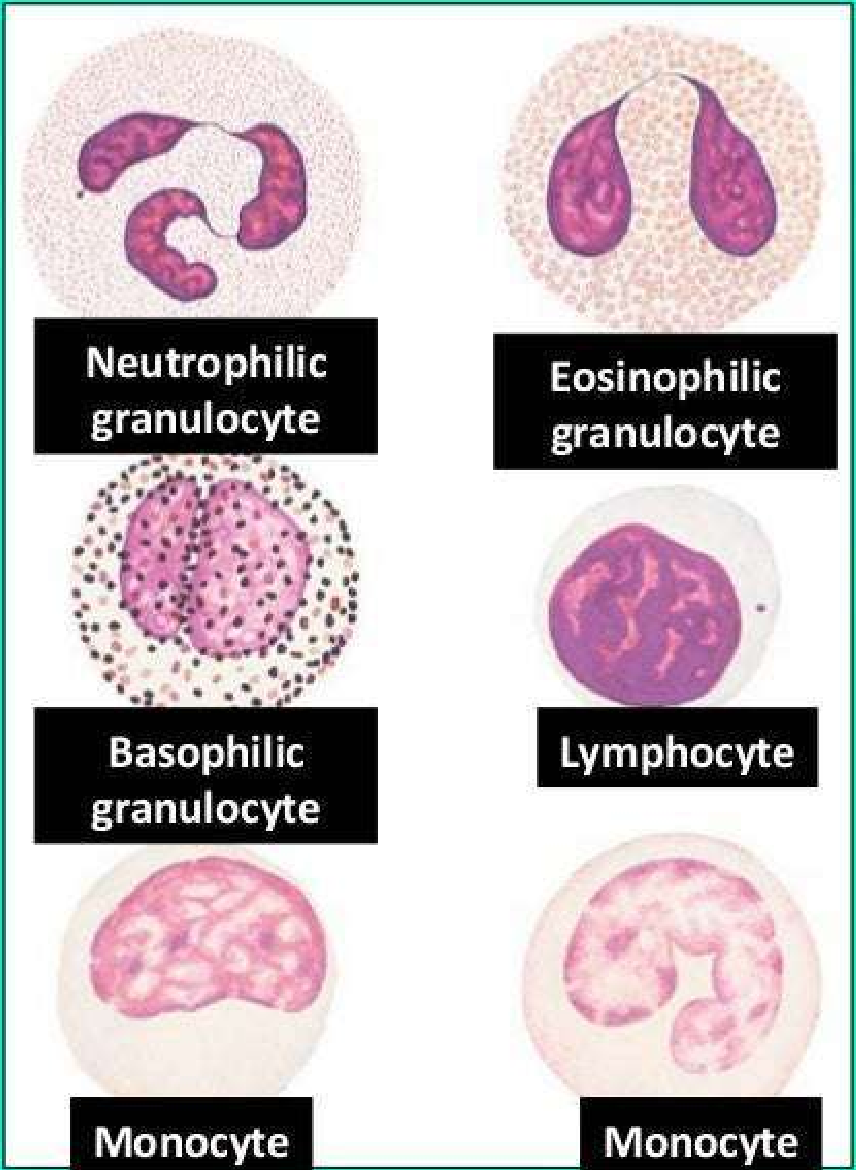
Aplastic anemia: Destruction of red bone marrow

Hemolytic anemia: Due to excessive breakdown of red blood cells

Pernicious anemia: Due to impaired absorption of vitamin B_{12} because of a lack of intrinsic factor in gastric secretions.

White blood Cells (WBCs)

- **Range:** 5000 – 10,000/mm^3 of blood
- Produced by **leukopoiesis** in red bone marrow, Contain nuclei
- **Functions**
  - Defense against pathogens
  - Removal of toxins, wastes & damaged cells
- **Two types**
- Granulocytes: 75% of total WBC
  - Neutrophils
  - Eosinophils
  - Basophils
- Agranulocytes: 25% of total WBC
  - Lymphocytes
  - Monocytes

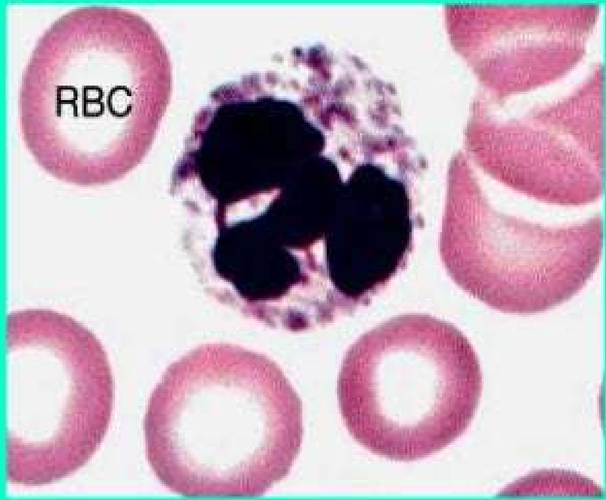


Leukocytosis & Leukopenia

- **Leukocytosis:** An increase in the number of WBCs above 10,000, is called as leukocytosis.
- **Leukopenia:** A decease in the number of white blood cells below 5000, is called as leukopenia.

Neutrophil

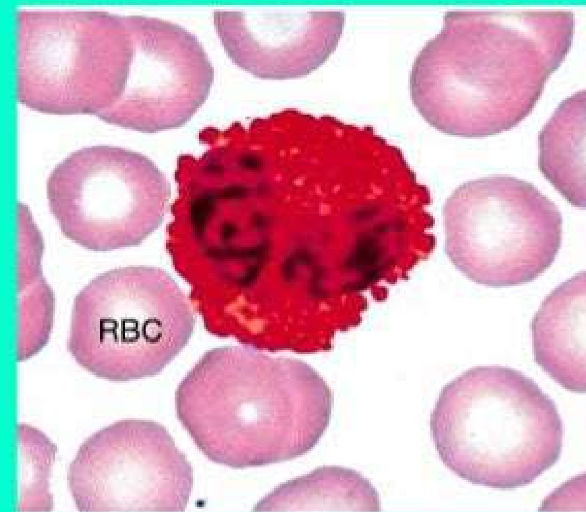
- 60-70% of total WBC's
- Granules do not stain with dyes
- Diameter: 10-12 µm
- Nucleus: Usually 2-4 lobed



Functions:

- Neutrophils are phagocytic towards bacteria (1 neutrophil can phagocytize 5-20 bacteria)

Eosinophil

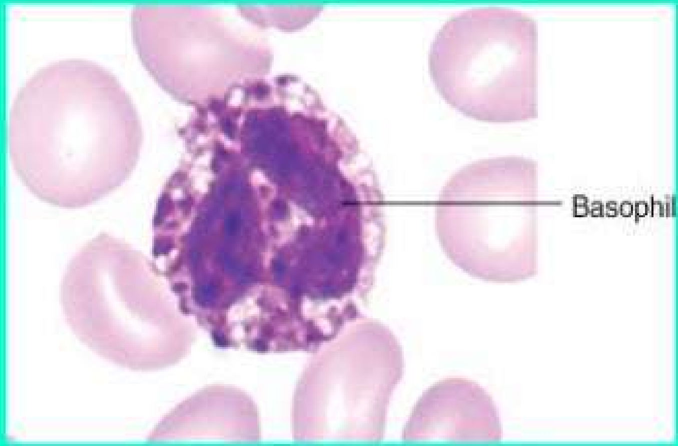


- 2-4 % of total WBC's
- Granules stained by red acidic dyes
- Diameter 10-12 µm
- Nucleus: Usually 2 lobes

- **Functions:**
- Involved in allergic reactions & parasitic infections.
- They destroy the antigen-antibody complexes & restrict the process of inflammation.

Basophil

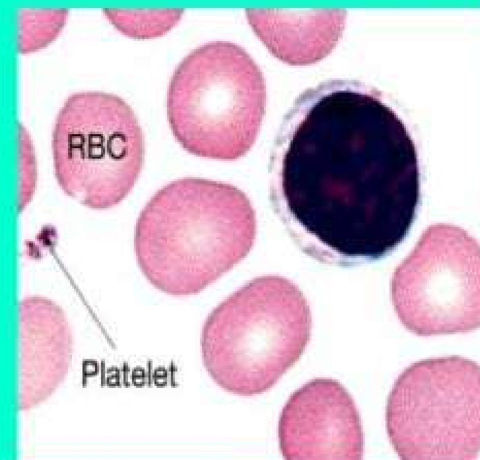
- 0.5- 1 % of total WBC's
- Granules stained with basic, purple blue color
- Diameter 8-10 μm
- Nucleus: Irregular and usually 2 lobes
- Granules contain heparin & histamine



- **Functions:**
- At the site of infection basophils convert into mast cells
- Basophils & mast cells release histamine, bradykinin & serotonin

Lymphocyte

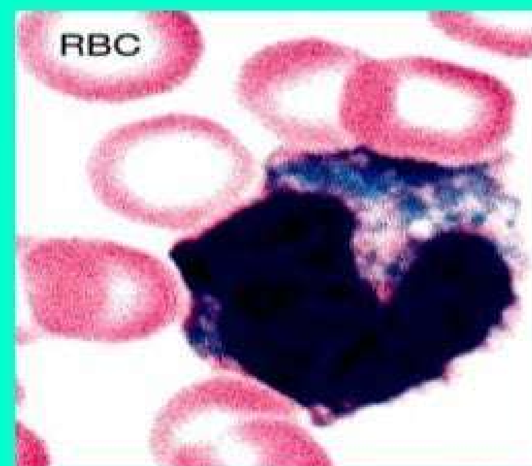
- 20-25 % of total WBC's
- Depending upon the site of production & their actions, divided into T, B cells & Natural killer cells
- They are divided into
  - Small lymphocytes- Diameter 6-9 µm
  - Large Lymphocyte- Diameter 10-14 µm
- Nucleus: Round



- **Functions:**
- Plays important role in immunity.

Monocyte

- 3-8 % of total WBC's
- Diameter: 12-20 μm
- Nucleus: Oval or kidney shaped
- Monocytes are converted into macrophages of the tissues



- **Functions:**
- Phagocytosis

Thrombocytes

- Range: 250,000-500,000 /mm^3 of blood
- Have no nuclei
- Diameter: 2-4 µm
- Life span: 10 -12 days

- **Function**
- Involved in blood clotting mechanism

Hemostasis- Stoppage of bleeding

- When the blood vessel get damaged, platelet plays a vital role in Hemostasis.
- 3 mechanisms are involved in hemostasis;

✓ **Vascular spasm**

✓ **Blood clotting**

✓ **Platelet plug formation**

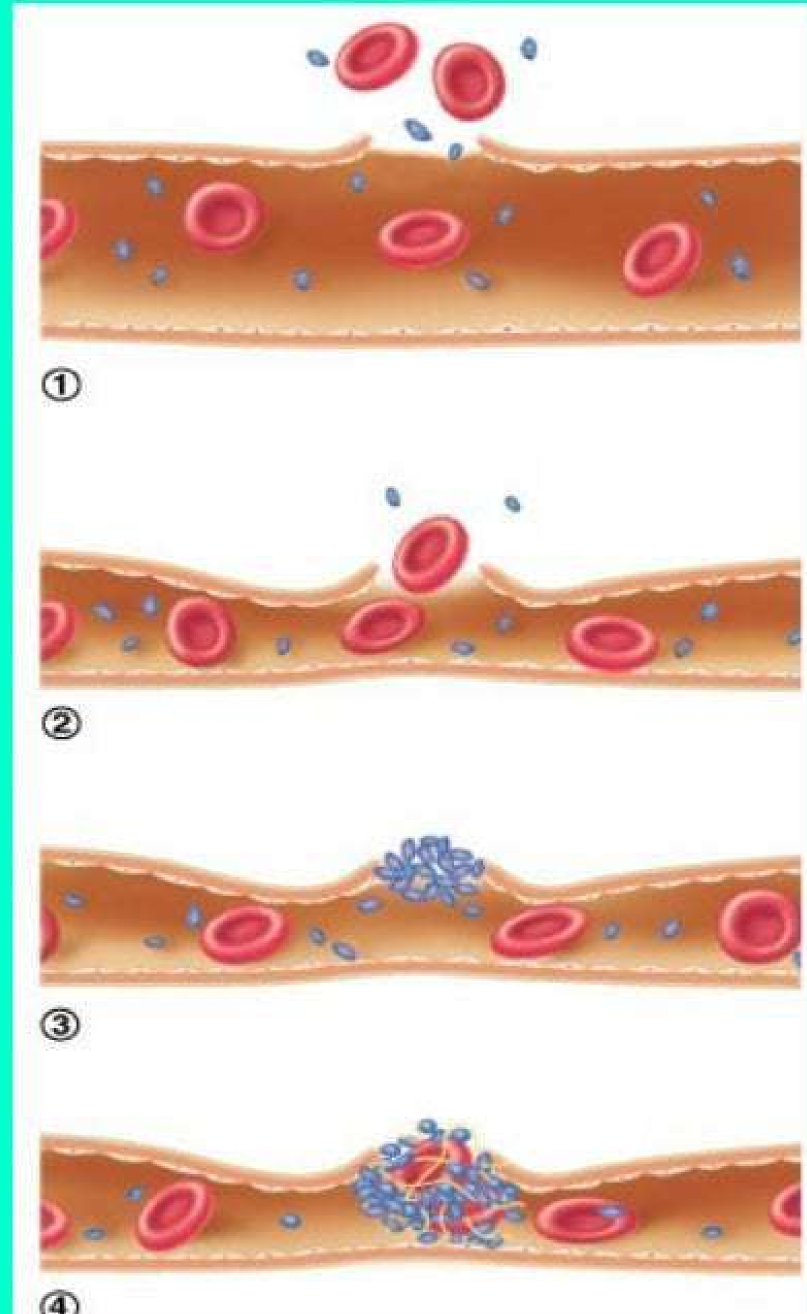
Hemostasis

1. Blood vessel injury

2. Vasoconstriction

3. Platelet plug formation

4. Coagulation



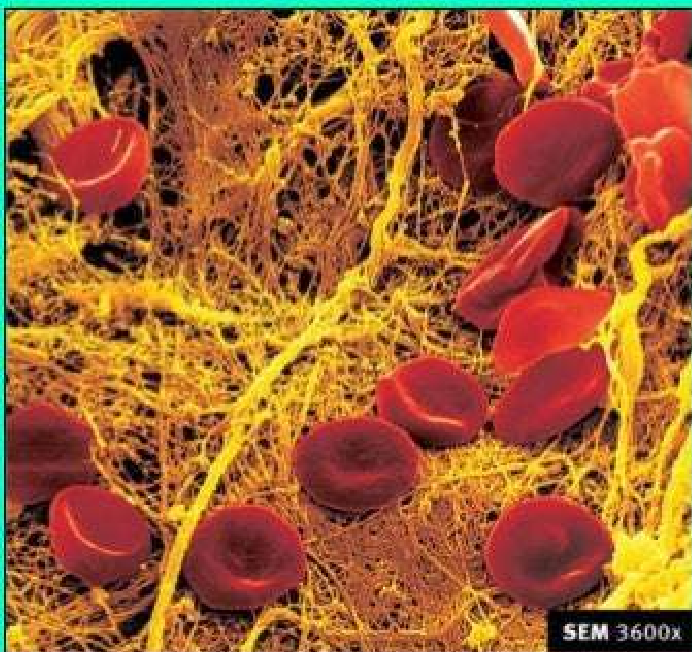
Vascular spasm

- When arteries are damaged, the smooth muscle in the walls of arteries contracts immediately, a reaction is called as **vascular spasm.**
- This reduces blood loss for several minutes to several hours.
- The spasm is caused due to **release of mediators** from the activated platelets.

Blood clotting

- Blood clot consists of network of **insoluble protein fibers** called as **fibrin** in which the **formed elements (RBCs, WBCs & Platelets)** of blood are trapped.
- The process of clot formation is called as **clotting.**

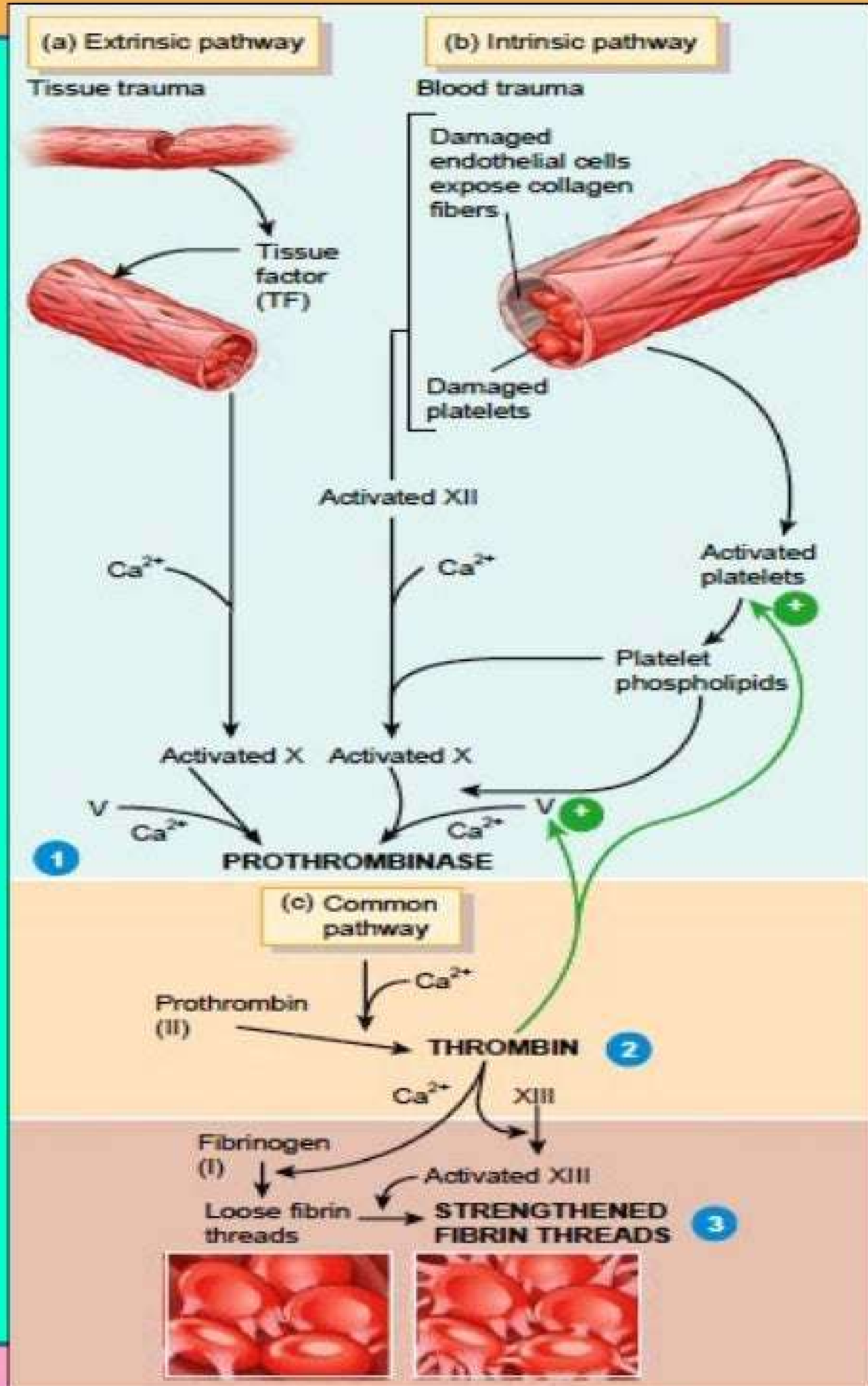
Blood clotting



Blood clotting factors:

I.Fibrinogen
II.Prothrombin
III.Tissue factor
IV.Calcium ions
V.Labile factor- Proaccelerin
VI.Absent
VII.Stable factor- Proconvertin
VIII.Antihaemophilic factor (A)
IX.Christmas factor or AHF (B)
X.Stuart factor
XI.Plasma thromboplastin or AHF (C)
XII.Hageman factor or AHF (D)
XIII.Fibrin- stabilizing factor

Extrinsic Pathway



Intrinsic Pathway

The Extrinsic Pathway

- **Fewer steps** & occurs rapidly within a seconds
- Tissue protein called **tissue factor (TF)** leaks into the blood from cells *outside* blood vessels & initiates the formation of prothrombinase.
- TF is a complex mixture of lipoproteins & phospholipids released from the surfaces of damaged cells.
- In the presence of Ca^{2}, TF begins a sequence of reactions that activates clotting factor X .
- Once factor X is activated, it combines with factor V in the presence of Ca^{2} to form the enzyme prothrombinase, completing the extrinsic pathway.

The Intrinsic Pathway

- More complex & occurs more slowly, requires several minutes.
- Its activators are present either in direct contact with blood or contained within the blood.
- Outside tissue damage is not needed.
- If endothelial cells become damaged, blood can come in contact with collagen fibers of the blood vessel.
- Trauma to endothelial cells causes damage to platelets, resulting in release of phospholipids by the platelets.

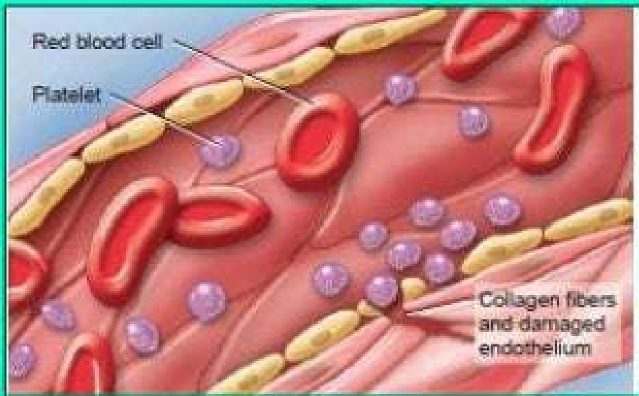
The Intrinsic Pathway

- Contact with collagen fibers activates clotting factor XII, which begins a sequence of reactions that activates clotting factor X.
- Platelet phospholipids & Ca^{2} can also participate in the activation of factor X.
- Once factor X is activated, it combines with factor V to form the active enzyme prothrombinase, completing the intrinsic pathway.

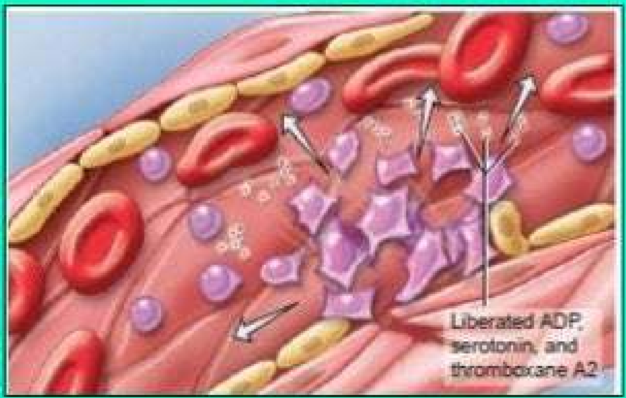
The Common Pathway

- The formation of **prothrombinase** starts the beginning of the common pathway.
- In the second stage of blood clotting, prothrombinase & Ca^{2} catalyze the conversion of **prothrombin** to **thrombin**.
- In the third stage, thrombin, in presence of Ca^{2}, converts **fibrinogen** (soluble), to loose **fibrin** threads (insoluble).
- Thrombin also activates factor XIII (fibrin stabilizing factor), which strengthens and stabilizes the fibrin threads into a **sturdy clot**.

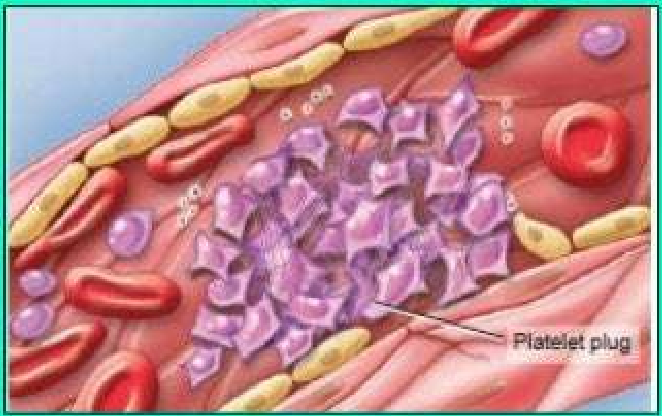
Platelet Plug formation



1. Platelet Adhesion



2. Platelet release reaction



3. Platelet aggregation

Platelet Plug formation

- Inspite of having small size, platelets store lot many chemicals.
- It contains ADP, ATP, Ca^2, serotonin, thromboxane A_2, a prostaglandin, fibrin-stabilizing factor & platelet-derived growth factor (PDGF).

Platelet Plug formation

- **Initially, platelets stick to parts of a damaged** blood vessel, such as collagen fibers of damaged endothelial cells.
- This process is called as **platelet adhesion.**
- Due to adhesion, the platelets become activated, & their characteristics change dramatically.
- They extend many projections and they begin to liberate the contents of their vesicles.
- This phase is as called **platelet release reaction.**

Platelet Plug formation

- Liberated ADP & thromboxane A_2 play a major role of activating nearby platelets.
- **Serotonin & thromboxane A_2** function as **vasoconstrictors**, causing contraction of vascular smooth muscle, which decreases blood flow through the injured vessel.

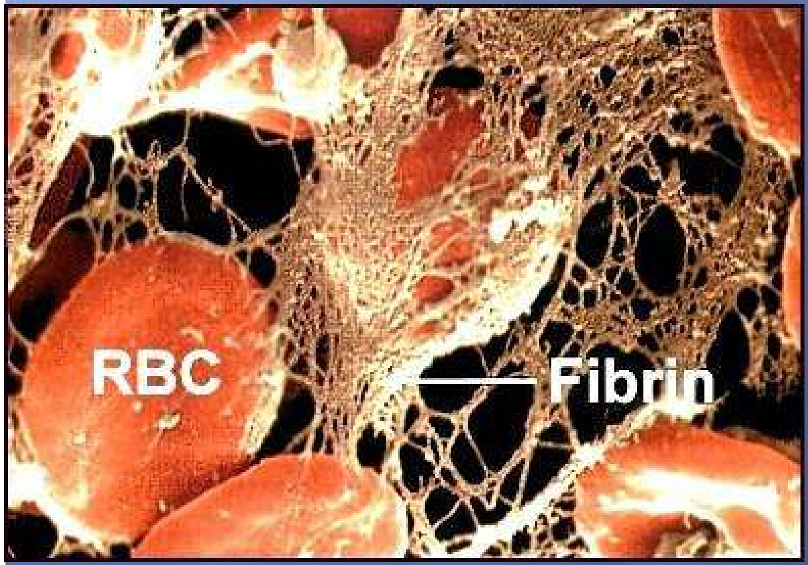
Platelet Plug formation

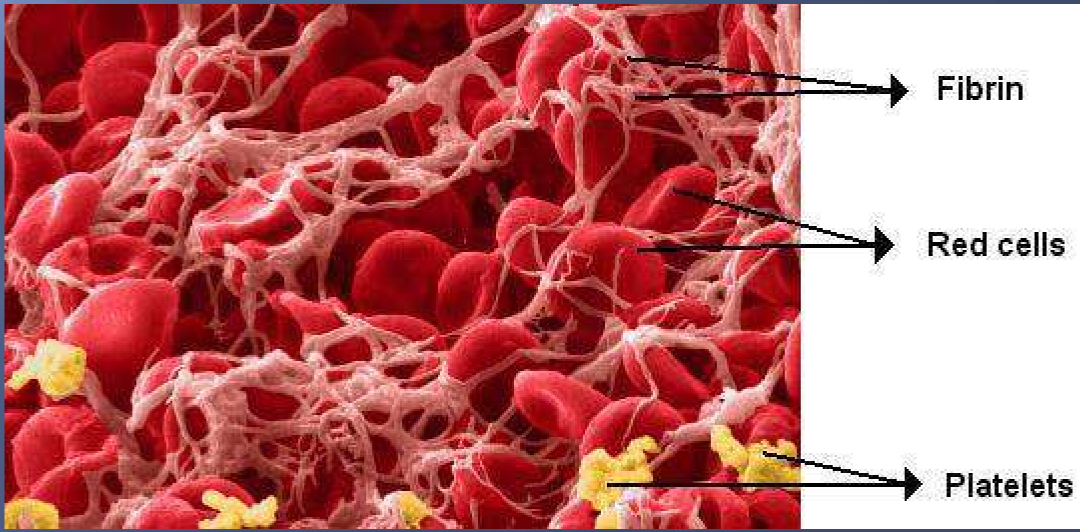
- The release of ADP makes other platelets sticky, & adhere to the originally activated platelets.
- This gathering of platelets is called as **platelet aggregation**.
- The accumulation & attachment of large numbers of platelets to the site of injury to form a solid mass called as **platelet plug**.

BLOOD CLOTTING

By
Hima saila.M
Assistant professor

HAEMOSTASIS





Haemostasis

* The term *haemostasis* means prevention of blood loss.

* Haemostasis is the process of forming clots in the walls of damaged blood vessels and preventing blood loss, while maintaining blood in a fluid state within the vascular system.

Mechanism

Haemostasis involves 4 main steps:

1. **Vascular spasm**
2. **Platelets reaction**
3. **Formation of platelet plug**
3. **Blood coagulation**

I-Vascular spasm

Reduces flow of blood from injured vessel.

Cause:

1- Sympathetic reflex

2- Release of vasoconstrictors (TXA_2 and serotonin) from platelets that adhere to the walls of damaged vessels.

II- Platelet plug formation

Mechanism:

Platelet adherence
Platelet activation
Platelet aggregation

Platelets

- Produced in the bone marrow by fragmentation of the cytoplasm of megakaryocytes (1000-5000/cell).
- 1/3 of marrow output of platelets is trapped in spleen (splenectomy?)
- Normal count: 150,000-400,000/µL (250,000)
- Life span 7-10 days.
- Removed from circulation by tissue macrophage system mainly in spleen.
- Thrombopoietin: major regulator of platelet production (produced by liver and kidney).
- It increases no. & rate of maturation of megakaryocytes.

Functional characteristics of platelets

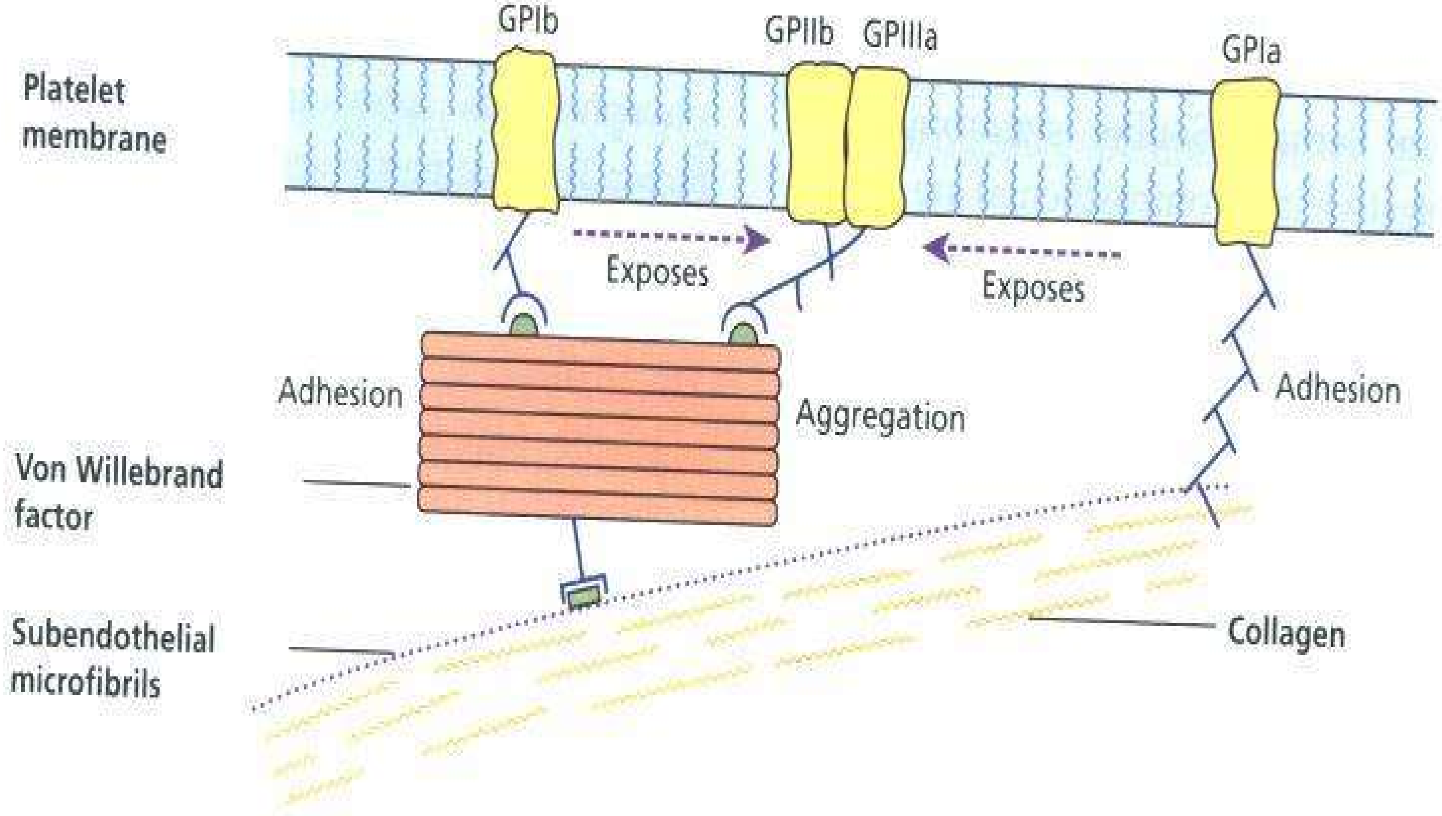
- The cell membrane of platelets contains:
  - A coat of glycoprotein (receptors) that cause adherence to injured endothelial cells and exposed collagen.
  - Phospholipids, that play an important role in blood clotting.

- **Their cytoplasm :**
  - **Contains:**
    - **contractile proteins (actin & myosin).**
    - **Dense granules, which contain substances that are secreted in response to platelet activation including serotonin & ADP.**
    - ***α*-granules, which contain secreted proteins e.g. platelet-derived growth factor (PDGF) which stimulates wound healing, fibrin stabilizing factor (factor XIII) and other clotting factors.**
  - **Can store large quantities of Ca^{++}.**

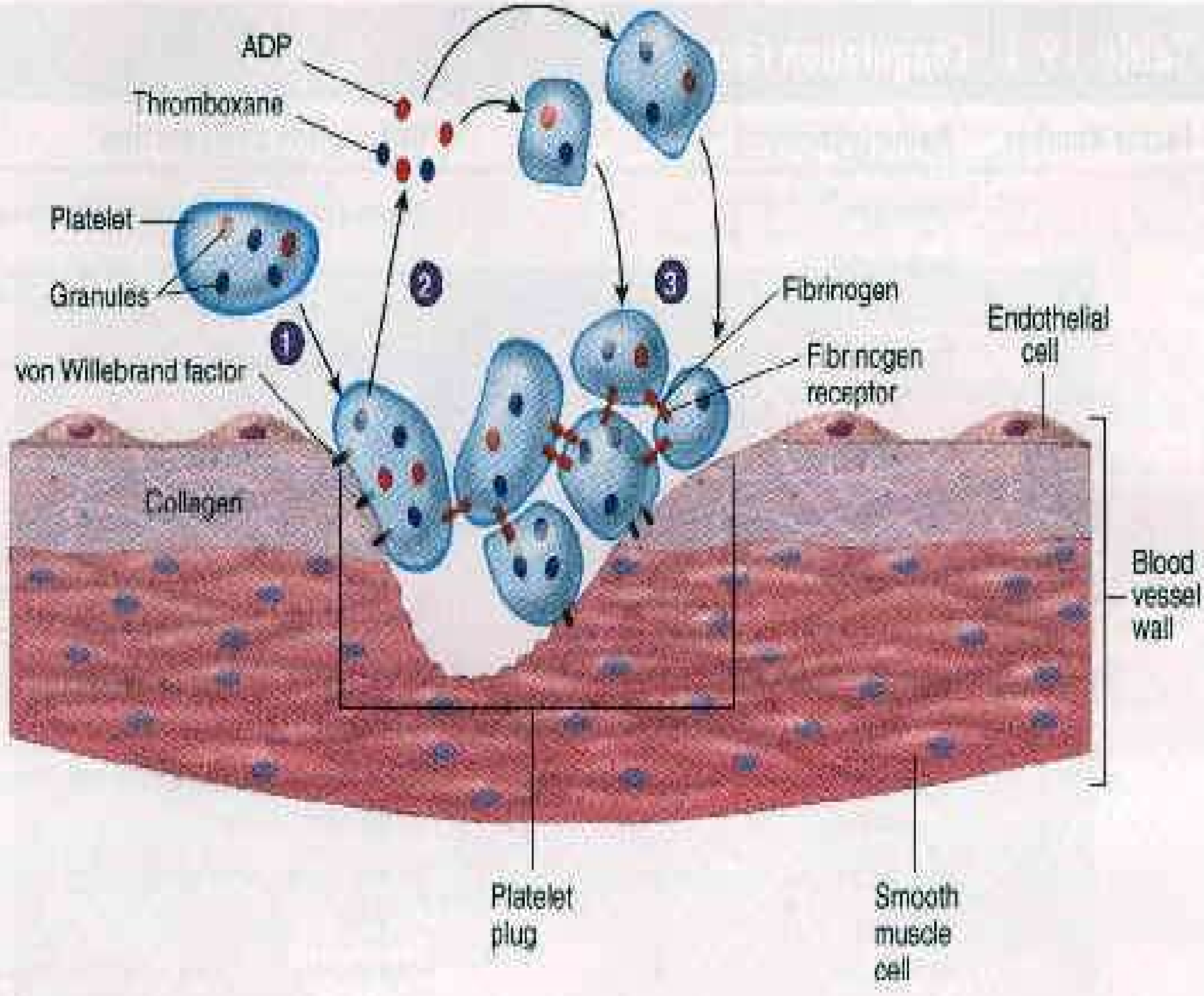
Mechanism of platelet plug formation

* *Platelet adhesion:* **When a blood vessel wall is injured, platelets adhere to the exposed collagen and von Willebrand factor in the wall via platelet receptors →** ***Platelet activation.***

* **Activated platelets release the contents of their granules including ADP and secrete TXA_2 → activates nearby platelets to produce further accumulation of more platelets (*platelet aggregation*) and forming a *platelet plug*.**


GPIb
GPIIb
GPIIIa
GPIa
Platelet membrane
Exposes
Exposes
Adhesion
Aggregation
Adhesion
Von Willebrand factor
Subendothelial microfibrils
Collagen

1. Platelet adhesion occurs when von Willebrand factor connects collagen and platelets.
2. The platelet release reaction is the release of ADP, thromboxanes, and other chemicals that activate other platelets.
3. Platelet aggregation occurs when fibrinogen receptors on activated platelets bind to fibrinogen, connecting the platelets to one another. A platelet plug is formed by the accumulating mass of platelets.



Platelet Plug Formation

Blood Coagulation

- The clotting mechanism involves a cascade of reactions in which clotting factors are activated.
- Most of them are plasma proteins synthesized by the liver (vitamin K is needed for the synthesis of factor II, VII, IX and X).
- They are always present in the plasma in an inactive form.
- When activated they act as proteolytic enzymes which activate other inactive enzymes.
- Several of these steps require Ca^{++} and platelet phospholipid.

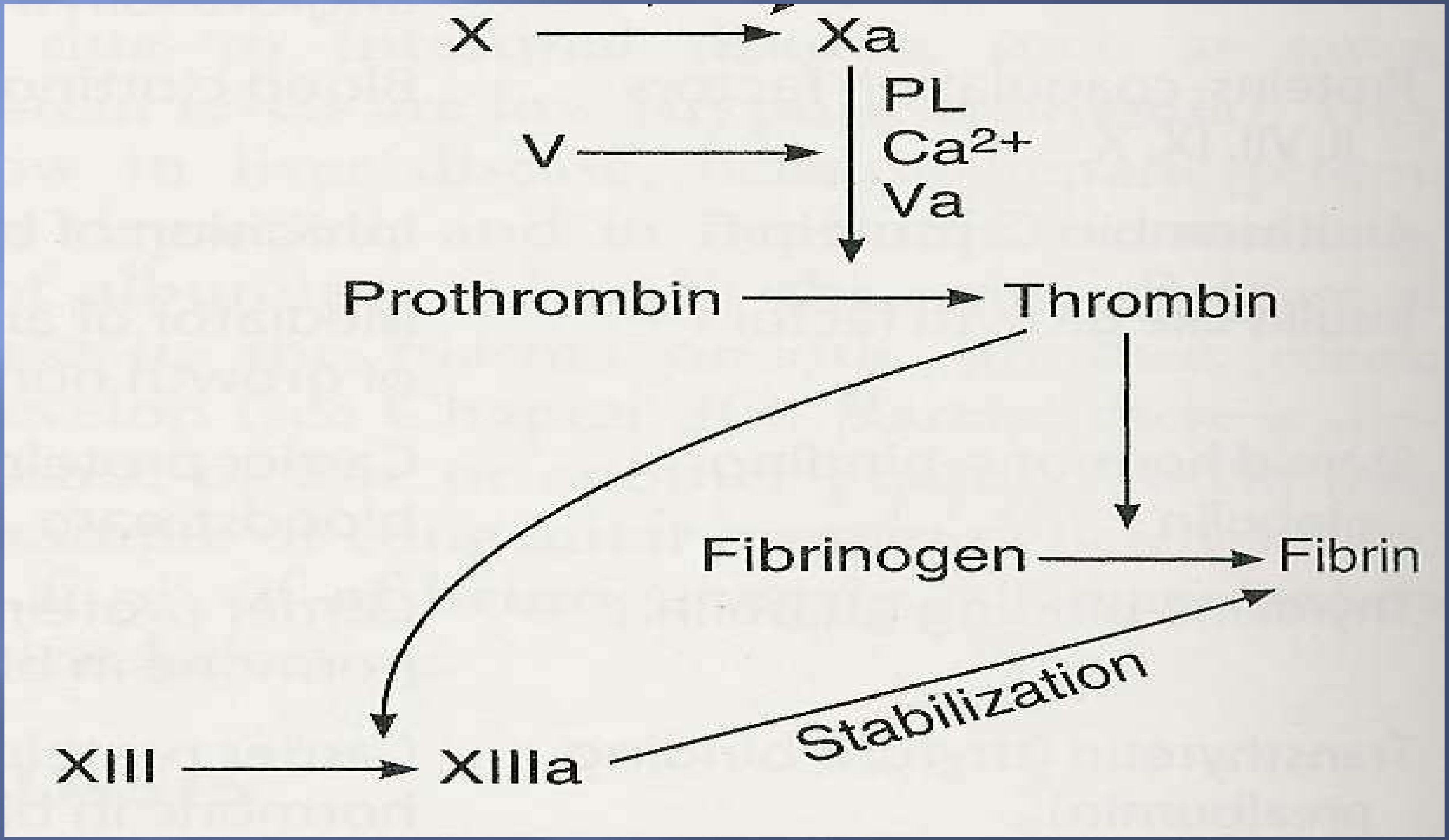
Table 18.1 The coagulation factors

Factor number	Descriptive name
I	Fibrinogen
II	Prothrombin
III	Tissue factor
V	Labile factor
VII	Proconvertin
VIII	Antihaemophilic factor
IX	Christmas factor
X	Stuart–Prower factor
XI	Plasma thromboplastin antecedent
XII	Hageman (contact) factor
XIII	Fibrin-stabilizing factor
	Prekallikrein (Fletcher factor)
	HMWK (Fitzgerald factor)

*Active without proteolytic modification.
HMWK, high molecular weight kininogen.

Blood Coagulation

- The ultimate step in clot formation is the conversion of fibrinogen → fibrin.



Factor X can be activated by reactions in either of 2 systems:

An Intrinsic system.
An Extrinsic system

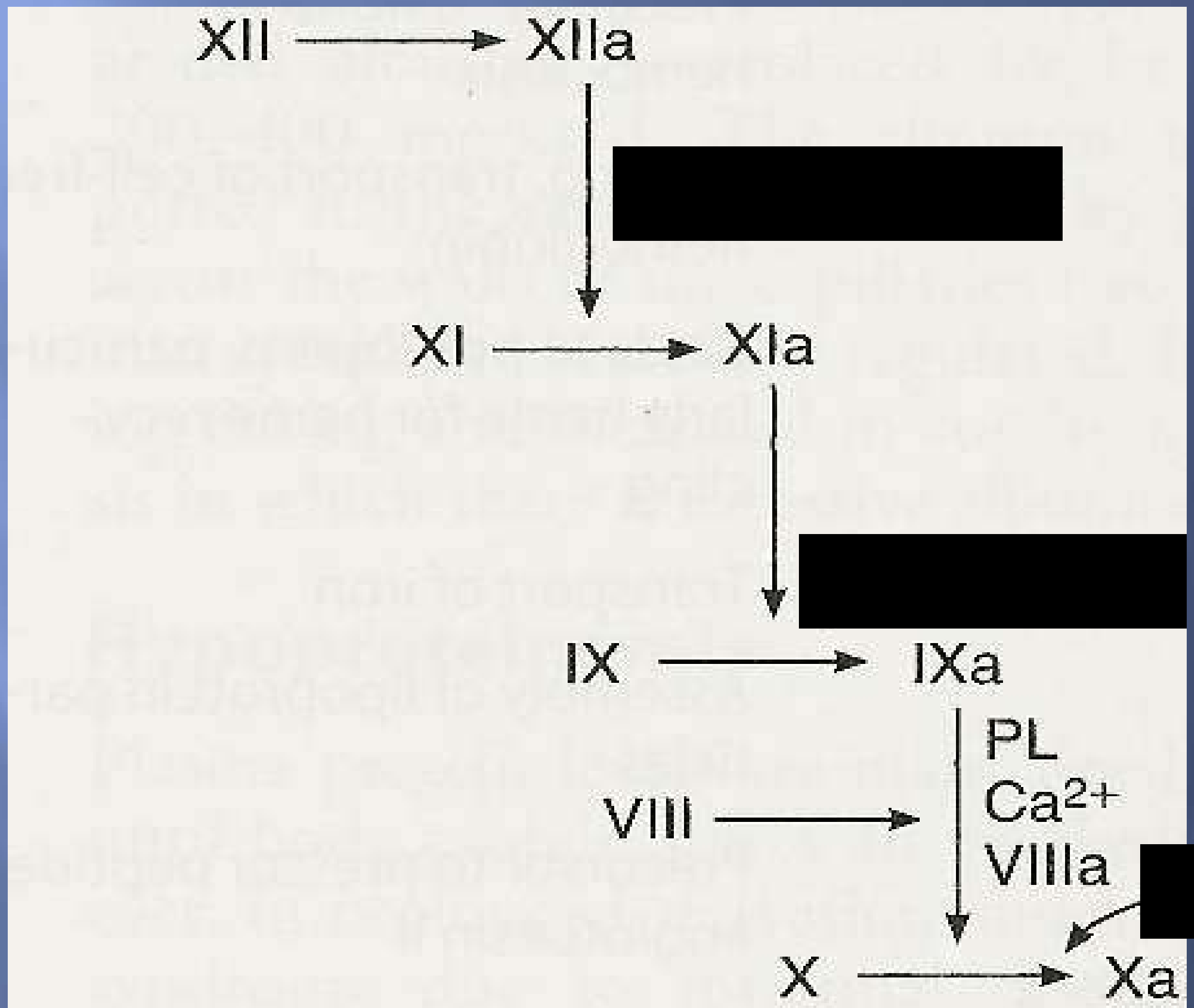
Intrinsic pathway

The initial reaction is the conversion of inactive factor XII to active factor XIIa.

Factor XII is activated in vitro by exposing blood to foreign surface (glass test tube).

Activation in vivo occurs when blood is exposed to collagen fibers underlying the endothelium in the blood vessels.

INTRINSIC SYSTEM



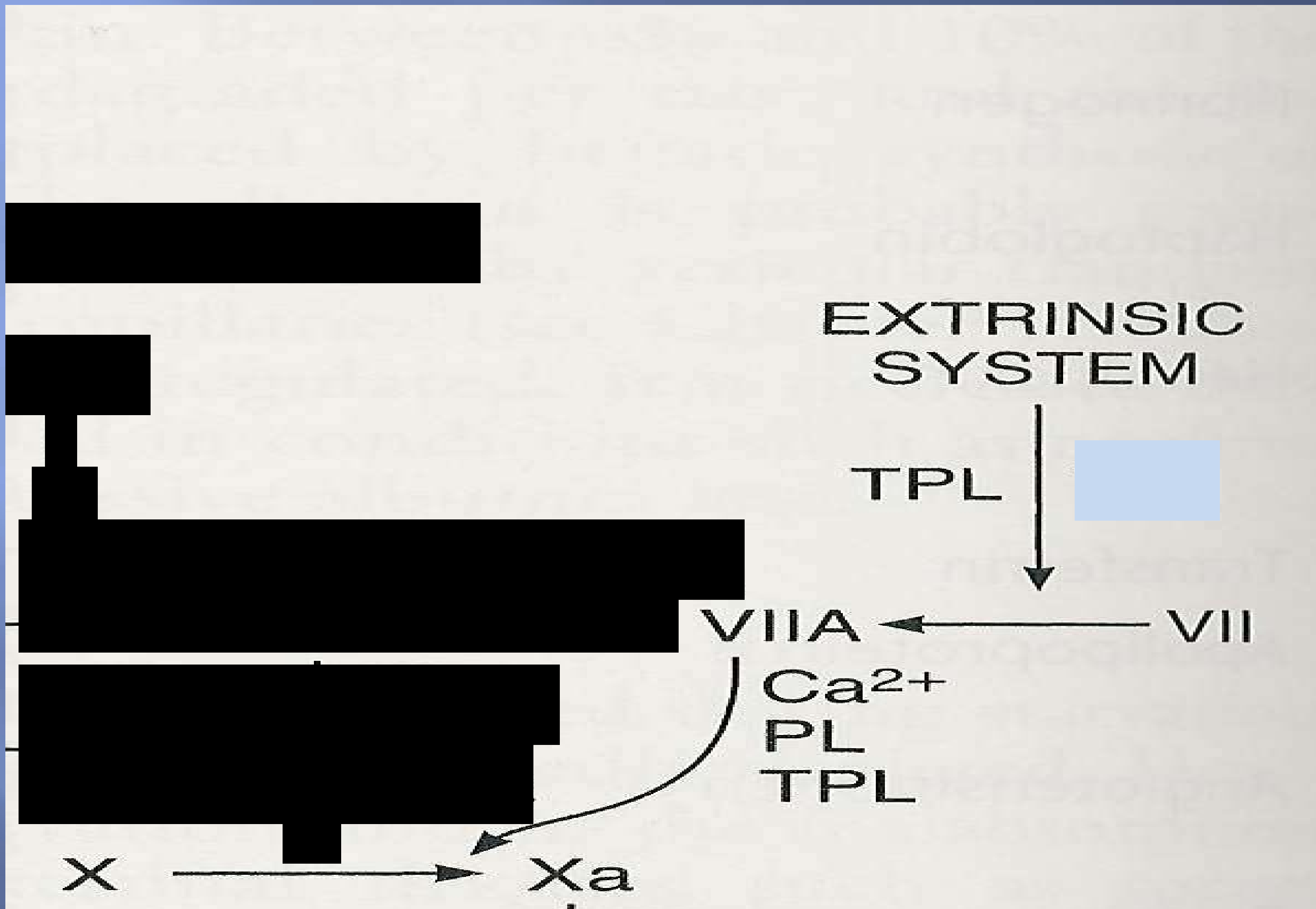
Extrinsic pathway

Requires contact with tissue factors external to blood.

This occurs when there is trauma to the vascular wall and surrounding tissues.

The extrinsic system is triggered by the release of tissue factor (thromboplastin from damaged tissue), that activates factor VII.

The tissue thromboplastin and factor VII activate factor X.


[redacted]
EXTRINSIC
SYSTEM
TPL
VIIA
VII
Ca2+
PL
TPL
X
Xa

Clot retraction

Clot formation is fully developed in 3-6 min

Contraction of platelets trapped within the clot shrinks the fibrin meshwork pulling the edges of the damaged vessel closer together.

During clot retraction serum is squeezed from the clot.

SUMMARY

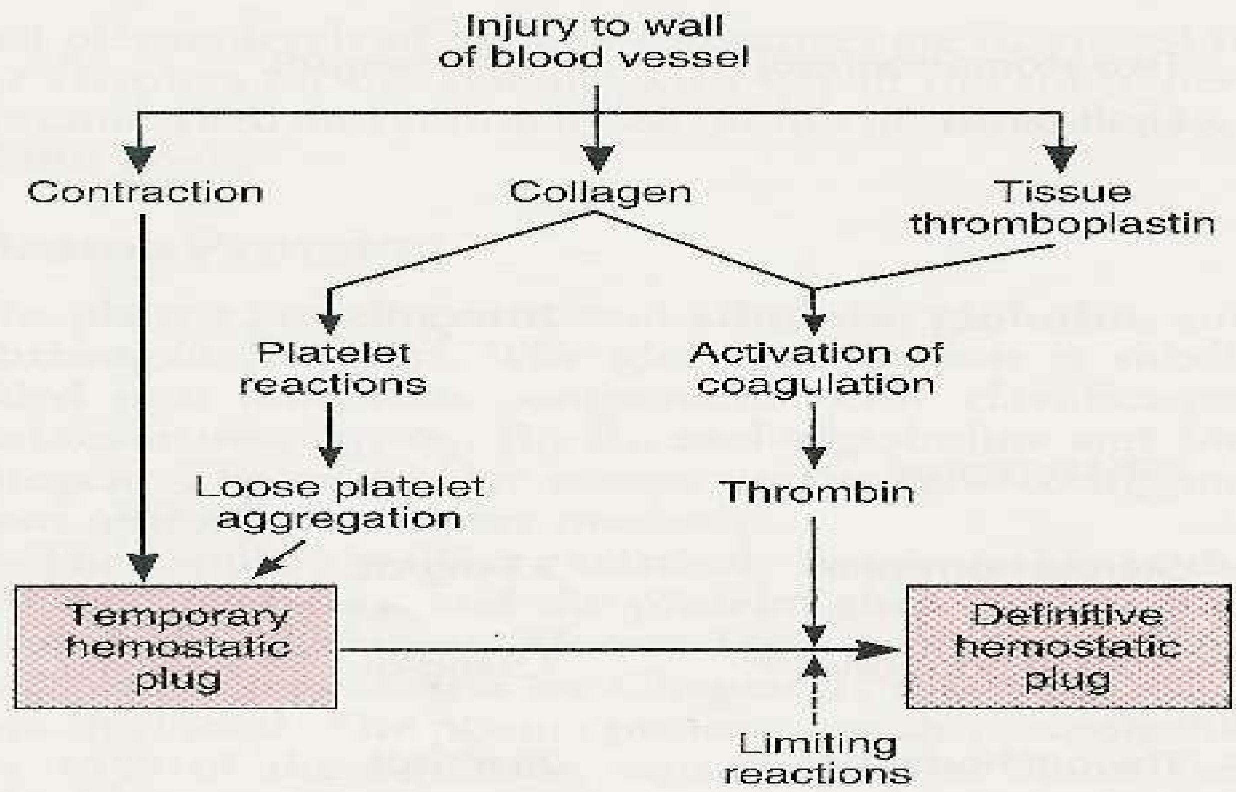


Figure 27–23 **Summary of reactions involved in hemostasis. The dashed arrow indicates inhibition.** (Modified from Deykin D: Thrombogenesis, N Engl J Med 1967;267:622.)

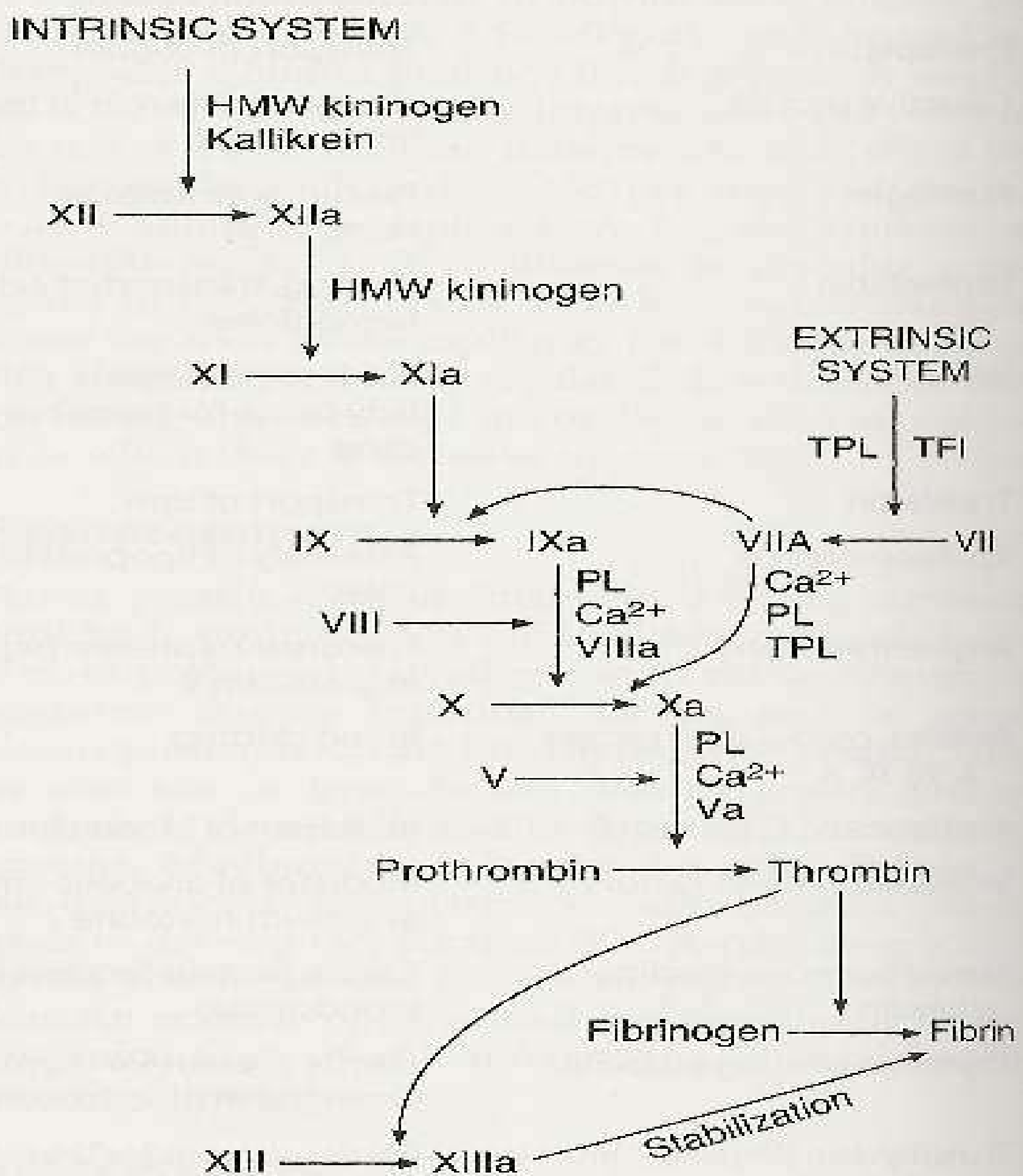


Figure 27–24 The clotting mechanism. a, active form of clotting factor. TPL, tissue thromboplastin; TFI, tissue factor pathway inhibitor. For other abbreviations, see Table 27–8.

THANK YOU

INTEGUMENTARY SYSTEM

BY
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ASSISTANT PROFESSOR
DEPT OF PHARMACOLOGY
SRI PADMAVATHI SCHOOL OF PHARMACY

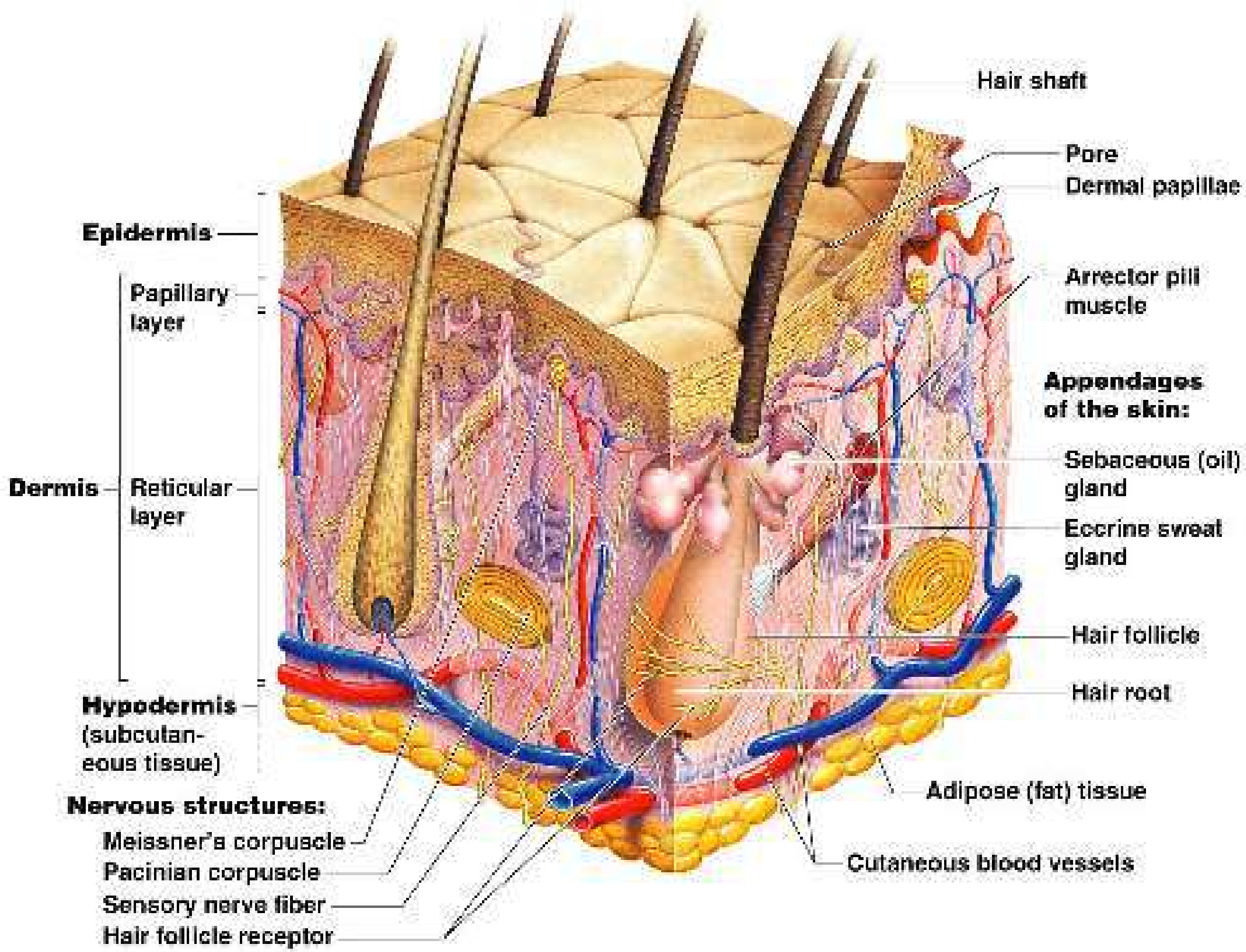
Skin Functions of Skin

- Mechanical/Chemical damage – keratin toughens cells; fats cells cushion blows; and pressure receptors to measure possible damage
- Bacterial damage – skin secretions are acidic and inhibit bacteria.
- Ultraviolet radiation – melanin produced to protect from UV damage

Skin Functions

- Thermal control – regulates body temperature
  - Heat loss: sweat to cool the skin
  - Heat retention: prevents blood to rush into capillary beds
- Waterproofing – contains lipids to prevent drying out
- Excretion of waste – urea and uric acid secreted in sweat
- Makes vitamin D – modifies cholesterol molecules in skin and converts it to vitamin D

SKIN

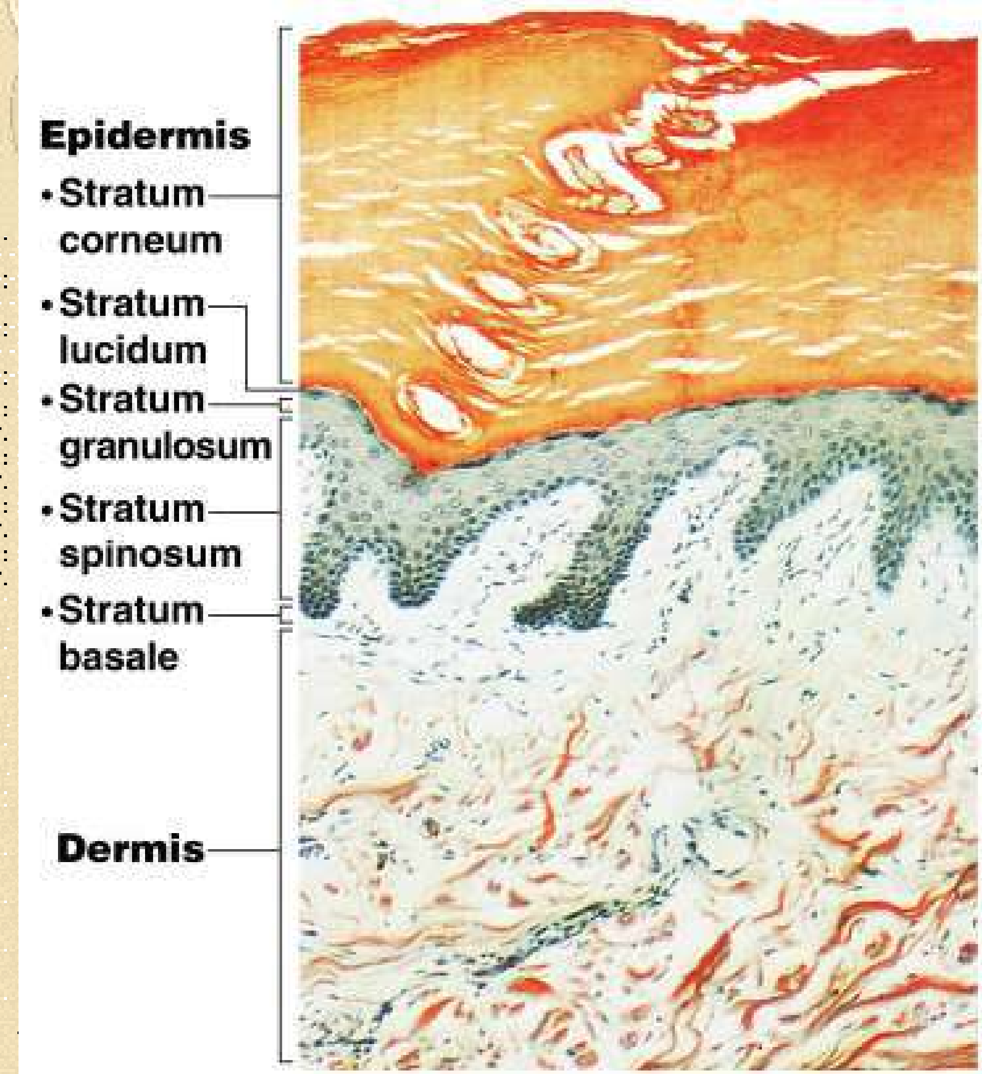


Hair shaft
Pore
Dermal papillae
Epidermis
Papillary layer
Arrector pili muscle
Appendages of the skin:
Sebaceous (oil) gland
Eccrine sweat gland
Dermis
Reticular layer
Hair follicle
Hair root
Hypodermis (subcutaneous tissue)
Adipose (fat) tissue
Nervous structures:
Meissner's corpuscle
Pacinian corpuscle
Sensory nerve fiber
Hair follicle receptor
Cutaneous blood vessels

Skin Structure

- Epidermis — outer layer
  - Stratified squamous epithelium
  - Often keratinized (hardened by keratin)
- Dermis
  - Dense connective tissue
- Subcutaneous tissue
  - hypodermis

Skin Structure

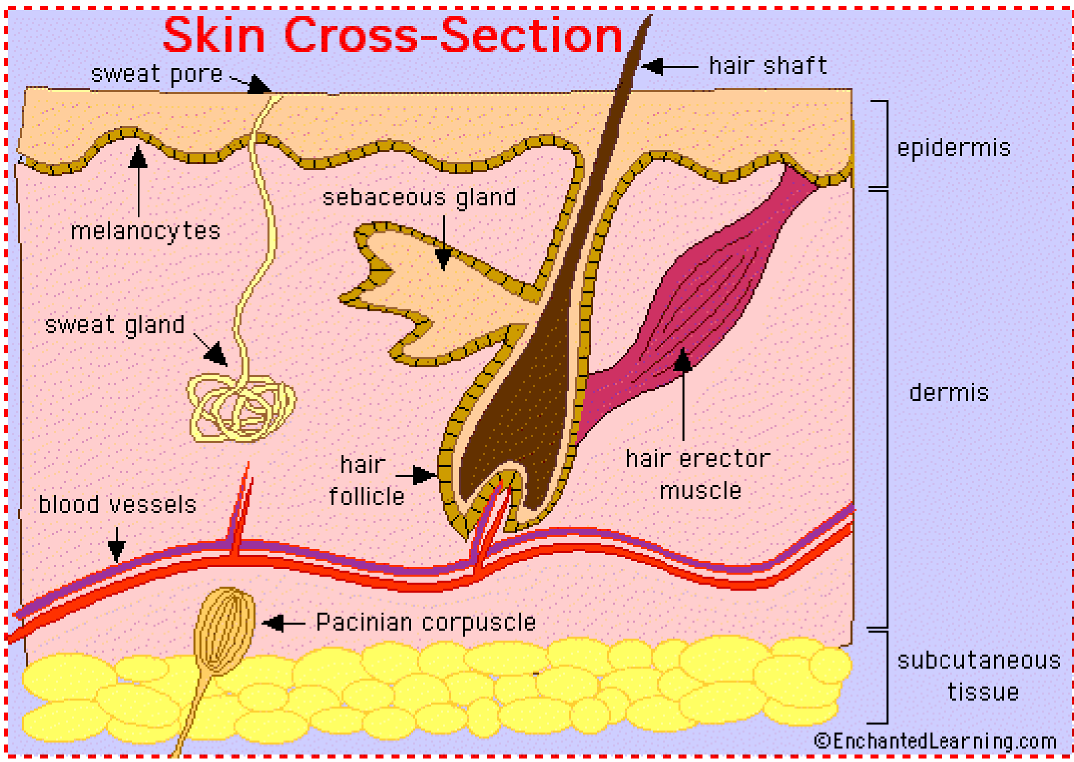


Summary of layers from deepest to most superficial:

Stratum basale
Stratum spinosum
Stratum granulosum
Stratum lucidum
Stratum corneum

Skin Structure

- Subcutaneous tissue (hypodermis) is deep to dermis
  - Not part of the skin
  - Anchors skin to underlying organs, bones and muscles
  - Contains half of the body's fat; acts as padding and insulation.



Layers of the Epidermis

- Stratum basale
  - Deepest layer of epidermis
  - Cells actively undergoing cell division
  - New cells are pushed upward to become the more superficial layers
- Stratum spinosum – intermediate layer
- Stratum granulosum – another layer

Layers of the Epidermis

- Stratum lucidum
  - Formed from dead cells of the deeper layers
  - Occurs only in thick, hairless skin of the palms of hands and soles of feet
- Stratum corneum
  - Outermost layer of epidermis
  - Scale-like dead cells are filled with keratin which is a protective protein preventing water loss from skin

Keratinization

- Cells migrate to the epidermis where eventually they fall off.
- As they move upward, keratin is added.
- The cells in the epidermis contain a lot of keratin which resists damage.
- Distinct layers of cells are called *strata*.

A cell takes ~ 40 – 56 from creation to sloughing off

Melanin

- Pigment (melanin) produced by melanocytes
- Melanocytes are mostly in the stratum basale
- Color is yellow to red to brown to black
- Amount of melanin produced depends upon genetics and exposure to sunlight

Melanin continued….

- Large amounts of melanin occur in some regions like freckles, moles, and nipples.
- Less melanin occurs in the lips, hands, and soles of the feet.
- All races have the same number of melanoctyes! The amount of melanin produced is determined by genetics.

Dermis

- Two layers
  - Papillary layer (upper dermal region)
    - Projections called dermal papillae
      - Some contain capillary loops containing blood
      - Some pain receptors and touch receptors
  - Reticular layer (deepest skin layer)
    - Blood vessels
    - Sweat and oil glands
    - Deep pressure receptors

What causes Normal Skin Color

- Melanin
  - Yellow, brown, or black pigments
- Carotene
  - Orange-yellow pigment from some vegetables
- Hemoglobin
  - Red coloring from blood cells in dermal capillaries
  - Oxygen content determines the extent of red coloring

Dermis

- Overall dermis structure
  - Collagen and elastic fibers located throughout the dermis
    - *Collagen fibers* give skin its toughness
    - *Elastic fibers* give skin elasticity
  - Dermal papillae – extend toward the epidermis and deliver nutrients, remove waste products (sweat = urea and uric acid) and aid in regulating body temperature.

THANK YOU

***Course Description*:**

This course is 16 weeks long with three hours every week.

It is an introduction to the study of the structure and function of the human body. This course (A) introduces the student to the concepts of anatomy and physiology as subjects in the nursing curriculum and begins with how the body is organized from the chemical level to the organismal level.

A description of the various cell and tissue types follows and then the student is introduced to the individual body systems.

Course objectives:

The Anatomy and Physiology (A) is designed to let the student familiar with the basic anatomical structure of the human body.

Students will learn what the various organs of the body do to contribute to the overall physiology of the body as well as the interaction between them.

CHAPTER 1

The Human Body : An Orientation

- Anatomy – the study of the s***tructure*** and ***shape*** of the body and body parts & their ***relationships*** to one another. The term anatomy comes from the Greek words meaning to cut (tomy) apart (ana) .
  - Gross anatomy(macroscopic anatomy) – the study of large, easily observable structures (by naked eye), such as the heart or bone.
  - Microscopic anatomy (cytology, histology) – the study of very small structures, where a magnifying lens or microscope is needed.

- Physiology – the study of how the body and its parts *work or function*

physio =nature , ology = the study of.

- Like anatomy , physiology has many subdivisions. For example, neurophysiology explains the working of the nervous system , and cardiac physiology studies the function of the heart.

Relationship between Anatomy and Physiology

Anatomy and Physiology are always related . Structure determines what functions can take place. For example, the lungs are not muscular chambers like the heart and can not pump blood, but because the walls of lungs are very thin, they can exchange gasses and provide oxygen to the body.

Levels of Structural Organization

The human body exhibits 6 levels of structural complexity :

1- Chemical level , the simplest level of structural ladder .At this level atoms combine to form molecules such as water, sugar, & proteins

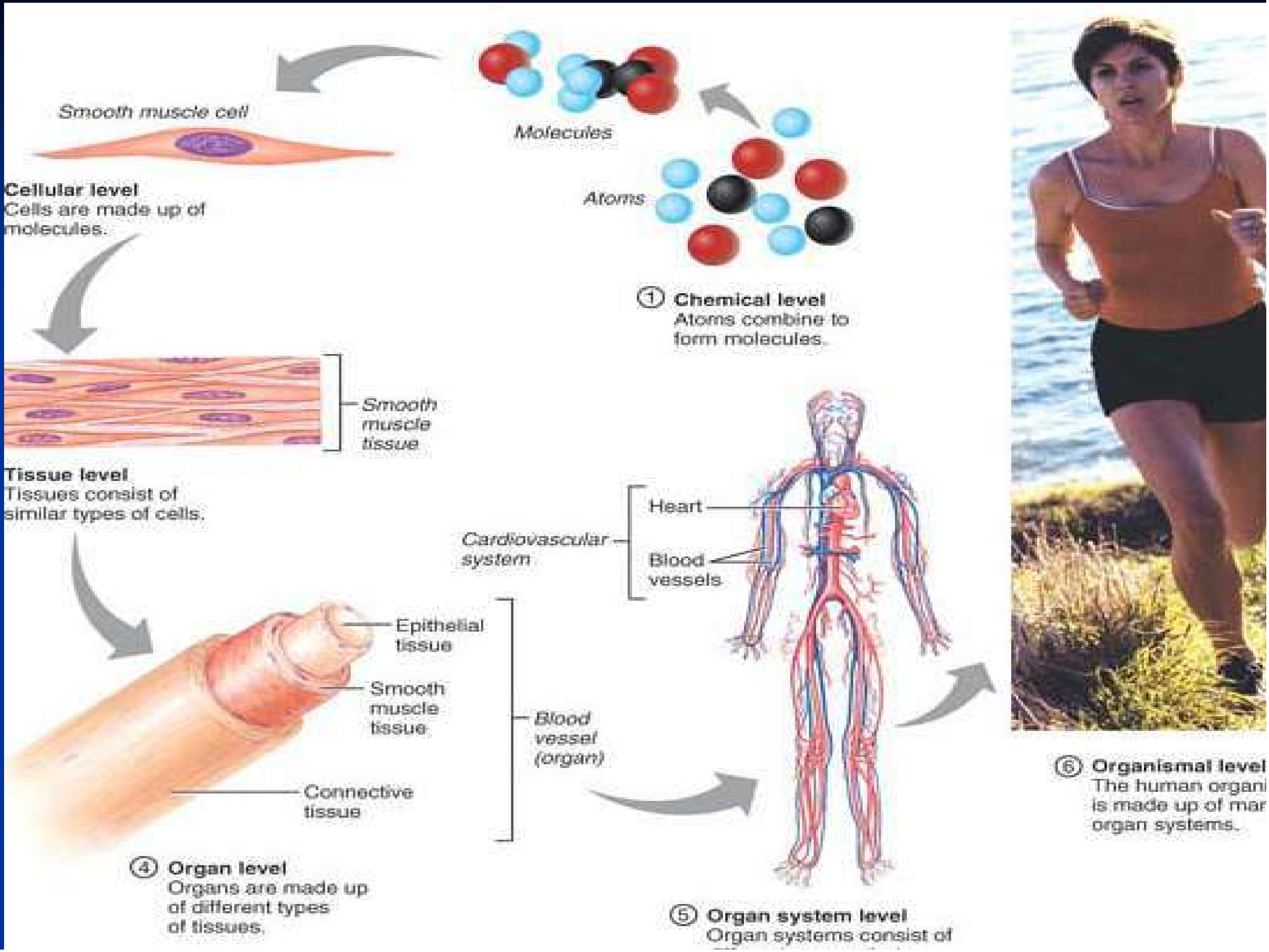
2- Cellular level the smallest units of living things .

3- Tissue level , groups of similar cells that have a common function (4 basic types)

4- Organ level, an organ is a structure composed of 2 or more tissue types that performs a specific function .

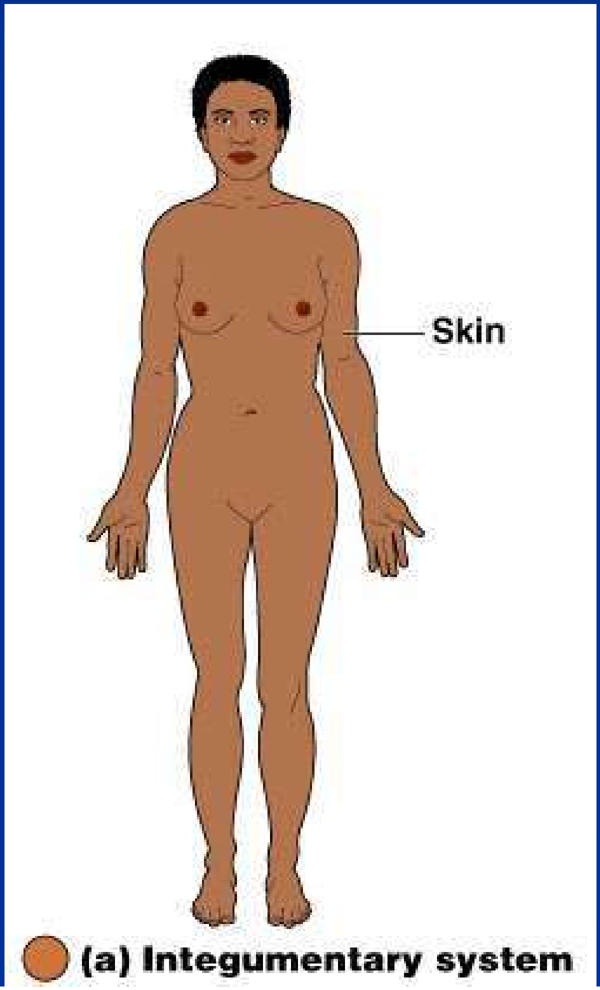
5- Organ System is a group of organs that work together to accomplish a common purpose (each organ has its own job to do)

6- Organismal level , represents the highest level of structural organization(total of 11 organ systems)



Smooth muscle cell
Molecules
Atoms
Cellular level
Cells are made up of molecules.
① Chemical level
Atoms combine to form molecules.
Smooth muscle tissue
Tissue level
Tissues consist of similar types of cells.
Heart
Cardiovascular system
Blood vessels
Epithelial tissue
Smooth muscle tissue
Blood vessel (organ)
Connective tissue
④ Organ level
Organs are made up of different types of tissues.
⑤ Organ system level
Organ systems consist of
⑥ Organismal level
The human organi
is made up of mar
organ systems.

Body systems: The human body has 11 systems
1-INTEGUMENTARY



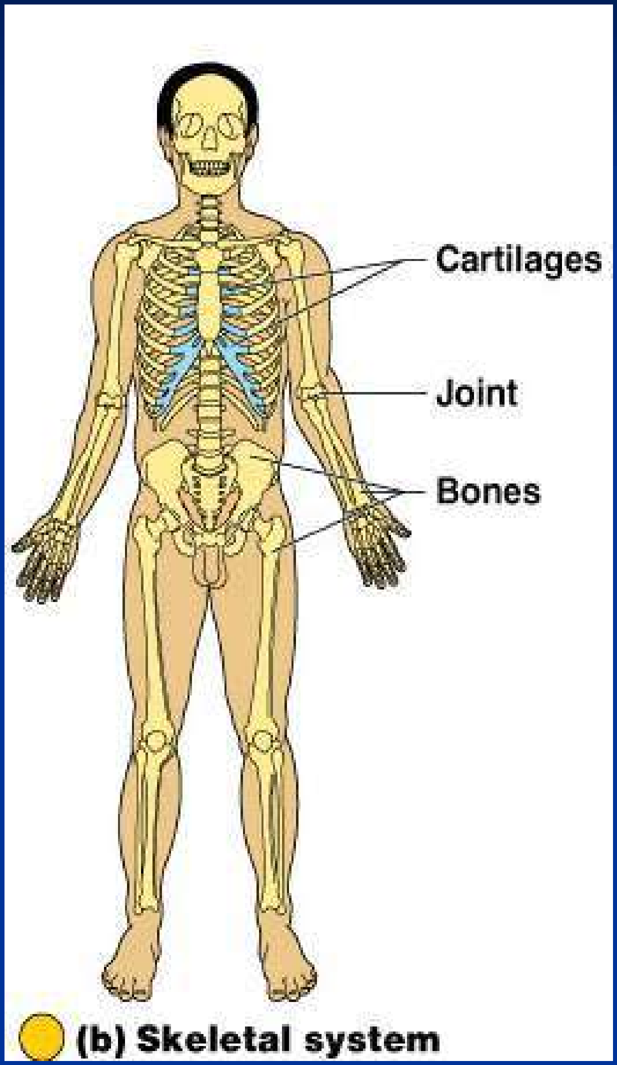
ORGANS

- Skin

FUNCTIONS

- Waterproofs, cushions, protects deeper tissue
- Excretes salts & urea; pain, pressure
- Regulates body temp; synthesize vitamin D

2-SKELETAL



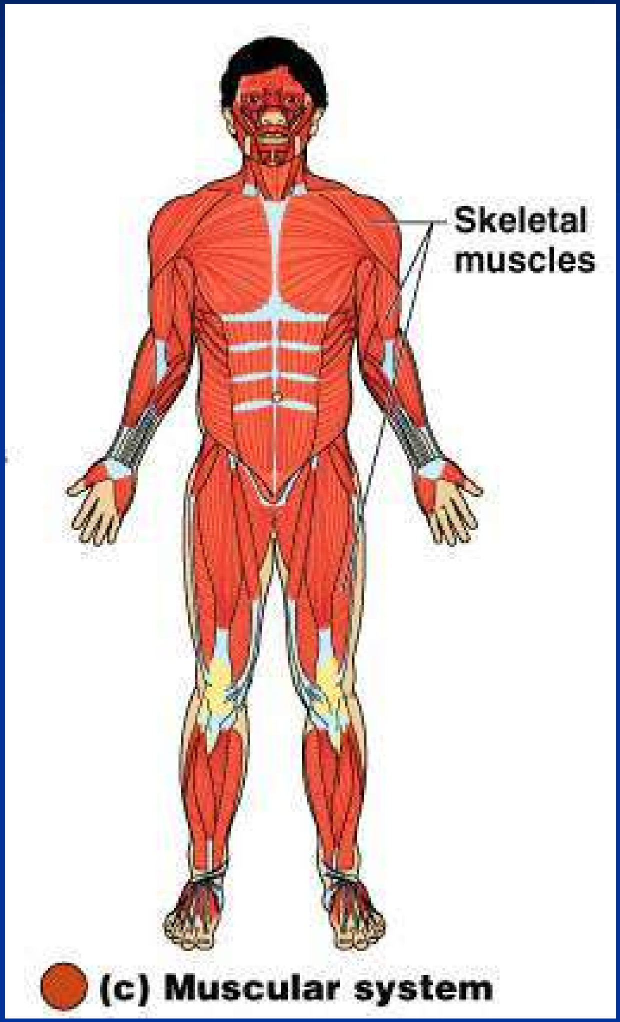
ORGANS

- Bones, cartilages, ligaments, joints

FUNCTIONS

- Protects & supports body organs
- Framework for muscles & movement
- Hematopoiesis; store minerals

3- MUSCULAR



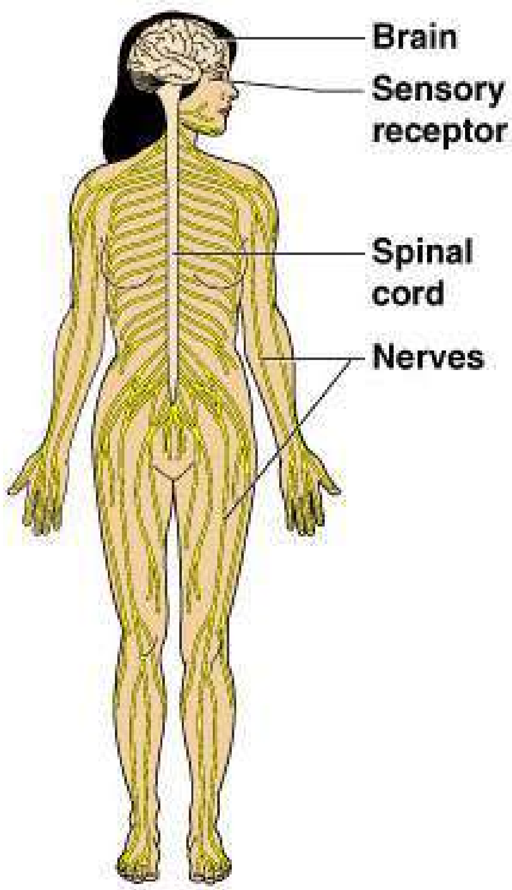
ORGANS

- Skeletal muscle (attached to bone)

FUNCTIONS

- Contraction & mobility (locomotion)
- Facial expression, posture
- Produce body heat

4- NERVOUS



(d) Nervous system

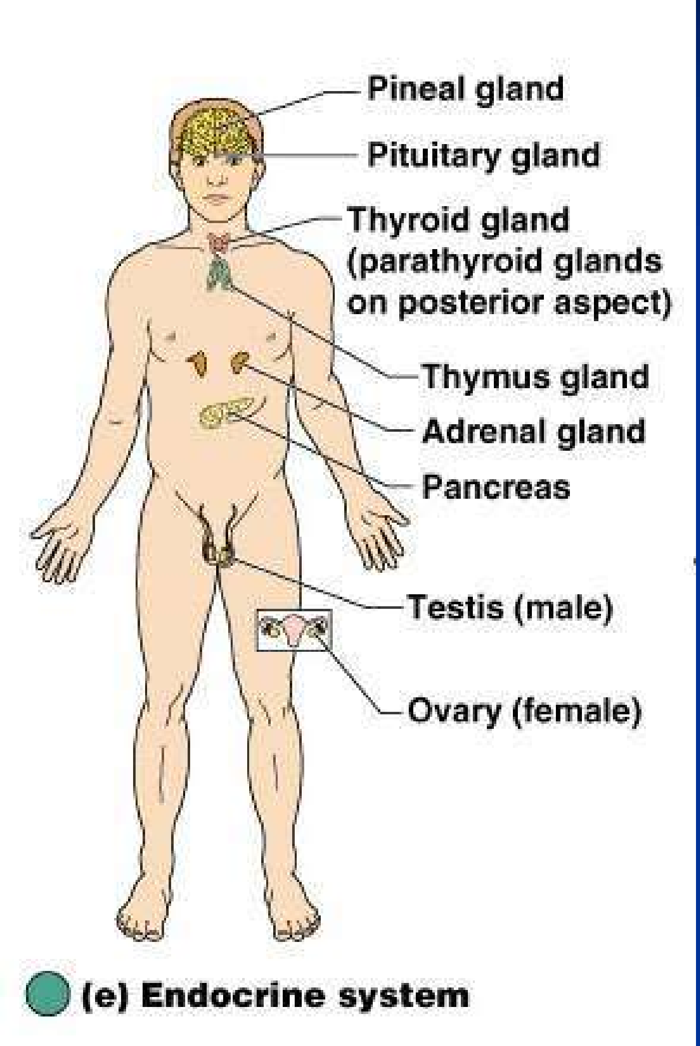
ORGANS

- Brain, spinal cord, nerves, & sensory receptors

FUNCTIONS

- Fast-acting central control system
- Responds to external/internal stimuli via nerve impulses (electrical messages)

5- ENDOCRINE



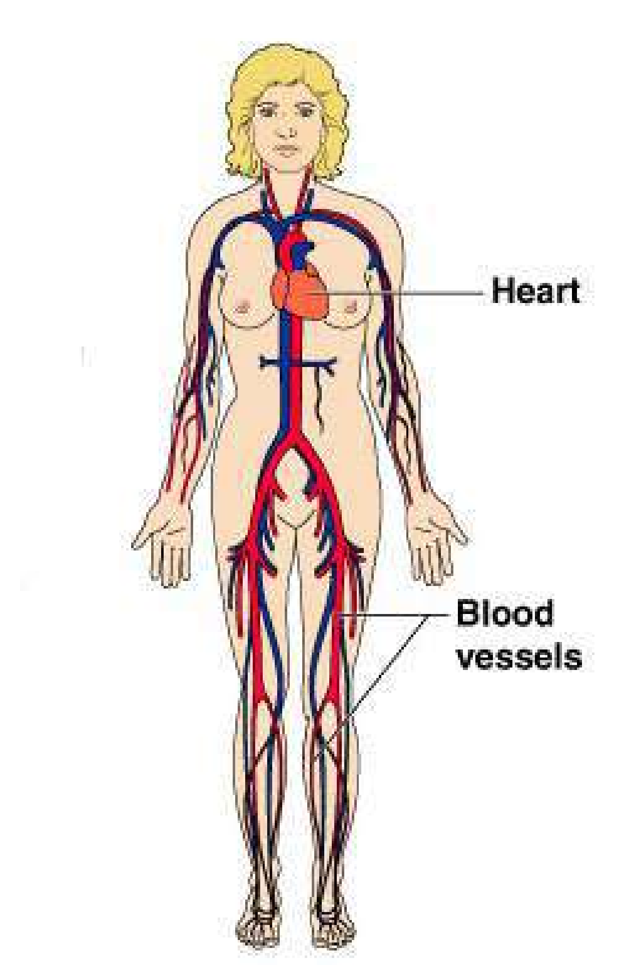
ORGANS

- Pituitary, thyroid, parathyroids, adrenals, thymus, pancreas, pineal, ovaries, testes…..etc.

FUNCTIONS

- Slow -acting control system
- Glands produce hormones that regulate growth, reproduction, metabolism,…. etc.

6- Circulatory



(f) Cardiovascular system

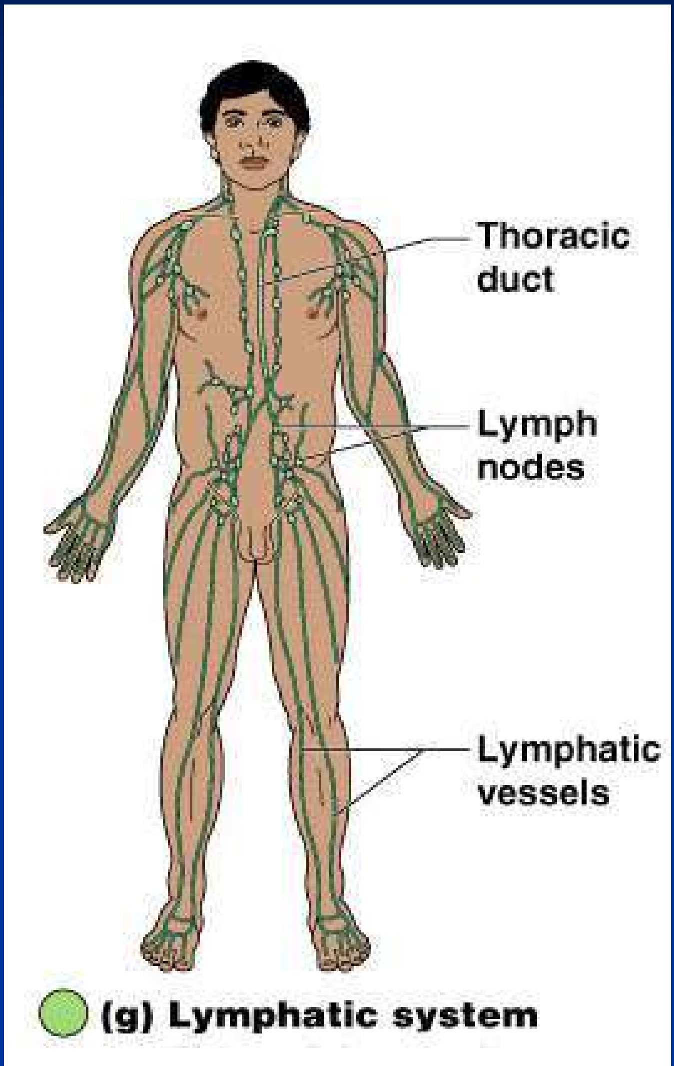
ORGANS

- Heart, blood vessels, capillaries &blood

FUNCTIONS

- Carries O_2 nutrients, hormones, & other substances to and from tissue cells
- White blood cells protect against bacteria, toxins, tumors

7- LYMPHATIC



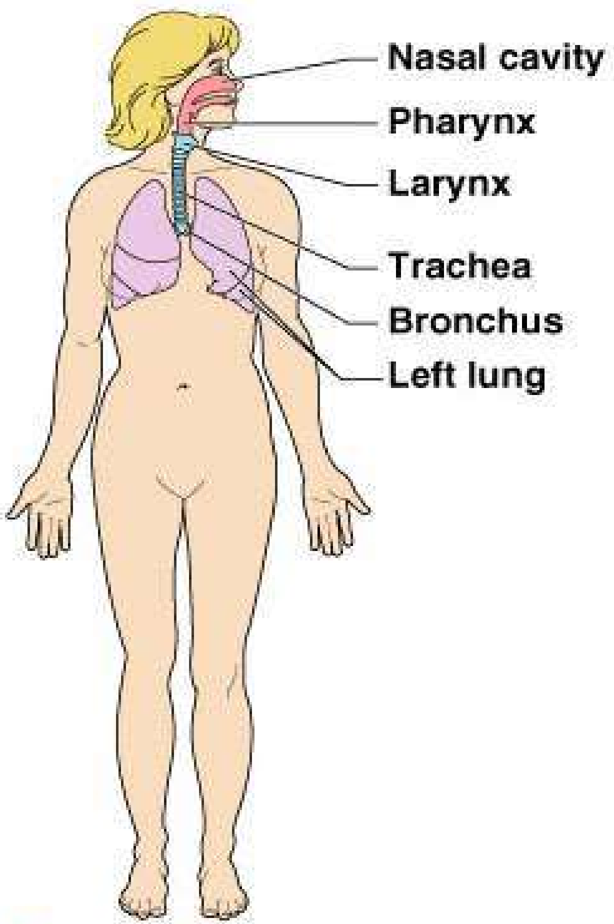
ORGANS

- Lymphatic vessels, lymph nodes, spleen, tonsils

FUNCTIONS

- Complements circulatory system by returning leaked fluid back to blood vessels
- Cleanses the blood; involved in immunity

8- RESPIRATORY



(h) Respiratory system

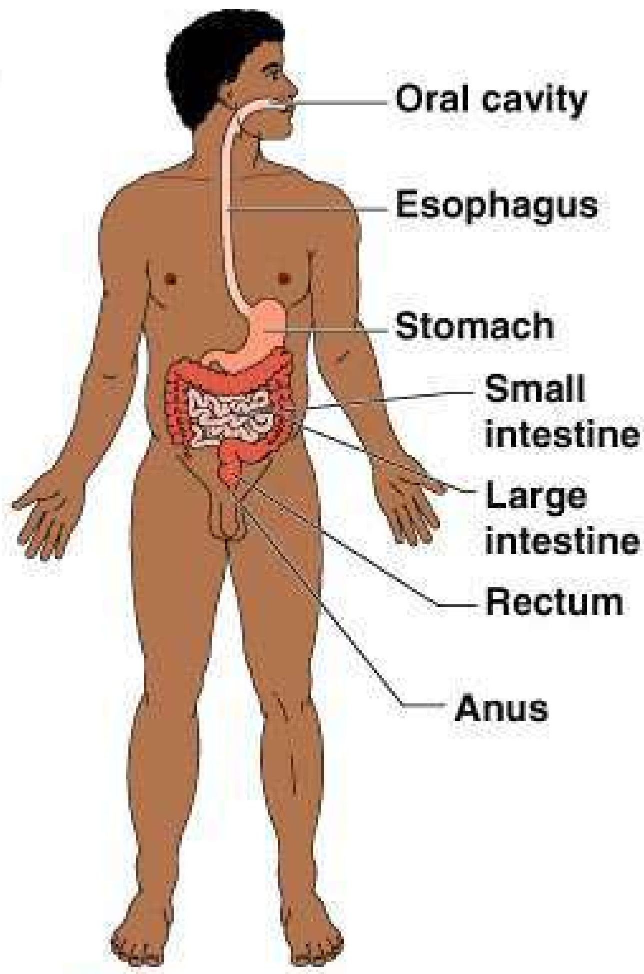
ORGANS

- Nasal cavity, pharynx, larynx, trachea, bronchi, & lungs

FUNCTIONS

- Keeps blood supplied with O_2 & removes CO_2
- Carries out gas exchanges through air sacs in lungs

9- DIGESTIVE



(i) Digestive system

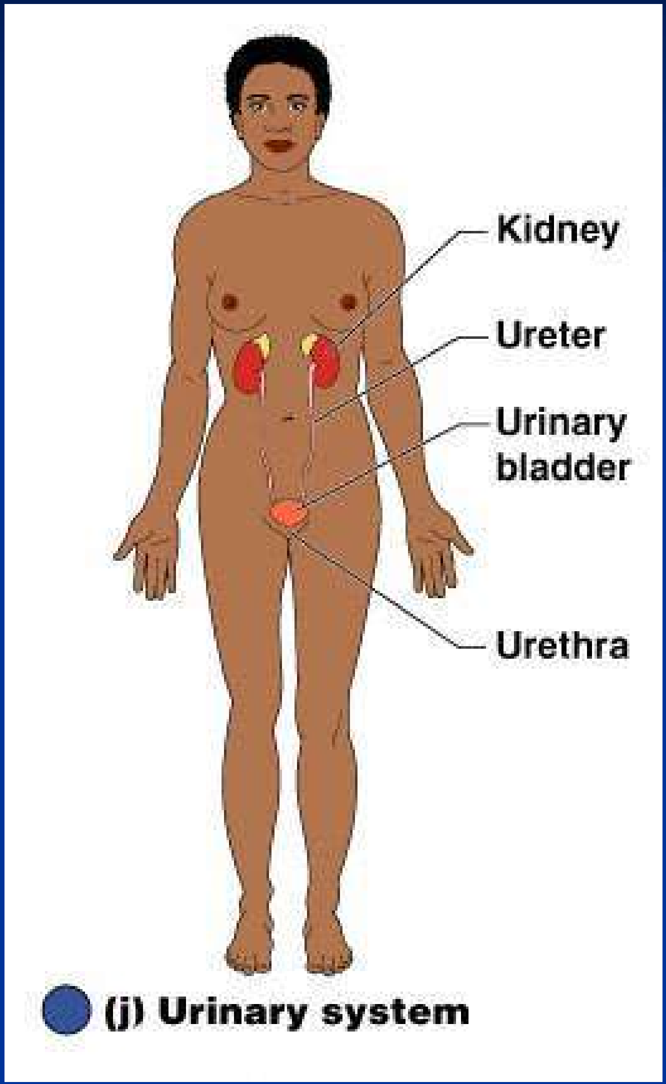
ORGANS

- Oral cavity, esophagus, stomach, small intestine, large intestine, rectum, anus (liver & pancreas)

FUNCTIONS

- Breaks food down into absorbable units that enter the blood; indigestible food eliminated as feces

10- URINARY (EXCRETORY)



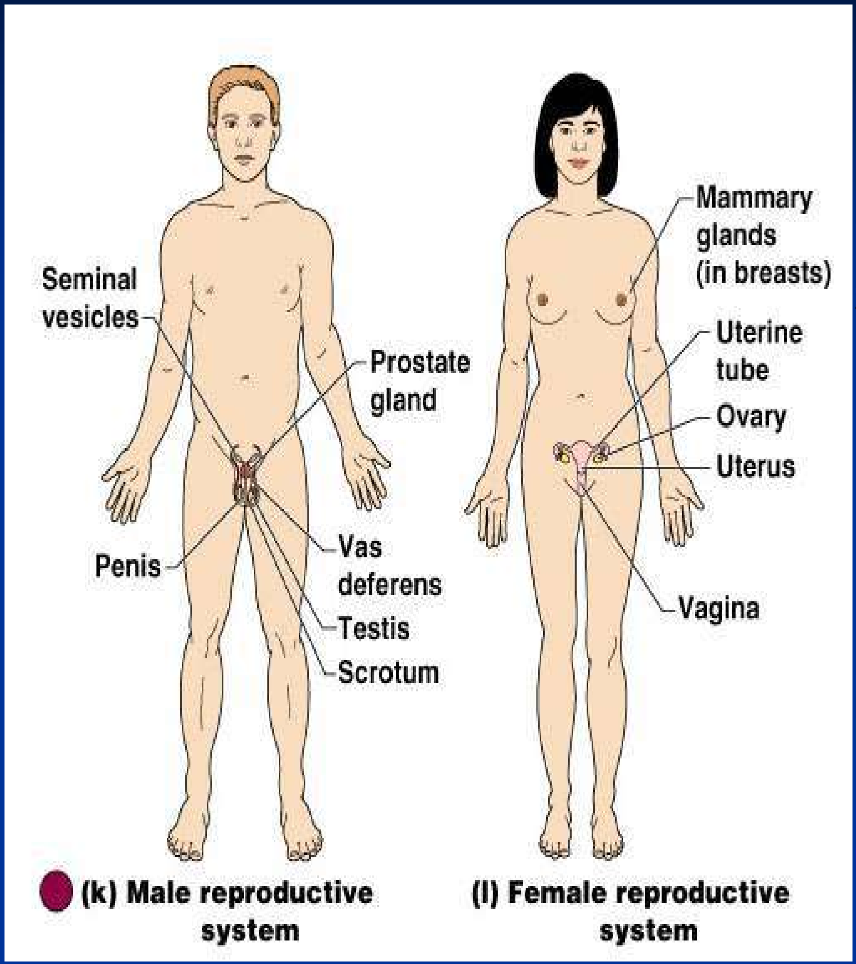
ORGANS

- Kidney, ureter, urinary bladder, urethra

FUNCTIONS

- Eliminates nitrogenous waste from the body (urea & uric acid)
- Regulates water, electrolytes, & acid-base balance of the blood

11- REPRODUCTIVE



ORGANS

- Male
  - Seminal vesicles, prostate, penis, vas deferens, testis, scrotum
- Female
  - Ovaries, mammary glands, uterus, vagina, uterine tube

FUNCTIONS

- Primary function for both sexes is to produce offspring
- Male – testes produce sperm & male sex hormones
- Female – ovaries produce eggs & female sex hormones; mammary glands for nourishment

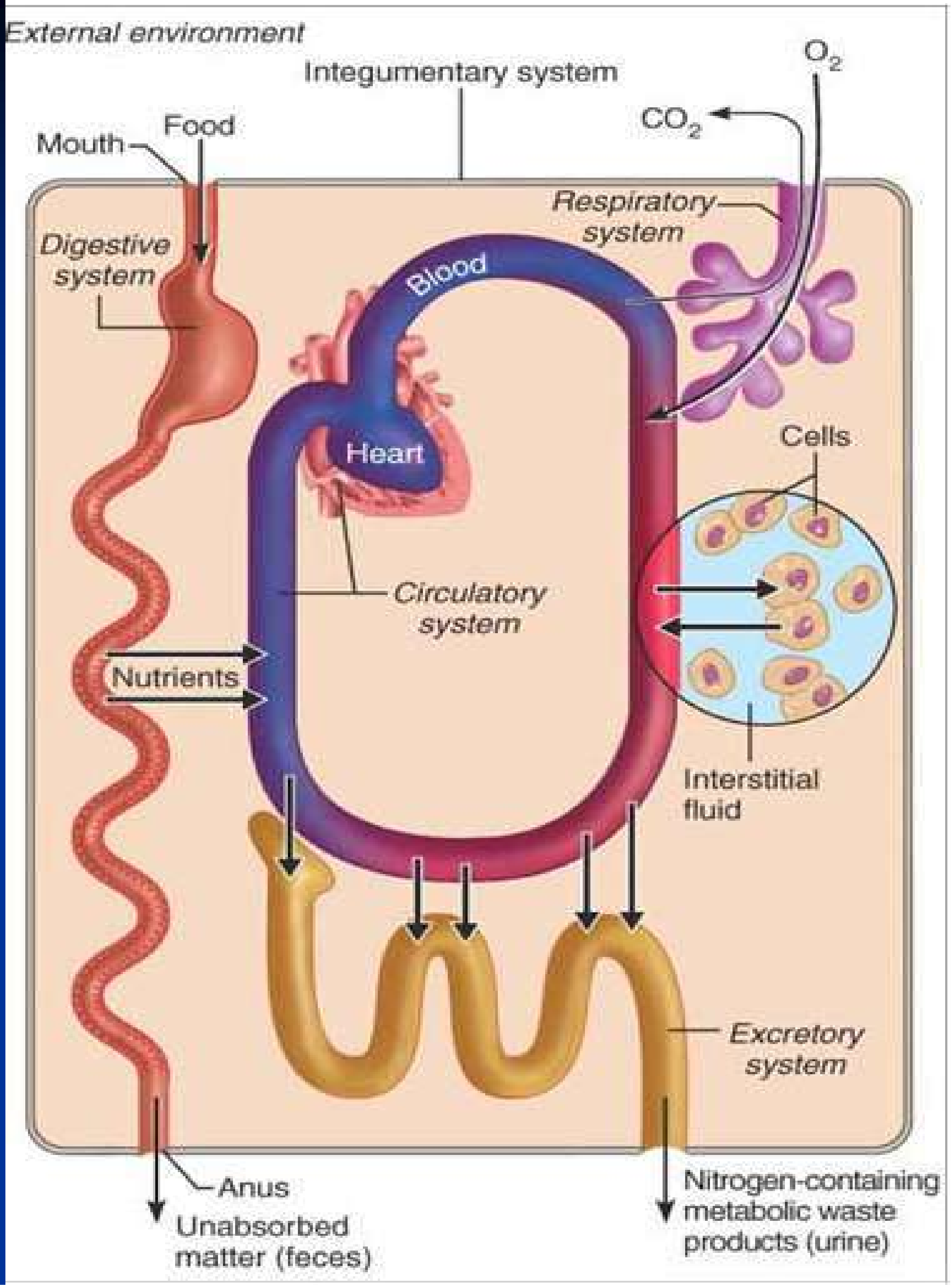


FIGURE 1.2 **Examples of interrelationships among body organ systems.** The integumentary system protects the body as a whole from the external environment. The digestive and respiratory systems, in contact with the external environment, take in nutrients and oxygen, respectively, which are then distributed by the blood to all body cells. Elimination of metabolic wastes is accomplished by the urinary and respiratory systems.

Maintaining Life

I-Necessary Life Functions : All living organisms carry out certain vital functional activities necessary for life, including :

1-Maintenance of boundaries: Every living organism must maintain its inside distinct from outside.

-All the cells are surrounded by a selectively permeable membrane.

-The body as a whole is enclosed and protected by the integumentary system, or skin, which protects our internal organs from drying out, bacteria, heat, sunlight, and chemicals .

2-Movement :

-It includes the activities promoted by the muscular system , the skeletal system provides the bony framework that the muscles pull on as they work.

-Movement also occurs when substances such as blood, foodstuffs, and urine are propelled through internal organs .

- On the cellular level, the muscle cell's ability to move by shortening is more precisely called **contractility.**

3- Responsiveness or **irritability,** is the ability to sense changes (stimuli) in the environment and then respond to them.

-you involuntarily pull your hand away from the painful stimulus .

-When carbon dioxide in your blood rises to dangerously high levels, your breathing rate speeds up.

Because nerve cells are highly irritable and communicate rapidly with each other via electrical impulses, the nervous system is most involved with responsiveness. However, all body cells are irritable to some extent.

4-Digestion :is the breaking down of ingested foodstuffs to simple molecules that can be absorbed into the blood. The nutrient-rich blood is then distributed to all body cells by the cardiovascular system.

In a simple, one-celled organism such as an **amoeba**, the cell itself is the "digestion factory," but in the multicellular human body, the digestive system performs this function for the entire body.

5- **Metabolism** is a broad term that includes all chemical reactions that occur within body cells. It includes breaking down substances into their simpler building blocks (**catabolism**), synthesizing more complex cellular structures from simpler substances (**anabolism**), and using nutrients and oxygen to produce (via **cellular respiration**) ATP, that power cellular activities.

Metabolism depends on the digestive and respiratory systems to make nutrients and oxygen available to be distributed throughout the body. Metabolism is regulated largely by hormones secreted by endocrine system glands.

6- **Excretion** is the process of removing excreta (ek-skre'tah), or wastes, from the body.

– The digestive system rids the body of indigestible food residues in feces.

-The urinary system disposes of nitrogen-containing metabolic wastes, such as urea, in urine.

- Carbon dioxide, a by-product of cellular respiration, is carried in the blood to the lungs, where it leaves the body in exhaled air.

7- **Reproduction** : is making a whole new person which is the major task of the reproductive system.

- When a **sperm** unites with an **egg**, a fertilized egg forms, which then develops into a baby within the mother's body.
- The reproductive system is regulated by hormones of the endocrine system.
- Because males produce sperm and females produce eggs (ova), there is a division of labor in the reproductive process, and the reproductive organs of males and females are different .
- The female's reproductive structures provide the site for fertilization of eggs by sperm, then protect and nurture the developing fetus until birth.

8- **Growth** is an increase in size of a body part or the organism. It is usually accomplished by increasing the **number** of cells. However, individual cells also increase in size when not dividing. For true growth to occur, **constructive** activities must occur at a faster rate than **destructive** ones

II.Survival Needs

Survival needs include:

1-nutrients

Nutrients, taken in via the diet, contain the chemical substances used for energy and cell building.

-**Carbohydrates** are the major energy fuel for body cells.

-**Proteins**, and to a lesser extent fats, are essential for building cell structures.

- **Fats** also provide a reserve of energy-rich fuel.

- **Selected minerals and vitamins** are required for the chemical reactions that go on in cells and for oxygen transport in the blood. The mineral calcium helps to make bones hard and is required for blood clotting.

2- **Oxygen** : All the nutrients in the world are useless unless oxygen is also available. Because the chemical reactions that release energy from foods are oxidative reactions that require oxygen, human cells can survive for only a few minutes without oxygen. Approximately 20% of the air we breathe is oxygen. It is made available to the blood and body cells by the cooperative efforts of the respiratory and cardiovascular systems.

3- Water accounts for 60–80% of body weight and *is the single most abundant chemical substance in the body*. It provides the watery environment necessary for chemical reactions and the fluid base for body secretions and excretions. Water is obtained chiefly from ingested foods or liquids and is lost from the body by evaporation from the lungs and skin and in body excretions.

4- If chemical reactions are to continue at life-sustaining rates, **normal body temperature** must be maintained. As body temperature drops below 37°C (98.6°F), metabolic reactions become slower and slower, and finally stop. When body temperature is too high, body proteins lose their characteristic shape and stop functioning. At either extreme, death occurs. *Most body heat is generated by the activity of the muscular system*.

5- **Atmospheric pressure** is the force that air exerts on the surface of the body. Breathing and gas exchange in the lungs depend on appropriate atmospheric pressure. At high altitudes, where atmospheric pressure is lower and the air is thin, gas exchange may be inadequate to support cellular metabolism.

Notice :*The mere presence of these survival factors is not sufficient to sustain life. They must be present in appropriate amounts; excesses and deficits may be equally harmful. For example, the food we eat must be of high quality and in proper amounts; otherwise, nutritional disease, obesity, or starvation is likely.*

Homeostasis

- Describes the body's ability to maintain relatively stable internal conditions even though the outside world is continuously changing
- The literal translation of homeostasis is "unchanging,"(homeo= the same, stasis = standing still which is not true).

The term does not really mean a static, or unchanging, state. Rather, it indicates a dynamic state of equilibrium, or a balance, in which internal conditions vary, but always within relatively narrow limits. *In general, the body is in homeostasis when its needs are adequately met and it is functioning smoothly.*

Homeostatic Control Mechanisms

Communication within the body is essential for homeostasis.

Communication is accomplished chiefly by the *nervous* and *endocrine systems*, which use neural electrical impulses or blood borne hormones, respectively, as information carriers.

Regardless of the factor being regulated(the variable)all homeostatic control mechanisms have *at least three* interdependent components

.

The **first** component, the ***receptor,*** is some type of sensor that monitors the environment and responds to changes, called *stimuli*, by sending information (input) to the **second** component, the ***control center***. Input flows from the receptor to the control center along the so-called **afferent** pathway. The **control center,** analyzes the input it receives and then determines the appropriate response or course of action.

The **third** component, the ***effector*,** provides the means of response (output) to the stimulus. Information flows from the control center to the effector along the **efferent** pathway. The results of the response then *feed back* to influence the stimulus, either depressing it (negative feedback) so that the whole control mechanism is shut off or enhancing it (positive feedback) so that the reaction continues at an even faster rate.

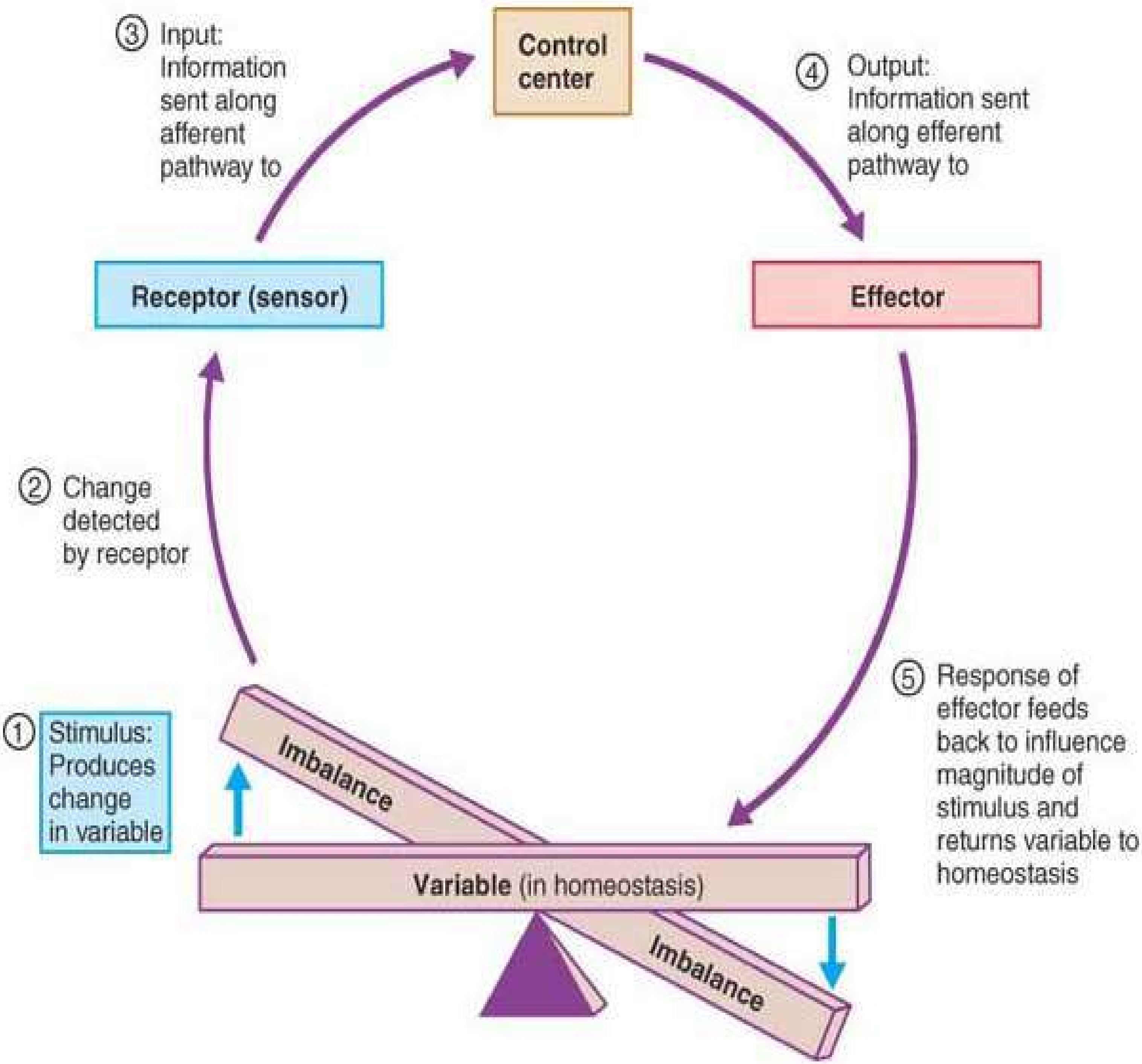


FIGURE 1.4 **The elements of a homeostatic control system.** Communication between the receptor, control center, and effector is essential for normal operation of the control system.

- Homeostatic control mechanisms are TWO:
  - Negative feedback mechanisms – the net effect of the response to the stimulus is the shut off of the original stimulus or to reduce its intensity
    - E.g. – body temp, blood chemical levels
  - Positive feedback mechanisms – tend to increase the original disturbance (stimulus) and push the variable farther from its original value
    - E.g. – ovulation, blood clotting, birth

Negative Feedback Mechanisms

Most homeostatic control mechanisms are **negative feedback mechanisms.** In these systems, the output shuts off the original stimulus or *reduces its intensity*. These mechanisms cause the variable to change in a direction opposite to that of the initial change, returning it to its "ideal" value; thus the name "negative" feedback mechanisms.

A good example of a nonbiological negative feedback system is a home heating system connected to a temperature-sensing thermostat . If the thermostat is set at 20°C (68°F), the heating system (effector) is triggered ON when the house temperature drops below that setting. As the furnace produces heat and warms the air, the temperature rises, and when it reaches 20°C or slightly higher, the thermostat triggers the furnace OFF.

This process results in a cycling of "furnace-ON" and "furnace-OFF" so that the temperature in the house stays very near the desired temperature of 20°C. Your body "thermostat," located in a part of your brain called the *hypothalamus*, operates in a similar fashion.

Positive Feedback Mechanisms

In positive feedback mechanisms, the result or response enhances the original stimulus so that the activity (output) is *accelerated*.

This feedback mechanism is "positive" because the change that occurs proceeds in the same direction as the initial disturbance, causing the variable to deviate further and further from its original value or range.

In contrast to negative feedback controls, which maintain *many* physiological functions or keep blood chemicals within narrow ranges, positive feedback mechanisms usually control *infrequent* events that do not require continuous adjustments. However, **TWO** familiar examples of their use as homeostatic mechanisms are the enhancement of *labor contractions during birth* **and** *blood clotting*.

The body's ability to regulate its internal environment is fundamental, and all negative feedback mechanisms have the same goal: preventing sudden severe changes within the body. Body temperature and blood volume are only two of the variables that need to be regulated. *There are hundreds!* Other negative feedback mechanisms regulate heart rate, blood pressure, the rate and depth of breathing, and blood levels of oxygen, carbon dioxide, and minerals.

Homeostatic Imbalance

Homeostasis is so important that **most disease** can be regarded **as a result of its disturbance**, a condition called ***homeostatic imbalance***. As we age, our body's control systems become less efficient, and our internal environment becomes less and less stable. These events increase our risk for illness and produce the changes we associate with aging.

Examples of homeostatic imbalance are provided throughout this course to enhance understanding of normal physiological mechanisms.

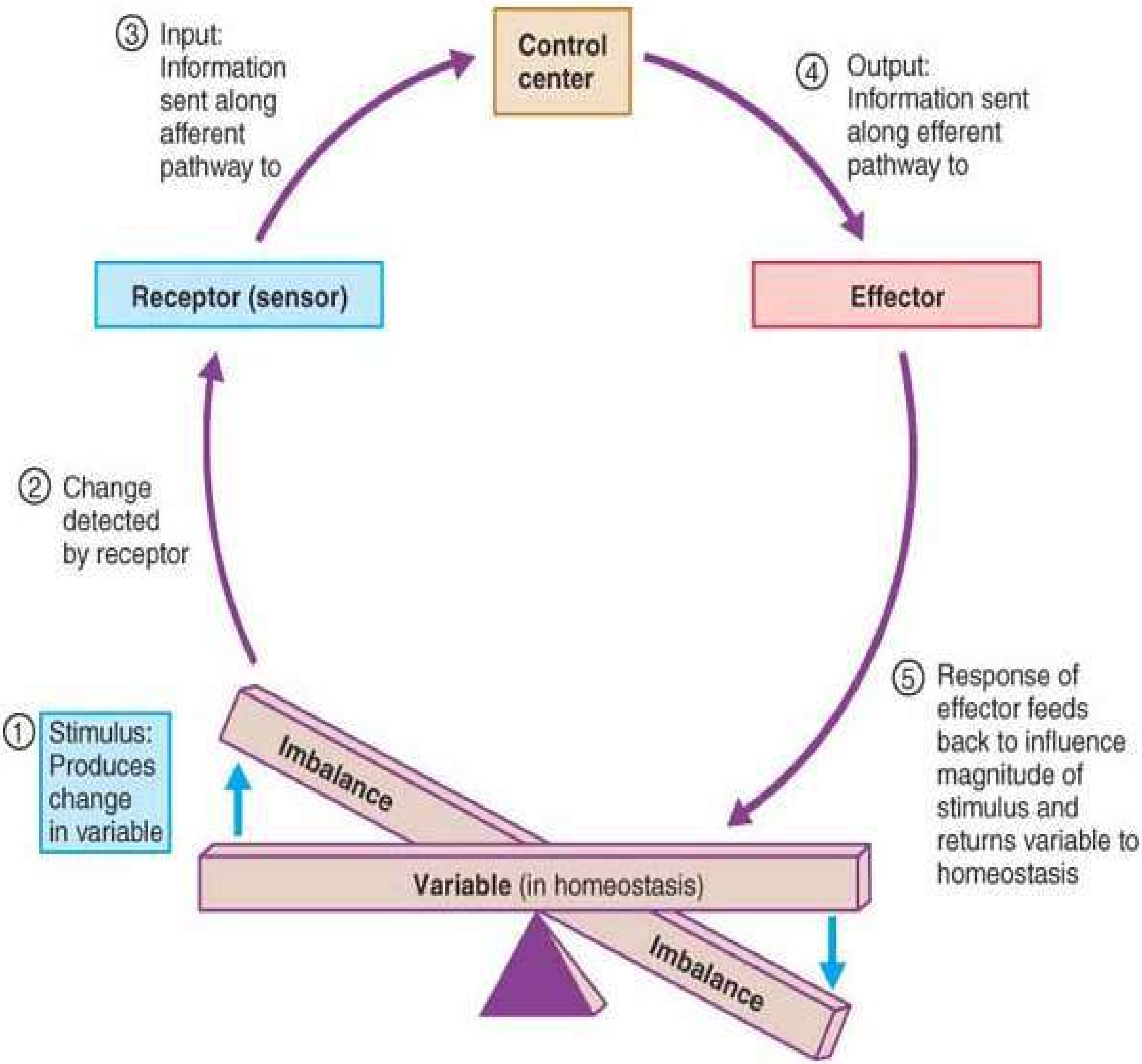


FIGURE 1.4 **The elements of a homeostatic control system.** Communication between the receptor, control center, and effector is essential for normal operation of the control system.

The Language of Anatomy

Anatomical Position

- Standing erect
- Feet parallel
- Arms hanging at the sides
- Palms facing forward

Anatomical position – body is erect with the feet parallel and the arms hanging at the sides with the palms facing forward. (It's important to note throughout this course, most terminology refers to this position regardless of the position the body happens to be in at the time)

Directional terms

- Superior (cranial or cephalad) – toward the head end or upper part of a structure or body; above
- Inferior (caudal) – away from the head end or toward the lower part of a structure or body; below
- Anterior (ventral) – toward or at the front of the body; in front of
- Posterior (dorsal) – toward or at the backside of the body; behind
- Medial – toward or at the midline of the body; on the inner side of
- Lateral – away from the midline of the body; on the outer side of

- Proximal – close to the origin of the body part or the point of attachment of a limb to the body trunk.
- Distal – farther from the origin of a body or the point of attachment of a limb to the body trunk.
- Superficial (external) – toward or at the body surface.
- Deep (internal) – away from the body surface; more internal.

Examples:

- The navel is inferior to the breastbone
- The heart is posterior to the breastbone
- The arms are lateral to the chest
- The elbow is proximal to the wrist
- The skin is superficial to the skeleton
- The forehead is superior to the nose
- The breastbone is anterior to the spine
- The heart is medial to the arm
- The armpit is intermediate between the breastbone and the shoulder
- The knee is distal to the thigh
- The lungs are deep to the rib cage

1. The navel is --------------to the breastbone
2. The heart is ------------- to the breastbone
3. The arms are ------------- to the chest
4. The elbow is ------------- to the wrist
5. The skin is ------------- to the skeleton
6. The forehead is ------------------- to the nose
7. The breastbone is------------- to the spine
8. The heart is ------------to the arm
9. The armpit is ---------between the breastbone and the shoulder
10. The knee is ---------to the thigh
11. The lungs are ---------to the rib cage

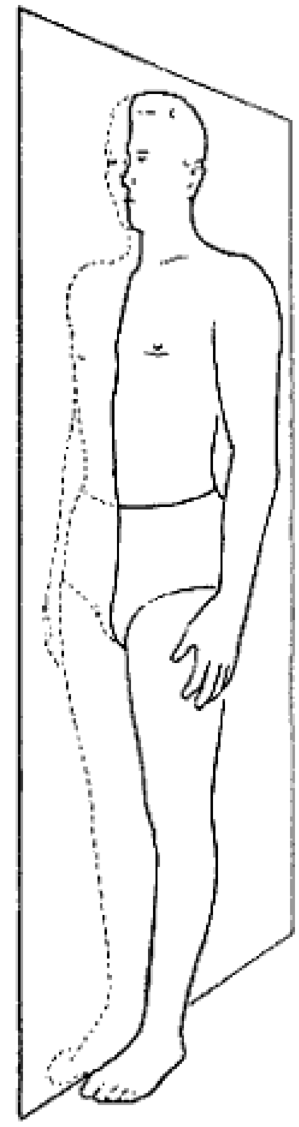
Body planes and sections

A section is a cut made along a plane

- Sagittal – cut made along the lengthwise or longitudinal plane of the body dividing it into left and right parts
- Midsagittal (median) plane – right and left parts are of equal size
- Frontal (coronal) plane – cut made along a lengthwise plane that divides the body into anterior and posterior parts
- Transverse plane (cross section) – cut made along a horizontal plane dividing the body or organ into superior and inferior parts

Planes

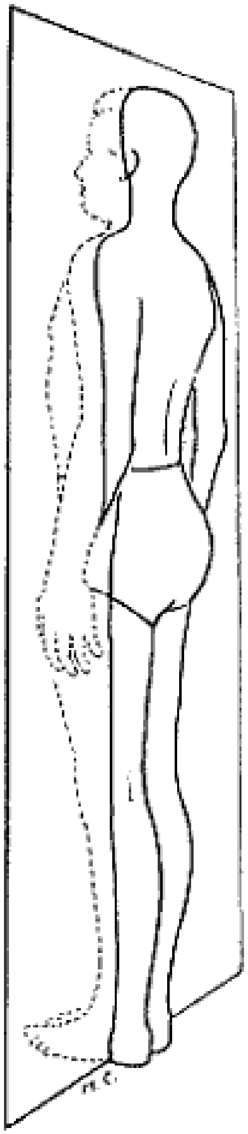
- Sagittal Plane – divides body into right and left parts.
- Midsagittal =median plane –divides body into two equal halves.



Sagittal/Anteroposterior Plane

Planes

- Frontal = coronal plane – divides body into anterior and posterior parts

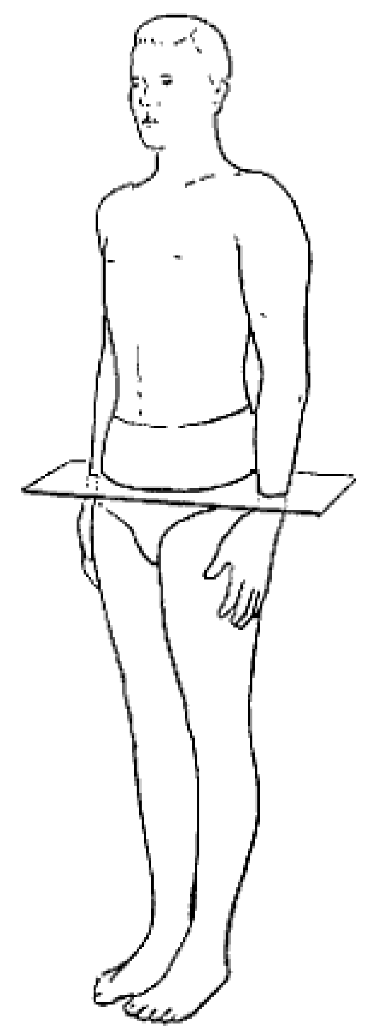


Frontal/Lateral Plane

Planes

- Transverse plane = cross

Section= horizontal section divides into upper and lower parts



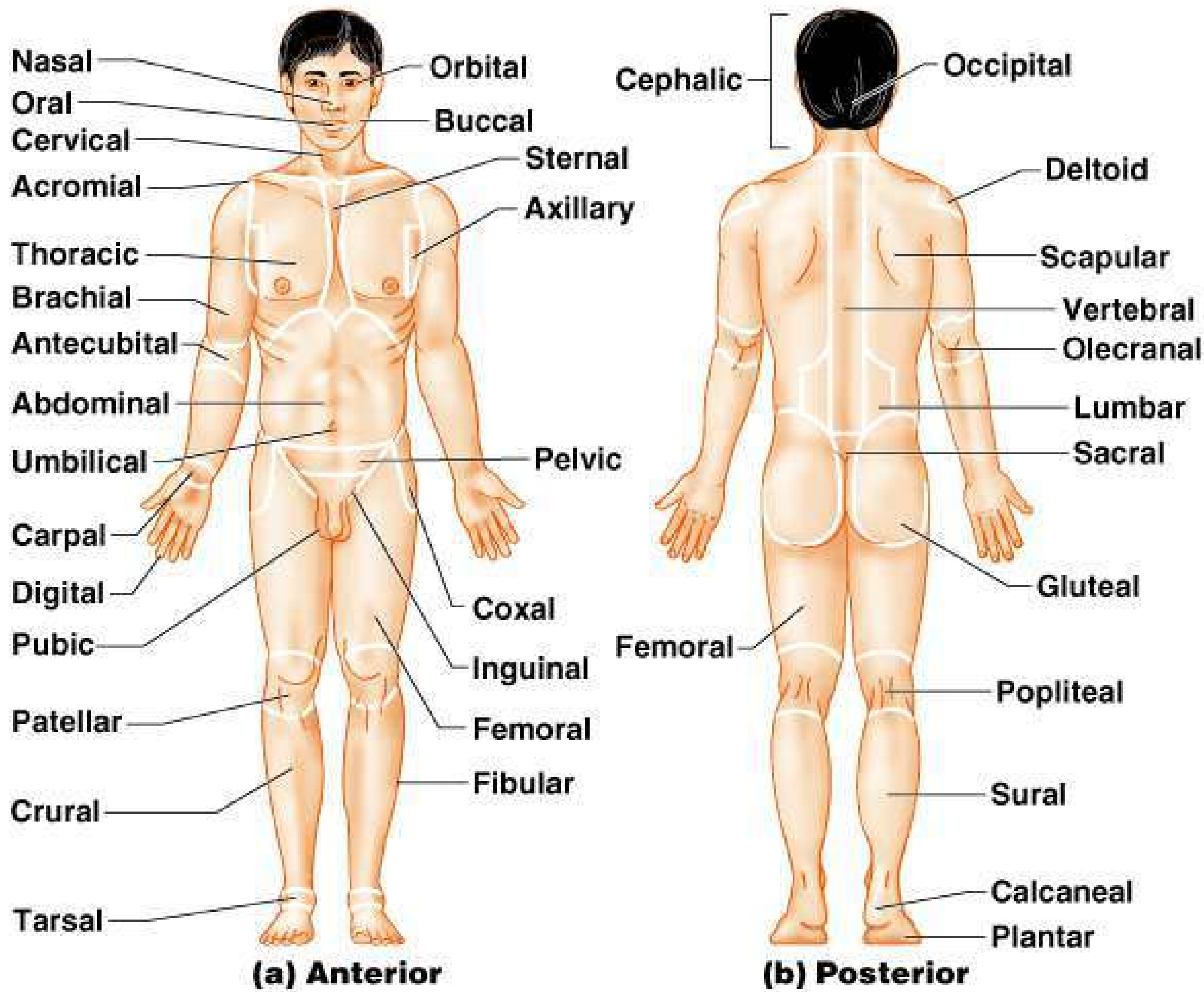
Horizontal/Transverse Plane

Regional terms

There are many visible landmarks on the surface of the body:

- Anterior body landmarks

- Posterior body landmarks


Nasal
Oral
Cervical
Acromial
Thoracic
Brachial
Antecubital
Abdominal
Umbilical
Carpal
Digital
Pubic
Patellar
Crural
Tarsal
Orbital
Buccal
Sternal
Axillary
Pelvic
Coxal
Inguinal
Femoral
Fibular
(a) Anterior
Cephalic
Occipital
Deltoid
Scapular
Vertebral
Olecranal
Lumbar
Sacral
Gluteal
Femoral
Popliteal
Sural
Calcaneal
Plantar
(b) Posterior

Body Cavities

There are two sets of internal body cavities called the **dorsal** and **ventral** body cavities. These cavities are **closed** to the outside.

1-Dorsal Body Cavity

Which protects the fragile nervous system organs has two subdivisions. The **cranial** cavity, in the skull, encases the brain. The **vertebral, or spinal,** cavity, which runs within the bony vertebral column, encloses the delicate spinal cord. The cranial and spinal cavities are continuous with one another

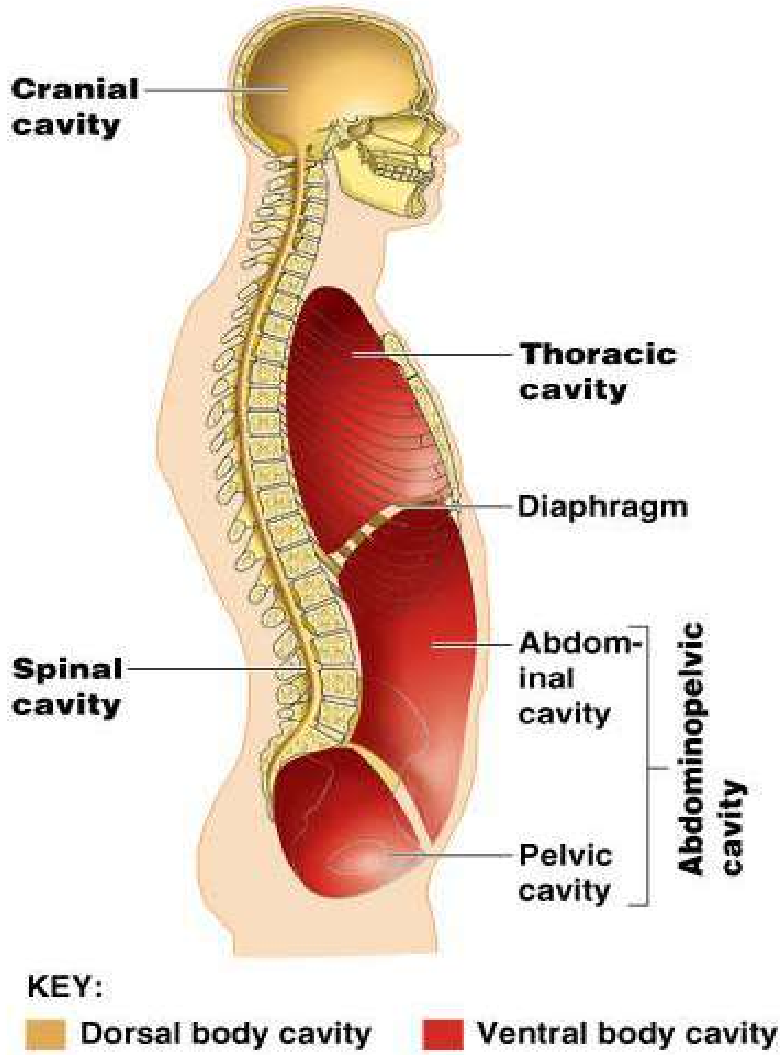
2- Ventral Body Cavity

The more anterior and larger of the closed body cavities is the **ventral body cavity** .It has **two** major subdivisions, the **thoracic** and the **abdominopelvic** cavities. It houses internal organs collectively called the **viscera** .

They are separated by the **diaphragm,** a dome-shaped muscle important in breathing.

The abdominopelvic cavity, as its name suggests, has two parts ***not physically separated*** by a muscular or membrane wall.

The inferior part, **the pelvic cavity,** lies in the bony pelvis .


Cranial cavity
Thoracic cavity
Diaphragm
Spinal cavity
Abdominal cavity
Pelvic cavity
Abdominopelvic cavity
KEY:
Dorsal body cavity
Ventral body cavity

HOMEOSTATIC IMBALANCE

When the body is subjected to physical trauma (as often happens in an automobile accident), the abdominopelvic organs are most vulnerable. This is because the walls of the abdominal cavity are formed only by trunk muscles and are not reinforced by bone. The pelvic organs receive a somewhat greater degree of protection from the bony pelvis

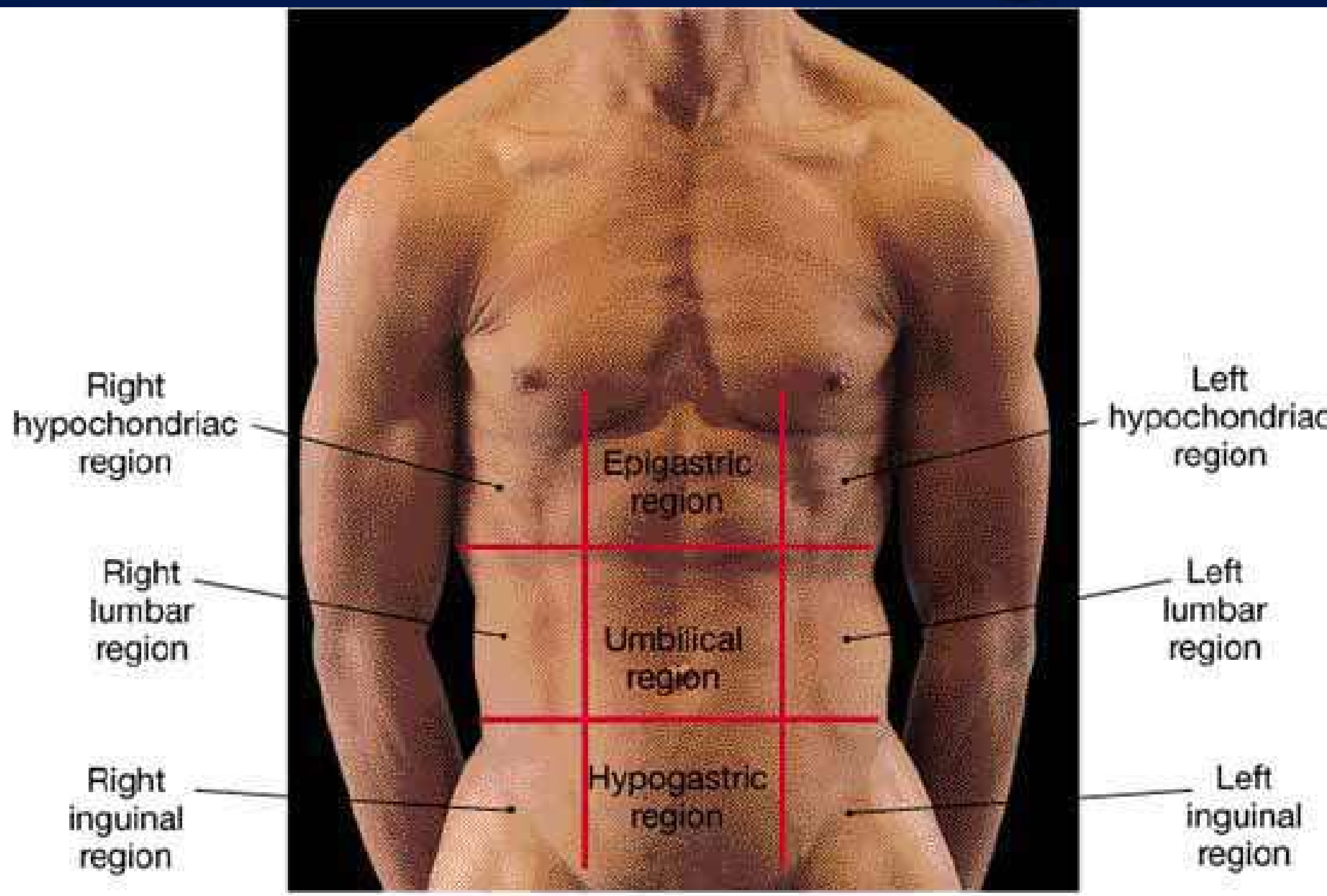
Abdominopelvic Regions and Quadrants

Because the abdominopelvic cavity is **large** and contains several organs, it helps to divide it into smaller areas for study.

One division method, used primarily by anatomists, uses two transverse and two parasagittal planes. These planes, divide the cavity into ***nine regions*** :

-The **umbilical** region is the centermost region deep to and surrounding the umbilicus (navel).

Abdominopelvic Regions



(b)

-The **epigastric** region is located superior to the umbilical region (epi = upon, above; gastri = belly).

-The **hypogastric** (pubic) region is located inferior to the umbilical region (hypo = below).

-The right and left **iliac**, or **inguinal,** regions (ing'gwĭ-nal) are located lateral to the hypogastric region (iliac = superior part of the hip bone).

-The right and **left lumbar regions** lie lateral to the umbilical region (lumbus = loin).

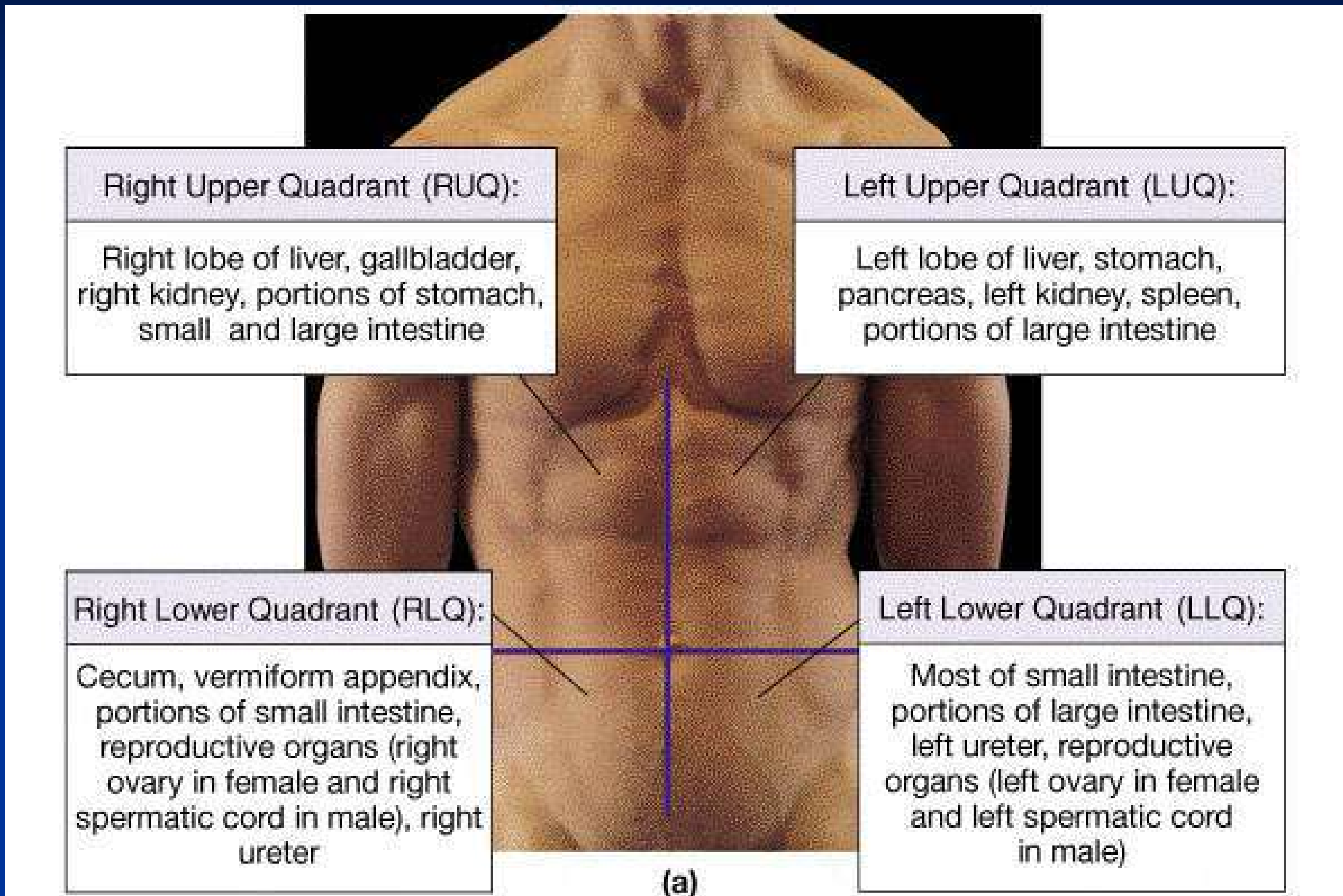
-The right and left **hypochondriac** regions flank the epigastric region laterally (chondro = cartilage).

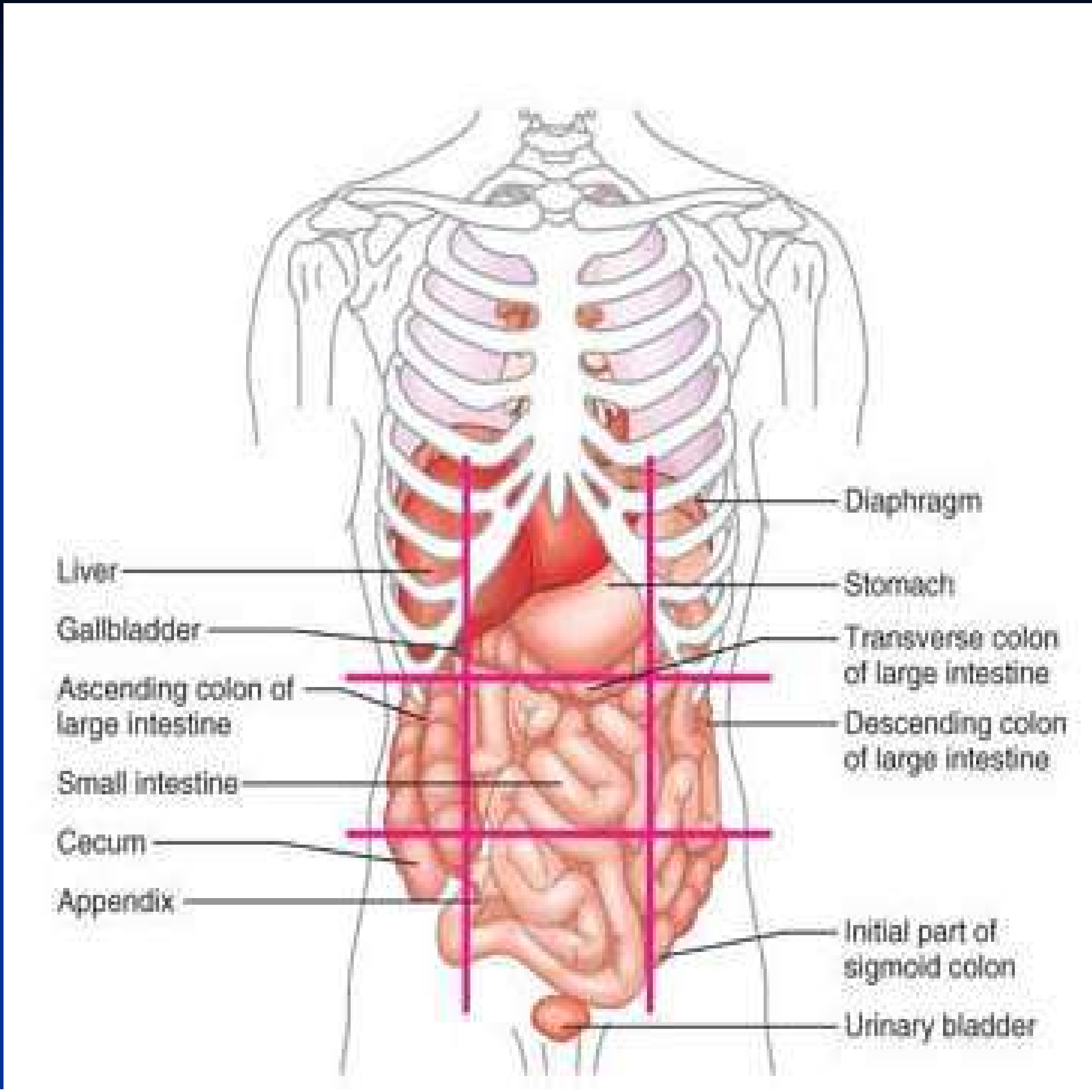
A simpler scheme to localize the abdominopelvic cavity organs is to imagine one transverse and one median sagittal plane pass through the **umbilicus** at right angles. The resulting quadrants are named according to their positions from the subject's point of view:

right upper quadrant (RUQ), **left upper** quadrant (LUQ),

right lower quadrant (RLQ), and **left lower** quadrant (LLQ).

Abdominopelvic Quadrants




Liver
Gallbladder
Ascending colon of large intestine
Small intestine
Cecum
Appendix
Diaphragm
Stomach
Transverse colon of large intestine
Descending colon of large intestine
Initial part of sigmoid colon
Urinary bladder

JOINTS

1

BY
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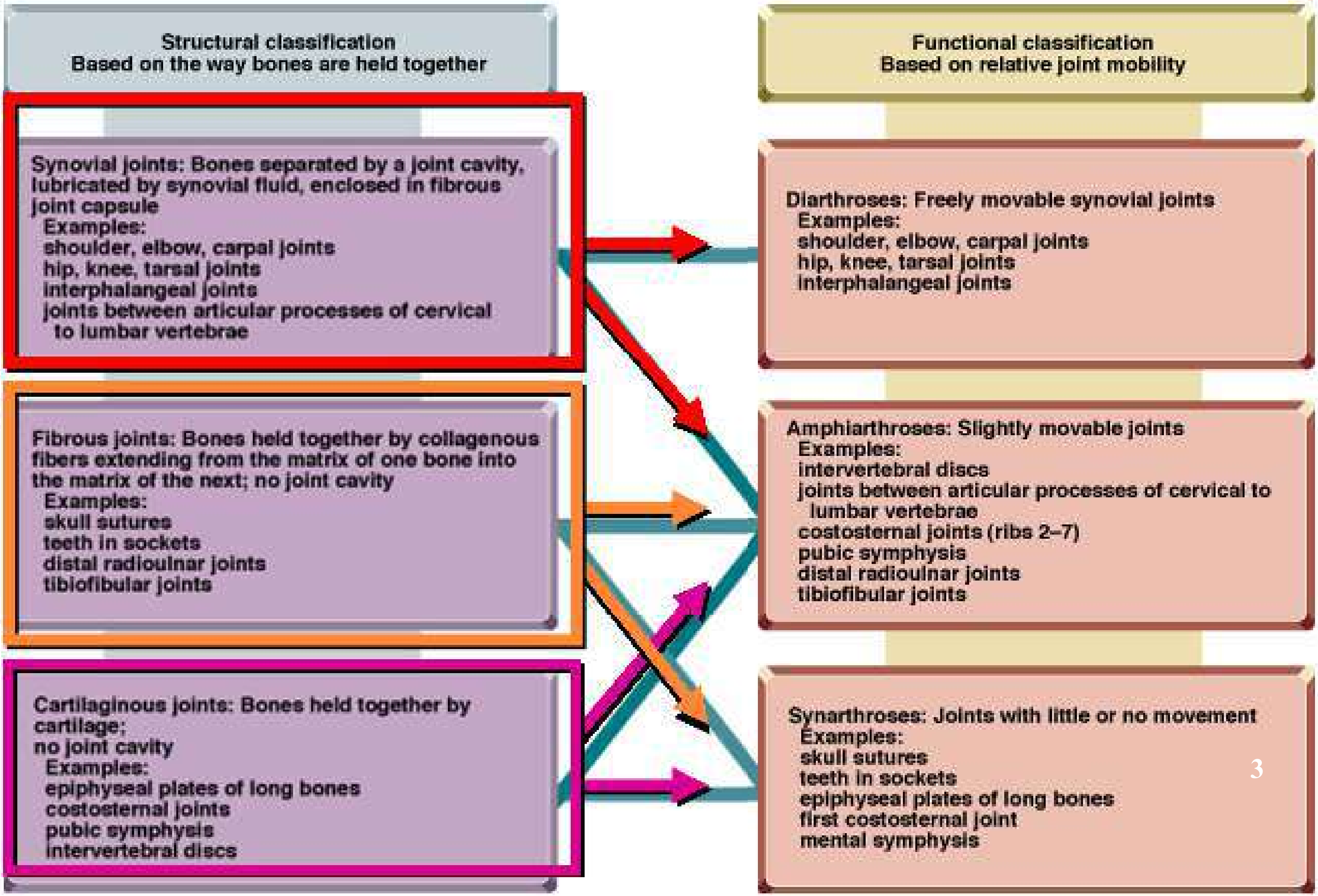
Joints and Their Classification

- Arthrology is the study of the joints
- Kinesiology is the study of musculoskeletal movement
- Joints are classified by their freedom of movement
  - diarthrosis (freely movable); amphiarthrosis (slightly movable) and synarthrosis (little or no movement)
- Joints are classified by the manner adjacent bones are joined -- fibrous, cartilaginous, bony and synovial joints

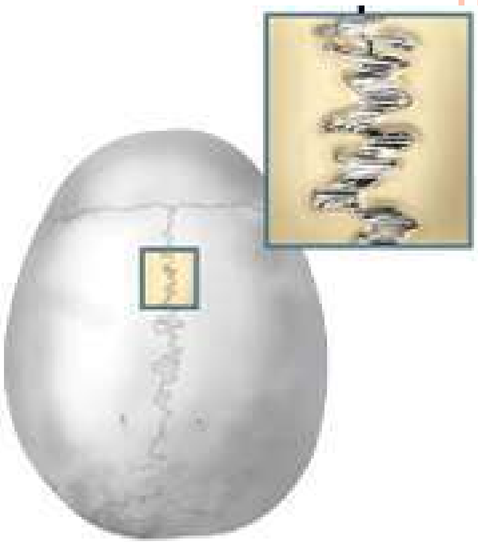
Joint Classification



Fibrous, Cartilaginous & Bony Joints

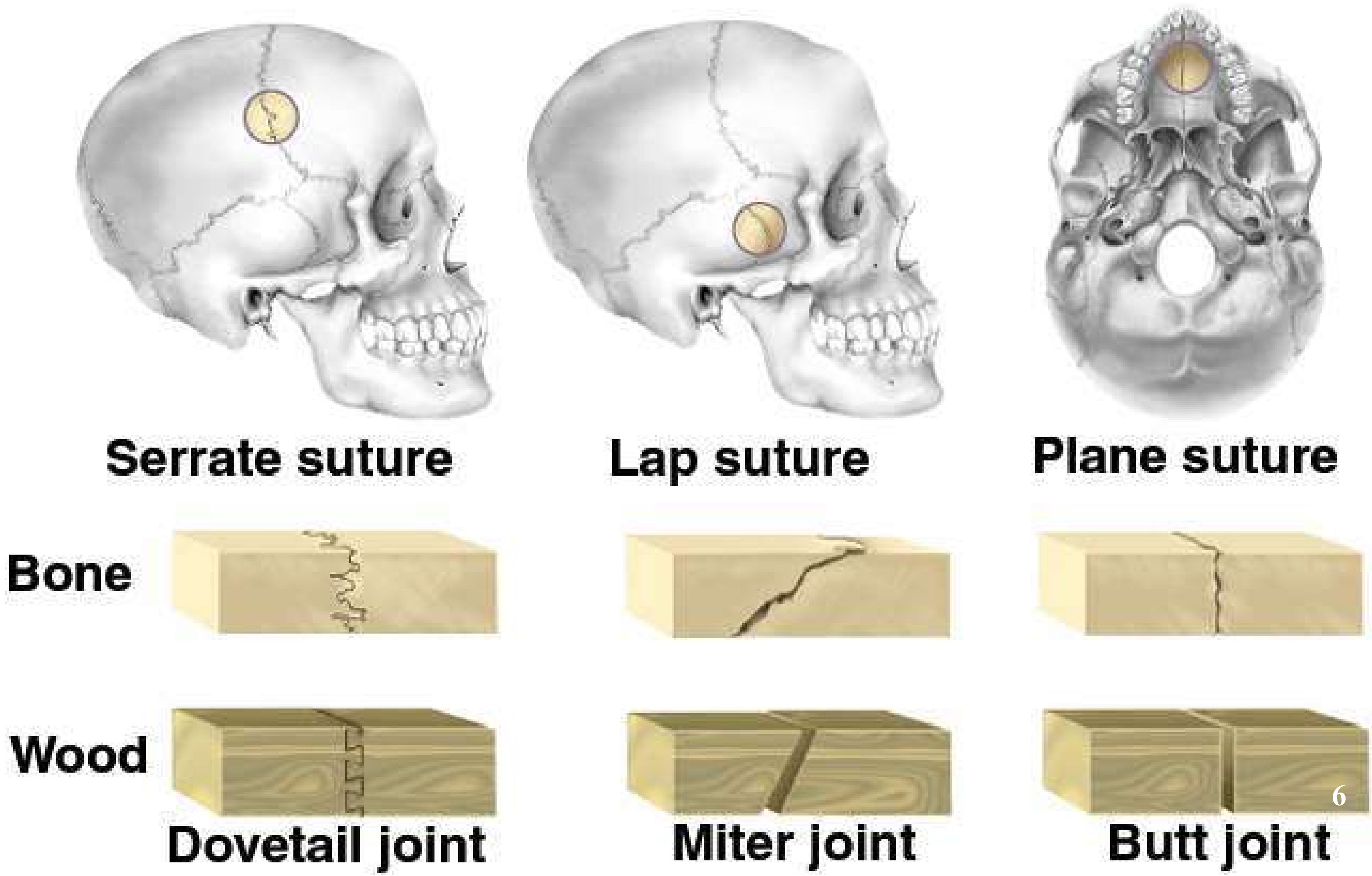
- Fibrous joints have collagen fibers spanning the space between bones
  - sutures, gomphoses & syndesmoses
- Cartilaginous joints have 2 bones bound to each other by cartilage
  - synchondroses or symphyses
- Bony joints have 2 bones fused by osseous tissue
  - synostoses in early adulthood

Fibrous Joint -- Sutures



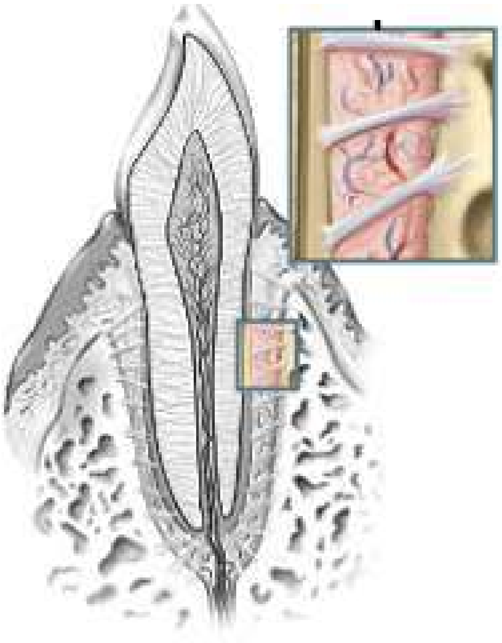
- Immovable fibrous joints that bind the bones of the skull to each other
- Serrate sutures appear as interlocking wavy lines
  - coronal, sagittal & lambdoid sutures
- Lap or squamous sutures are 2 bones with overlapping beveled edges
  - temporal & parietal bones
- Plane or butt sutures have straight, nonoverlapping edges
  - palatine processes of the maxillae

TYPES OF SUTURES

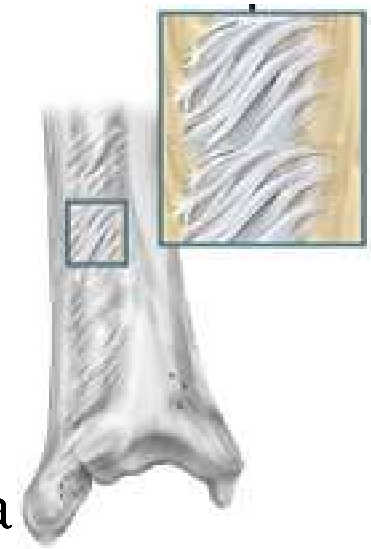


Fibrous Joint -- Gomphoses

- Attachment of a tooth to its socket is a joint called a gomphoses
- Tooth held in place by fibrous periodontal ligament
  - collagen fibers that extend from bone of jaw to tooth
- Allows tooth to move a little while chewing



FIBROUS JOINT -- SYNDESMOSES



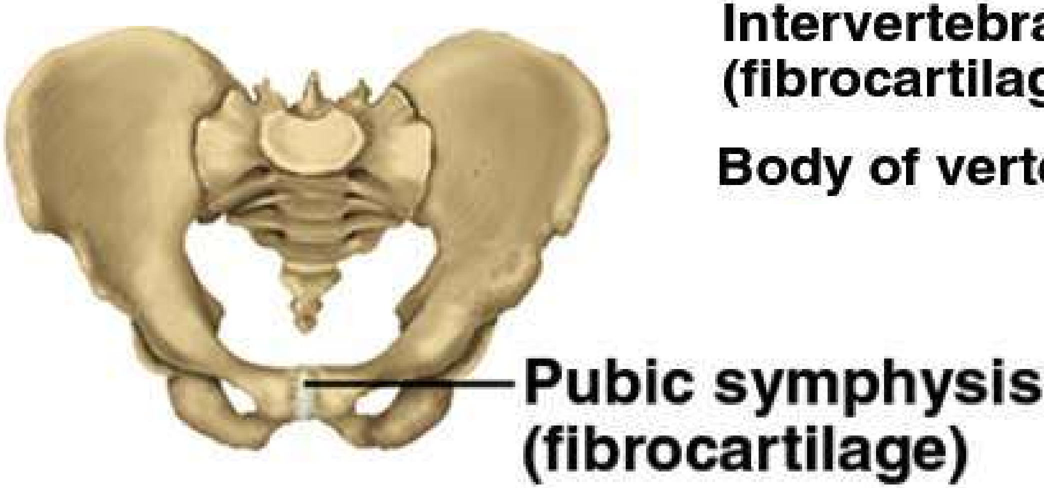
- Joint in which two bones are bound by a ligament only (interosseus membrane)
- Most movable of fibrous joints
- Interosseus membranes unite radius to ulna fibula

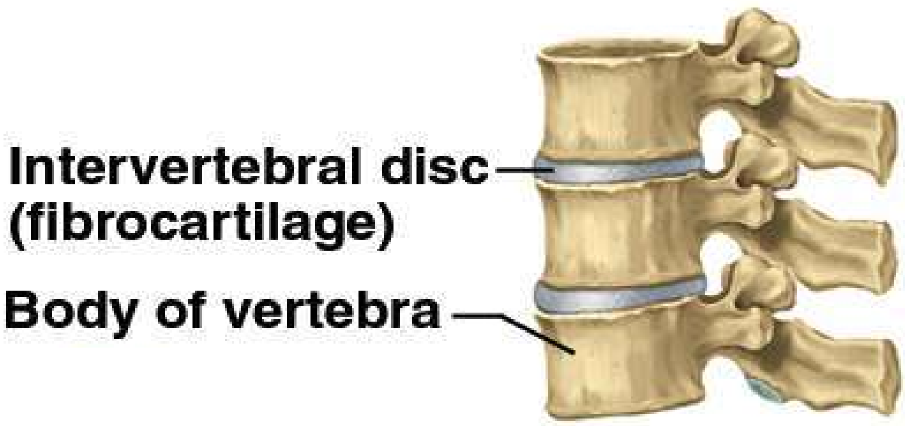
CARTILAGINOUS JOINT -- SYNCHONDROSES

- Bones are joined by hyaline cartilage
  - rib attachment to sternum by
  - epiphyseal plate in children binds epiphysis and diaphysis

Cartilaginous Joint -- Symphyses

- 2 bones joined by fibrocartilage
  - pubic symphysis and intervertebral discs
- Only slight amount of movement is possible

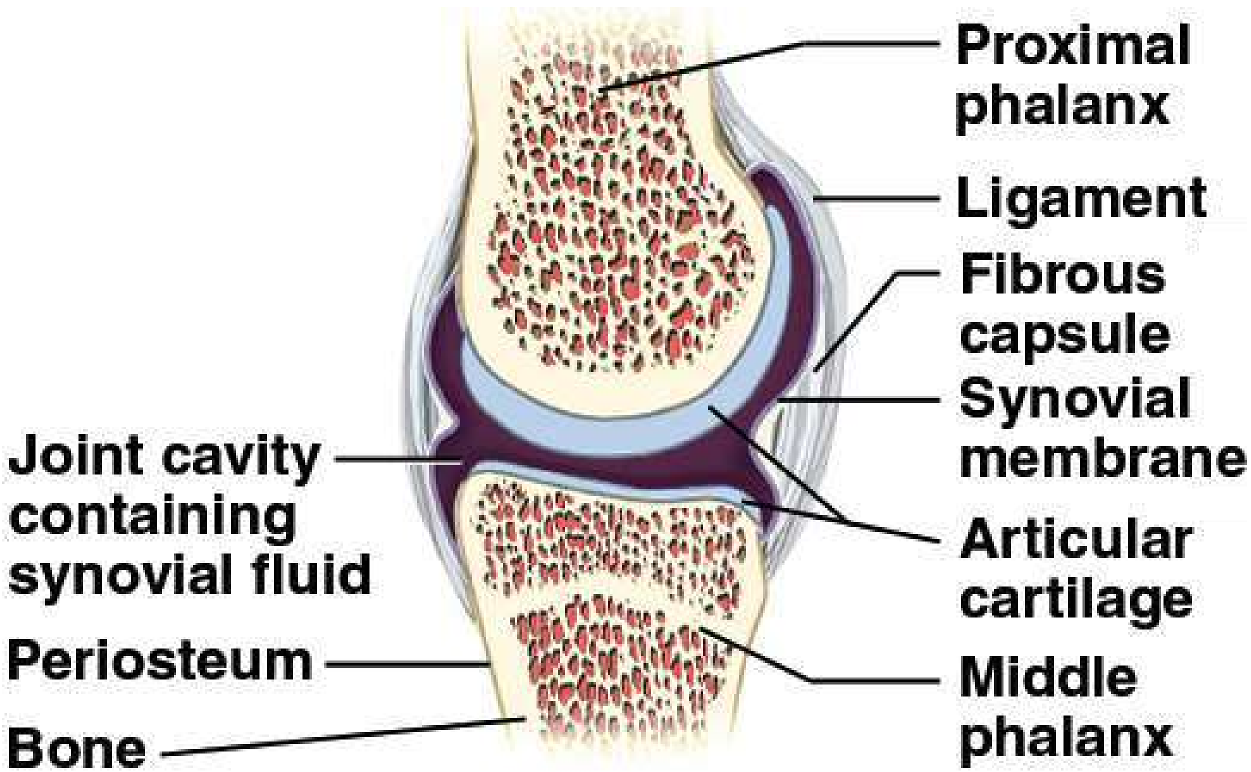




Bony Joints (Synostoses)

- 2 bones, once separate, fused by osseous tissue
- Ossification occurs with age
  - left and right mandible present at birth
  - left and right frontal bones present at birth
  - epiphyses and diaphysis of the long bones

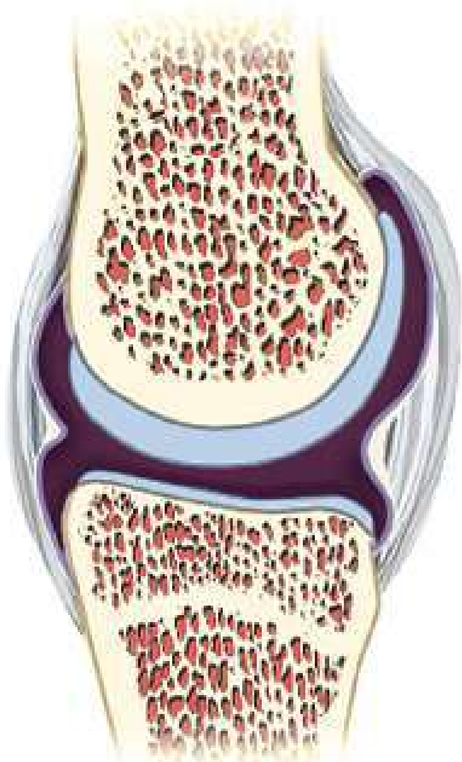
SYNOVIAL JOINT



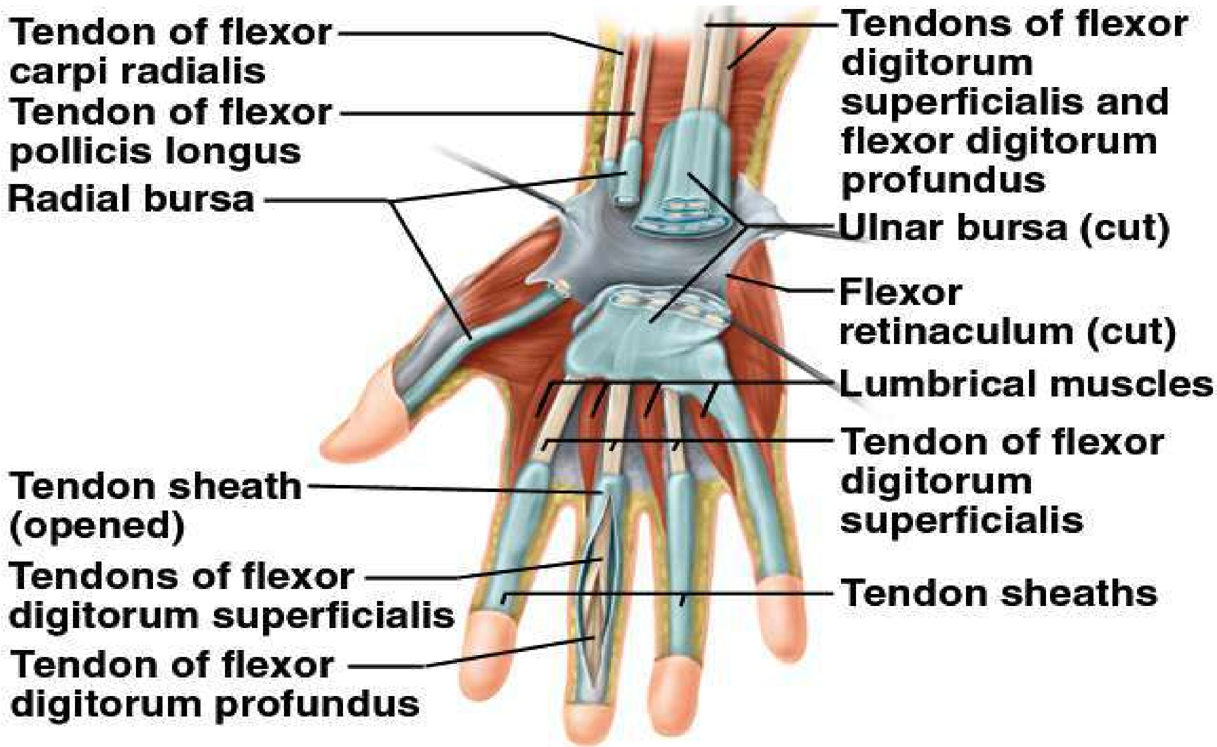
- Joint in which two bones are separated by a space called a joint cavity
- Most are freely movable

GENERAL ANATOMY OF SYNOVIAL JOINTS

- Articular capsule
  - fibrous capsule lined by synovial membr
  - continuous with periosteum
- Synovial fluid
  - viscous slippery fluid rich in albumin & hyaluronic acid & similar to raw egg wh
- Articular cartilage
  - hyaline cartilage covering the joint surf
- Meniscus is pad of fibrocartilage in jaw, wrist, knee and sternoclavicular joints
  - absorbs shock, guides bone movements & distributes forces
- Tendon attaches muscle to bone
- Ligament attaches bone to bone



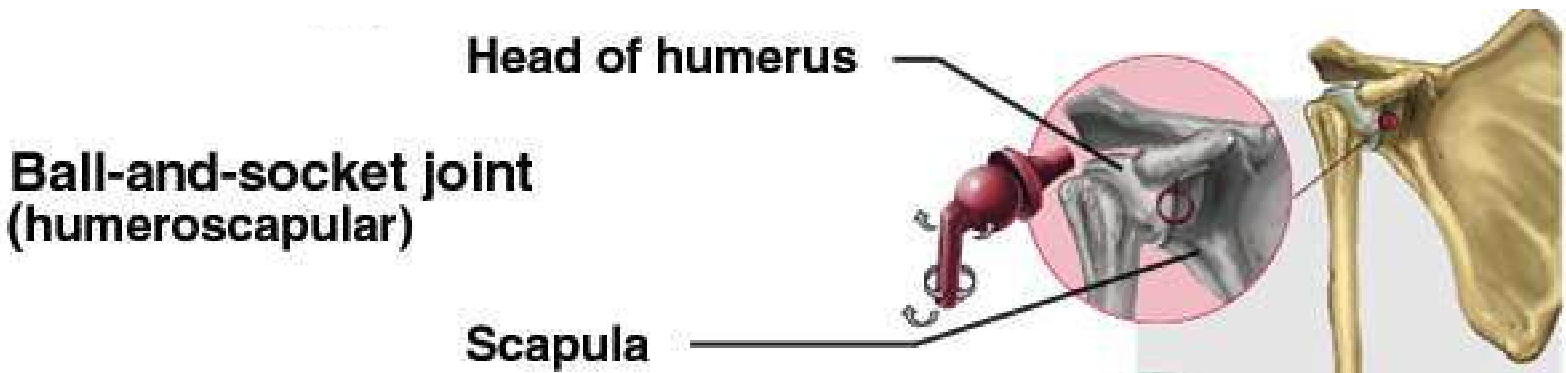
Tendon Sheaths and Bursae



- Bursa is saclike extension of joint capsule that extends between nearby structures allowing them to slide more easily past each other
- Tendon sheaths are elongated cylinders of connective tissue lined with synovial membrane & wrapped around a tendon
  - numerous in hand and foot

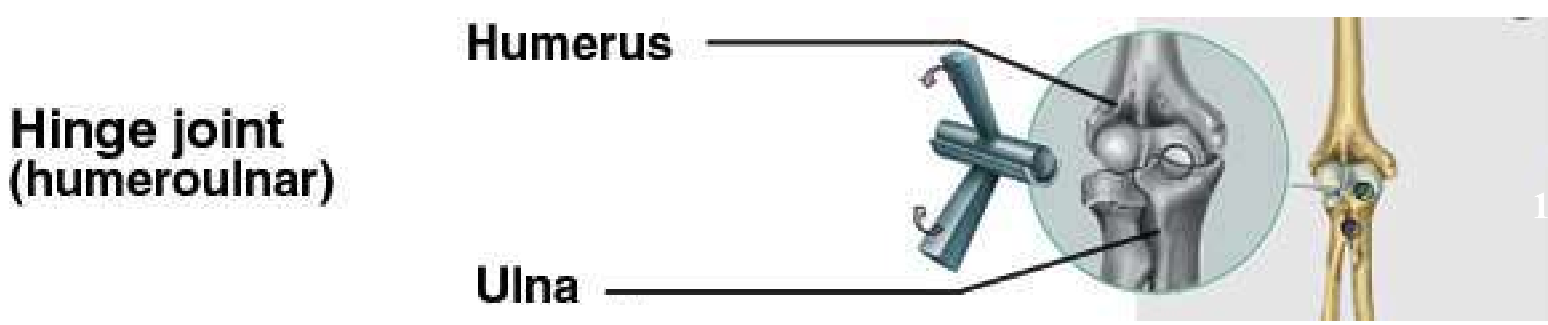
BALL-AND-SOCKET JOINTS

- Smooth hemispherical head fits within a cuplike depression
  - head of humerus into glenoid cavity of scapula
  - head of femur into acetabulum of hip bone
- Multiaxial joint



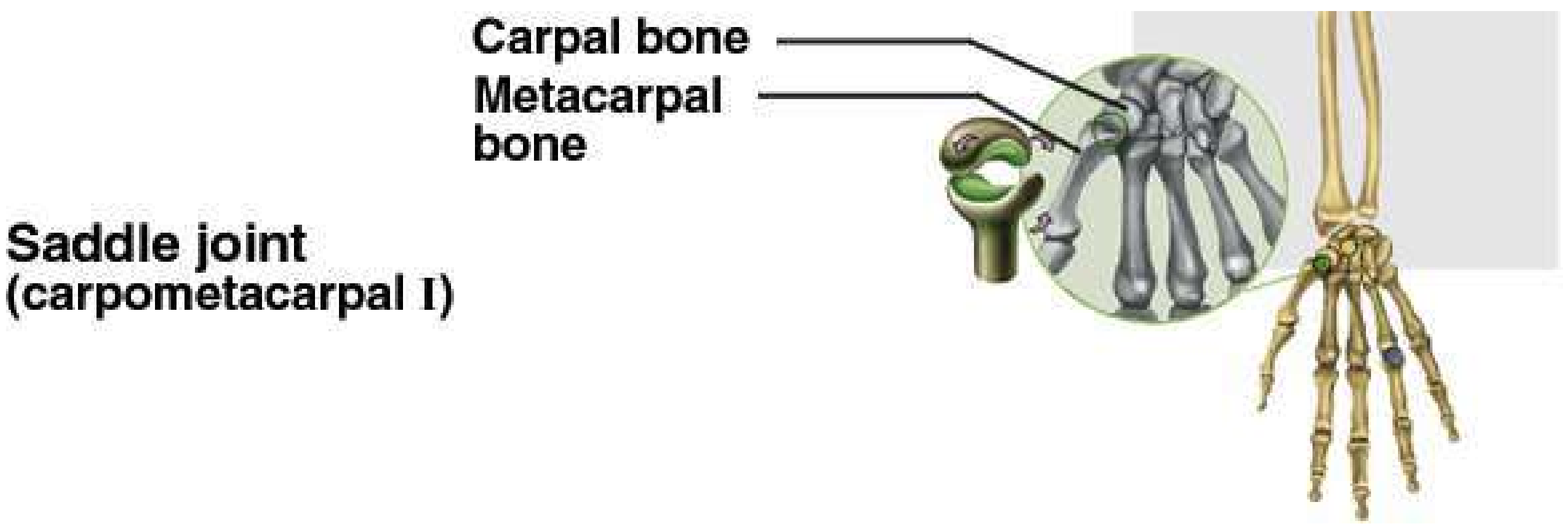
Hinge Joints

- One bone with convex surface that fits into a concave depression on other bone
  - ulna and humerus at elbow joint
  - femur and tibia at knee joint
  - finger and toe joints
- Monoaxial joint



Saddle Joints

- Each articular surface is shaped like a saddle, concave in one direction and convex in the other
  - trapeziometacarpal joint at the base of the thumb
- Biaxial joint
  - more movable than a condyloid or hinge joint forming the primate opposable thumb

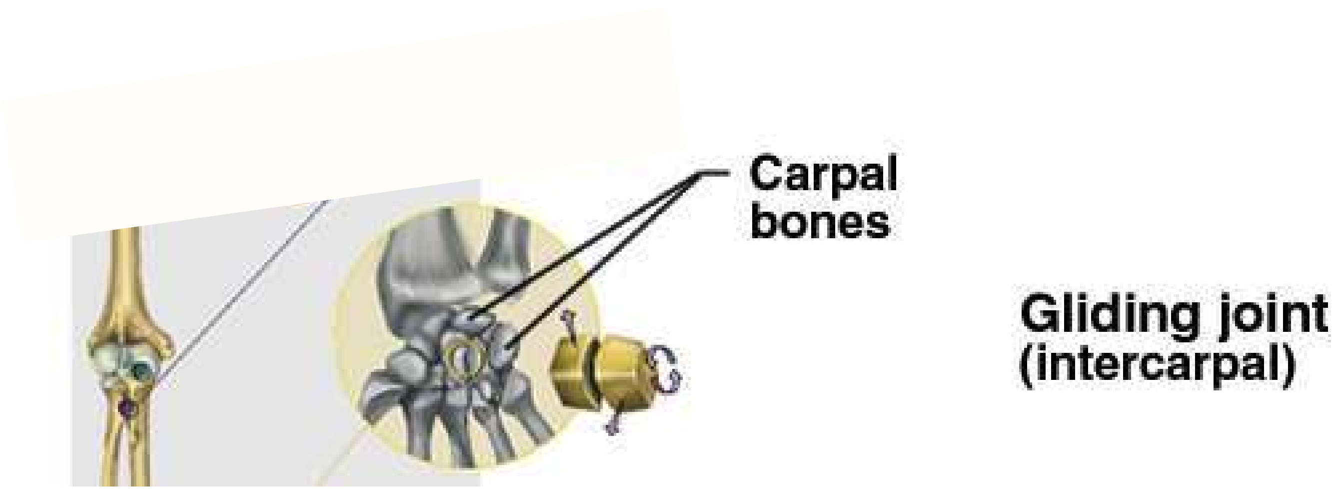


Pivot Joints

- One bone has a projection that fits into a ringlike ligament of another
- First bone rotates on its longitudinal axis relative to the other
    - atlantoaxial joint (dens and atlas)
    - proximal radioulnar joint allows the radius during pronation and supination

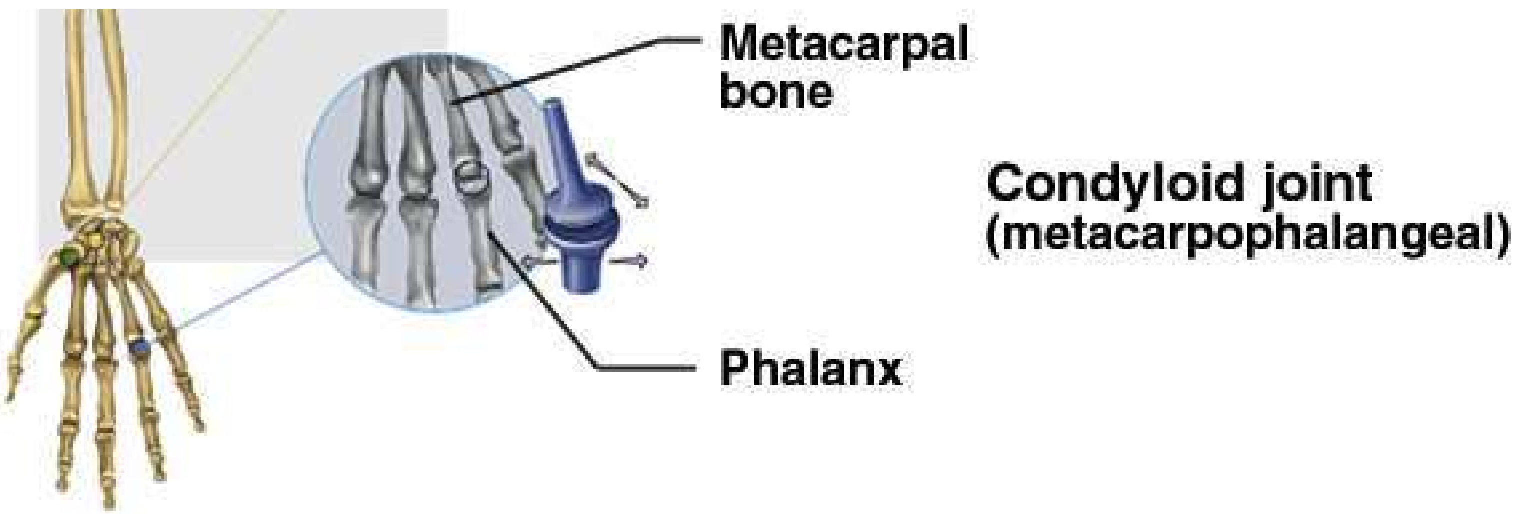
Gliding Joints

- Flat articular surfaces in which bones slide over each other
- Limited monoaxial joint
- Considered amphiarthroses



CONDYLOID (ELLIPSOID) JOINTS

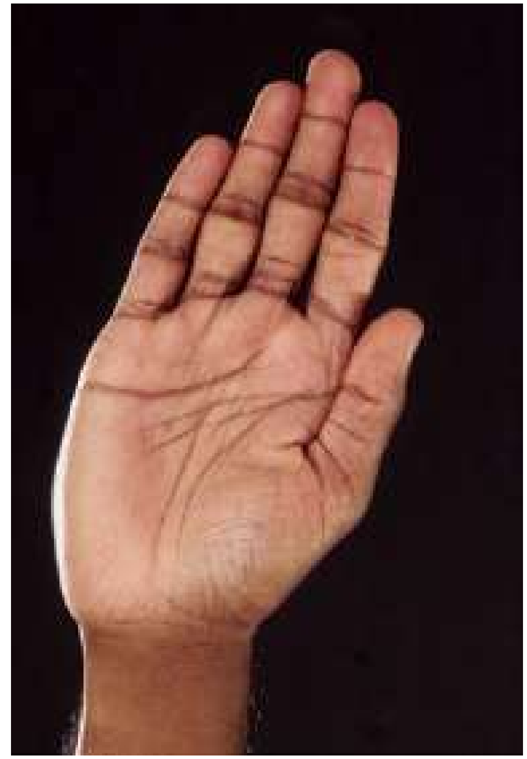
- Oval convex surface on one bone fits into a similarly shaped depression on the next
  - radiocarpal joint of the wrist
  - metacarpophalangeal joints at the bases of the fingers
- Biaxial joints



FLEXION, EXTENSION & HYPEREXTENSION

- Flexion decreases the angle of a joint
  - bending elbow or wrist
- Extension straightens a joint and returns a body part to the anatomical position
- Hyperextension is extension of a joint beyond 180 degrees

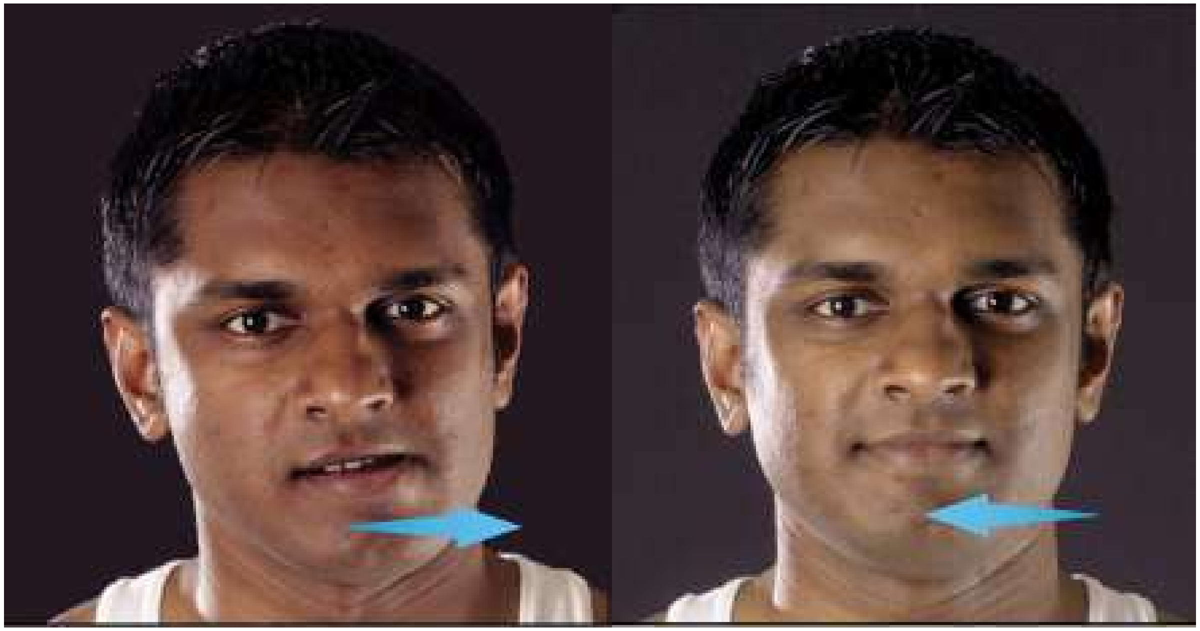
Abduction & Adduction

- Abduction is spreading the fingers away from the midline (middle finger)
- Adduction is movement is returning the fingers to the anatomical position

- Elevation is a movement that raises a bone vertically
  - mandibles are elevated during biting & clavicles during a shrug
- Depression is lowering the mandible or the shoulders
- Protraction is movement of a bone anteriorly (forward) on a horizontal plane
  - thrusting the jaw forward, shoulders or pelvis forward
- Retraction is movement of a bone posteriorly

Lateral & Medial Excursion

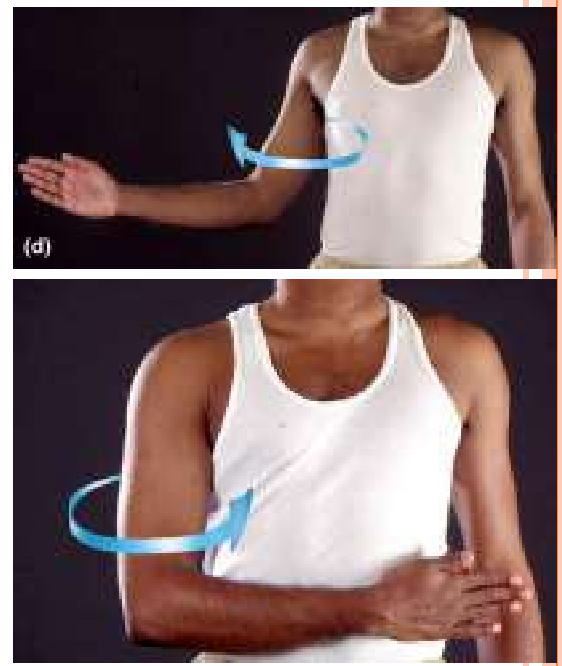


- Lateral excursion is sideways movement to right or left
- Medial excursion is movement back to the midline
- Side-to-side grinding movements occurring during chewing

Circumduction

- Movement in which one end of an appendage remains stationary while the other end makes a circular motion
- Sequence of flexion, abduction, extension & adduction movements
  - baseball player winding up for a pitch

Lateral and Medial Rotation



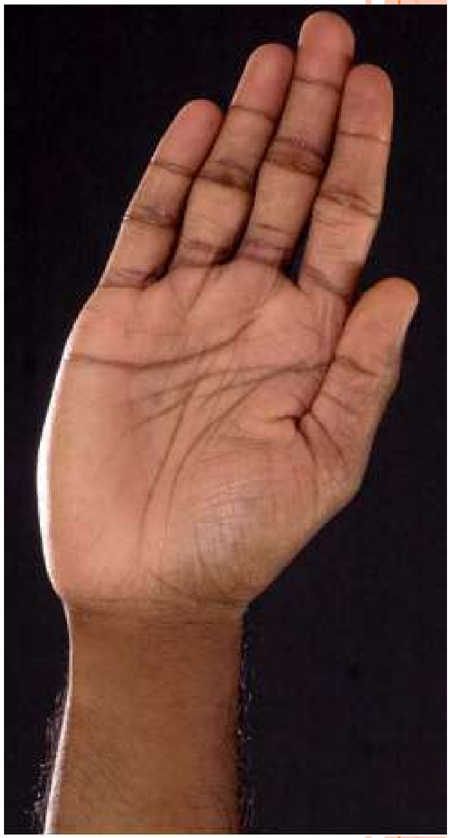
- Movement of a bone turning on its longitudinal axis
  - rotation of trunk, thigh, head or arm
- Medial rotation turns the bone inwards
- Lateral rotation turns the bone outwards

SUPINATION & PRONATION

- Occurs in the forearm and foot
- Supination
  - rotation of forearm so that the palm faces forward
  - inversion and abduction of foot (raising the medial edge of the foot)
- Pronation
  - rotation of forearm so the palm faces to the rear
  - eversion and abduction of foot (raising the lateral edge of the foot)

Opposition & Reposition

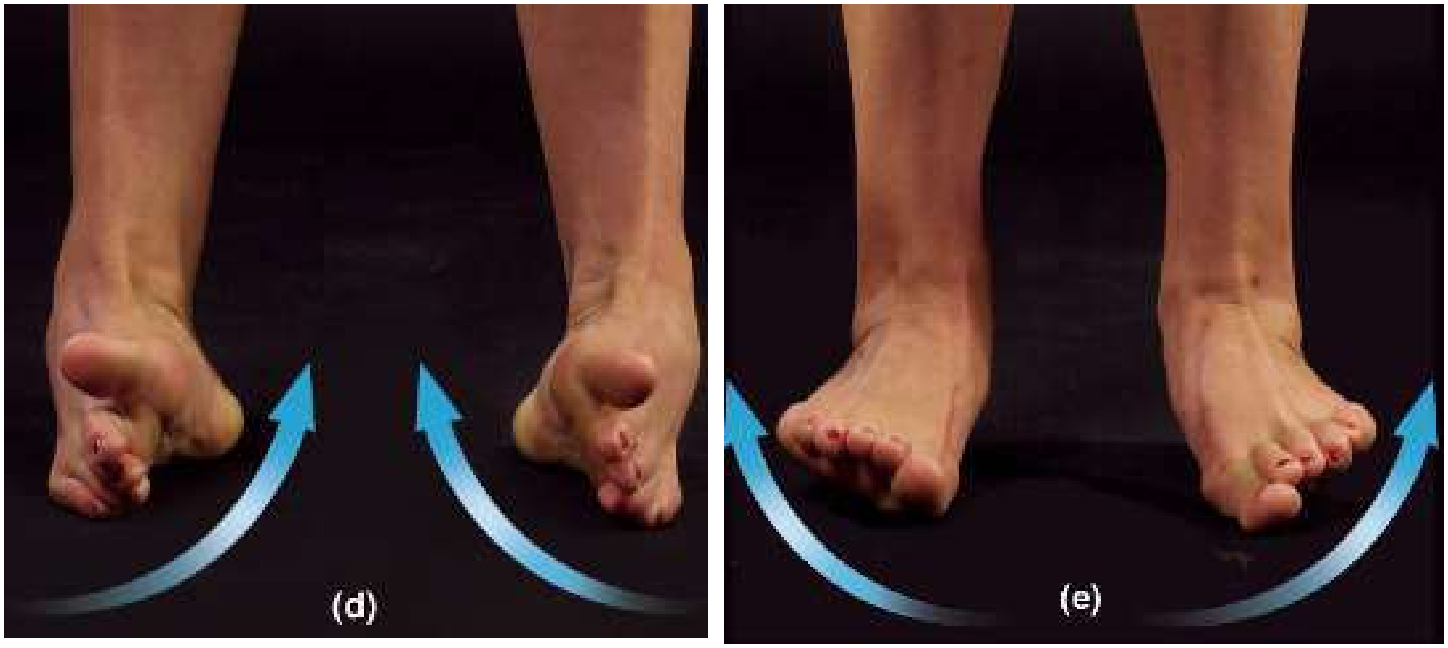
- Opposition is movement of the thumb to approach or touch the fingertips
- Reposition is movement back to the anatomical position
- Important hand function that enables the hand to grasp objects



Dorsiflexion & Plantar Flexion

- Dorsiflexion is raising of the toes as when you swing the foot forward to take a step (heel strike)
- Plantarflexion is extension of the foot so that the toes point downward as in standing on tiptoe

Inversion & Eversion



- Inversion is a movement in which the soles are turned medially
- Eversion is a turning of the soles to face laterally

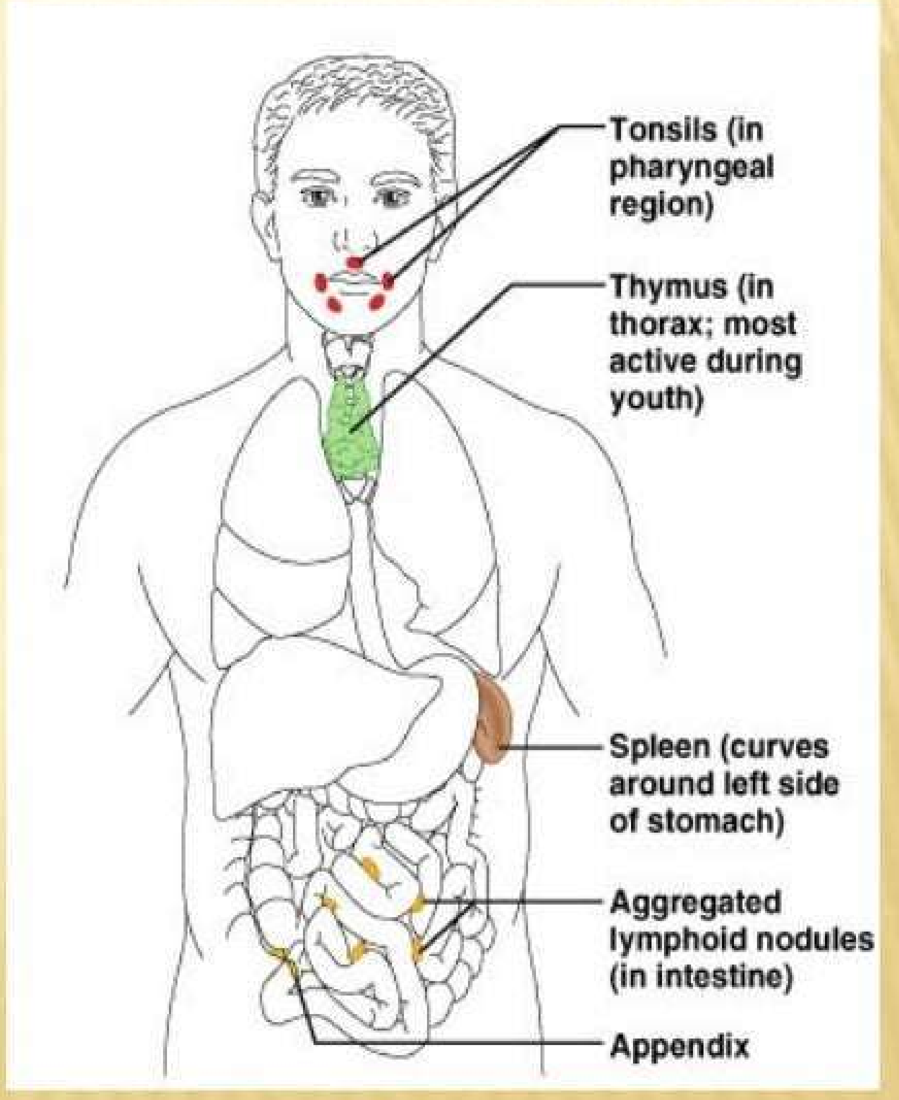
LYMPHATIC SYSTEM AND LYMPHOID ORGANS

BY
HIMA SAILA.M
DEPT OF PHARMACOLOGY
SRI PADMAVATHI SCHOOL OF PHARMACY

ORGANS OF IMMUNE SYSTEM

Lymphoid Organs

- Bone marrow
- Thymus
- Spleen
- lymph node
- Tonsils
- Small intestine & appendix aggregated lymphoid nodules



Lymphoid system:

1.Lymphoid organs are stationed throughout the body

2. They are concerned with the growth, development and differeciation of lymphocytes.

3.There are structurally and functionally diverse lymphoid organs and tissues

4.They are interconnected by the blood vessels and lymphatic vessels through which lymphocytes circulate.

5.These organs are involved in specific as well as non-specific immunity

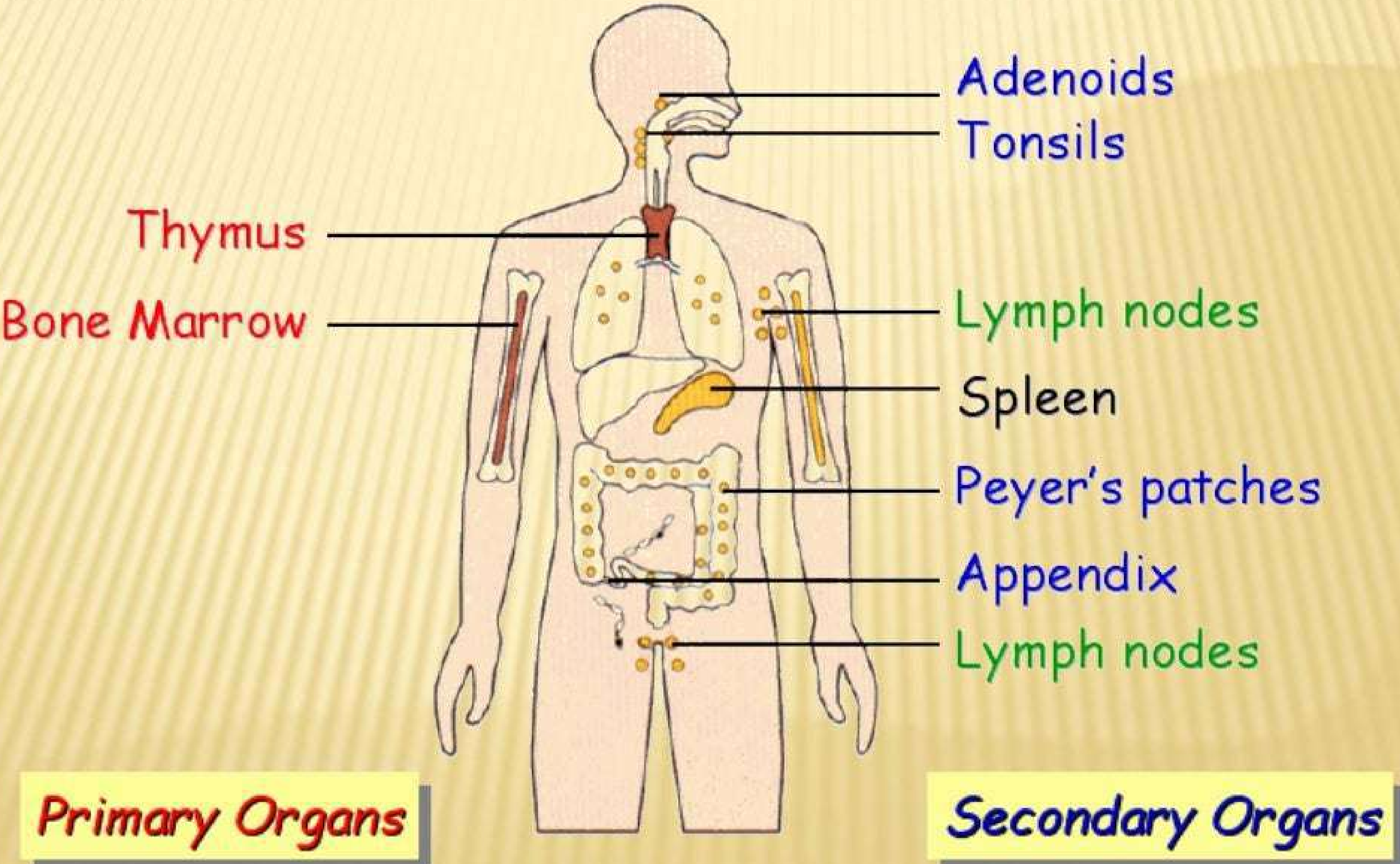
CLASSIFICATION

Based upon the functional development of the lymphatic cells the lymphoid organs are classified into 2 groups

1.PRIMARY LYMPHOID ORGANS / central/ generative organs

2. SECONDARY LYMPHOID ORGANS /perpheral

Lymphoid Organs



1.PRIMARY LYMPHOID ORGANS

1.BONE MARROW- all lymphocytes arise and b-cell maturation

2. THYMUS T- cell maturation

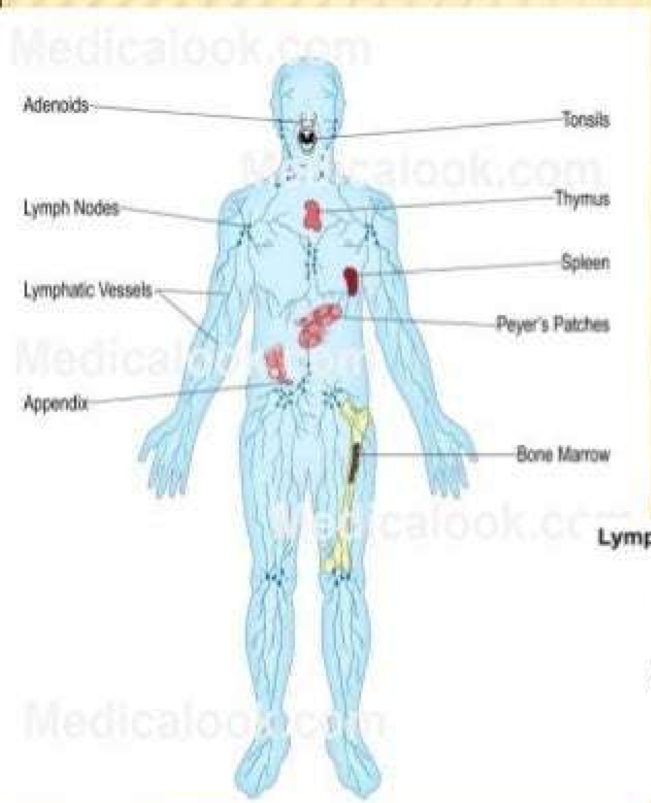
2. SECONDARY LYMPHOID ORGANS

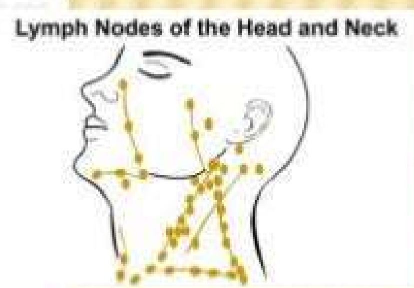
LYMPH NODE

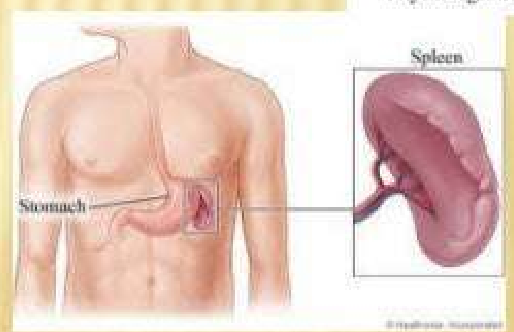
SPLEEN

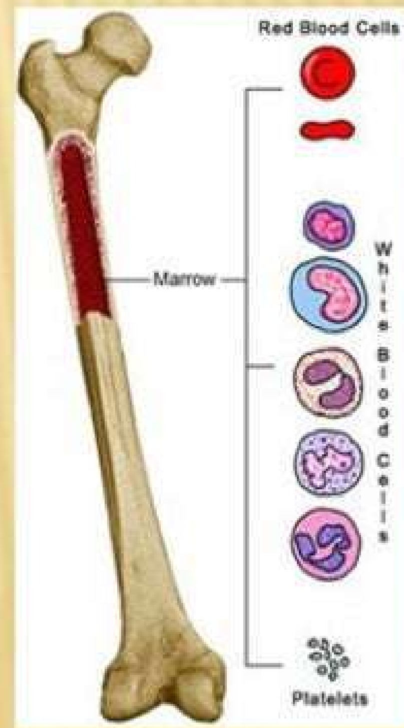
MUCOSA ASSOCIATED LYMPHOID TISSUE (MALT)

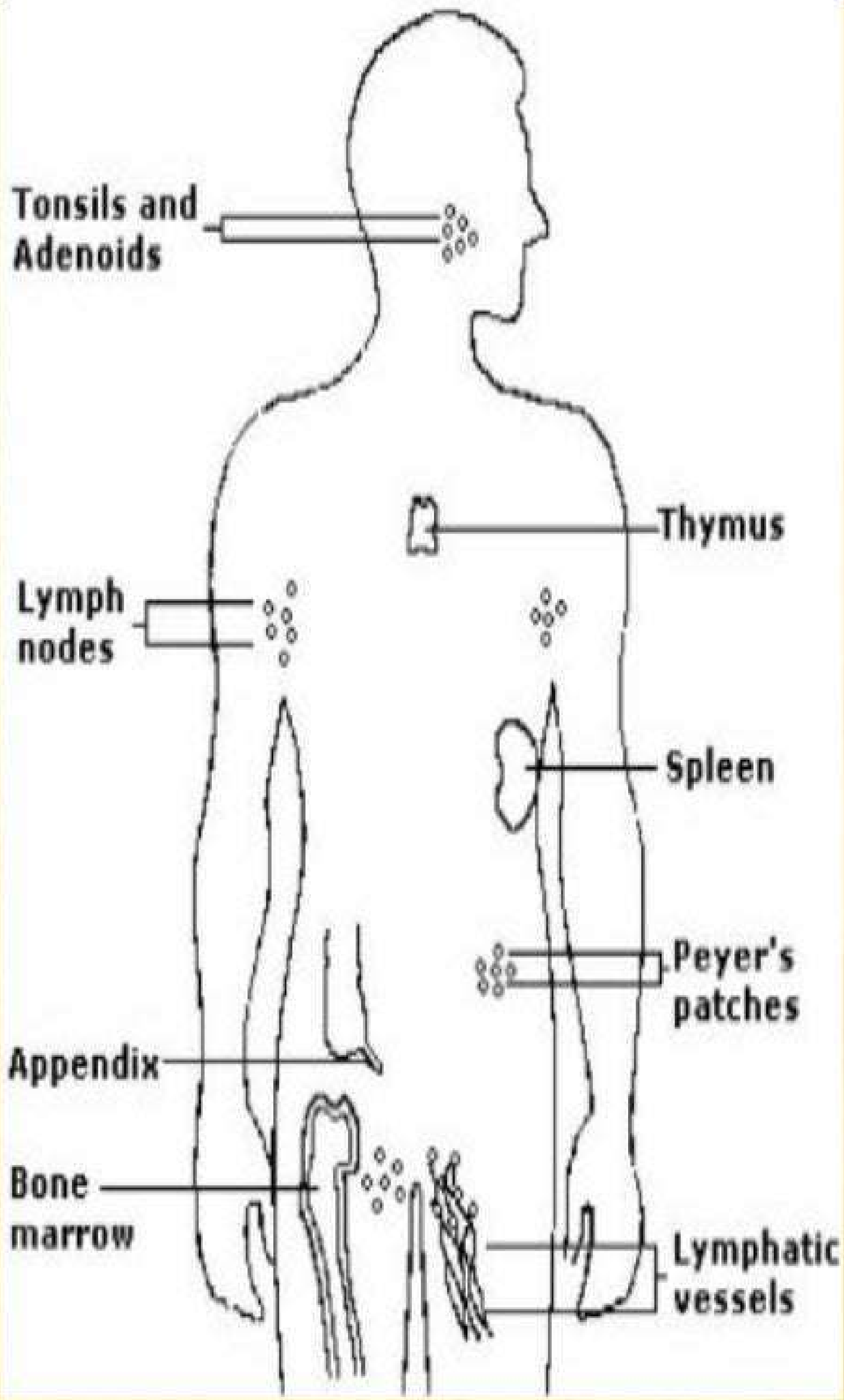
(GALT) (BALT) (UGALT) (CALT)

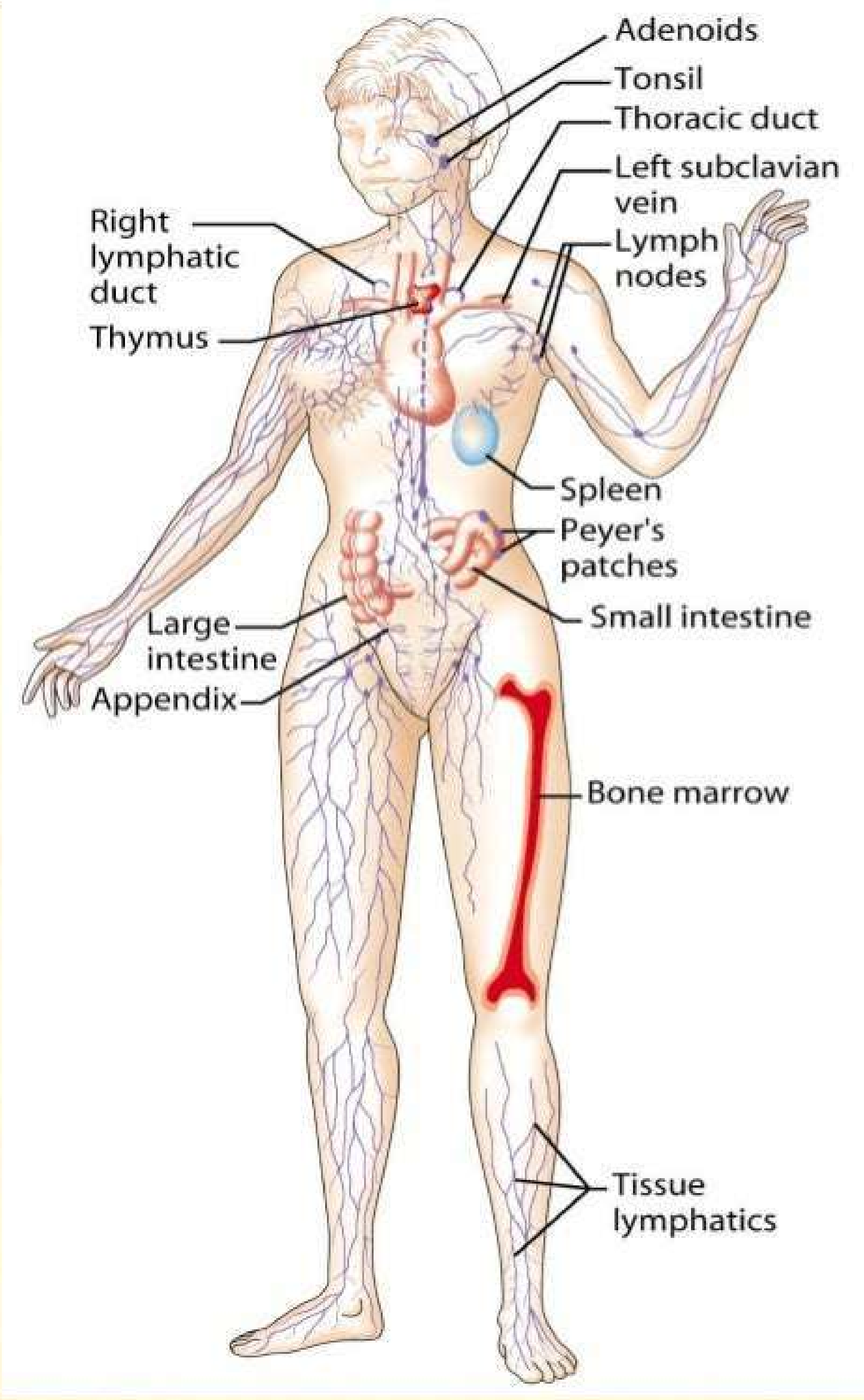









Tonsils and Adenoids
Thymus
Lymph nodes
Spleen
Peyer's patches
Appendix
Bone marrow
Lymphatic vessels


Adenoids
Tonsil
Thoracic duct
Left subclavian vein
Lymph nodes
Right lymphatic duct
Thymus
Spleen
Peyer's patches
Small intestine
Large intestine
Appendix
Bone marrow
Tissue lymphatics

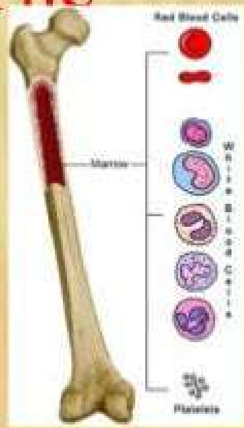
BONE MARROW

Bone marrow is the primary lymphoid organ .It is a soft tissue within the cavity of bones .Bone marrow is divisible into 2

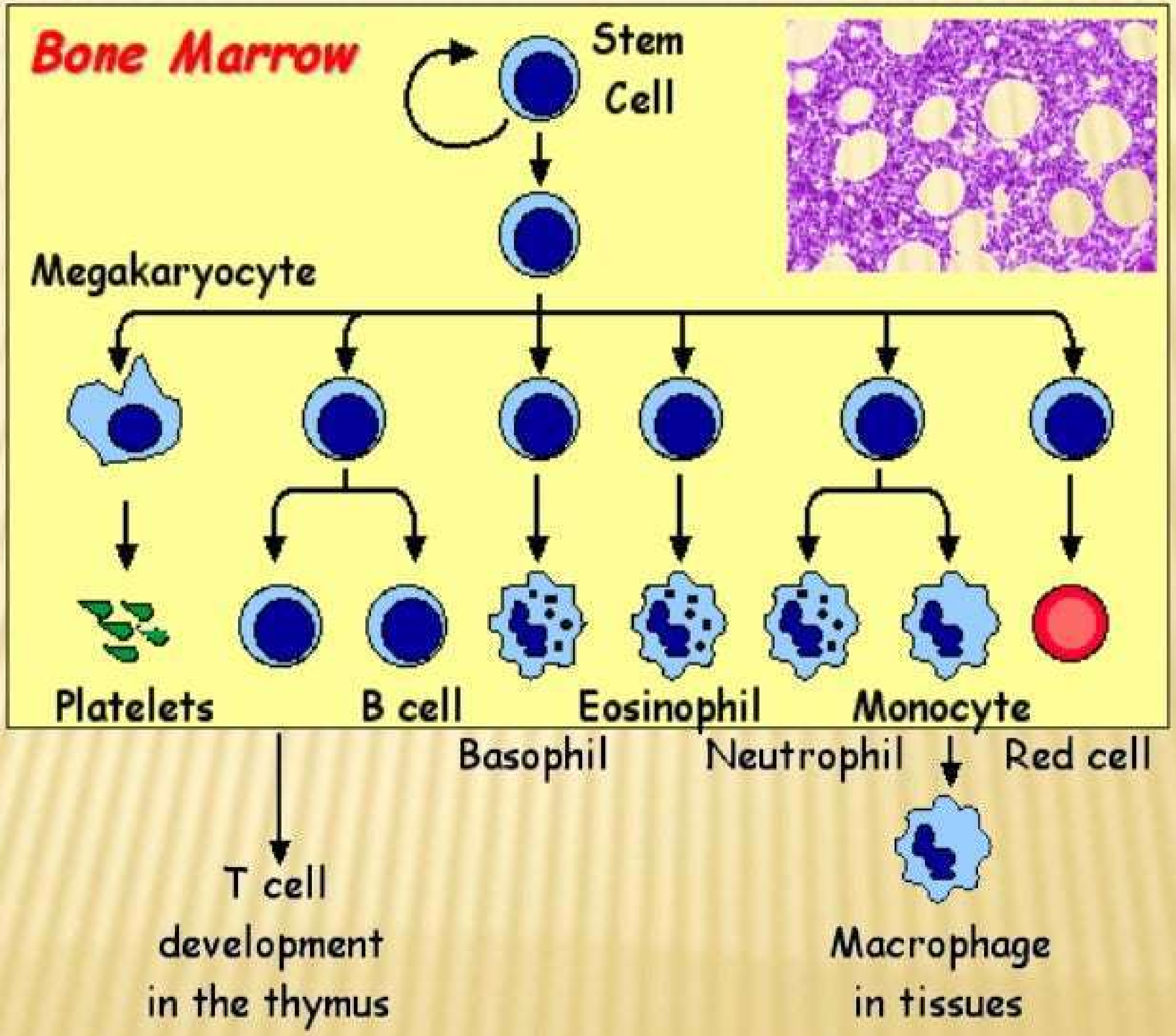
1.vascular region 2, haemtopoietic region.

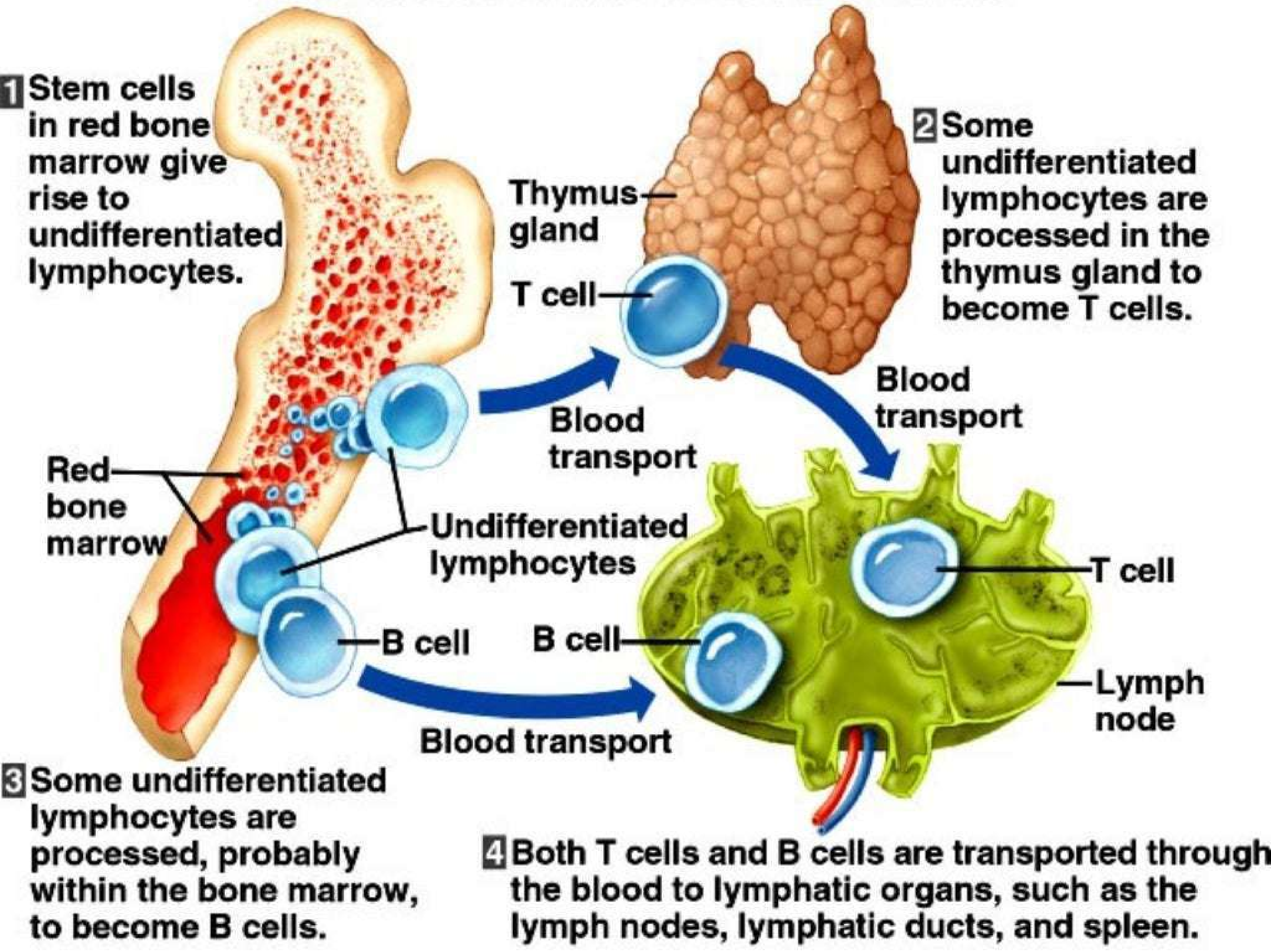
…..Vascular region is the circulatory system that supplies nutrient and removes waste from actively growing blood vessels.

Red marrow is actively involved in haemtopoiesis
Red marrow contains titipoent cells called stem cells. The devlopment of blood cells from stem cells is called Haematopoies.
Haematopoies is forms RBC,WBC- granulocytes, lymphocytes, monocytes and platlets.



Blood Cell Development




1 Stem cells in red bone marrow give rise to undifferentiated lymphocytes.
Red bone marrow
Undifferentiated lymphocytes
B cell
Blood transport
Thymus gland
T cell
2 Some undifferentiated lymphocytes are processed in the thymus gland to become T cells.
Blood transport
T cell
B cell
Lymph node
Blood transport
3 Some undifferentiated lymphocytes are processed, probably within the bone marrow, to become B cells.
4 Both T cells and B cells are transported through the blood to lymphatic organs, such as the lymph nodes, lymphatic ducts, and spleen.

Majority of lymphid progenitors develop into B-lyphocytes in the bone marrow.
Some of lymphoid progenitors migrate into the thymus , where they develop into the
T-lypmhocytes.
During secondary immune response large number of plasma cells are produced in the bone marrow. They secrete large amount of abs. So bone marrow is a source of ab synthesis.
The bone marrow is the site of generation of all circulating blood cells in the adult including lympocytes and is the site of B- cell maturation

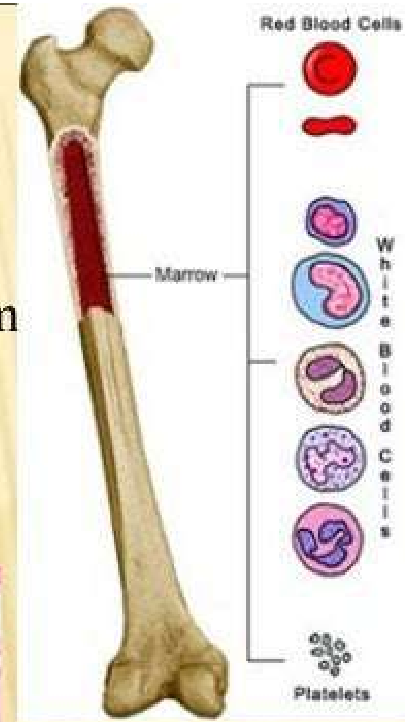
Bone marrow

The bone marrow is the site of generation of all circulating blood cells in the adult, including immature lymphocytes, and is the site of B cell maturation.

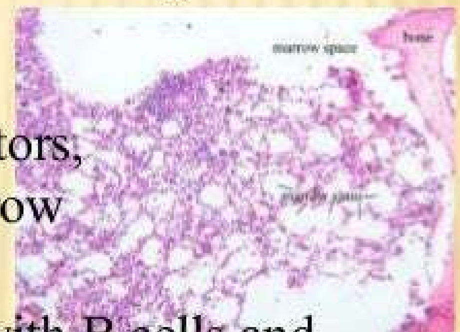
Functions of bone marrow

- The site of generation of all immunocytes
- The site of differentiation and maturation of immunocytes
- The site of immune response of B cell, specifically in secondary immune response.

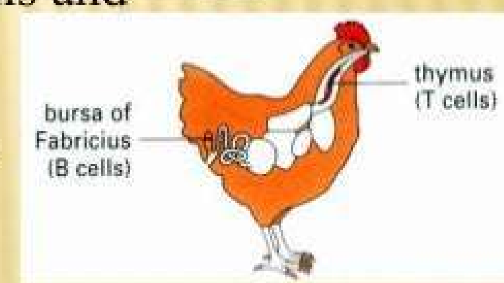
BONE MARROW



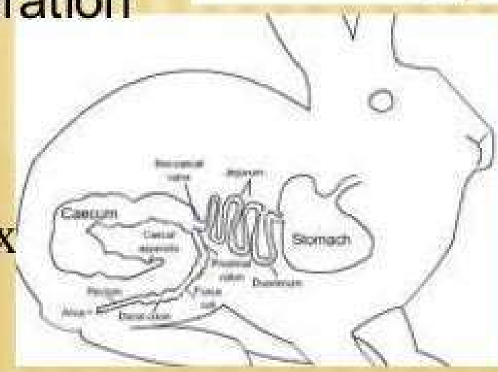
- ❖ All the cells of the immune system are initially derived from the bone marrow through a process called hematopoiesis
- ❖ In human bone marrow is the site for B- cell origin
- ❖ It is the site for B-cell maturation



- ❖ Immature B cells arise from lymphoid progenitors, proliferate and differentiate within the bone marrow
- ❖ The stromal cells in the bone marrow interact with B cells and secrete cytokines and help in the maturation of b-cells .



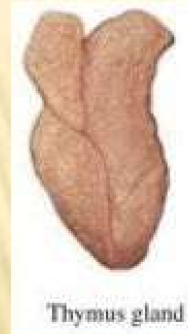
- ✓ In Birds – B-cell development in Bursa of Fabricus
  - ➢ Specific immune organs in birds
  - ➢ The site of differentiation and proliferation of B cells in birds.
- ✓ In cattle and sheep –fetal stage- spleen
  Later- small intestine
- ✓ In Rabbit- gut associated tissue- appendix

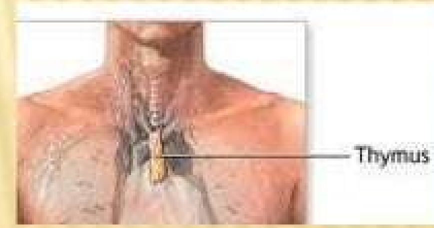


THYMUS:

Thymus is the site of T cell differentiation and maturation

It is a bilobed gland, Situated above heart in the thorax region each lobe is encapsulated and it is divided into lobules which are separated by strands of connective tissue – called trabeculae



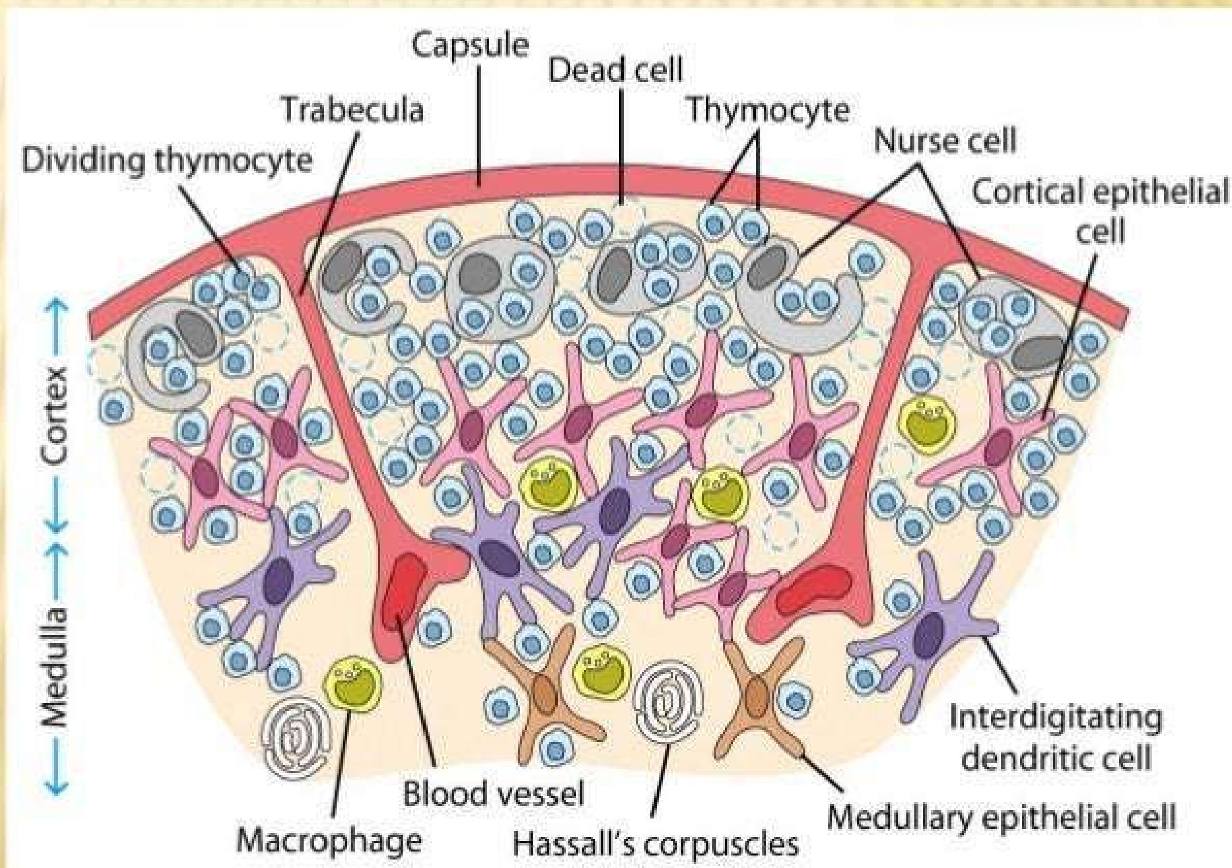


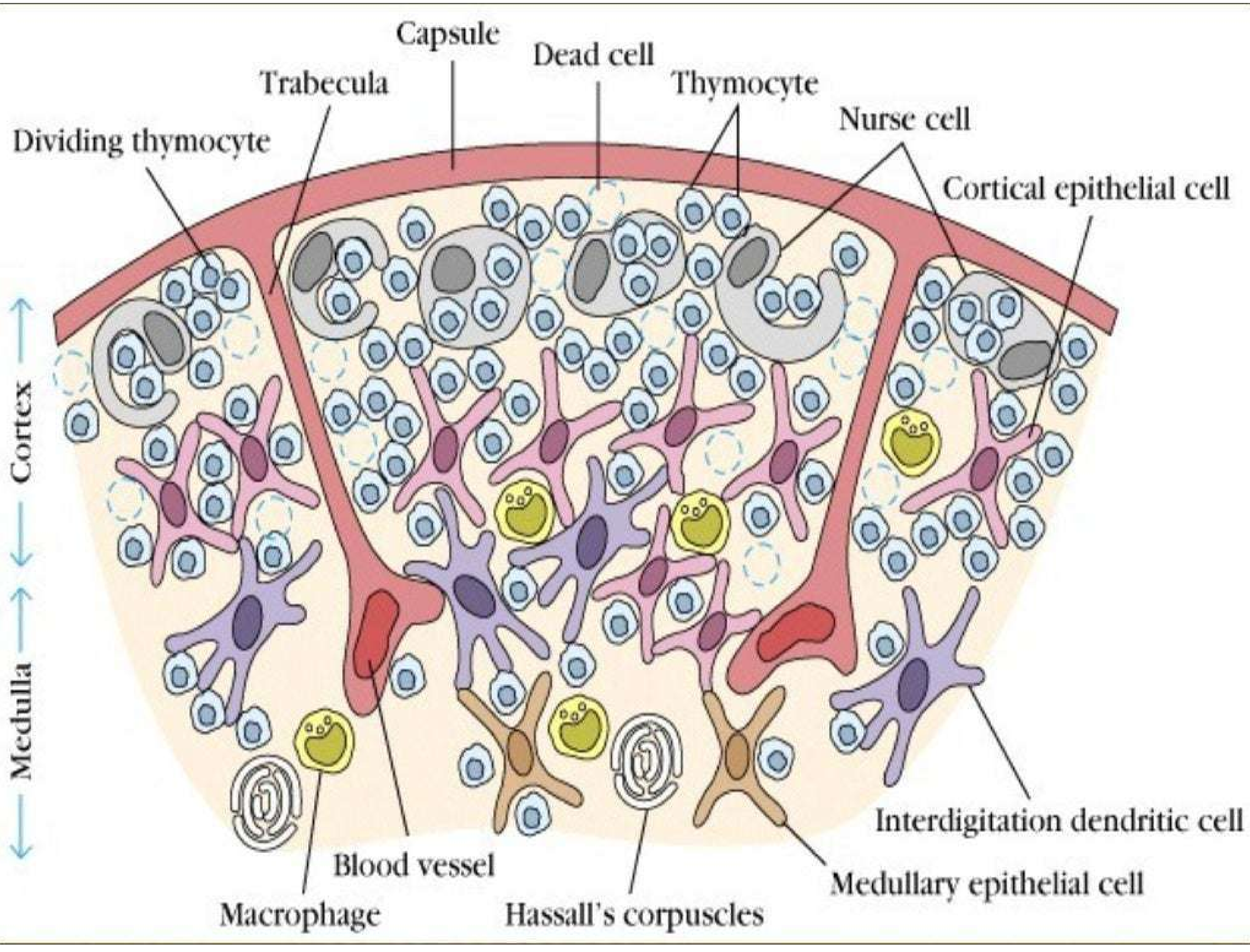
Each lobule contains – lymphocytes & each lobule organized into 2 compartments 1…Outer cortex 2.Inner medulla

Site of T cell maturation.

Relative Size
Greatest in Newborn

Absolute Size
Greatest at Puberty




Capsule
Dead cell
Trabecula
Thymocyte
Nurse cell
Dividing thymocyte
Cortical epithelial cell
Cortex
Medulla
Interdigitation dendritic cell
Blood vessel
Medullary epithelial cell
Macrophage
Hassall's corpuscles

The cortex contains mostly immature & proliferating thymocytes, Medulla is sparly populated with thymocytes.

some of which mature and migrate to the medulla -

in medulla they learn to discriminate between self and non-self during fetal development and for a short time after birth.

T cells leave the medulla to enter the peripheral blood circulation, through which they are transported to the secondary lymphoid organs

About 95% of all T cells die in the thymus.

Besides lymphoid cells it is composed of

1.Epithelial cells (cortical and medullary)

2. Macrophages

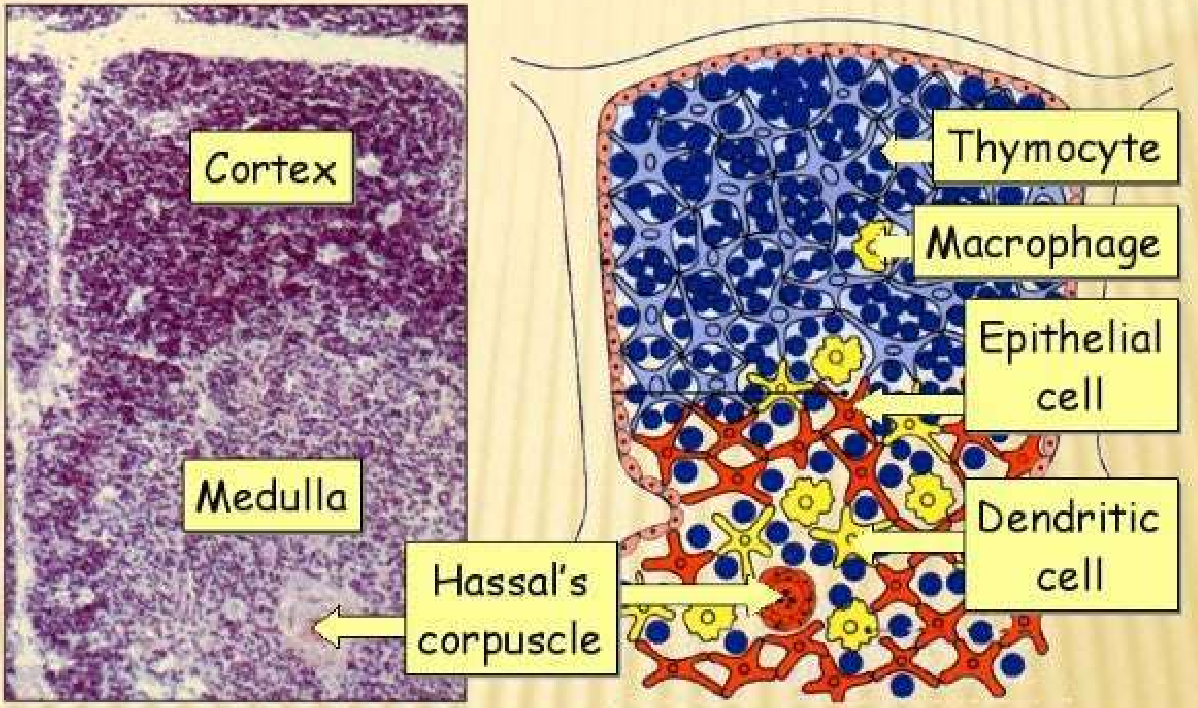
3. Dendritic cells

4. Nurse cells

5. Hassall's corpuscles

Lymphocytes in the thymus are called thymocytes

Thymus Structure



Function of the thymus

- Generate and select T- cells

- Through clonal selection mechanism , thymus cause the death of those T- cells that cannot recognize Ag- MHC- complexes and those that react with self Ag- MHC & stop danger of causing autoimmune diseases.

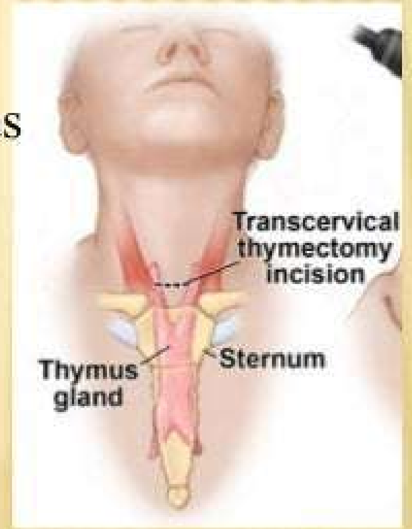
- Thus about 95% of all T cells die in the thymus.

Role Of Thymus In Immune Function

Thymectomy.

- Thymectomy is the surgical removal of thymus

- Thymectomized mice show decrease in circulating lymphocytes & absence of cell mediated immunity



Digeorge's syn.

- Congenital birth defect in humans
- A Mutation on the 22^{nd} Chromosome
- Absence of thymus and so T- cell deficiency

DiGeorge anormaly

Nude mice

Thymus fails to develop

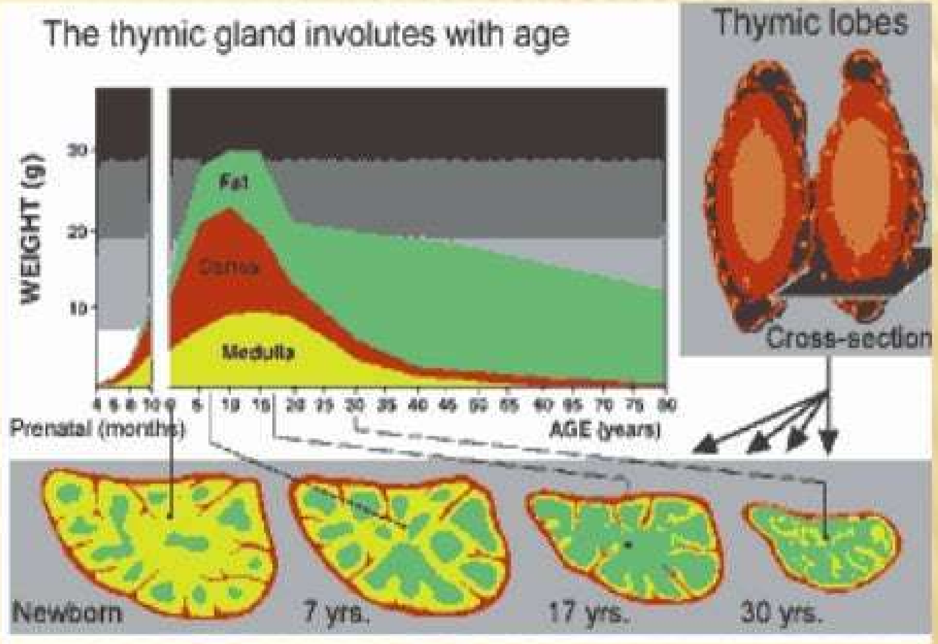
Mutation in the gene encoding a transcription factor

Nude mouse is unable to produce T-cells, and is, therefore, immunodeficient & increase in infections

Nude mice

Aging and thymic function

- Thymus diminishes in size with age
- Thymus attains maximum size at puberty
- Then degenerates with decrease in both cortical & medullary cells
- An increase in total fat content
- In infants the average wt. of thymus is 70g
- In elders the average wt. is 3g
- The age dependent involutions leaves an organ the reduced wt.



Evidence for the effect of age on the immune function

Thymus from 1day old mouse and 33 month was removed and grafted to thymectomized adult.

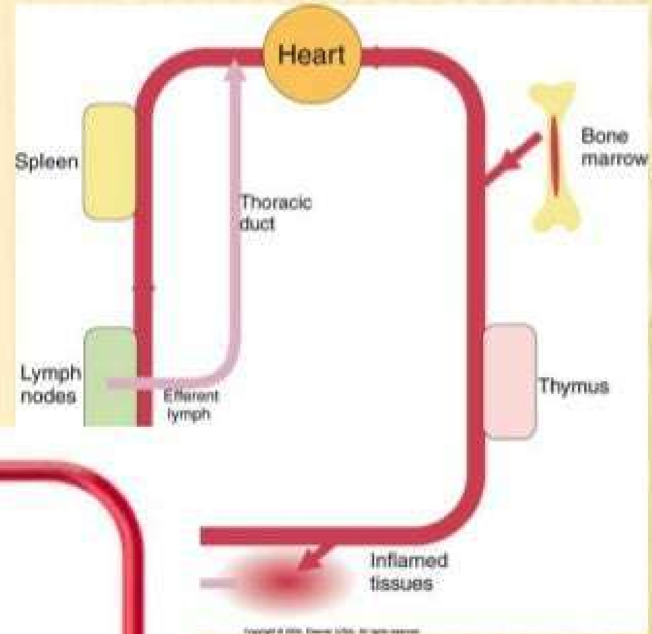
Thymus form 1day –old- mouse showed large improvement in immune function than mice receiving the 33 month old thymus

One way system: to the heart

Return of collected excess tissue fluid

Return of leaked protein

"Lymph" is this fluid
Edema results if system blocked or surgically removed

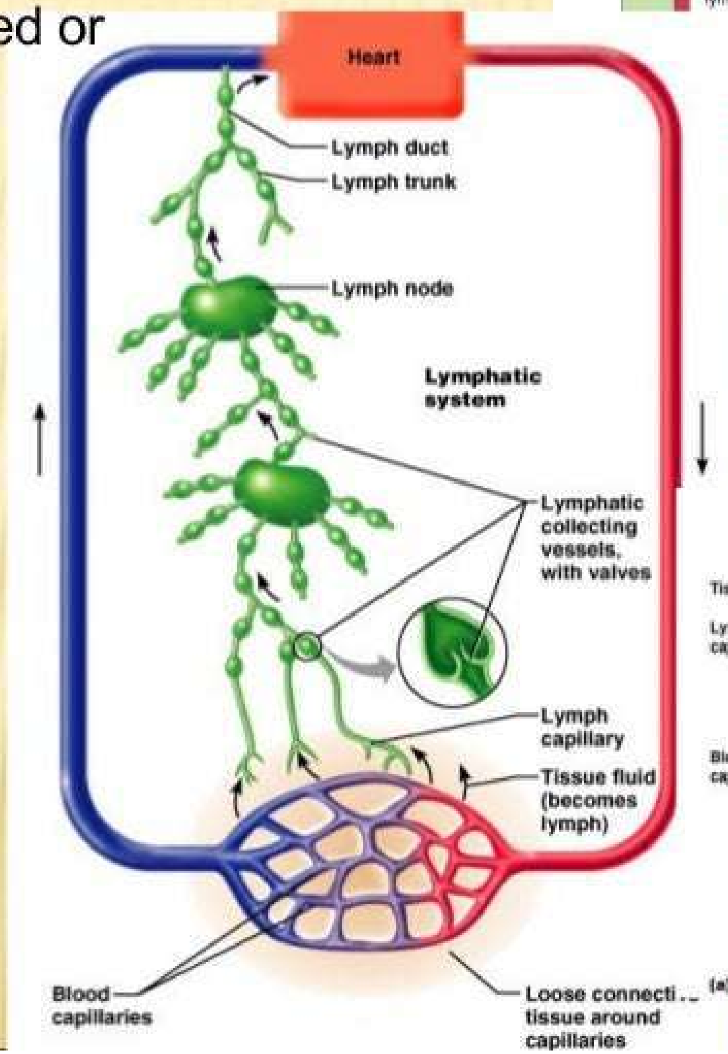


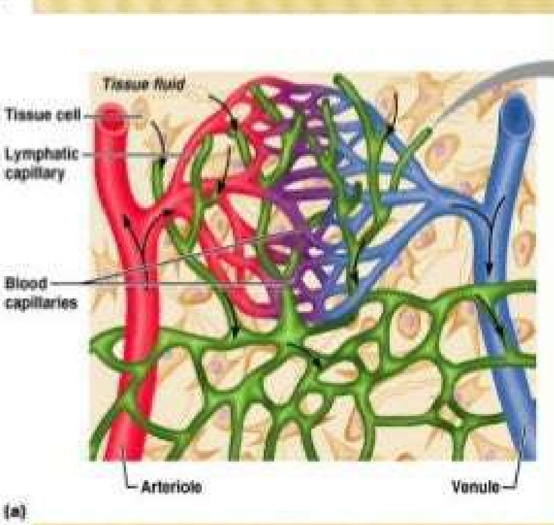
Lymph capillaries

Have one way minivalves allowing excess fluid to enter but not leave

Picks up bacteria and viruses as well as proteins, electrolytes and fluid

(lymph nodes destroy most pathogens)





SECONDARY LYMPHOID ORGANS

- Primary follicle
  - Unactivated lymphoid follicle
- Secondary follicle
  - Follicle that is activated by antigen
  - Ring of B cells that surround germinal center
    - Proliferating B cells and T helper cells

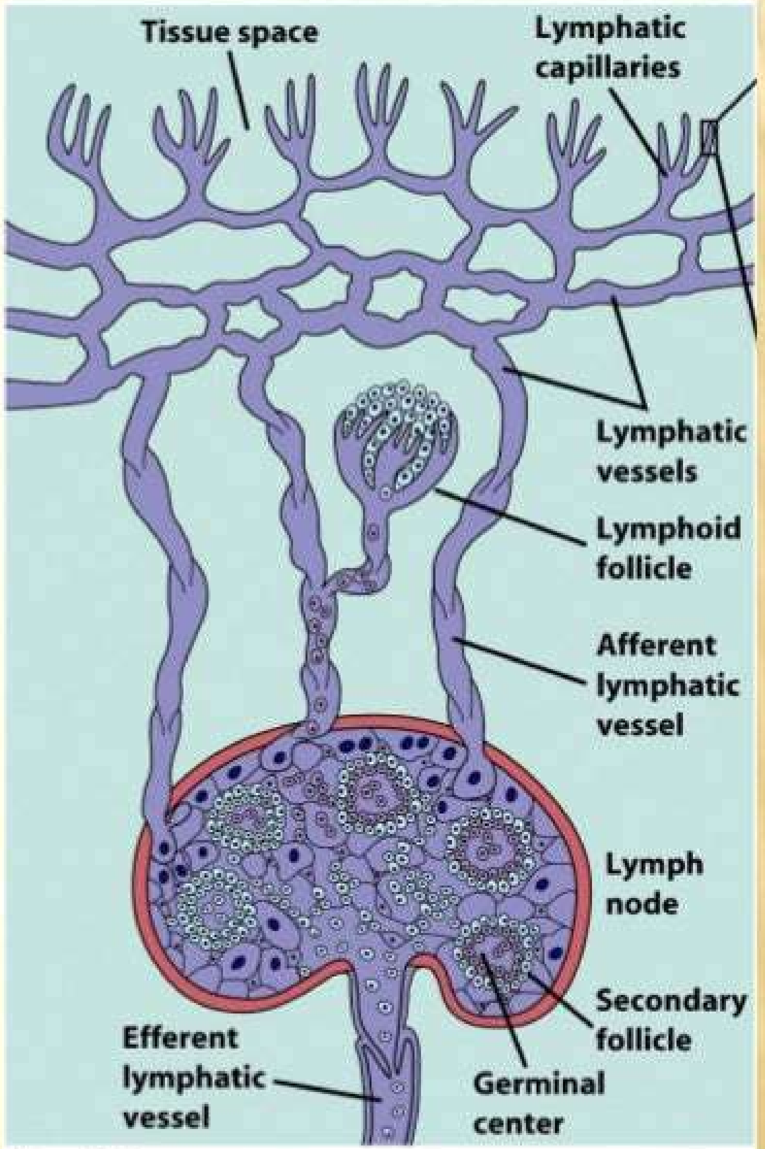


Figure 2-14
Kuby IMMUNOLOGY, Sixth Edition

LYMPHATIC SYSTEM

- Interstitial fluid (the portion that doesn't enter venous system) is returned to circulatory system by lymphatic vessels
- Largest lymphatic vessel – thoracic duct
  - Enters left subclavian vein
  - Lymph from right arm and right side of head enters through right lymphatic duct, drains into right subclavian
- Antigen is carried by lymph to lymph nodes

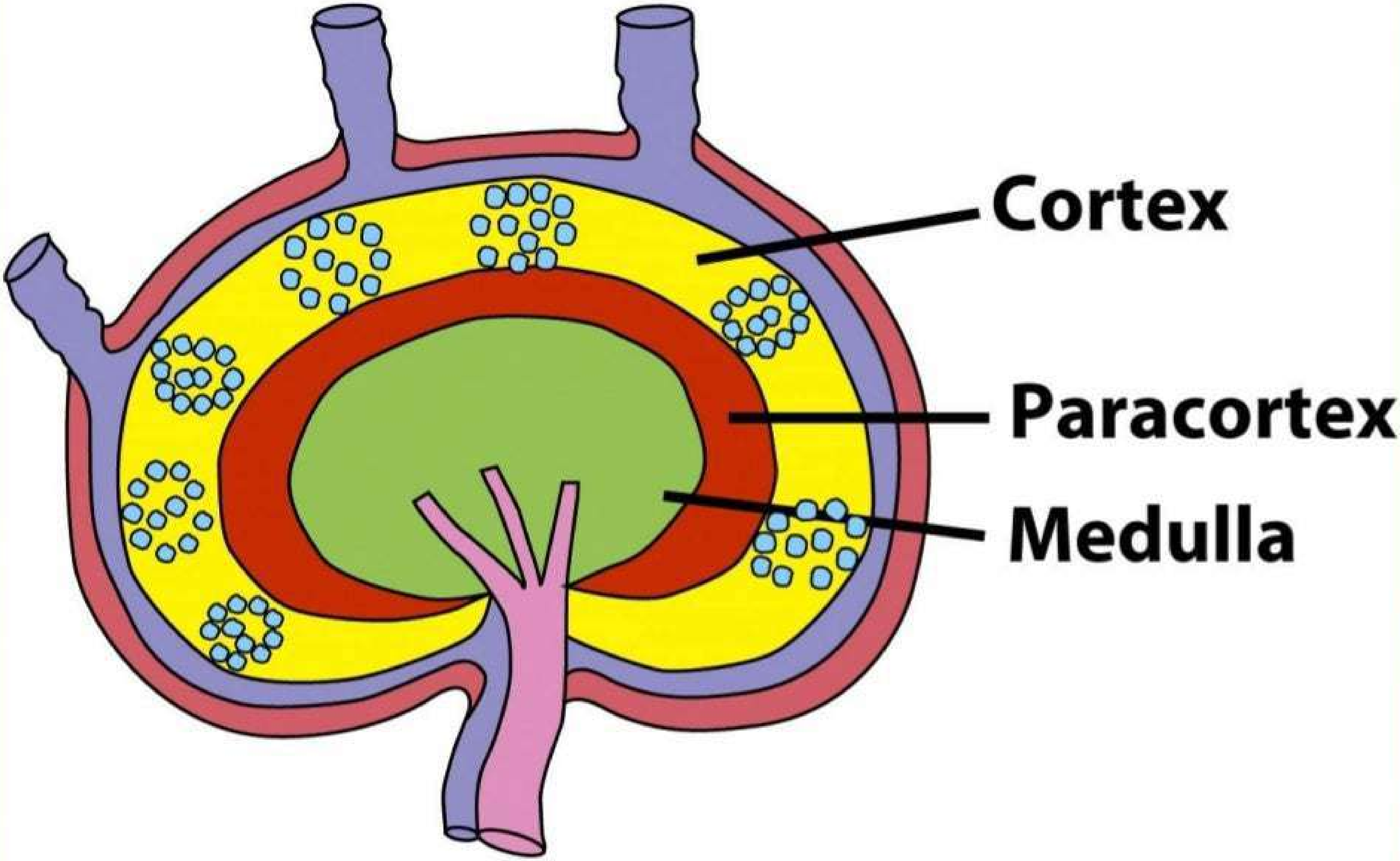
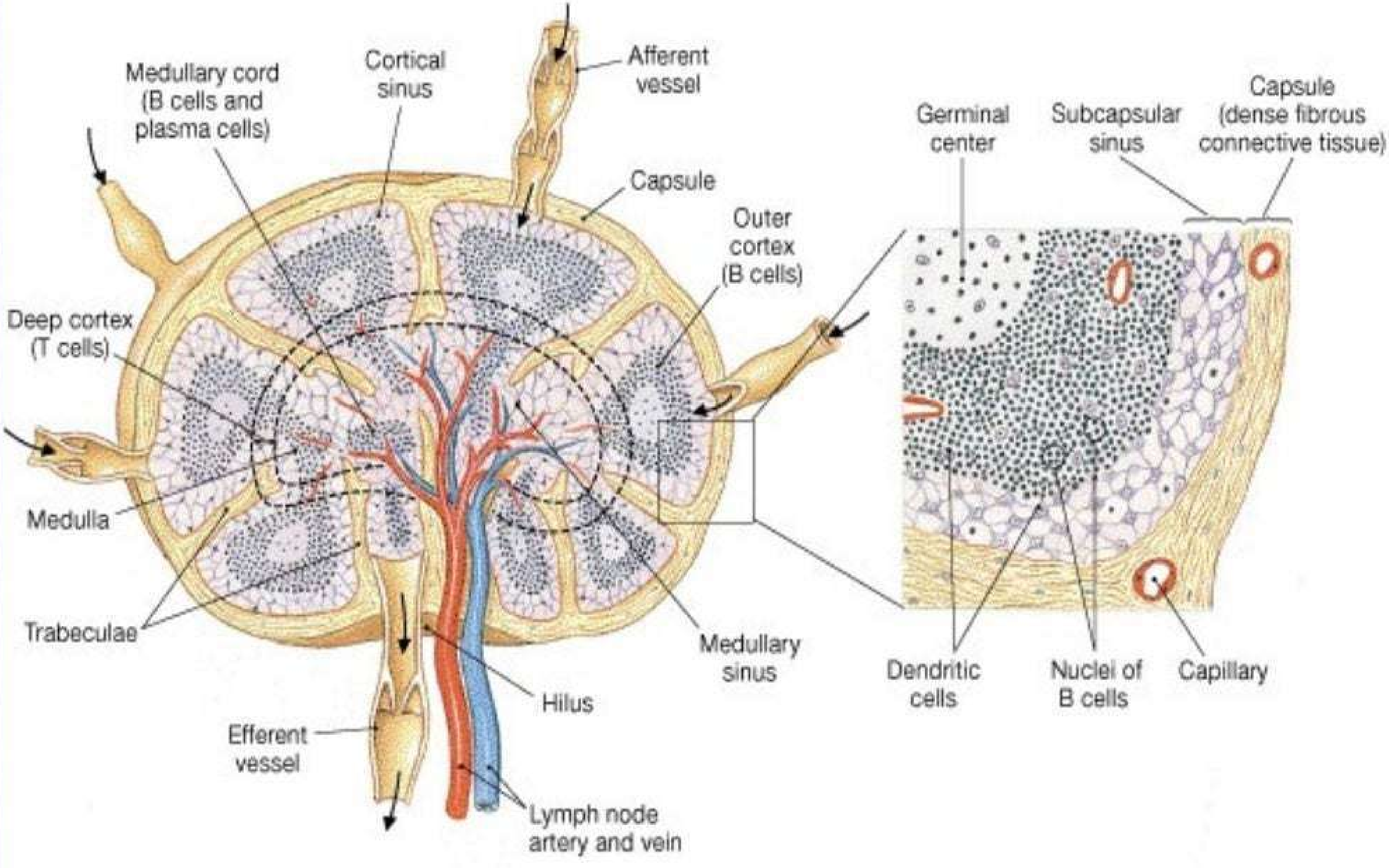


Figure 2-16a
Kuby IMMUNOLOGY, Sixth Edition



Medullary cord (B cells and plasma cells)
Cortical sinus
Afferent vessel
Capsule
Outer cortex (B cells)
Deep cortex (T cells)
Medulla
Trabeculae
Medullary sinus
Hilus
Efferent vessel
Lymph node artery and vein
Germinal center
Subcapsular sinus
Capsule (dense fibrous connective tissue)
Dendritic cells
Nuclei of B cells
Capillary

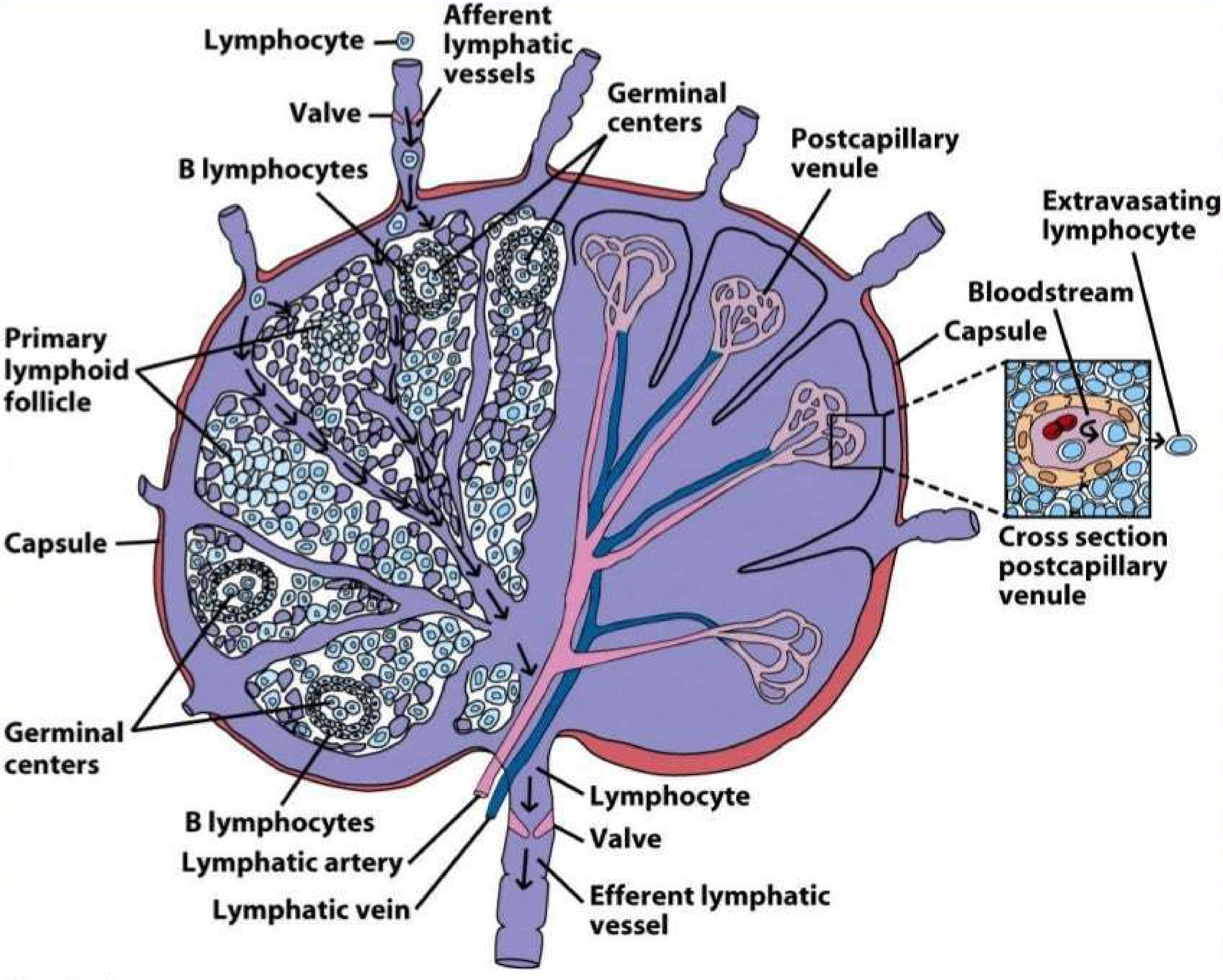


Figure 2-16b
Kuby IMMUNOLOGY, Sixth Edition

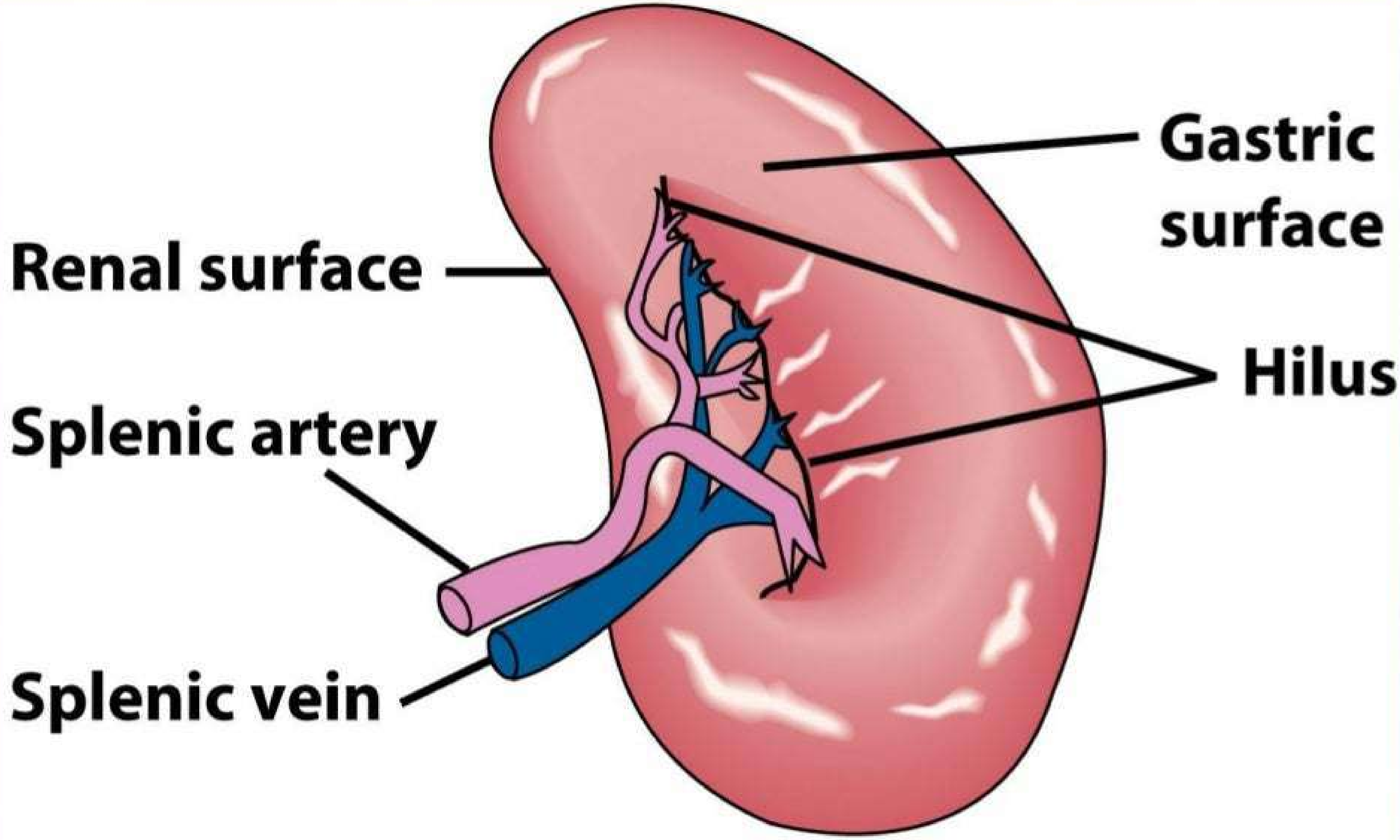


Figure 2-17a
Kuby IMMUNOLOGY, Sixth Edition

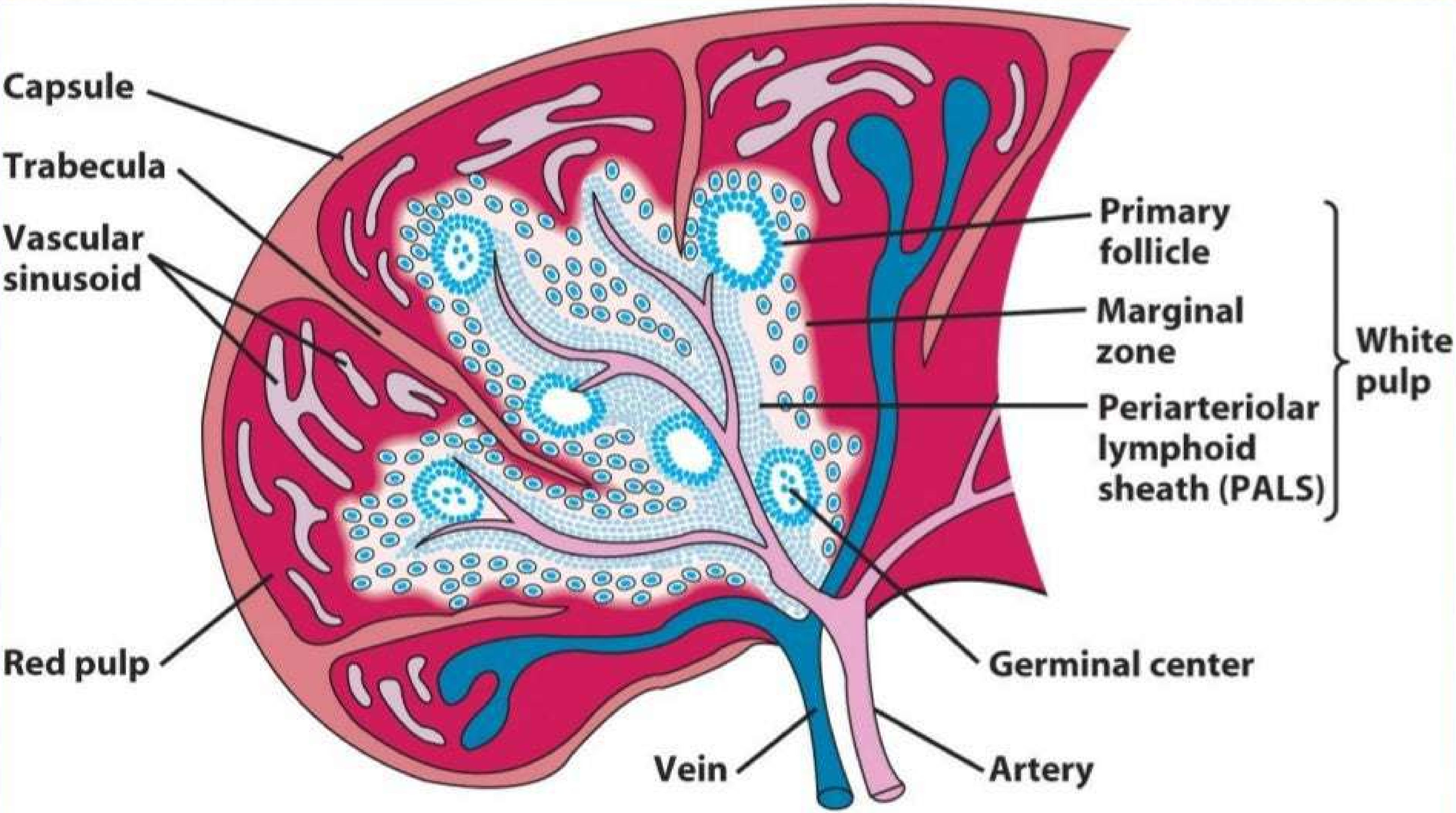


Figure 2-17b
Kuby IMMUNOLOGY, Sixth Edition

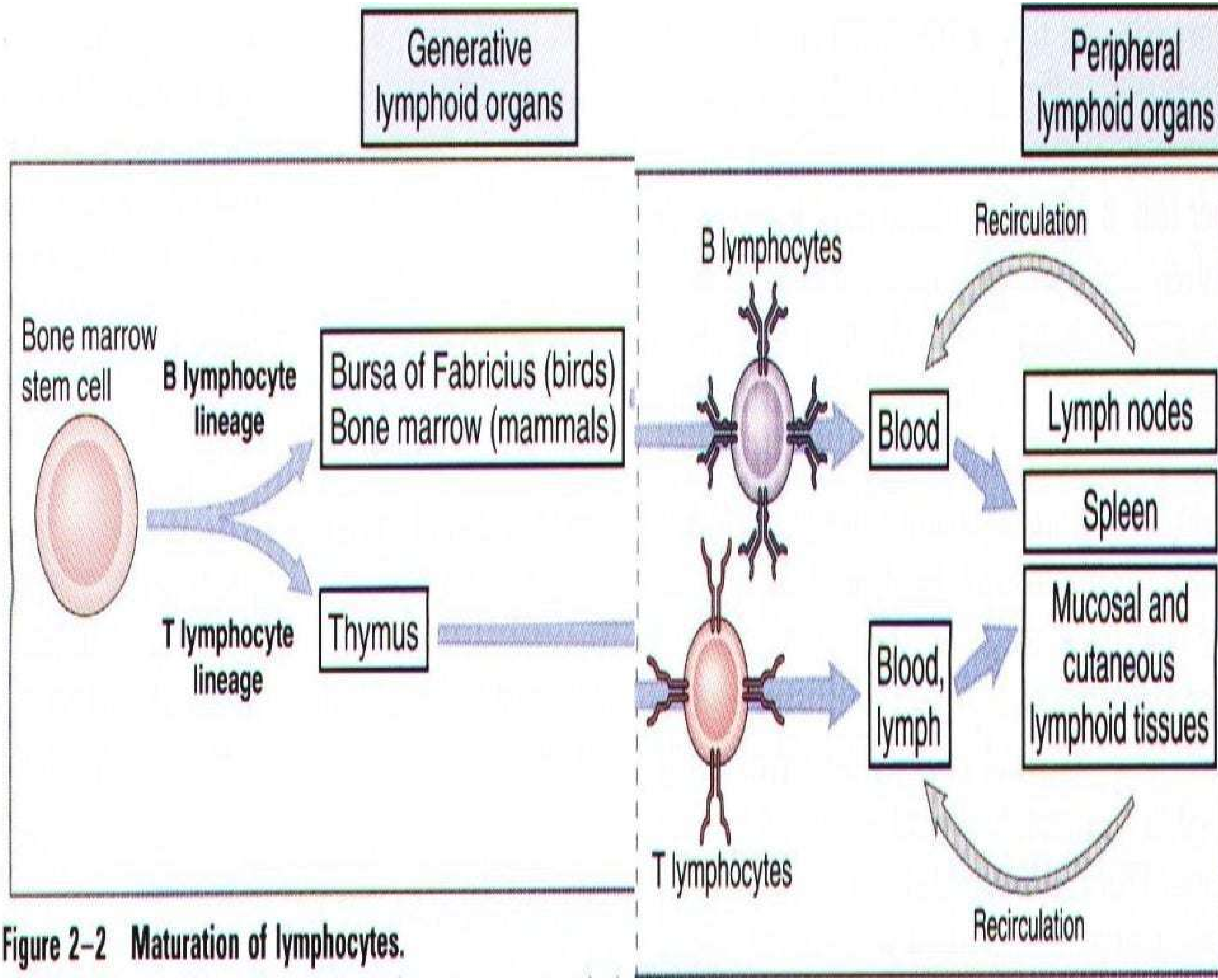


Figure 2–2 Maturation of lymphocytes.

THANK YOU

LYMPHATIC SYSTEM

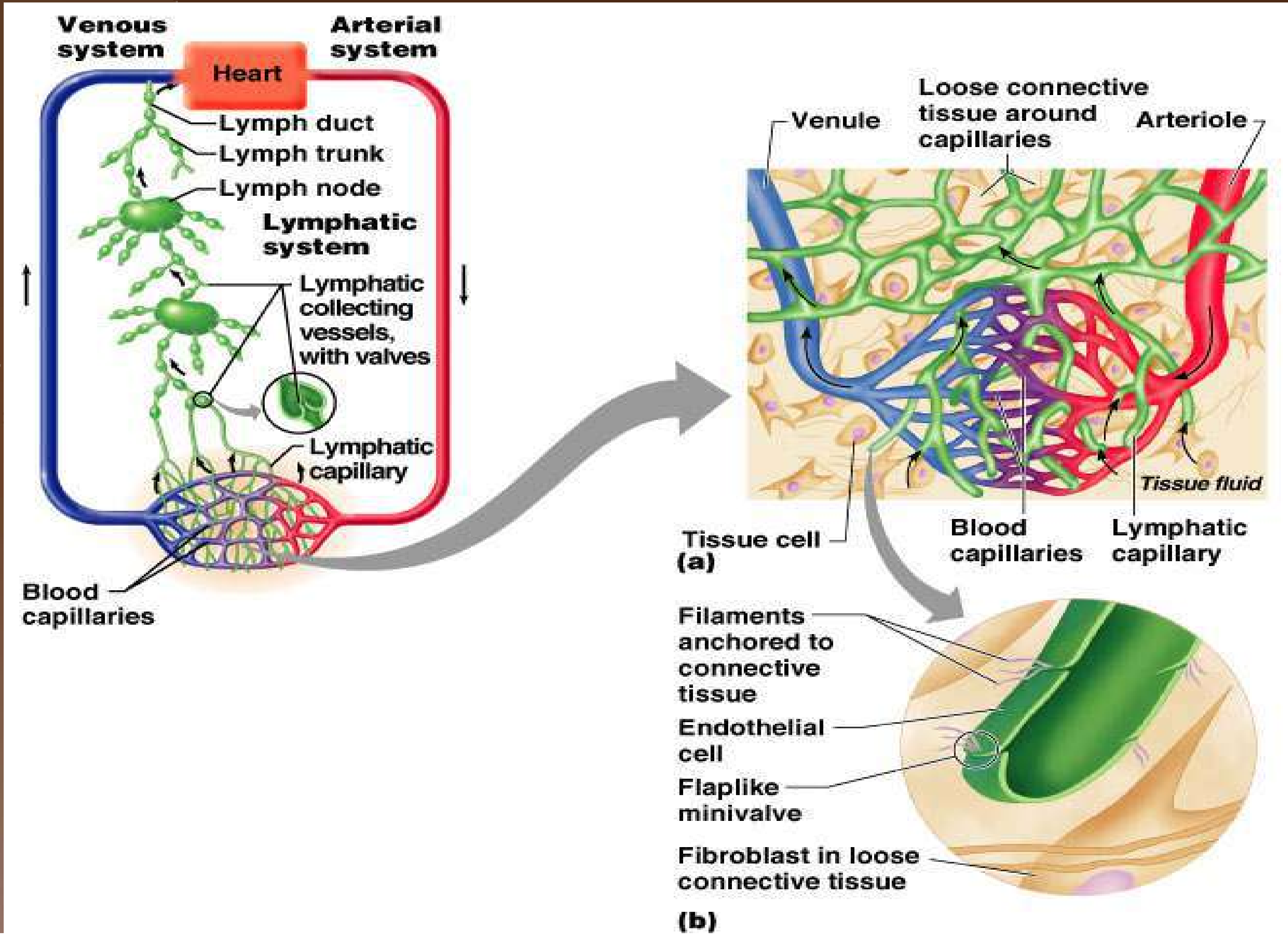
By
HIMA SAILA.M
ASSISTANT PROFESSOR
DEPT OF PHARMACOLOGY

LYMPH

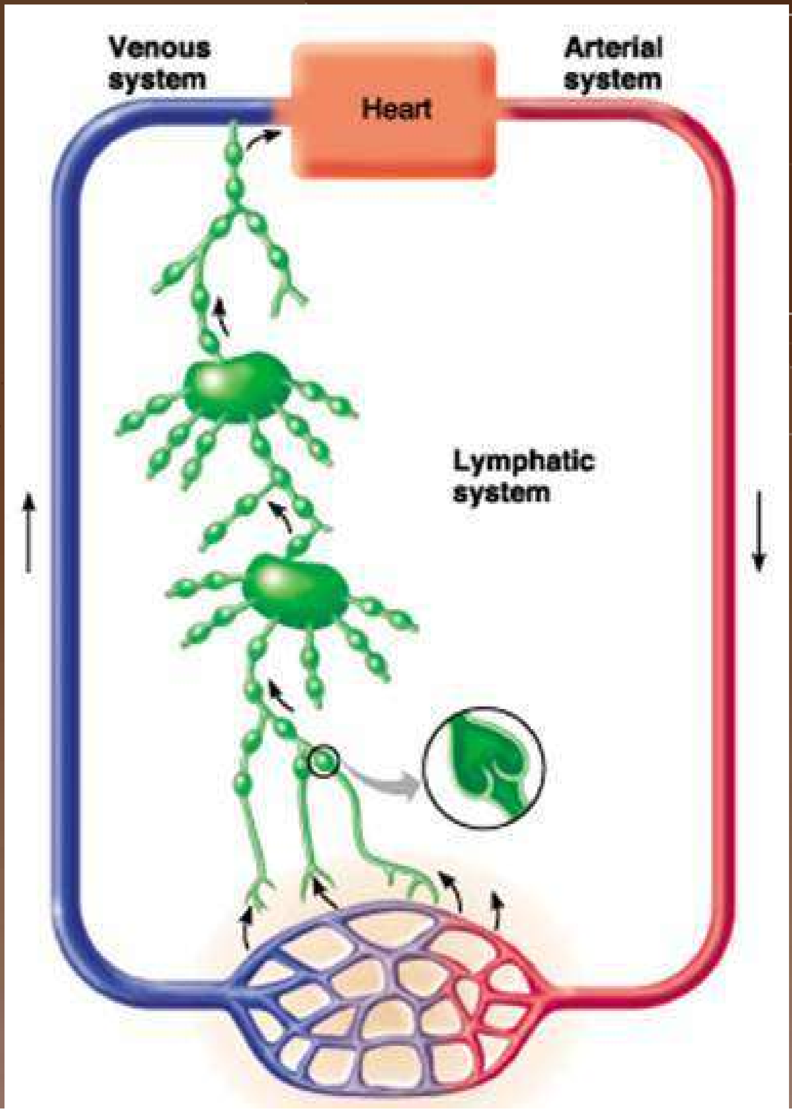
- What is lymph ?

  Tissue fluid (interstitial fluid) that enters the lymphatic vessels

FORMATION AND TRANSPORT OF TISSUE FLUID



LYMPHATIC SYSTEM



Essentially a drainage system accessory to venous system

larger particles that escape into tissue fluid can only be removed via lymphatic system

Functions of the Lymphatic System

24-5

- **Reabsorbs excess interstitial fluid:**
  - returns it to the venous circulation
  - maintain blood volume levels
  - prevent interstitial fluid levels from rising out of control.

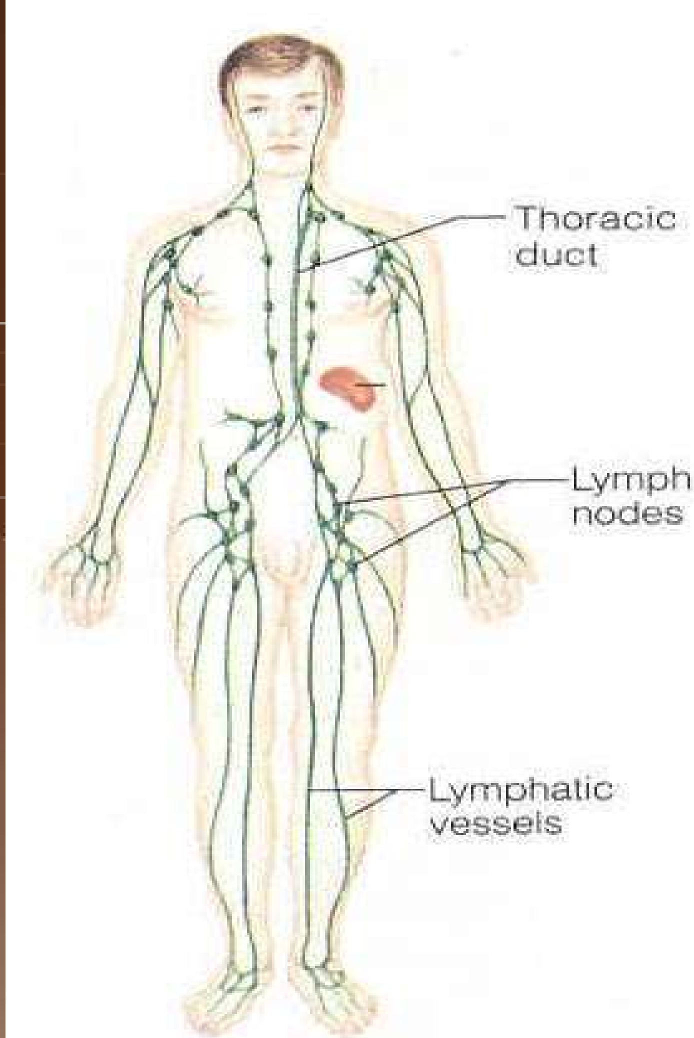
- **Transport dietary lipids:**
  - transported through lacteals
  - drain into larger lymphatic vessels
  - eventually into the bloodstream.

- **lymphocyte development, and the immune response.**

24-6

Components of the Lymphatic System

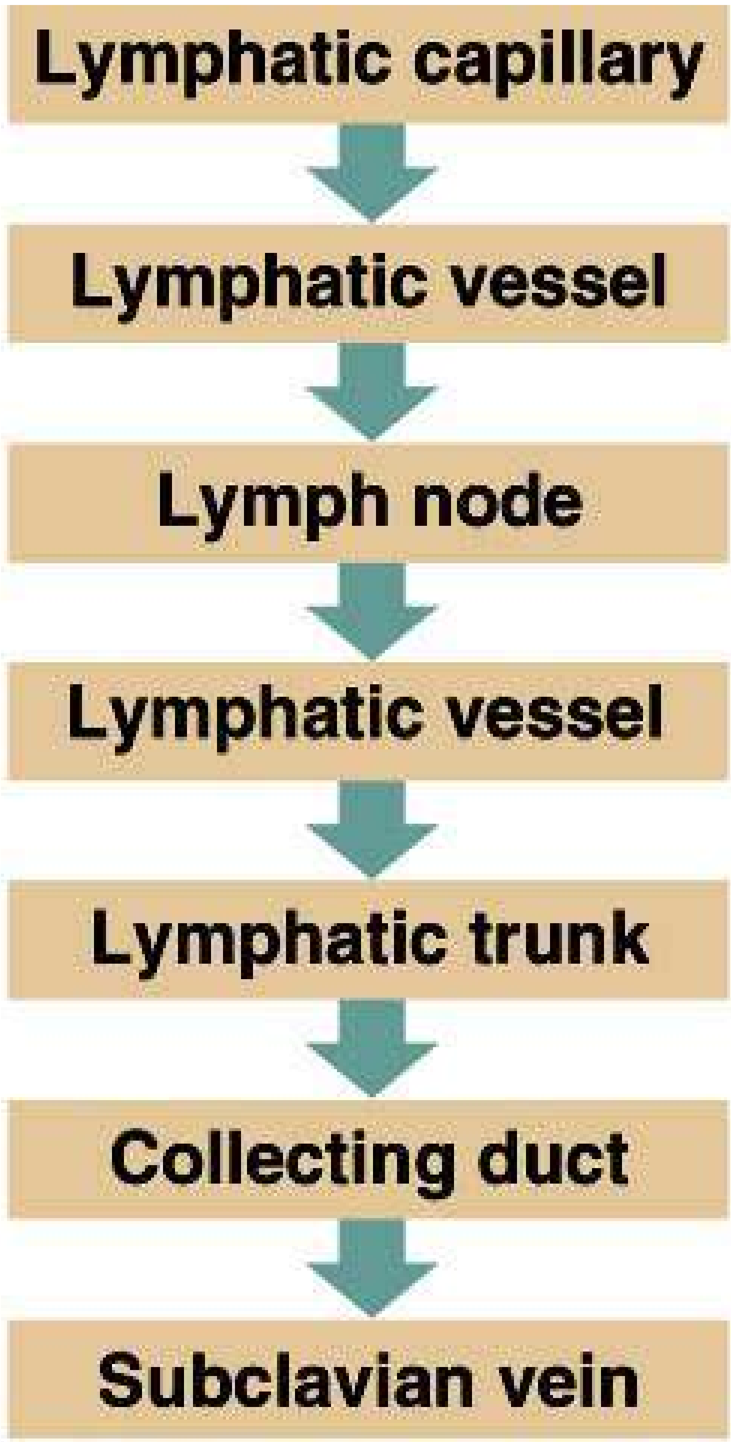
- Lymph
- Lymphatic Vessels
  - Lymphatic Capillaries
  - Lymphatic Vessels
  - Lymphatic Trunks
  - Lymphatic Ducts
- Lymphatic Organs
  - Thymus
  - Lymph Nodes
  - Spleen
  - Tonsils
- Lymphatic cells



Lymphatic system

Lymph Vessels

- Lymphatic **capillaries** –
- Lymphatic **collecting vessels**
- Lymphatic **trunks** –
- Lymphatic **ducts** –

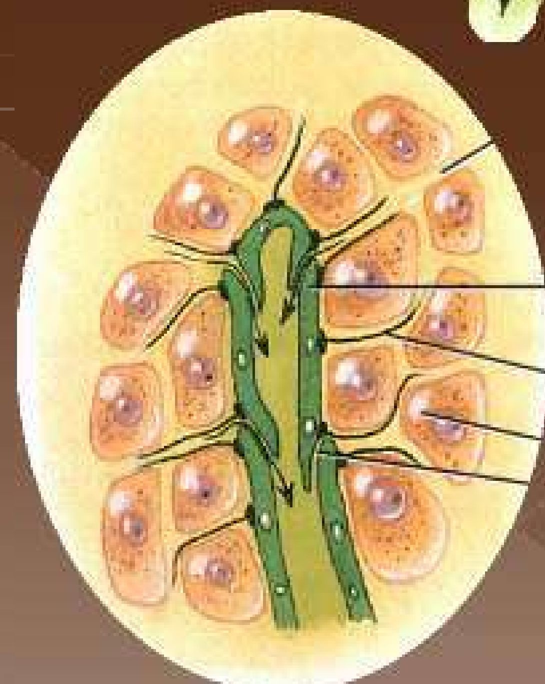

Lymphatic capillary
Lymphatic vessel
Lymph node
Lymphatic vessel
Lymphatic trunk
Collecting duct
Subclavian vein

Lymphatic Capillaries

24-9

Features of structure:

- Blind end
- Single layer of overlapping endothelial cells
- More permeable than that of blood capillary
- Absent from avascular structures, brain, spinal cord splenic pulp and bone marrow



Lymphatic Capillaries – Lacteals

24-10

- The small intestine contains special types of lymphatic capillaries called lacteals.
- Lacteals pick up not only interstitial fluid, but also dietary lipids and lipid-soluble vitamins.
- The lymph of this area has a milky color due to the lipid and is also called chyle.

Lymphatic Vessels

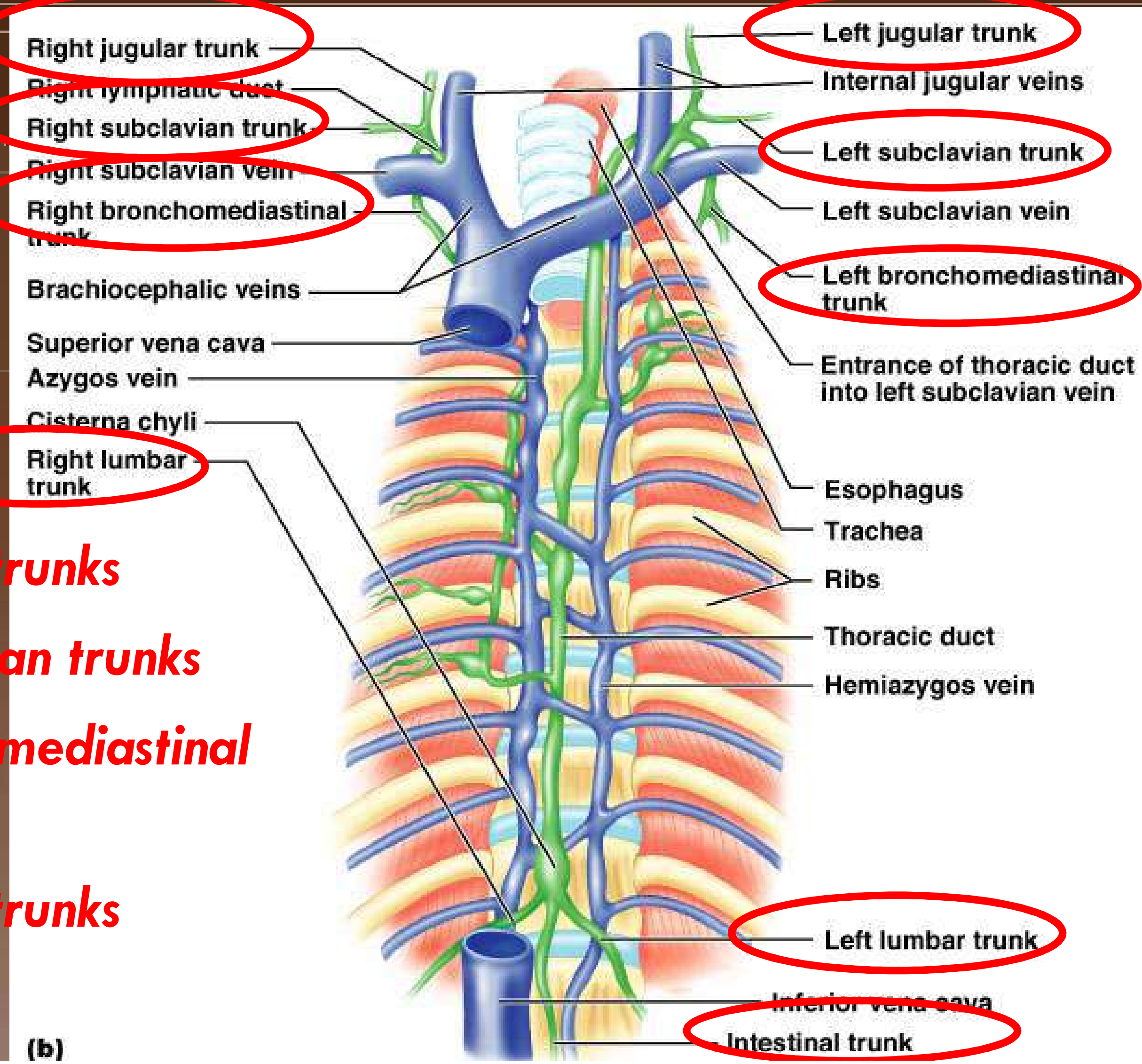
24-11

11

Features of structure

- Three layered wall but thinner than vein,
- More numerous valves than in vein
- Interposed by lymph nodes at intervals
- Arranged in superficial and deep sets

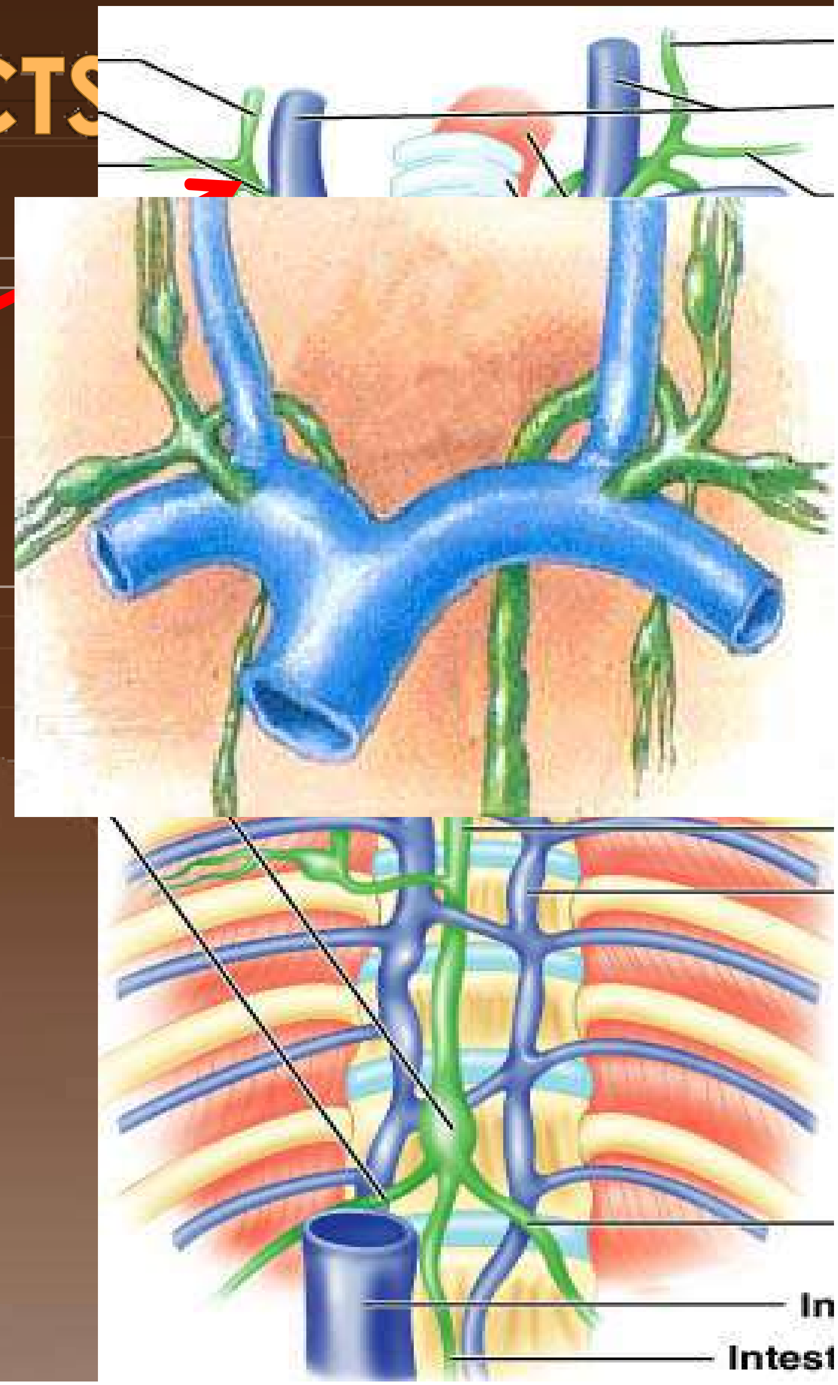
LYMPH TRUNKS



- *right and left **jugular trunks***
- *right and left **subclavian trunks***
- *right and left **bronchomediastinal trunks***
- *right and left **lumbar trunks***
- ***intestinal trunk***

LYMPHATIC DUCTS

Right lymphatic duct



- Formed by union of right jugular, subclavian, and bronchomediastinal trunks

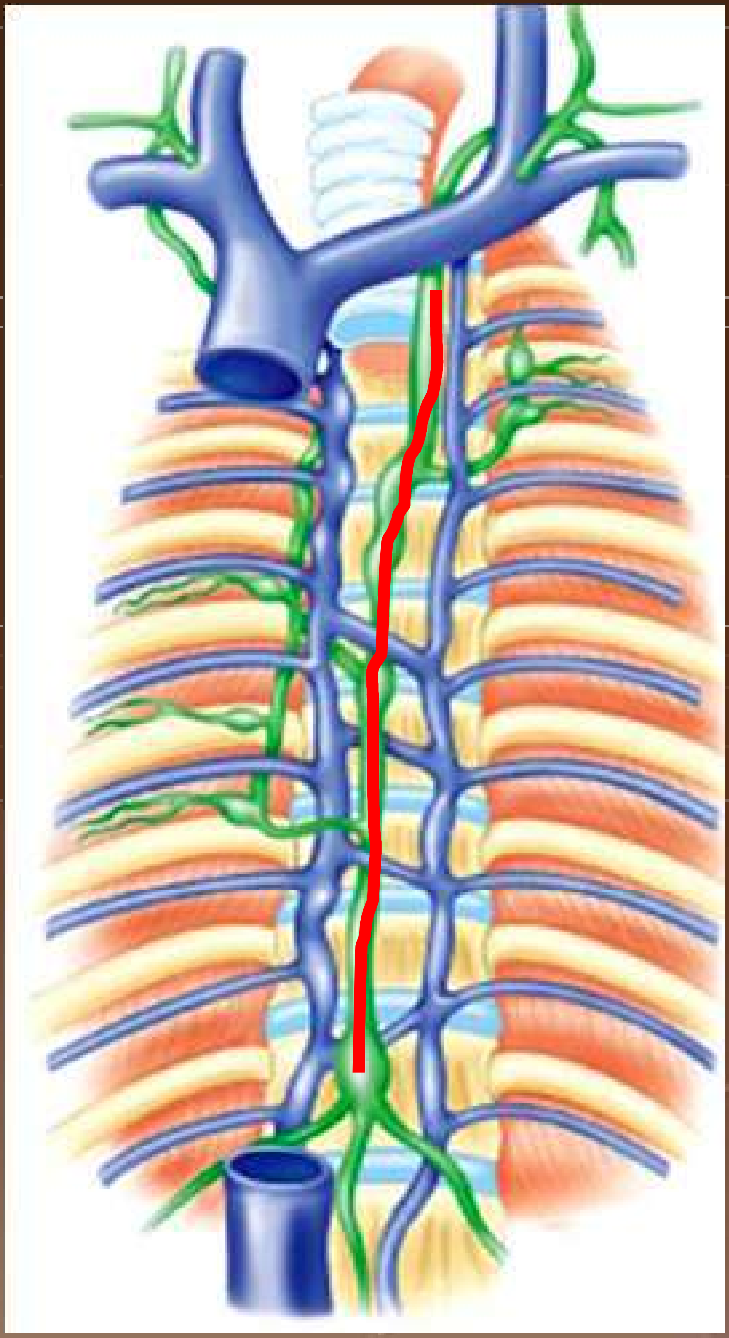
- Ends by entering the right venous angle

LYMPHATIC DUCTS

14

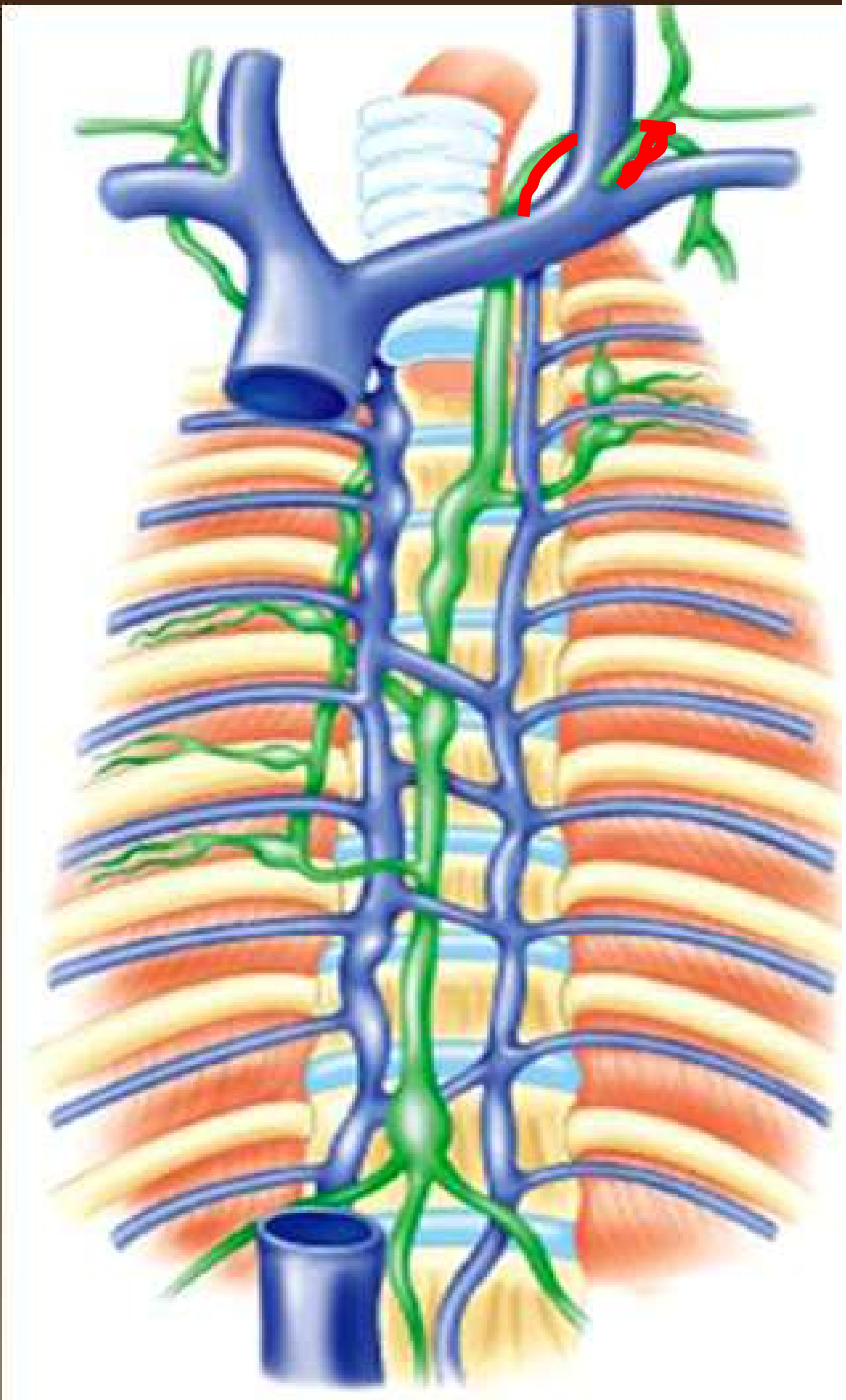
Thoracic duct

- Begins in front of L1 as a dilated sac, the cisterna chyli,
- formed by left and right lumbar trunks and intestinal trunk
- Enter thoracic cavity & ascends
- Travels upward, veering to the left at the level of T5



THORACIC DUCT..

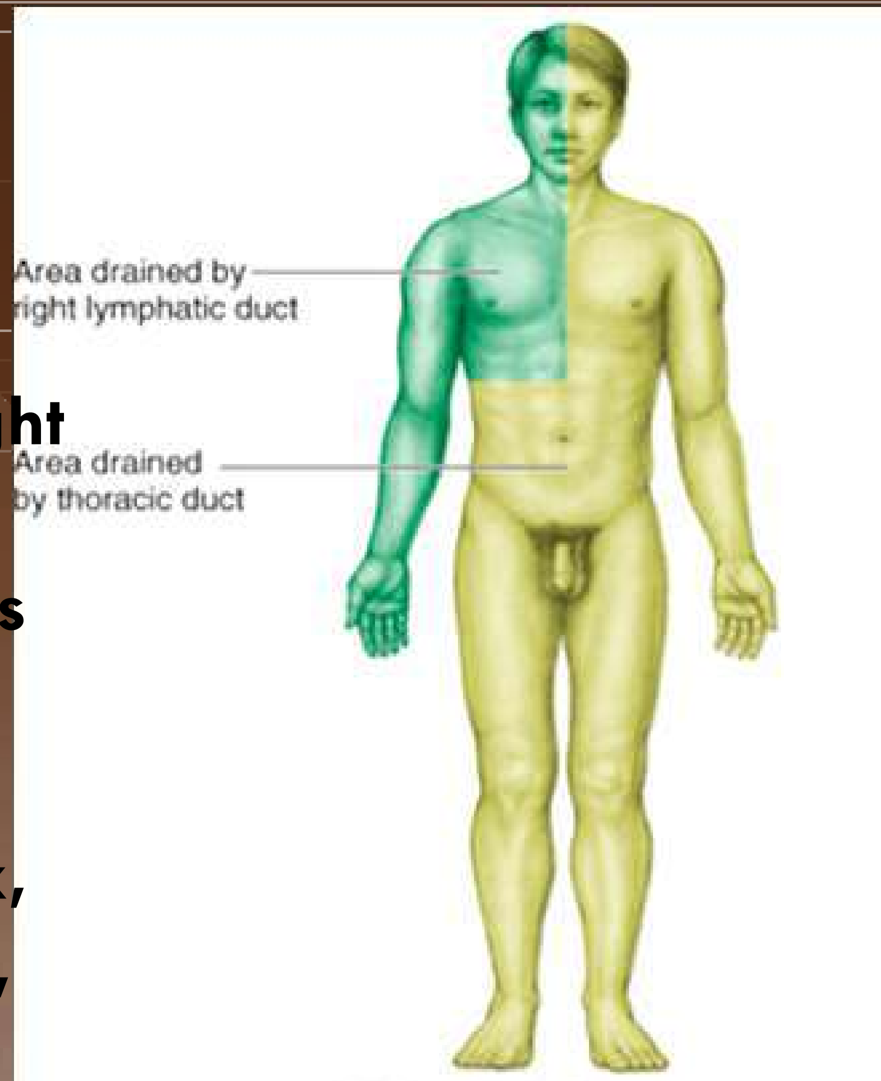
- At the root of the neck, it turns laterally
- arches forwards and descends to enter the left venous angle
- before termination, it receives the left jugular, Subclavian and broncho-mediastinal trunk



DRAINAGE PATTERN

RIGHT LYMPHATIC DUCT - Receives lymph from right half of head, neck, thorax and right upper limb, right lung, right side of heart, right surface of liver

THORACIC DUCT - Drains lymph from lower limbs, pelvic cavity, abdominal cavity, left side of thorax, and left side of the head, neck and left upper limb



(b) Lymph drainage pattern

24-17

Lymphatic Cells

- Also called **lymphoid cells.**
- Located in both the lymphatic system and the cardiovascular system.
- Work together to elicit an **immune response.**
- Types of lymphatic cells are:
  - macrophages
  - epithelial cells
  - dendritic cells
  - lymphocytes

LYMPHATIC ORGANS

18

Primary organs

- Red bone marrow
- Thymus gland

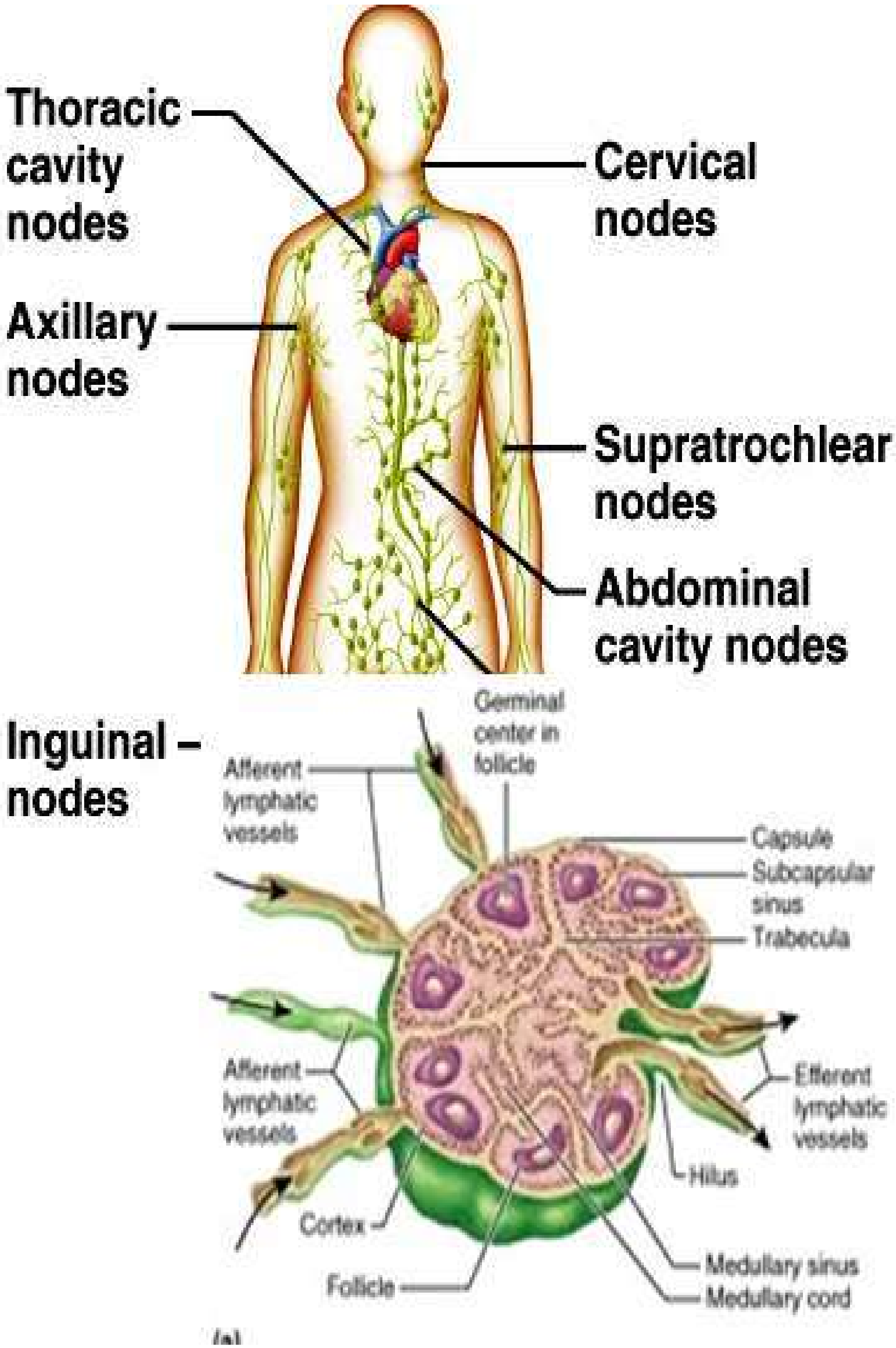
Secondary organs

- Lymph nodes
- Lymph nodules
- Spleen

Lymph Nodes

24-19

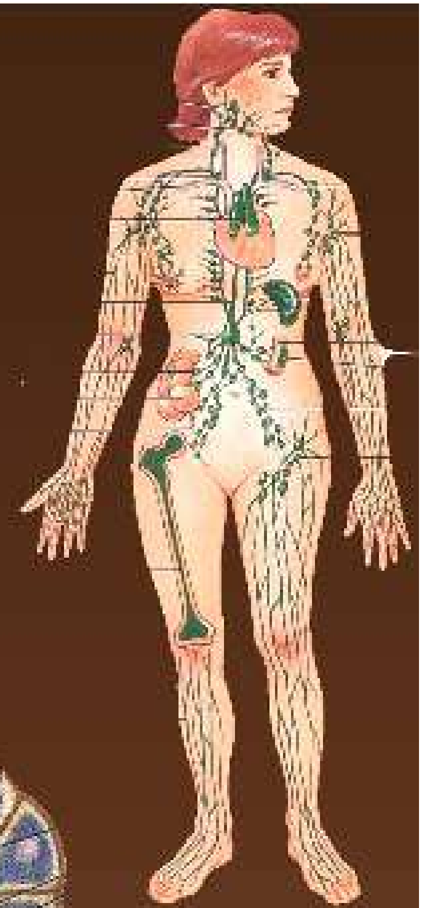
- Small, round or oval
- located along the **pathways** of lymph vessels.
- length from 1 - 25 millimeters
- Typically found in clusters
- receive lymph from many body regions.
- Lymph nodes are also found individually throughout the body tissues.

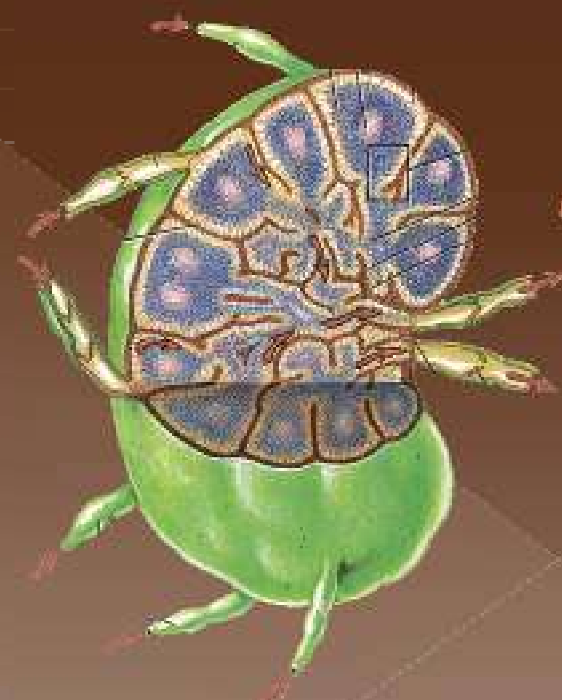


Lymph node

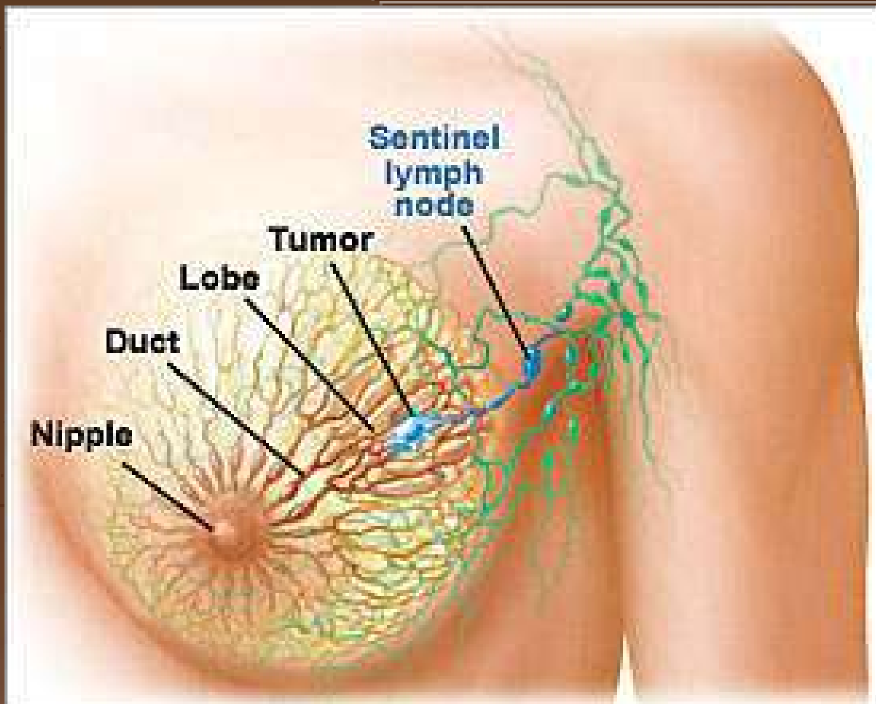
Features

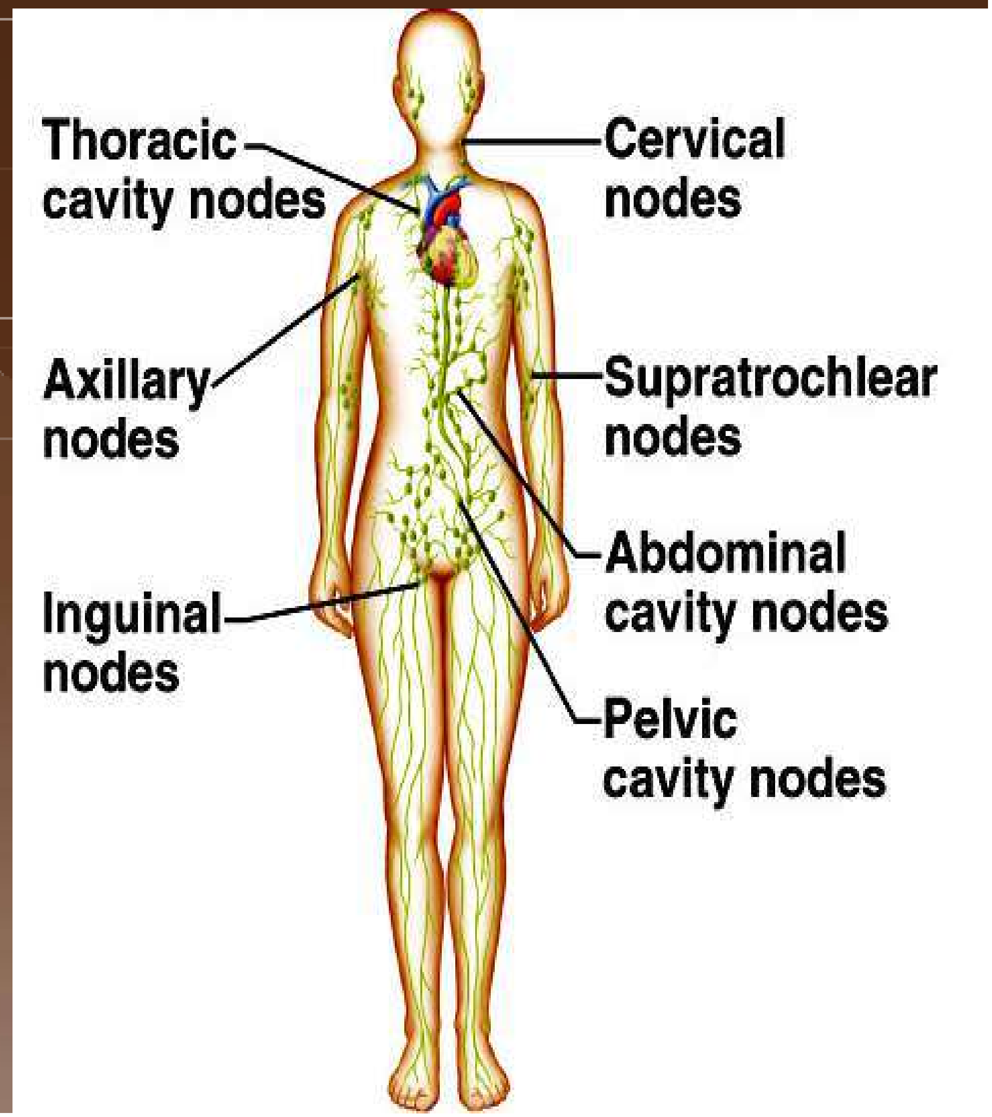
- Bean-shaped bodies
- With afferent vessels (entering at the periphery) and efferent lymph vessels(emerging at the hilus)
- Arranged in groups, along the blood vessels or the flexural side of the joint
- Divided into superficial and deep groups





Regional Lymph drainage

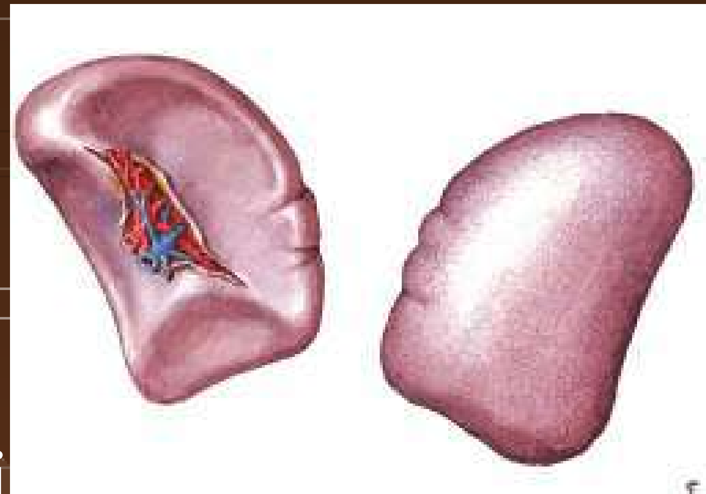


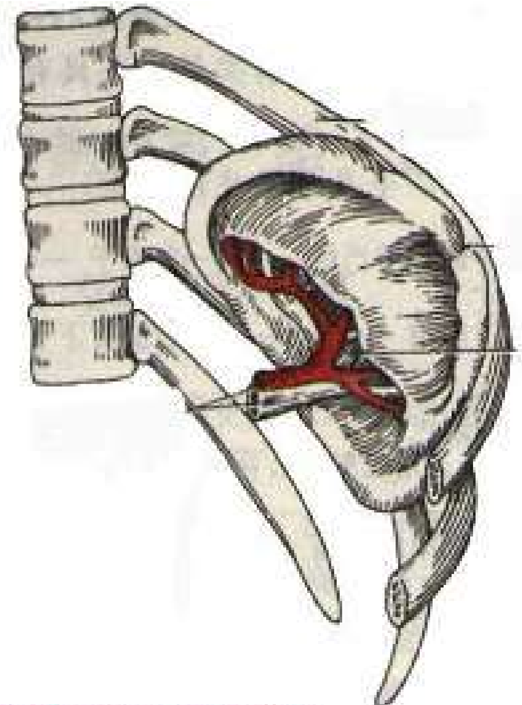


- **Regional Lymph Node** is the lymph node where the lymph of the organ or part of the body drainge to firstly

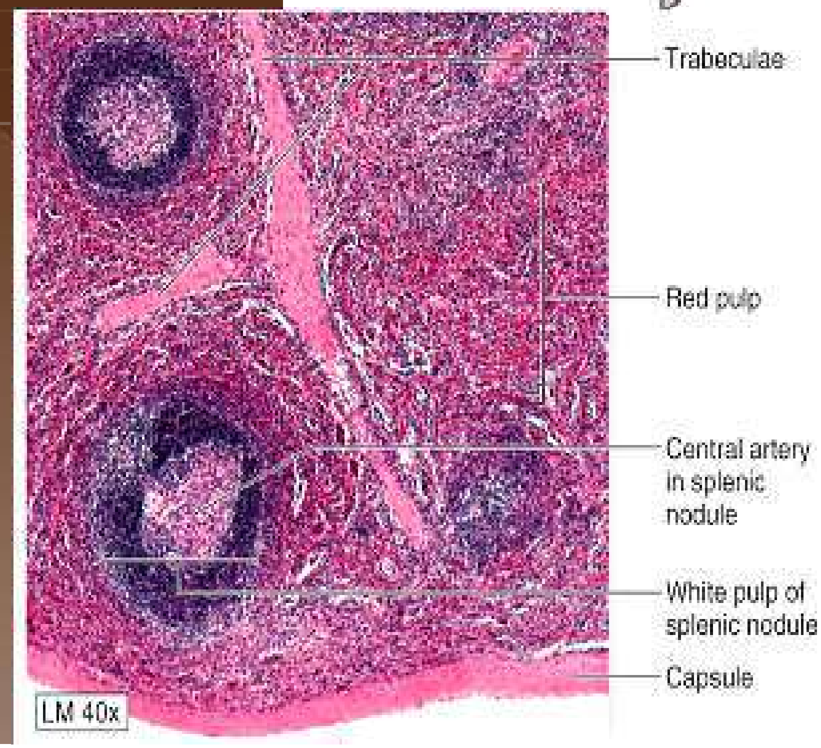
  Sentinel Lymph Node(in clinic)

Spleen





- Location
  - Left epigastric region
  - between 9^{th}-11^{th} rib
  - in line of 10^{th} rib
- Largest lymphatic organ in the body.
- Can vary considerably in size and weight

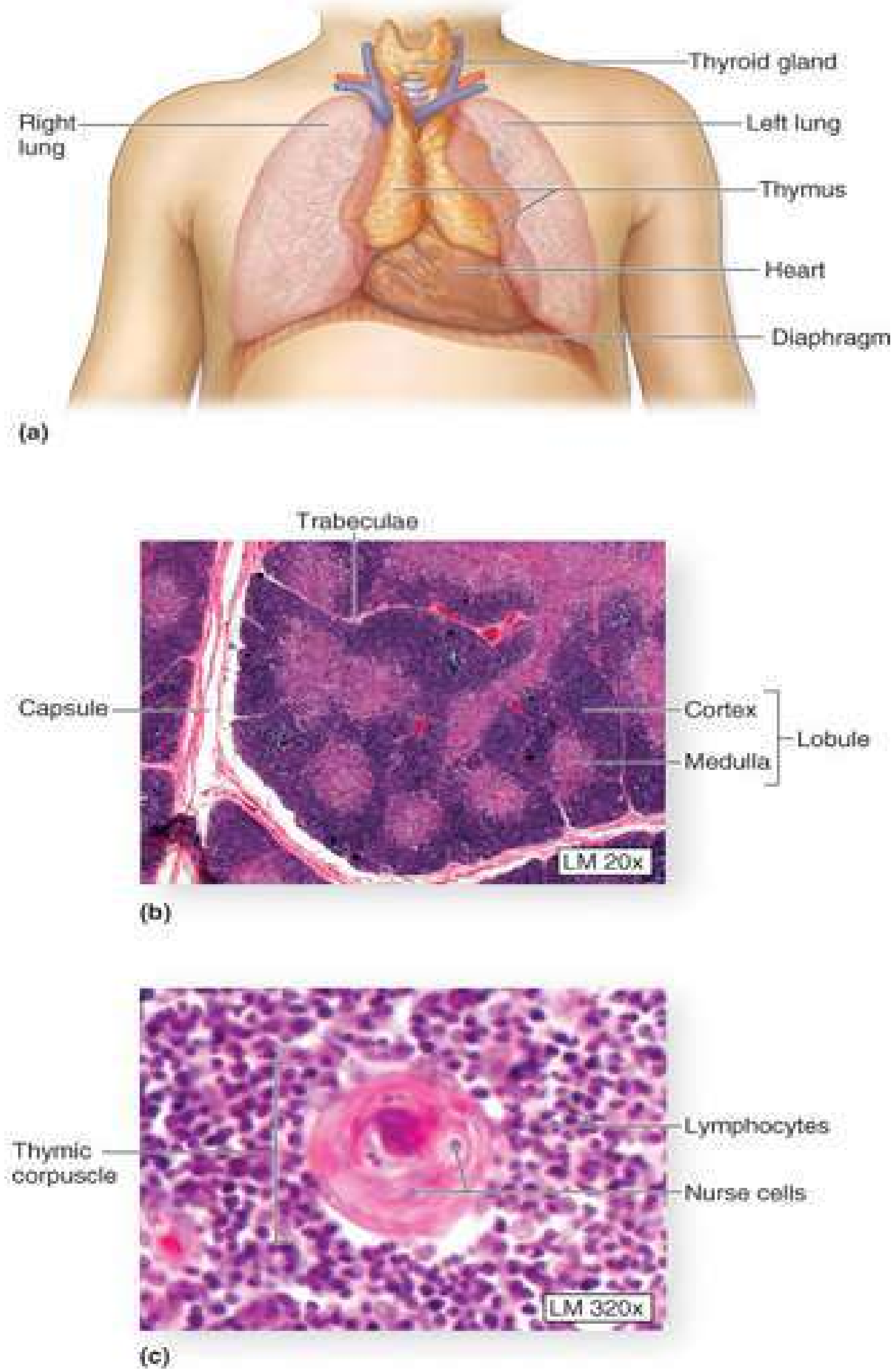


- Function

THYMUS

Features

- Consists of two elongated lobes
- Is a large organ in the fetus
- Occupies the thoracic cavity behind the sternum
- Secrete lymphopoietin



Lymphatic Nodules

24-
24

- **Oval clusters of lymphatic cells with some extracellular matrix that are not surrounded by a connective tissue capsule.**
- Filter and attack antigens.
- In some areas of the body, many lymphatic nodules group together to form larger structures.
  - mucosa-associated lymphatic tissue (MALT) or tonsils
  - very prominent in the mucosa of the small intestine, primarily in the ileum
    - **Peyer patches**
  - also present in the appendix

MALT

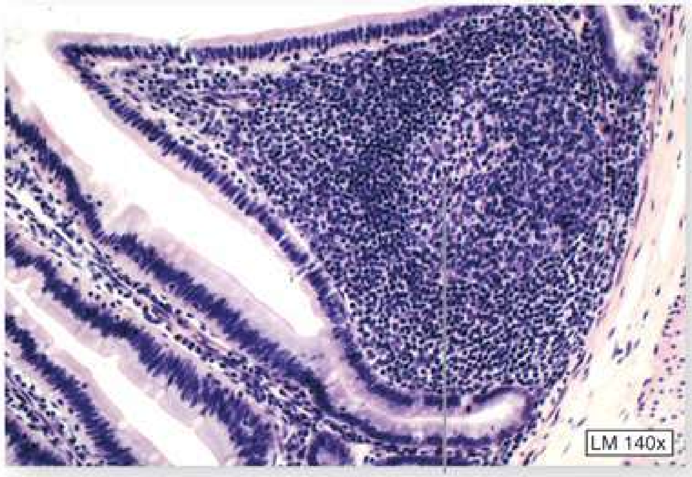
- MALT – mucosa-associated lymphatic tissue:
  - Peyer's patches, tonsils, and the appendix (digestive tract)
  - Lymphoid nodules in the walls of the bronchi (respiratory tract)
- MALT protects the digestive and respiratory systems from foreign matter

Tonsils

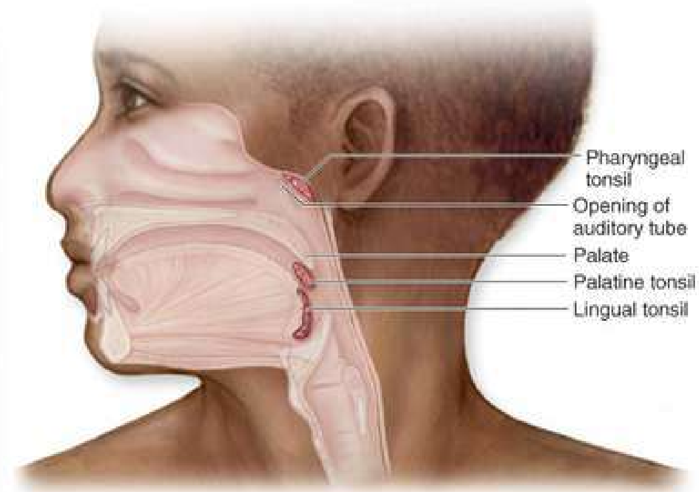
24-26

- clusters of lymphatic cells and extracellular matrix not completely surrounded by a connective tissue capsule.
- Consist of multiple germinal centers and crypts
- Several groups of tonsils form a protective ring around the pharynx.
  - pharyngeal tonsils (or adenoids) in nasopharynx
  - palatine tonsils in oral cavity
  - lingual tonsils along posterior one-third of the tongue

MALT (Mucosa Associated Lymphoid Tissue)



(a)



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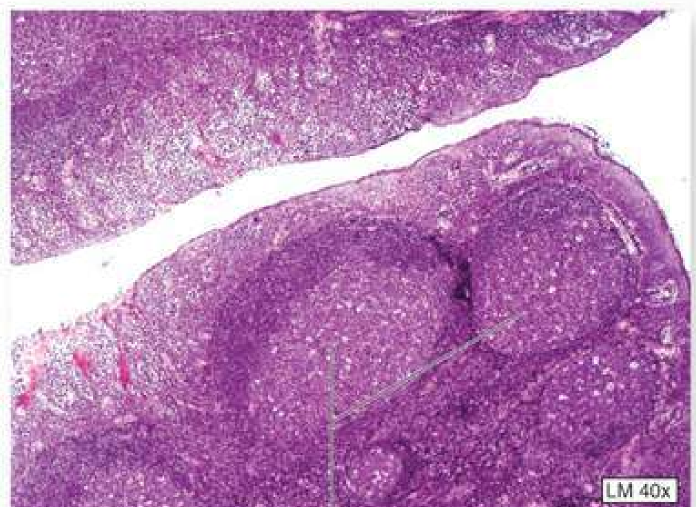


DISORDERS OF LYMPHATIC SYSTEM

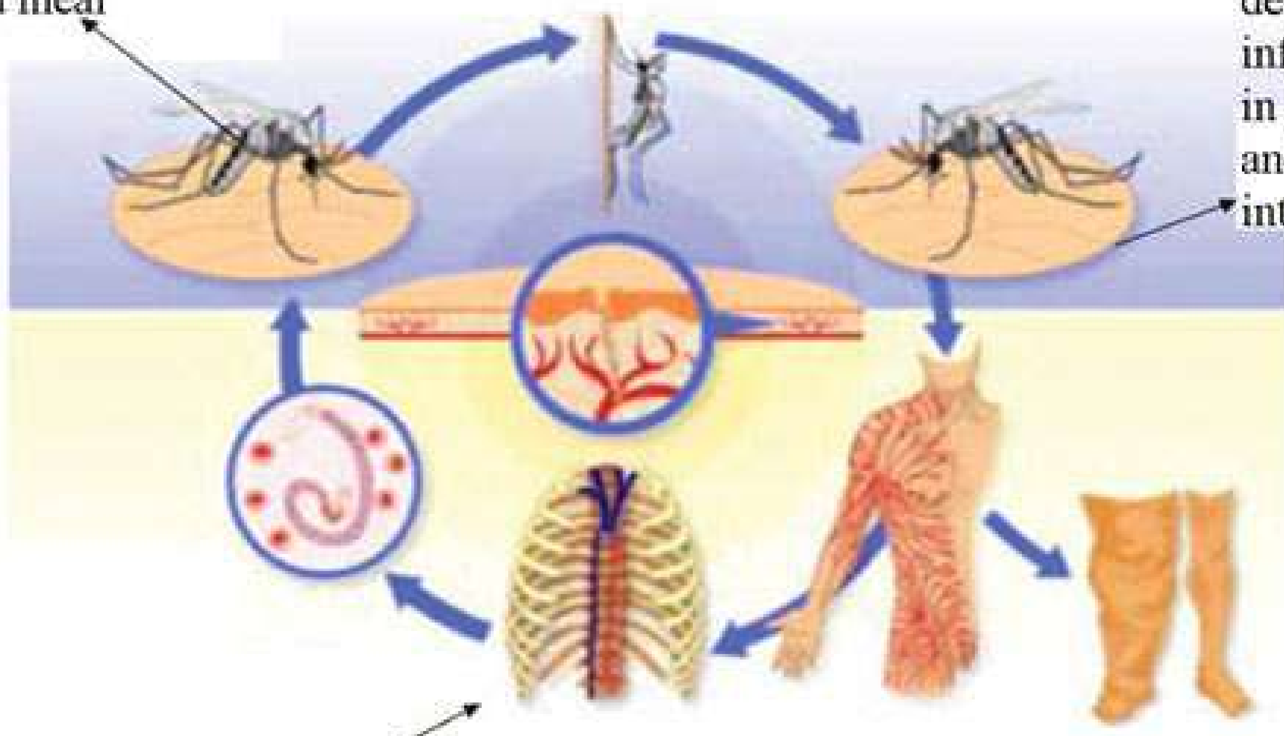
LYMPHANGITIS

- Inflammation of the lymph vessels
- Commonest cause bacteria called streptococcus pyogenes(most common).
- Lymph vessels appear as red streaks through the skin

FILARIASIS

(a) Microfilaria from an infected person enter the mosquito in a blood meal

(b) Microfilaria develop into infective larvae in the mosquito and are injected into a new host



(c) Larvae mature into adult worms and spread through the lymphatic vessels, where they mate and lay eggs

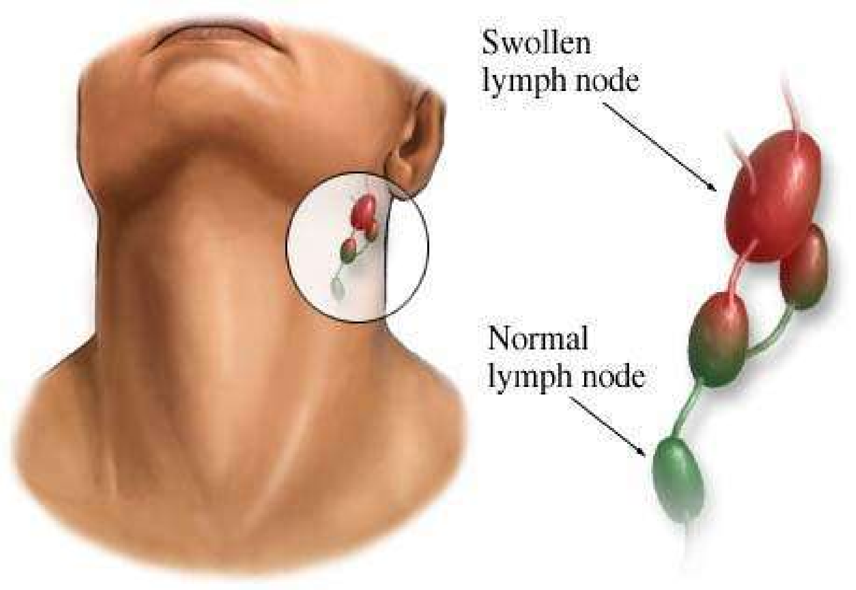
LYMPHEDEMA

- Occurs due to **accumulation of lymphatic fluid** in the interstitial tissue

- Sometimes can be appreciated after wearing tight clothing or jewellary on affected limb

LYMPHADENOPATHY

- Means a disease of the lymph nodes
- Lymph nodes become swollen/ enlarged and may be painful to touch



LYMPHOMAS

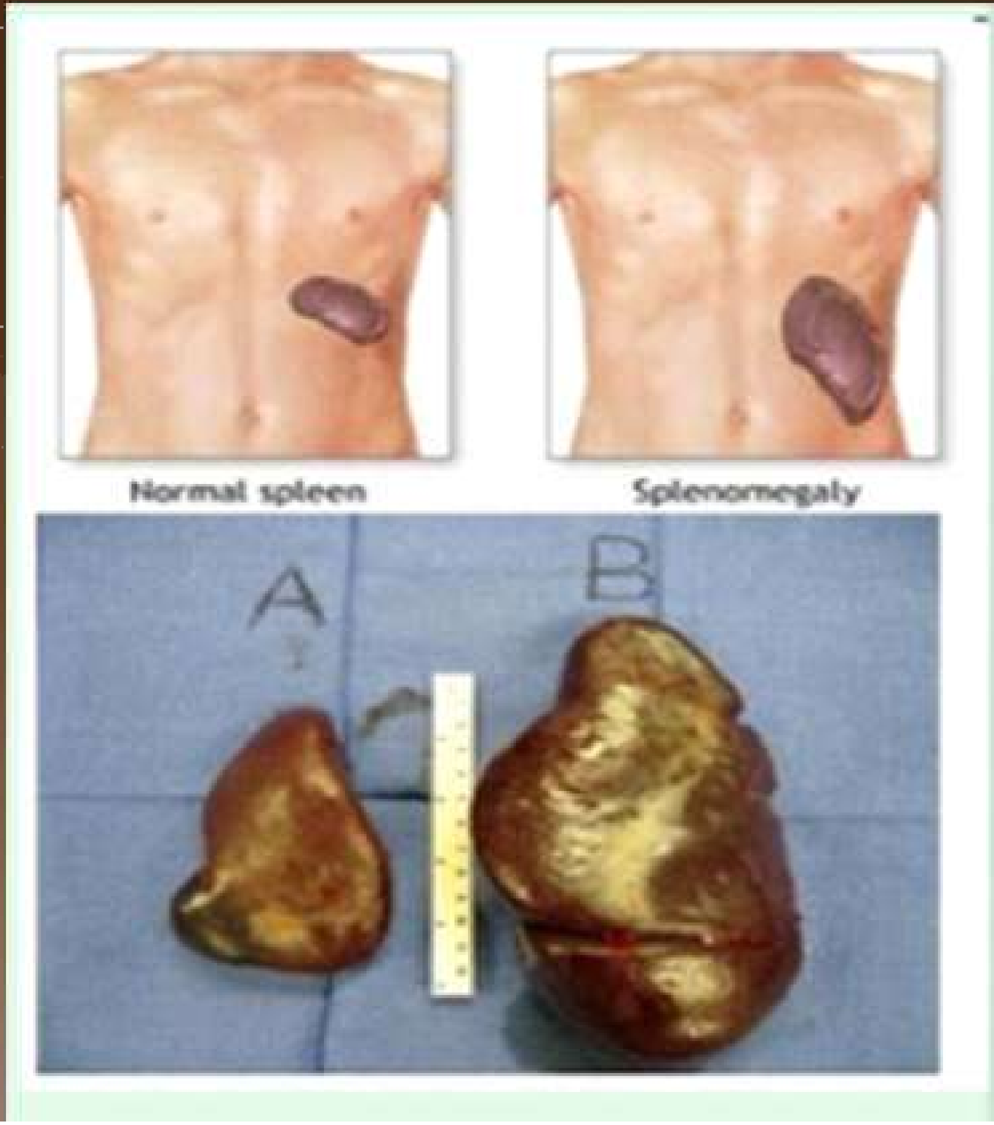
- Cancers originating either from the lymphocytes in the lymph nodes or the lymphatic tissue in organs
- Risk factors -- HIV, HEPATITIS, EBV infections

TONSILLITIS

- Infection of the pharyngeal tonsils
- Tonsils are swollen,
- Fever and pain during swallowing usually present
- Treatment – surgical removal of tonsils (TONSILLECTOMY)

SPLENOMEGALY

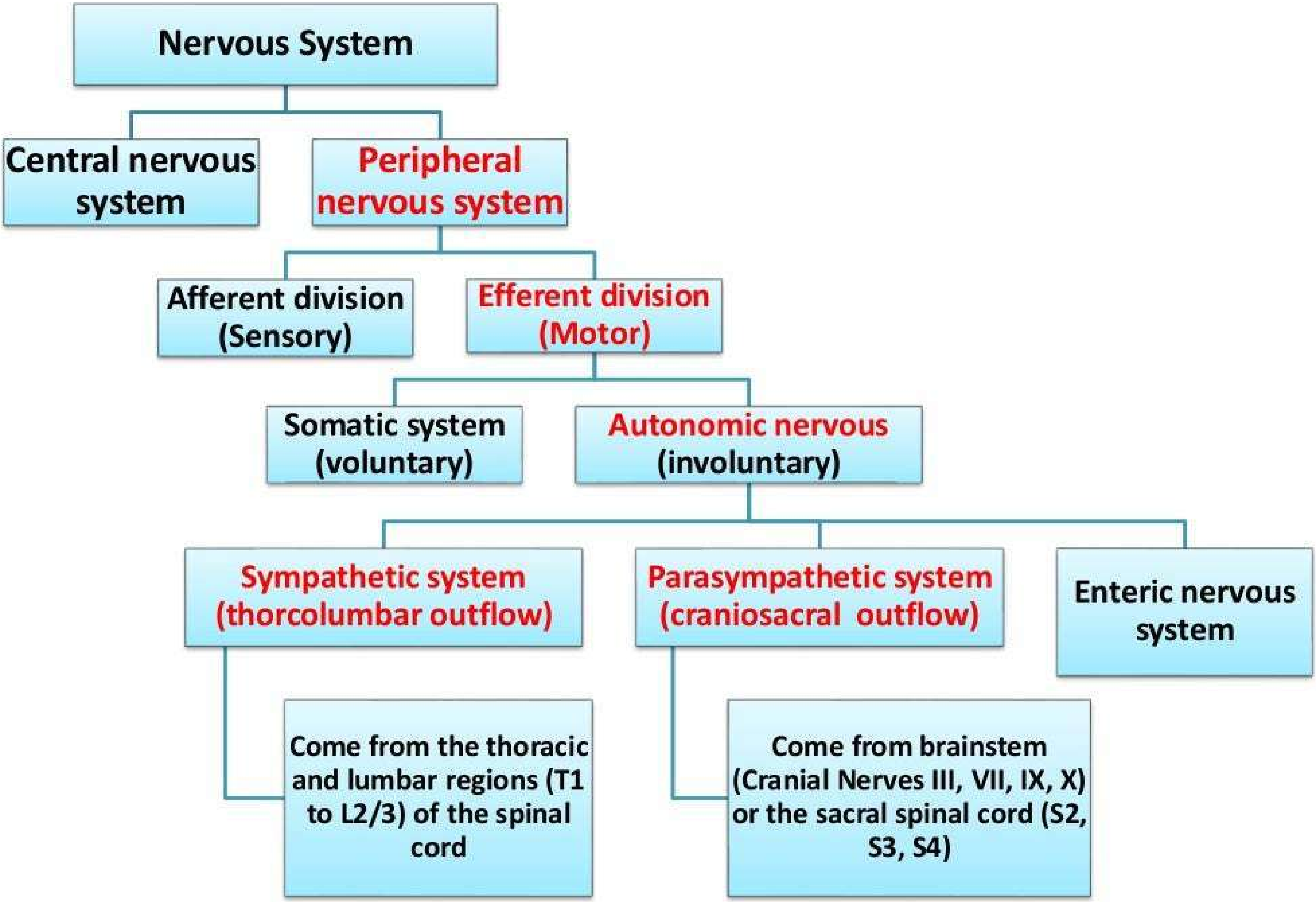
- Enlarged Spleen
- Various causes



THANK YOU

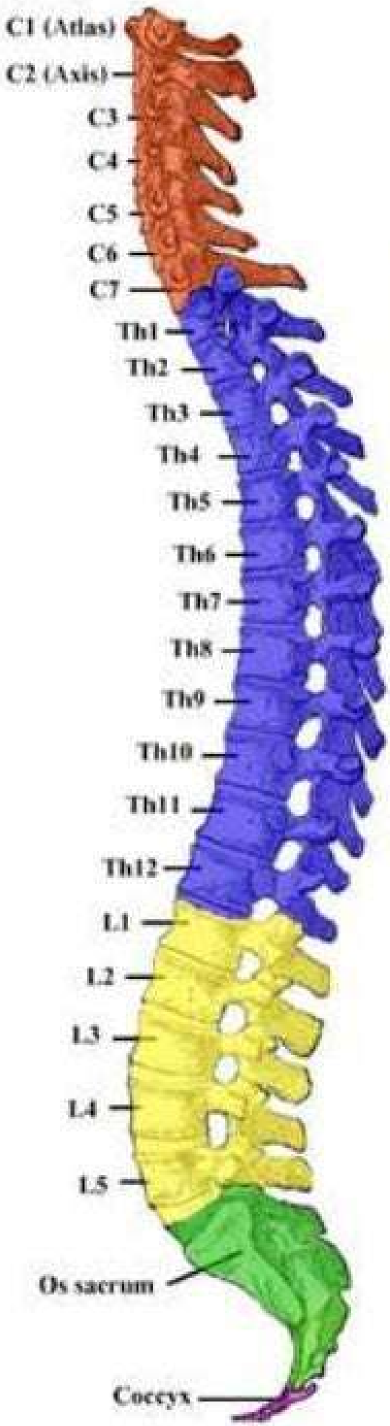
NERVOUS SYSTEM

BY
HIMA SAILA.M
ASSISTANT PROFESSOR
SRI PADMAVATHI SCHOOL OF PHARMACY



Nervous System
Central nervous system
Peripheral nervous system
Afferent division (Sensory)
Efferent division (Motor)
Somatic system (voluntary)
Autonomic nervous (involuntary)
Sympathetic system (thorcolumbar outflow)
Parasympathetic system (craniosacral outflow)
Enteric nervous system
Come from the thoracic and lumbar regions (T1 to L2/3) of the spinal cord
Come from brainstem (Cranial Nerves III, VII, IX, X) or the sacral spinal cord (S2, S3, S4)

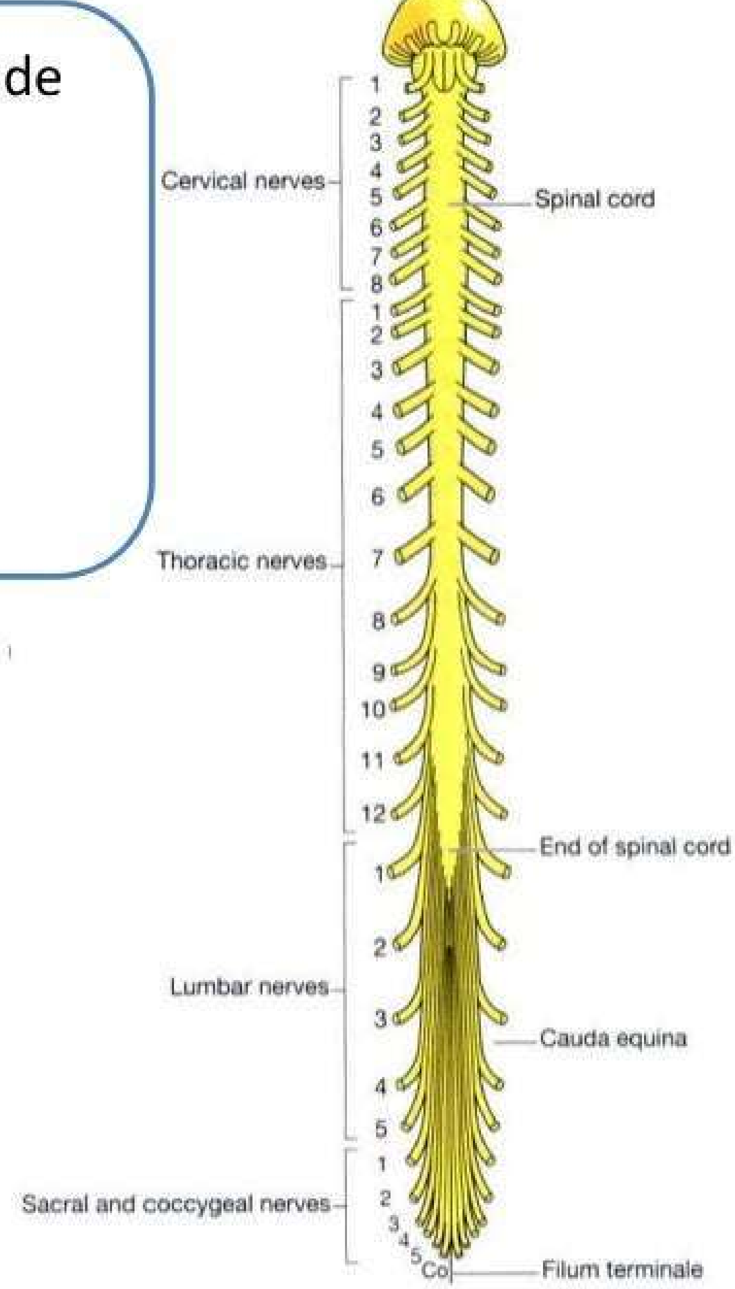
Spinal nerves



The human spinal column is made up of 33 bones.

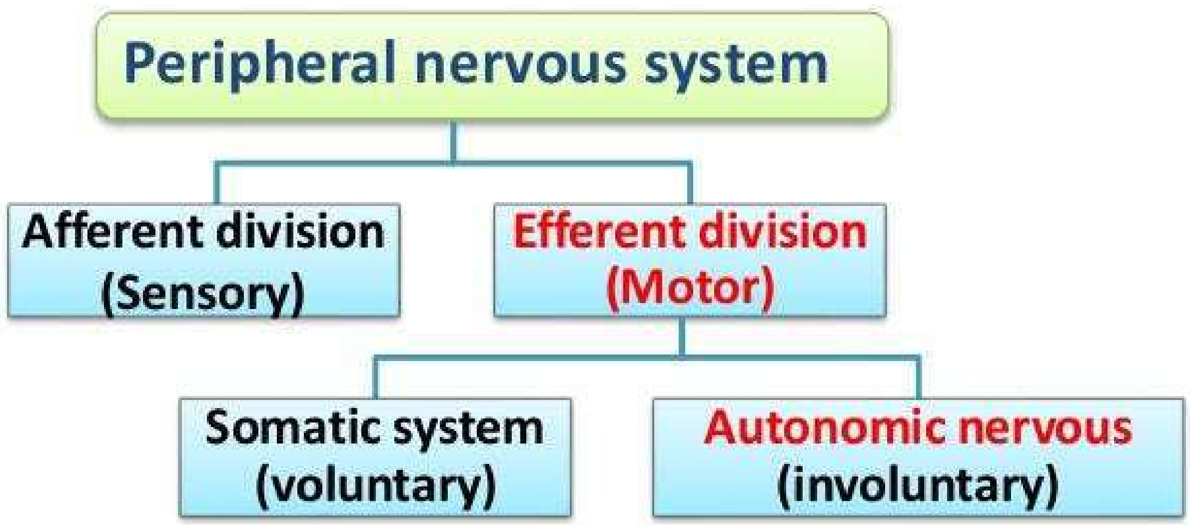
- 7 - cervical region
- 12 - thoracic region
- 5 - lumbar region
- 5 - sacral region
- 4 - coccygeal region

- **There are 31 pairs spinal nerves**
  - **8 cervical**
  - **12 thoracic**
  - **5 lumbar**
  - **5 sacral**
  - **1 coccygeal**



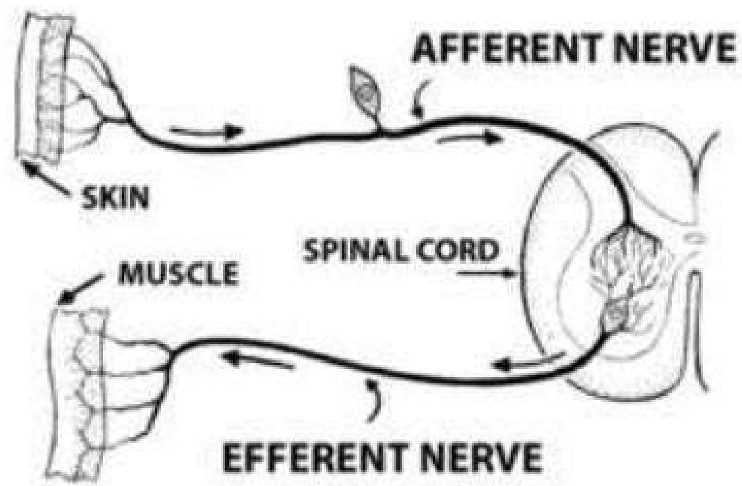
Peripheral Nervous System

- Most of the nerves of the peripheral nervous system are composed of **sensory nerve fibres conveying afferent impulses from sensory end organs to the brain** and **motor nerve fibres conveying efferent impulses from the brain through the spinal cord to the effector organs.**



Somatic Nervous System

- The somatic nervous system (SNS or voluntary nervous system) is the part of the peripheral nervous system.
- The somatic nervous system includes both **sensory** (**afferent nerves**) and **motor** (**efferent nerves**) neurons.
- Sensory neurons convey input from **receptors for somatic senses** (tactile, thermal, pain, and proprioceptive sensations) and from **receptors for the special senses** (sight, hearing, taste, smell, and equilibrium)



Autonomic Nervous System

- The autonomic nervous system is involved in a complex of reflex activities, which depend on sensory input to the brain or spinal cord, and on motor output.
- The majority of the organs of the body are supplied by both sympathetic and parasympathetic nerves which have opposite effects that are finely balanced to ensure the optimum functioning of the organ.

Autonomic Nervous System

- The autonomic nervous system (ANS) is a complex set of neurons that mediate **internal homeostasis** without conscious intervention or voluntary control.
- The ANS maintains blood pressure, regulates the rate of breathing, influences digestion, urination, and modulates sexual arousal.
- There are two main branches to the ANS – the **sympathetic nervous system** and the **parasympathetic nervous system**.

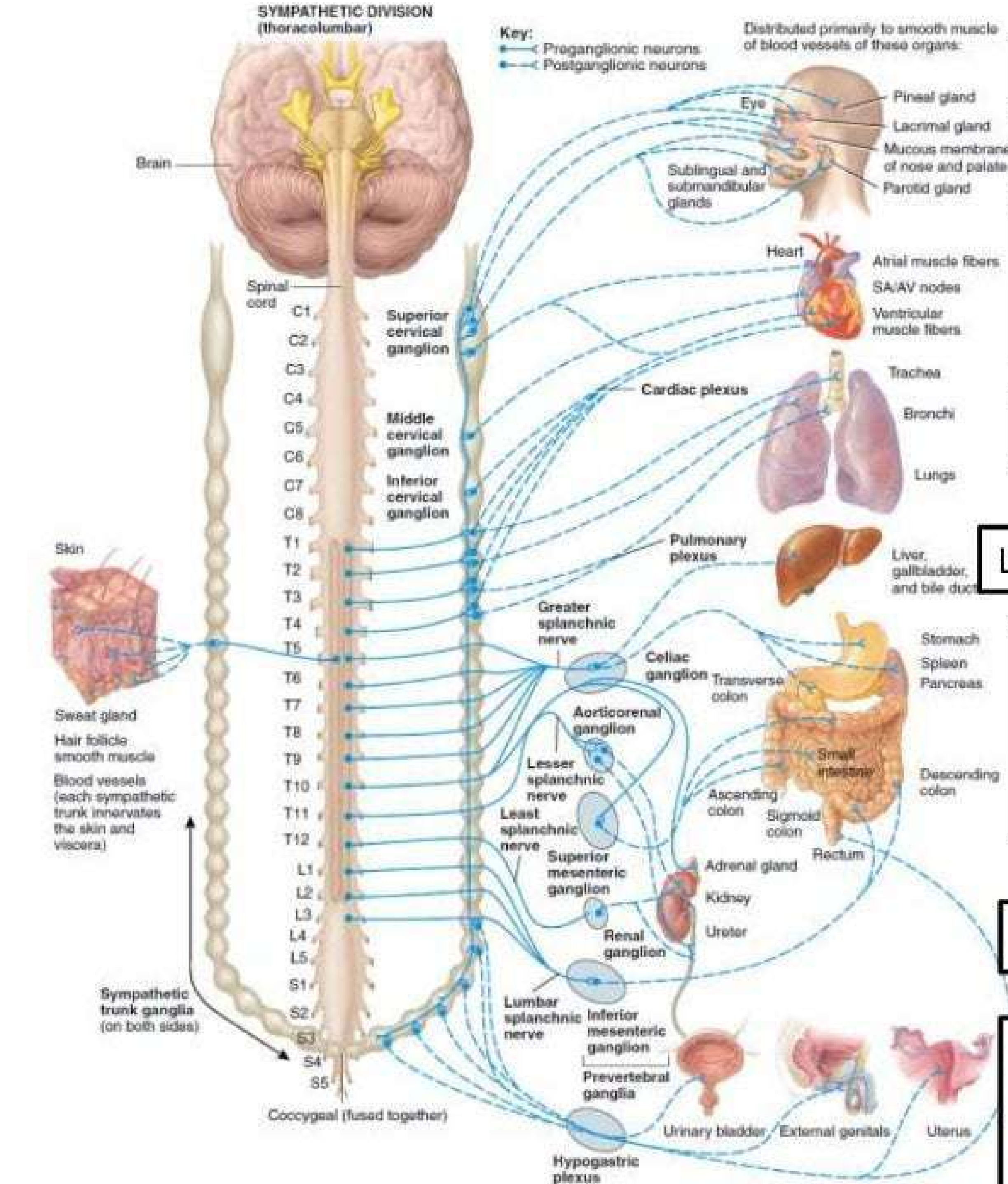
The effects of autonomic control are rapid and essential for homeostasis

Sympathetic nervous system

- Sympathetic nervous system otherwise called as thoracolumbar system.
- **Sympathetic stimulation** prepares the body to deal with exciting and **stressful situations**, e.g. **strengthening its defences in danger**. sympathetic stimulation mobilises the body for '**fight or flight**'.
- Neurones convey impulses from their origin in the hypothalamus, reticular formation and medulla oblongata to effector organs and tissues. The first neurone has its cell body in the brain and its fibre extends into the spinal cord.

Sympathetic nervous system

- Structure of the Sympathetic Division
  - Pathway from Spinal Cord to Sympathetic Trunk Ganglia
  - Organization of Sympathetic Trunk Ganglia
  - Pathways from Sympathetic Trunk Ganglia to Visceral Effectors



Iris muscle: Pupil dilated

Salivary glands: Secretion inhibited

Blood vessels in heart : Vasoconstriction
Heart: Rate and force of contraction increased

Trachea and bronchi: Bronchodilation

Liver: Glycogen glucose conversion increased

Stomach: Peristalsis reduced
Sphincters closed
Intestines: Peristalsis and tone decreased
Vasoconstriction

Kidney: Urine secretion decreased

Bladder: Smooth muscle wall relaxed
Sphincter closed
Sex organs: Generally Vasoconstriction

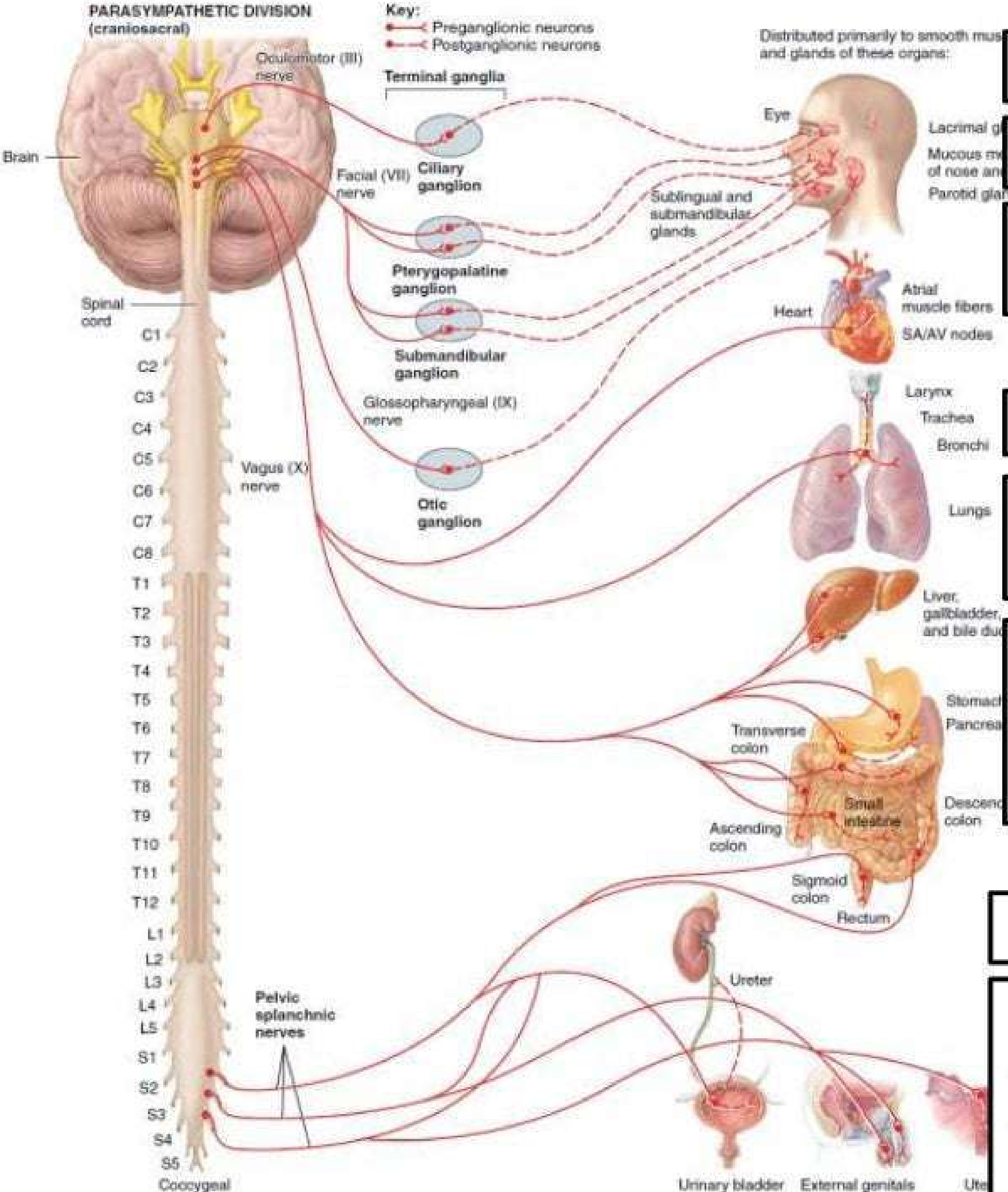
Structure of the sympathetic division of the autonomic nervous system

Parasympathetic nervous system

- Parasympathetic nervous system otherwise called as craniosacral outflow.
- **Parasympathetic stimulation** has a **tendency to slow down body** processes **except digestion and absorption of food** and **the functions of the genitourinary systems**. Its general effect is that of a '**peace maker**' allowing restoration processes to occur quietly and peacefully.
- Cell bodies of parasympathetic preganglionic neurons are found in nuclei in the brain stem.

Parasympathetic nervous system

- Structure of the Parasympathetic Division
  - The cranial parasympathetic outflow consists of preganglionic axons that extend from the brain stem in four cranial nerves. The cranial outflow has four pairs of ganglia and the ganglia associated with the vagus (X) nerve.
  - The sacral parasympathetic outflow consists of preganglionic axons in anterior roots of the second through fourth sacral spinal nerves.



Iris muscle: Pupil constricted

Salivary glands: Secretion increased

Heart: Rate and force of contraction decreased

Trachea and bronchi: Bronchoconstriction

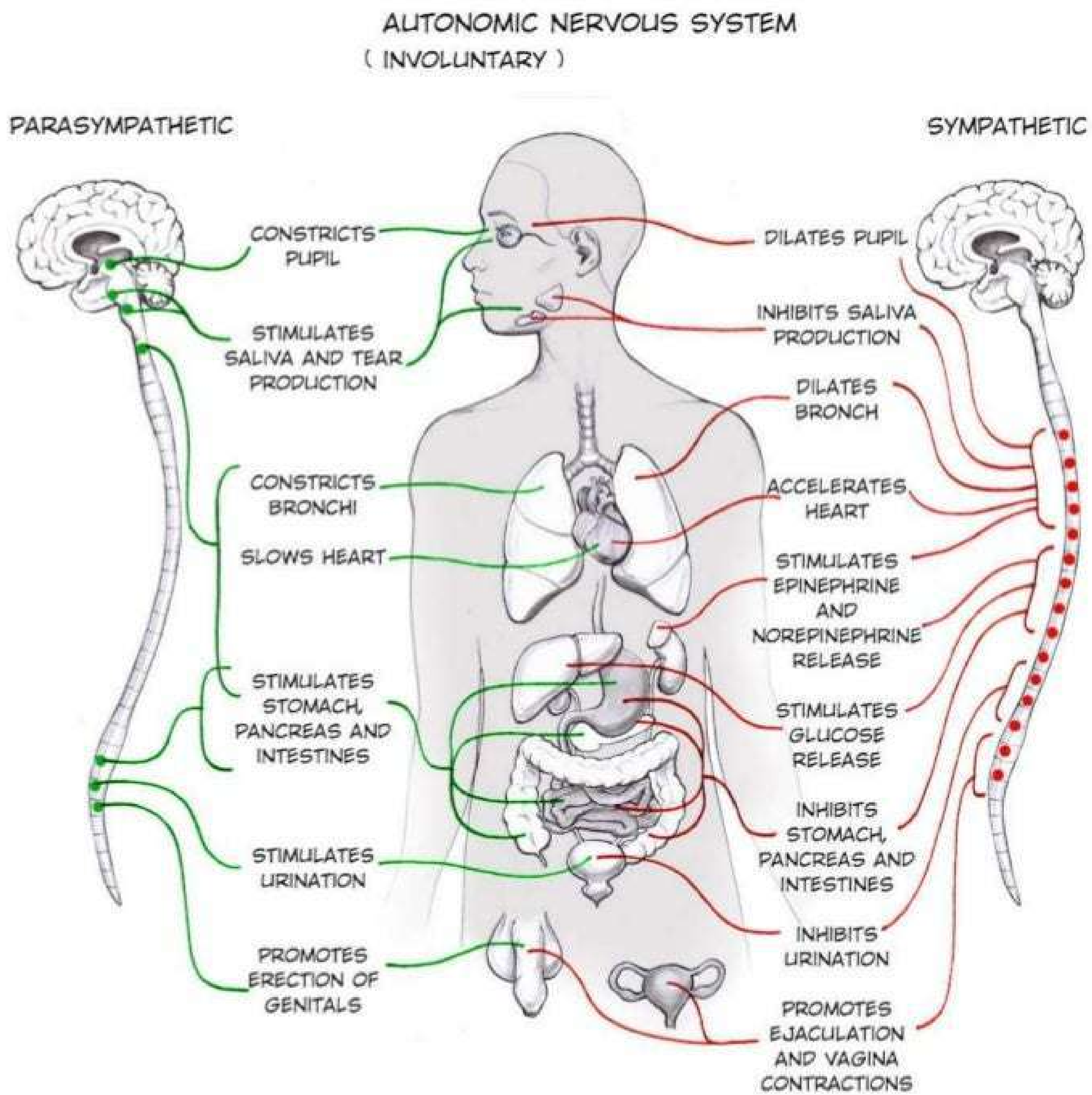
Liver: Blood vessels dilated
Secretion of bile increased

Stomach: Secretion of gastric juice and peristalsis increased
Intestines: Digestion and absorption increased

Kidney: Urine secretion increased

Bladder: Muscle of wall contracted
Sphincters relaxed
Sex organs: Male: erection;
Female: variable

Structure of the parasympathetic division of the autonomic nervous system



Ref: https://backyardbrains.com/experiments/img/AutonomicNervousSystem_web.jpg

Autonomic Motor Pathways

Autonomic Motor Pathways

- Each division of the ANS has two motor neurons (**preganglionic** and **postganglionic neuron**).
- **Preganglionic Neurons**
  - In the **sympathetic division (thoracolumbar division/ thoracolumbar outflow)**, the preganglionic neurons have their cell bodies in the lateral horns of the gray matter in the 12 thoracic segments and the first two (and sometimes three) lumbar segments of the spinal cord.
  - In the para**sympathetic division (craniosacral division/ craniosacral outflow)**, the preganglionic neurons have their cell bodies in in the nuclei of four cranial nerves in the brain stem (III, VII, IX, and X) and in the lateral gray matter of the second through fourth sacral segments of the spinal cord.

Autonomic Motor Pathways

Preganglionic Neurons

- **Autonomic Ganglia**
  - There are two major groups of autonomic ganglia
    - sympathetic ganglia
    - parasympathetic ganglia
- Sympathetic Ganglia:
  - The sympathetic ganglia are the sites of synapses between sympathetic preganglionic and postganglionic neurons.
  - There are two major types of sympathetic ganglia:
    - **sympathetic trunk ganglia** (also called vertebral chain ganglia or paravertebral ganglia)
    - **prevertebral ganglia** (collateral)- Five types of prevertebral ganglia are celiac ganglion, superior mesenteric ganglion, inferior mesenteric ganglion, aorticorenal ganglion and renal ganglion.

Autonomic Motor Pathways

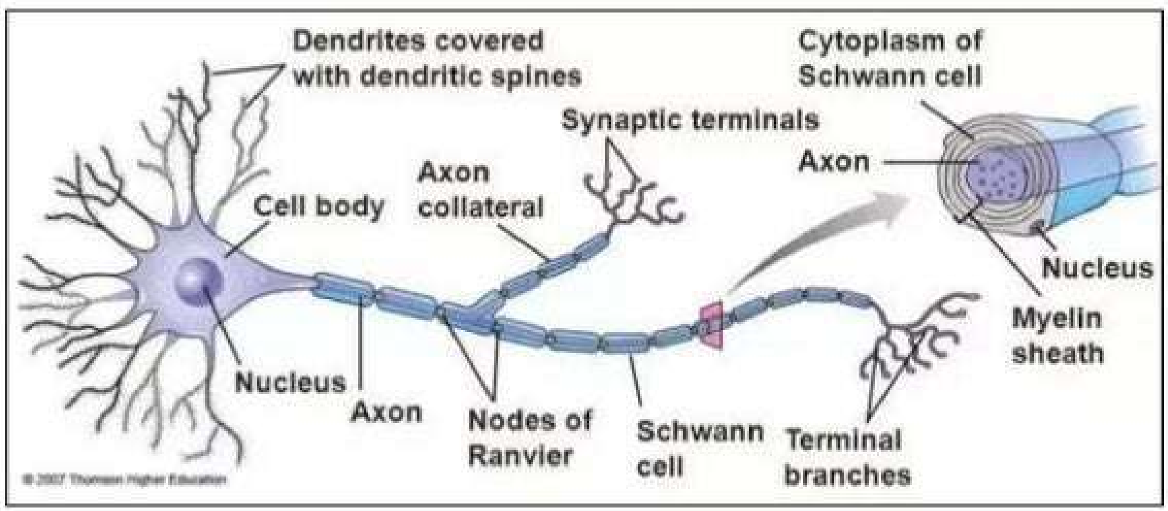
Preganglionic Neurons

- **Autonomic Ganglia**
  - There are two major groups of autonomic ganglia
    - sympathetic ganglia
    - parasympathetic ganglia
- parasympathetic ganglia:
  - Preganglionic axons of the parasympathetic division synapse with postganglionic neurons in terminal (intramural) ganglia. They are the ciliary ganglion, pterygopalatine ganglion, submandibular ganglion, and otic ganglion

Autonomic Motor Pathways

Postganglionic Neurons

- Once axons of sympathetic preganglionic neurons pass to sympathetic trunk ganglia, they may connect with postganglionic neurons.
- A **single sympathetic preganglionic fiber** has many axon collaterals (branches) and may **synapse with 20 or more postganglionic neurons**.



Autonomic Motor Pathways

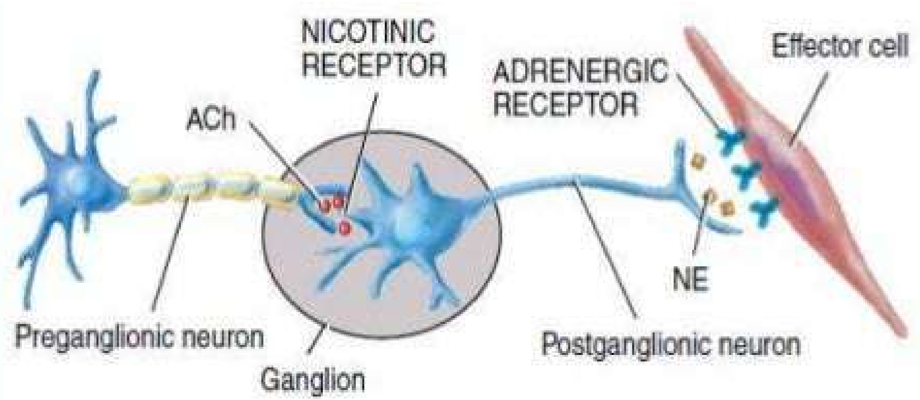
Postganglionic Neurons

- Axons of preganglionic neurons of the **parasympathetic division** pass to terminal ganglia near or within a visceral effector. In the ganglion, the **presynaptic neuron usually synapses with only four or five postsynaptic neurons**, all of which supply a single visceral effector, allowing parasympathetic responses to be localized to a single effector.

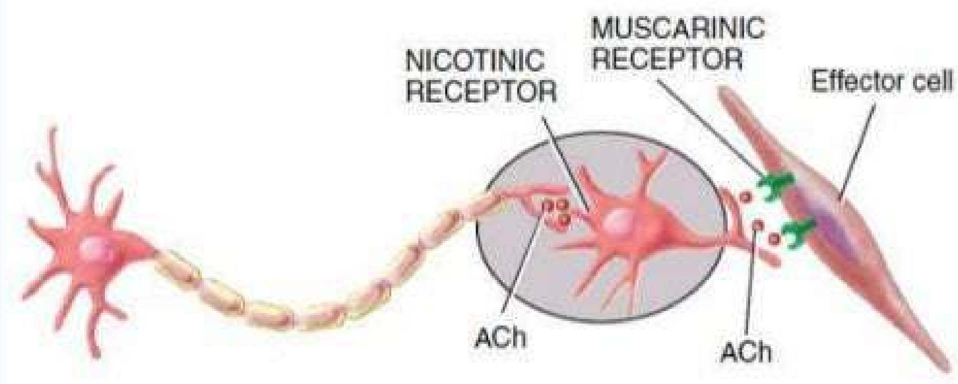
Autonomic Receptors

ANS Neurotransmitters and Receptors

ANS	Receptor	Receptor Sub-type
Parasympathetic nervous system	Nicotinic cholinergic receptors	Nn, Nm
	Muscarinic cholinergic receptors	M1, M2, M3, M4, M5
Sympathetic nervous system	α adrenergic receptor	α1, α2
	β adrenergic receptor	β1, β2, β3



Sympathetic nervous system



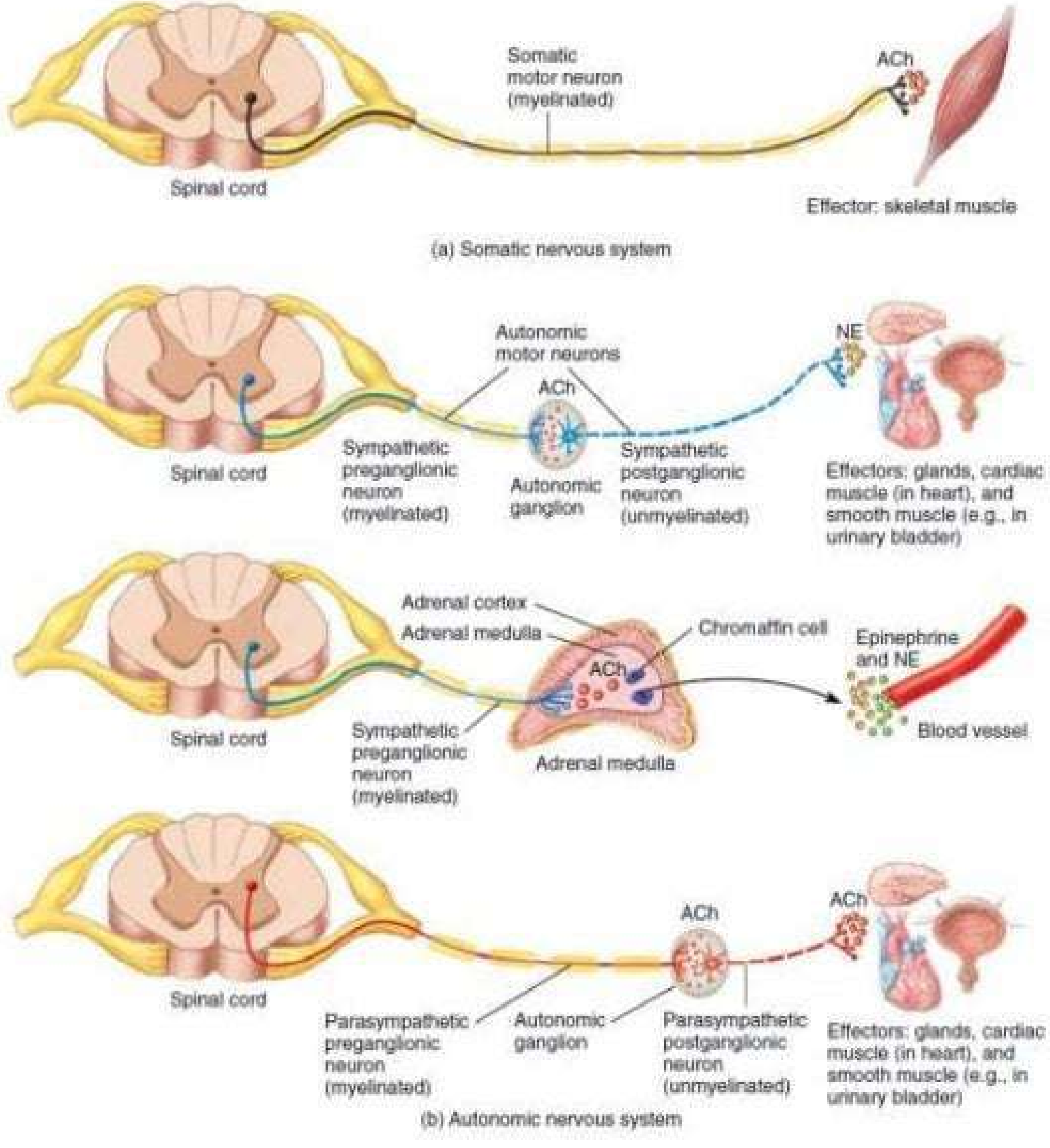
Parasympathetic nervous system

Comparison of Somatic and Autonomic Motor Neurons

Comparison of Somatic and Autonomic Motor Neurons

Somatic	Autonomic
Voluntary effectors: striated muscles	Involuntary effectors: smooth & cardiac muscles, glands
single motor neuron from spinal cord to target organ	usually 2 neurons with synapse (ganglion) between from spinal cord to target organ
Neurotransmitter always stimulatory	Neurotransmitter stimulatory or inhibitory
ACh released at synapse	ACh and NE released at synapses
No firing at rest	Baseline firing – speeds up when Stimulated
Effector at rest is flaccid	Effector at rest has intrinsic tone

Comparison of Somatic and Autonomic Motor Neurons



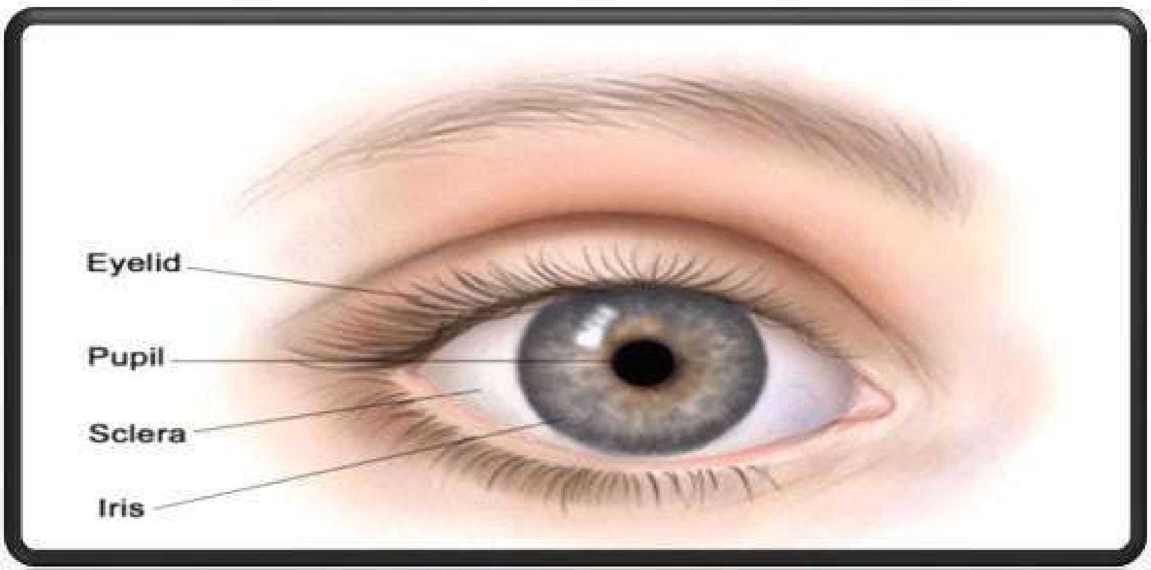
Motor neuron pathways in the (a) somatic nervous system and (b) autonomic nervous system

Thank you

SENSE ORGANS

EYE

- Eye is a sensory organ of vision which is situated in the orbital cavity of skull. It contains the eyeball which is surrounded and supported by a number of accessory structures.



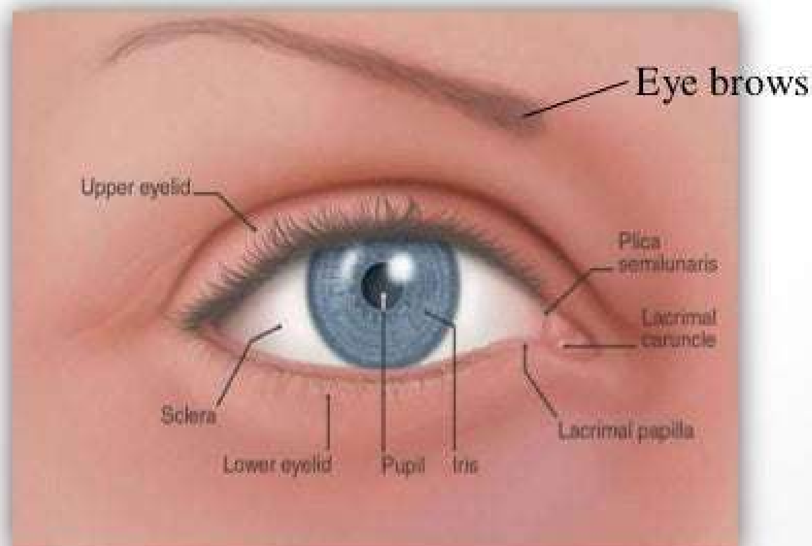
Accessory structures of eye:

1.) Eye brows:

- They are two arches of thick skin over the eyes. They contain thick hairs. They prevent the dripping of sweat into the eyes.

2.) Eyelids:

- They are the upper and lower eyelids which protect the eye.
- The upper eyelid is larger and more mobile. It is raised by levator palpebrae muscle. Both the eyelids are covered externally by skin and lined internally by conjunctiva. Eyelashes are short hairs which project from the free margin of eyelids.

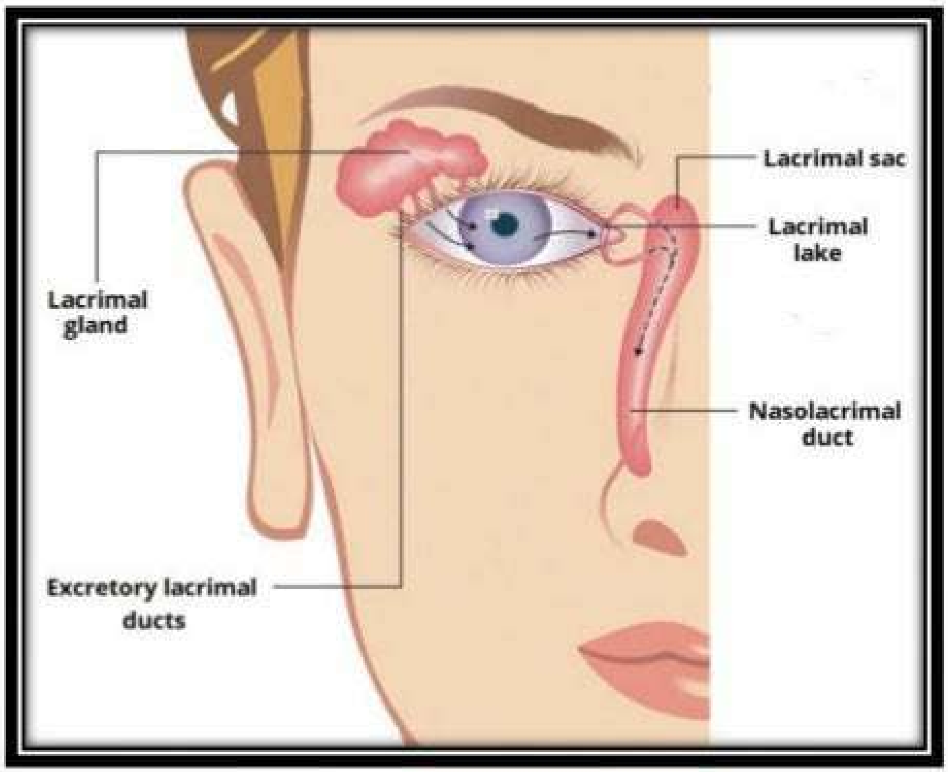


3.) Lacrimal apparatus:

It is concerned with the production of tear and it consists of

i.) A lacrimal gland situated in the lateral end of upper eyelid

ii.) Lacrimal duct, lacrimal sac and nasolacrimal duct through which tear is carried to the nasal cavity.



4.) Extrinsic muscles of eye:

- The eye ball is moved by six muscles. These muscles arise from the posterior bony wall of orbit and inserted into the sclera.

i.) Superior rectus-moves the eye upwards

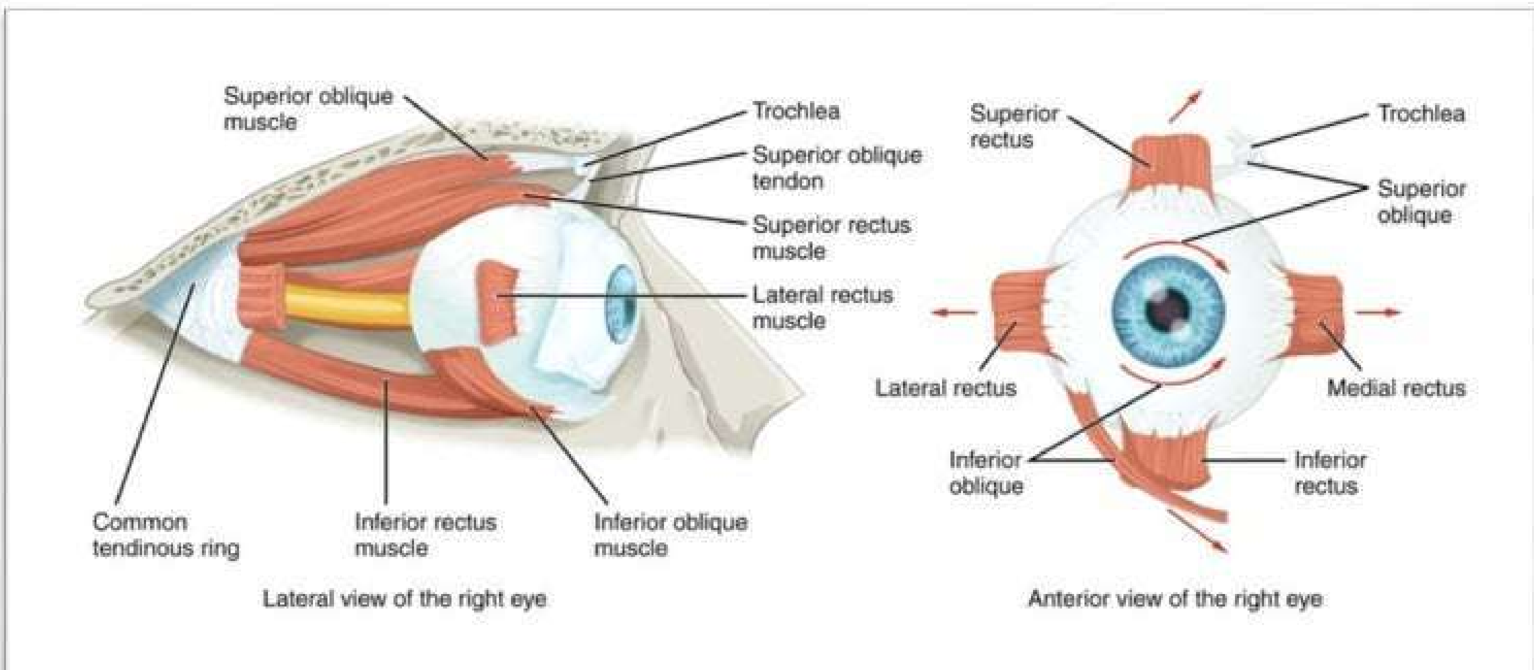
ii.) Inferior rectus-moves the eye downwards

iii.) Medial rectus-moves the eye inwards

iv.) Lateral rectus-moves the eye outwards

v.) Inferior oblique-moves the eye up and outwards

vi.) Superior oblique-moves the eye down and outwards



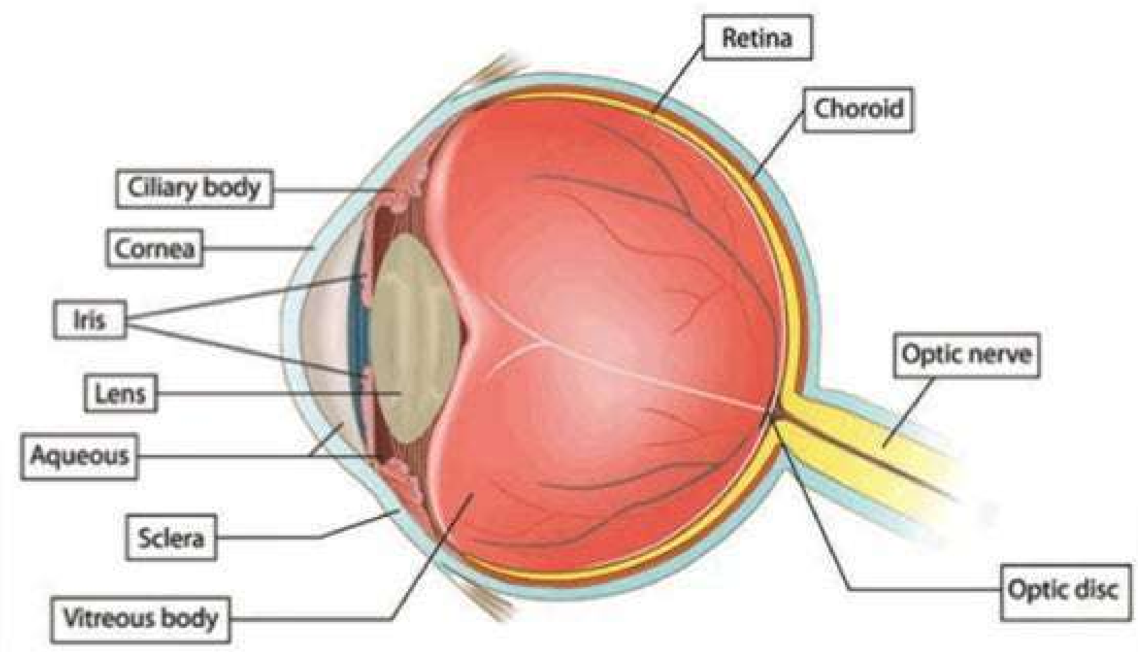
EYE BALL

- Eye ball is almost spherical in shape and it is situated in the anterior part of orbital cavity. The eye ball contains three coats and light transmitting structures.
- The three coats of eye ball are:

i.) Outer fibrous coat containing sclera and cornea.

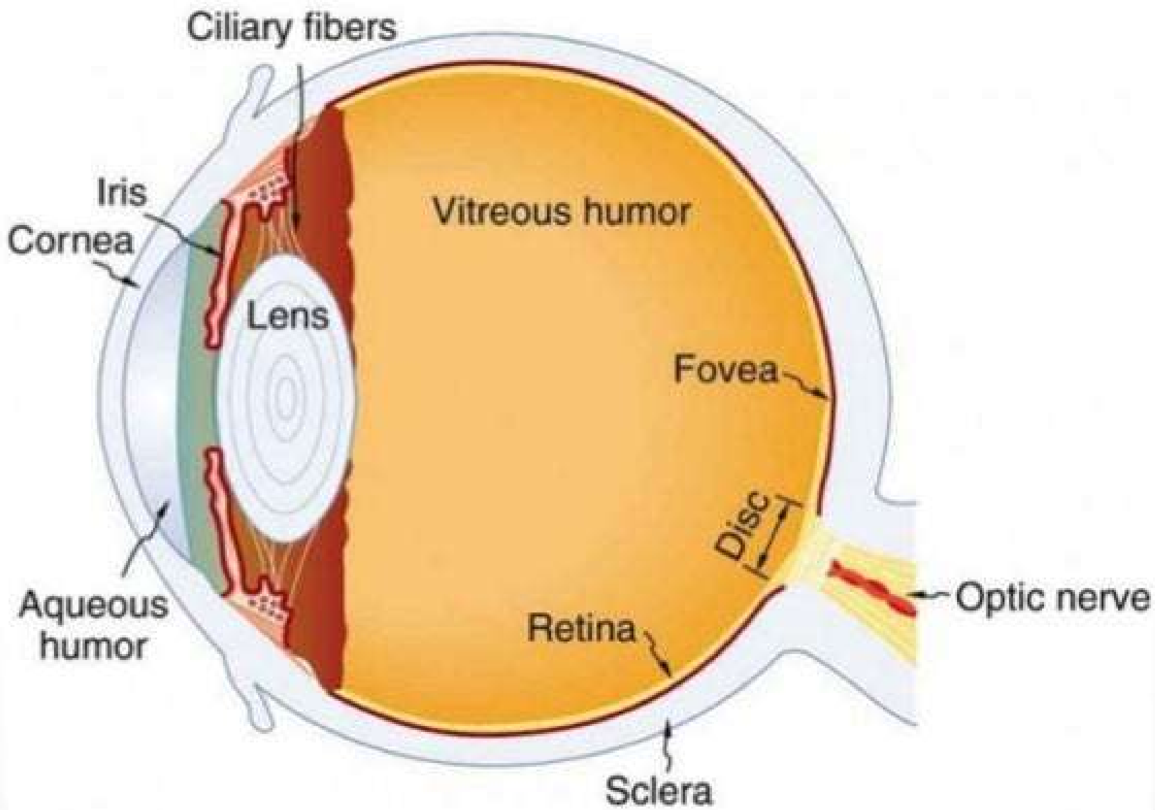
ii.) Middle vascular coat containing choroid, ciliary body and iris.

iii.) Inner nervous coat containing retina



The light transmitting structures are:

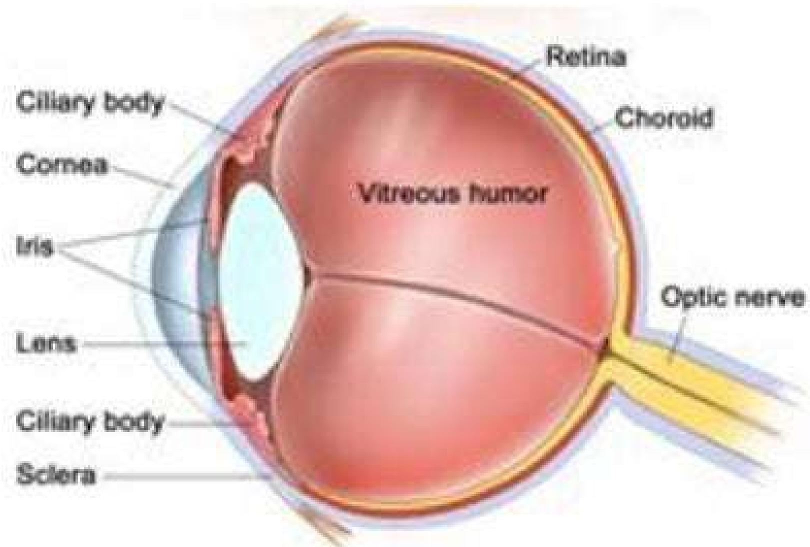
- Aqueous humour
- Lens
- Vitreous humour



Outer fibrous coat of eye ball:

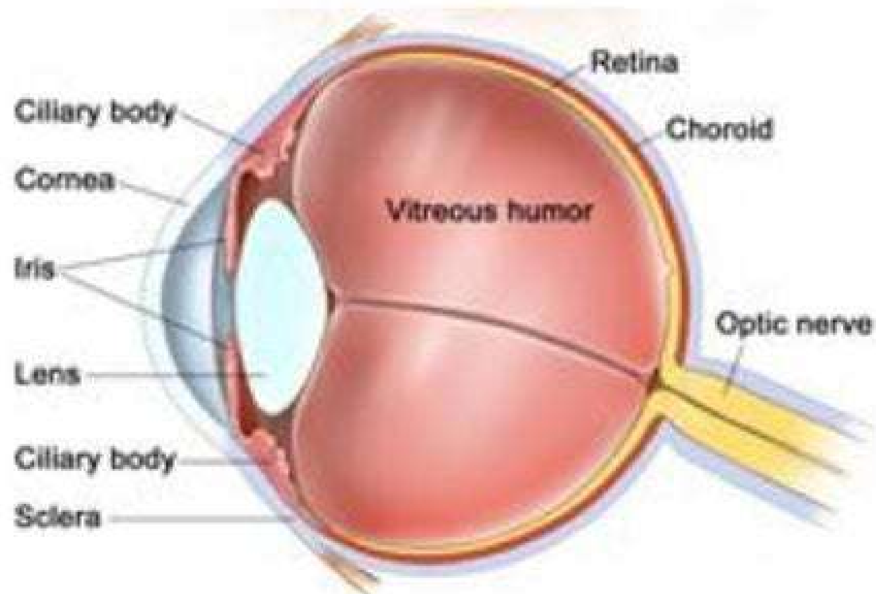
1.) Sclera:

- It forms the posterior five sixths of the outer coat. It forms the white of the eye and it is continuous with cornea in the front. Sclera protects the internal structures and also maintains the shape of eyeball. The optic nerve passes through the posterior aspect of sclera and reaches the retina.



2.) Cornea:

- It forms the anterior one-sixth of the outer coat. It is transparent and has a convex anterior surface. It has no blood supply, but it is richly supplied by sensory nerves.



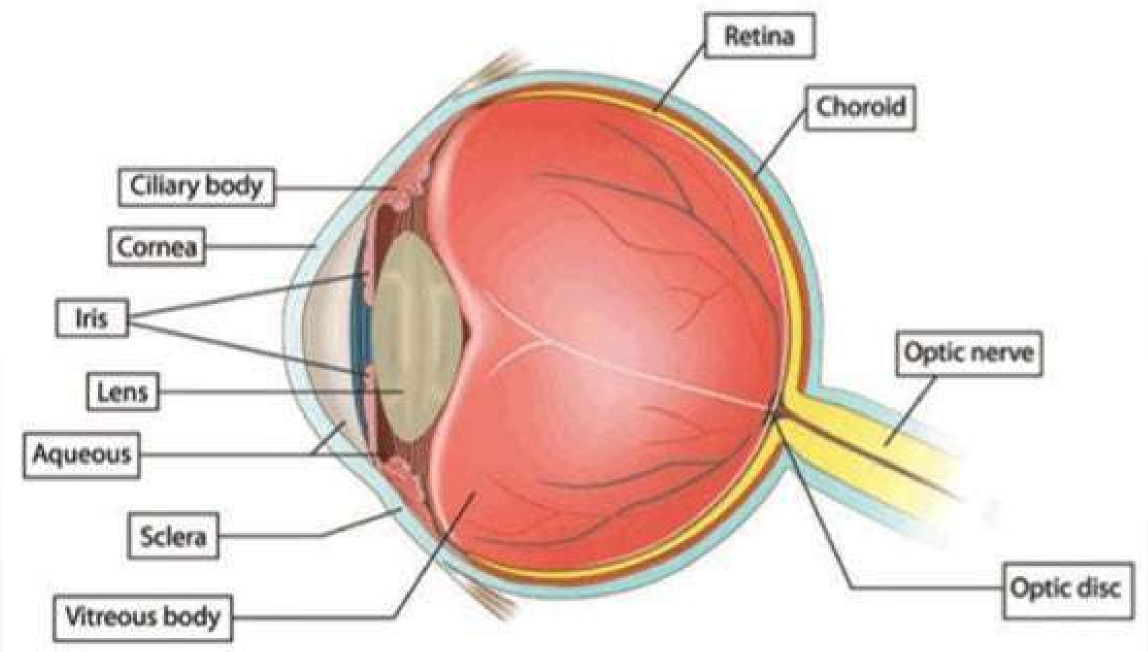
Middle vascular coat:

1.) Choroid:

- It is a thin, pigmented and highly vascular membrane. It lines the posterior compartment of eye and lies between the inner surface of sclera and retina.

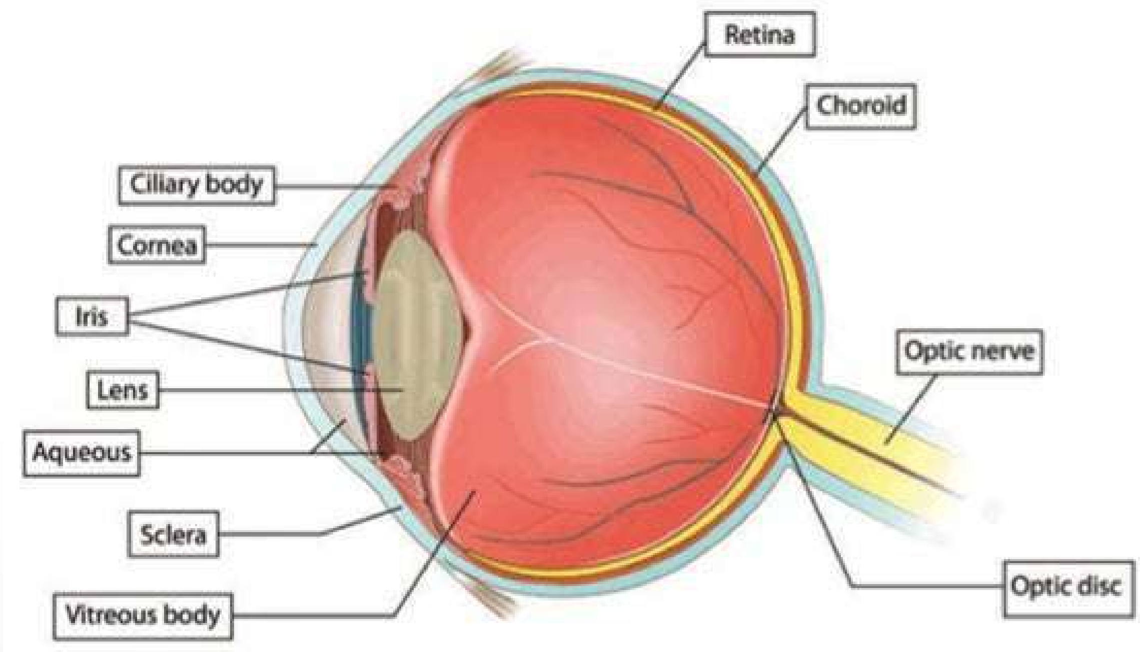
2.) Ciliary body:

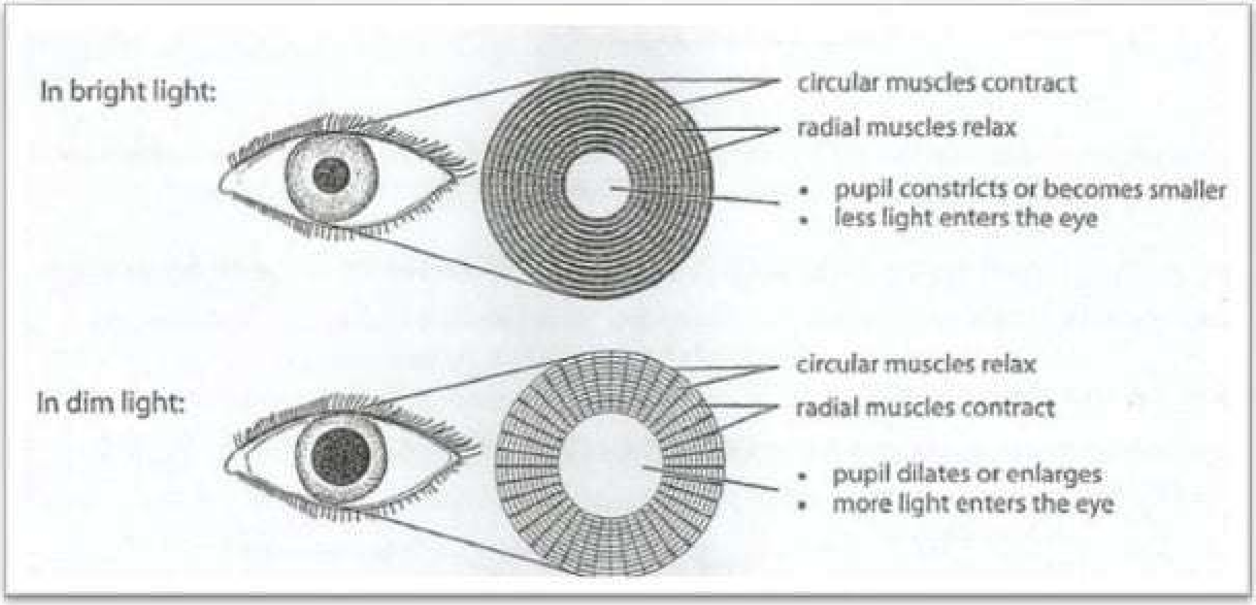
- It is the anterior continuation of choroid and it lies between choroid and iris. The ciliary body contains ciliary muscle. The suspensory ligament of lens is attached to ciliary muscle.

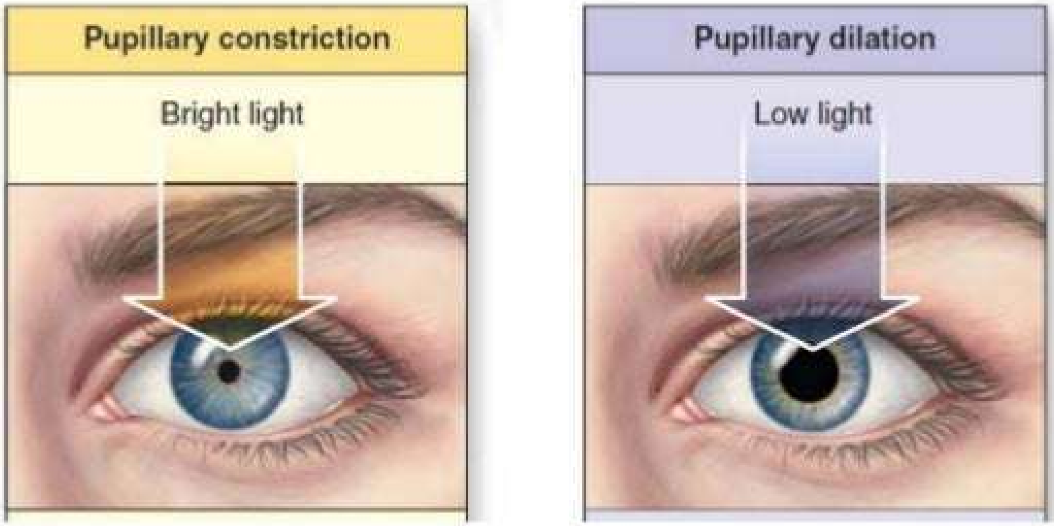


3.) Iris:

- It is the anterior continuation of ciliary body. Iris is a pigmented membrane and the colour of eye is dependent on its pigments. Iris has a central opening called pupil. Two sets of iris muscles control the pupil. They are: **Circular muscles** which reduce the pupillary size, **Radial muscles** which increase the pupillary size.




In bright light:
circular muscles contract
radial muscles relax
• pupil constricts or becomes smaller
• less light enters the eye
In dim light:
circular muscles relax
radial muscles contract
• pupil dilates or enlarges
• more light enters the eye

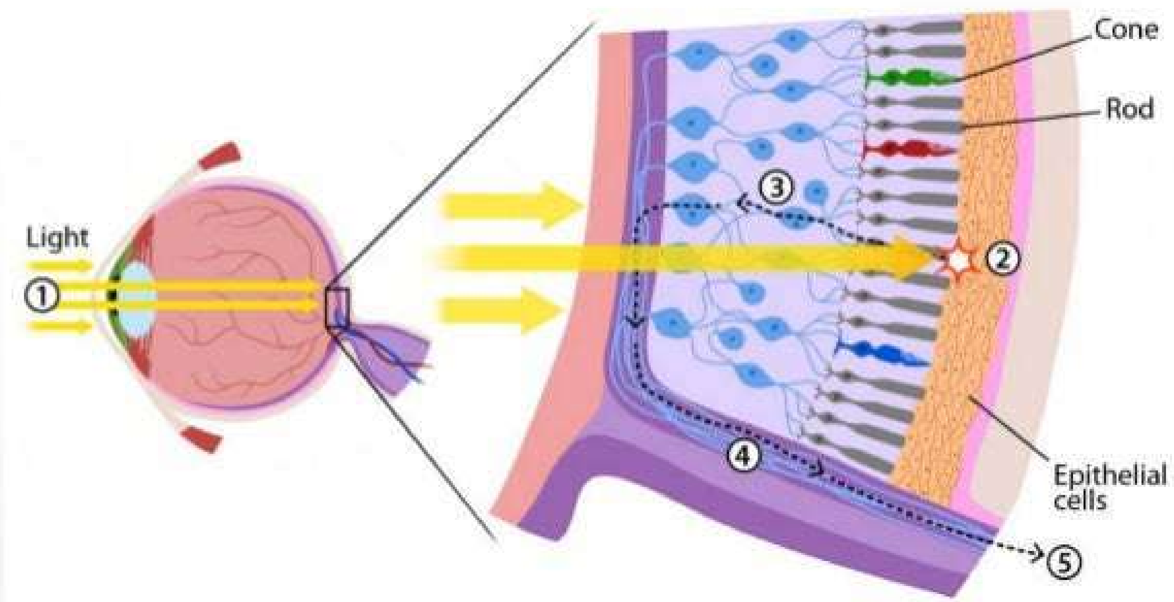

Pupillary constriction
Bright light
Pupillary dilation
Low light

Inner nervous coat:

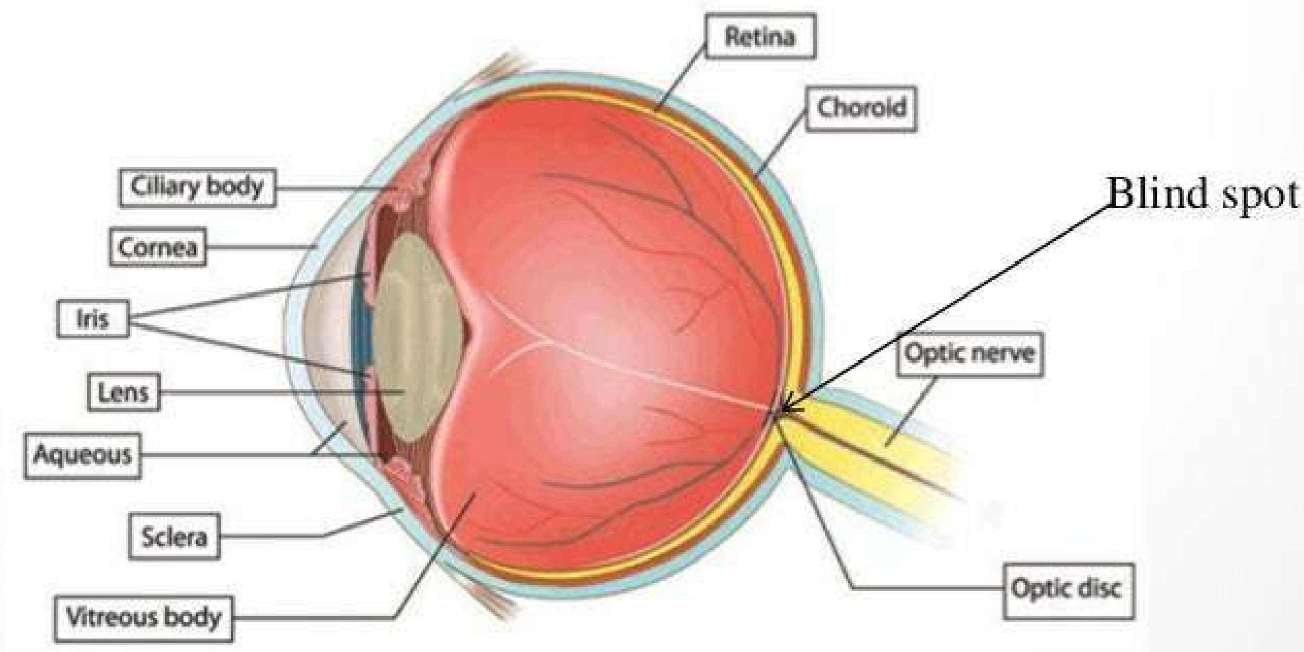
1.) Retina:

It is the innermost nervous coat of eyeball and lies immediately deeper to choroid. The retina contains:

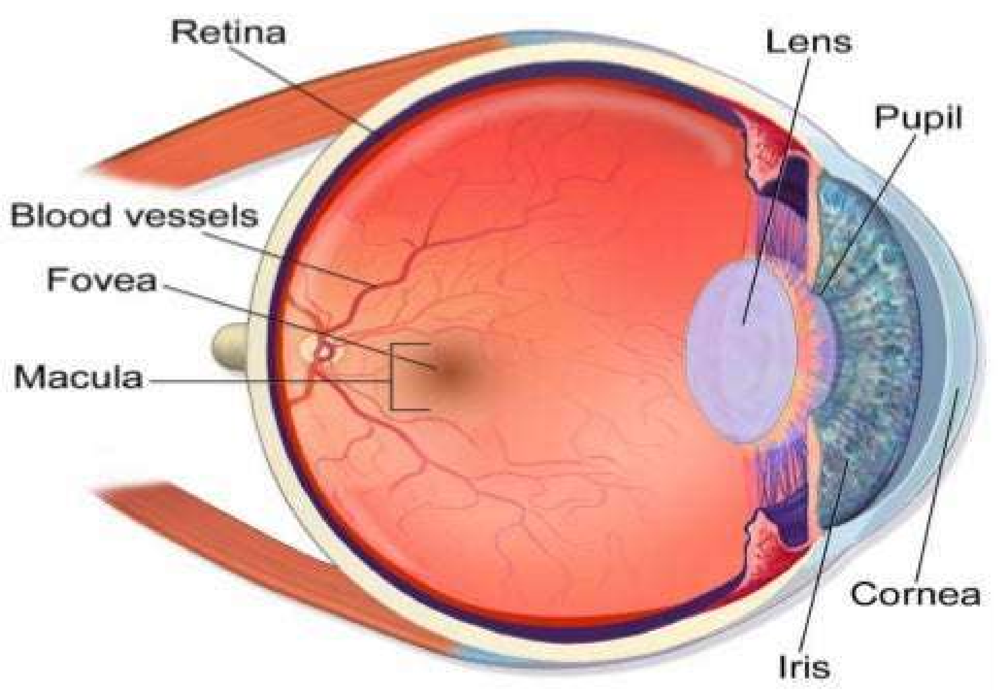
- Nerve cells and nerve fibres which are in the inner surface (facing the chamber of eye)
- Some special structures called **rod and cones** which are on the outer or choroidal surface of retina. These rods and cones receive the light and this sets up impulses which are transmitted through optic nerve.



- Optic disc is the point where the optic nerve leaves the eye ball. This point does not contain retina and it is insensitive to light. So this point is called as blind spot.



- Macula is a small area of retina which is situated just lateral to the entrance of optic nerve. Macula is exactly opposite to the centre of pupil. Direct or near vision is focused on macula.

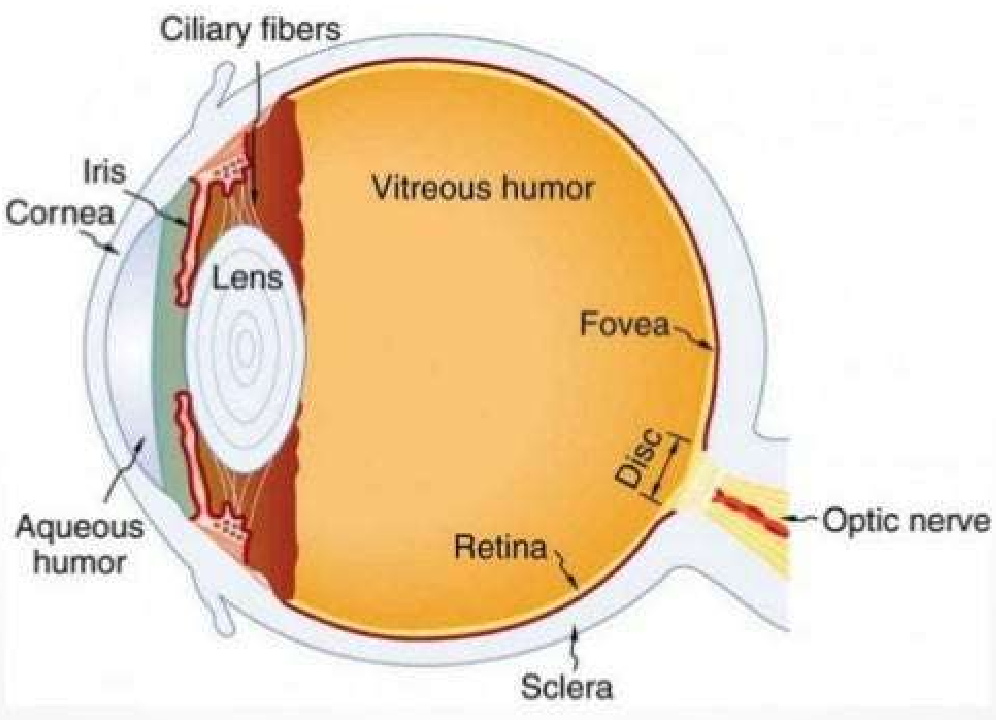


Eye Anatomy

Light transmitting structures:

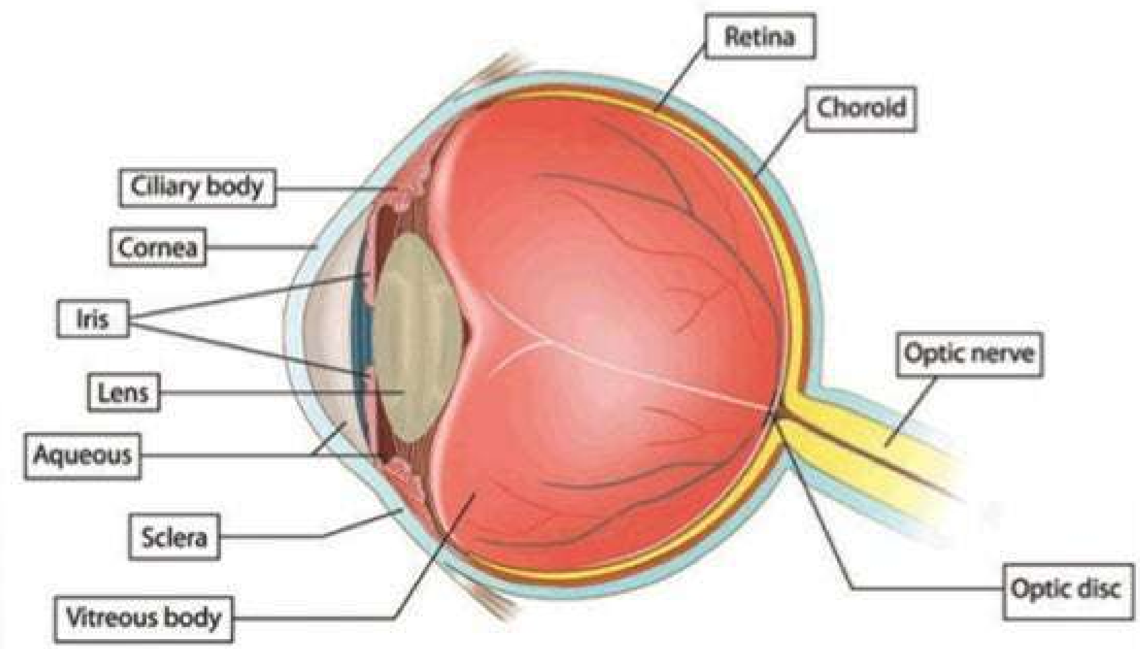
1.) Aqueous humour:

- It is a fluid present in the both the anterior and posterior chambers of eye. Anterior chamber is the space between cornea in front and iris and ciliary body at the back. Posterior chamber is the space between iris and lens. Glaucoma i.e. increase in intraocular tension occurs due to excessive collection and accumulation of aqueous humour.



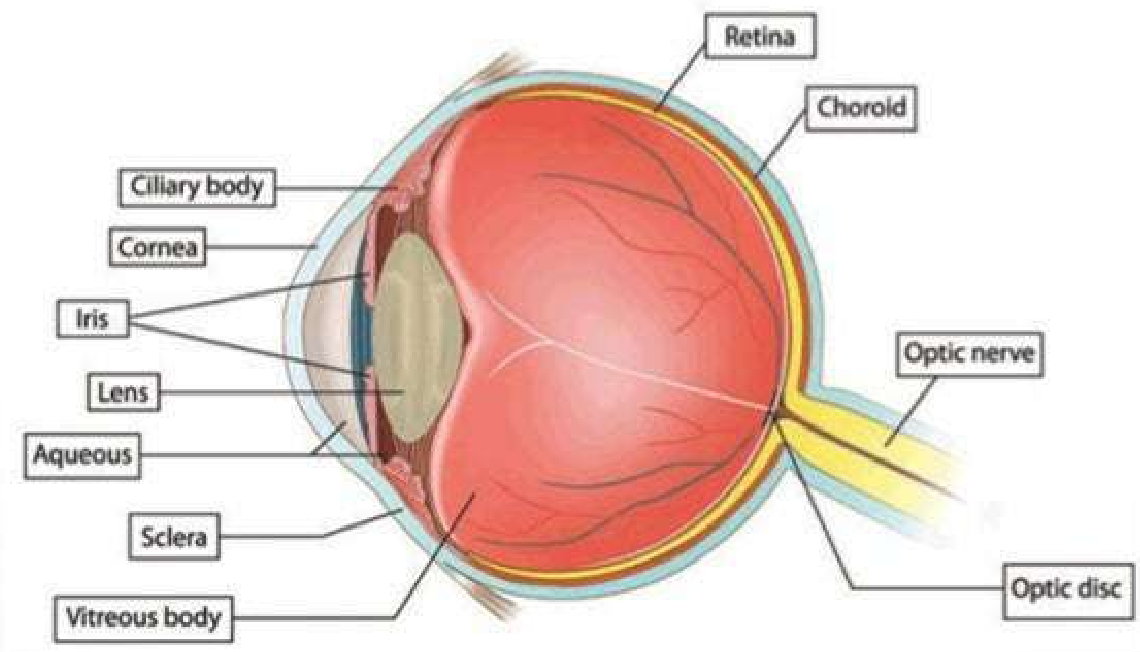
2.) Lens:

- It lies immediately behind the iris and pupil. It is attached to the ciliary body by means of suspensory ligament of lens. The thickness of lens is controlled by ciliary muscle through suspensory ligament. The lens focusses light entering through pupil on the retina.



3.) Vitreous humour:

- It is a jelly like fluid which fills the space between lens and retina. It maintains the shape of the eye. It gives shape and firmness to retina and it keeps the retina in contact with choroid and sclera.



Mechanism of sight:

The mechanism of sight(vision) is as follows:

1.) Light enters the eye through the cornea (which acts as an entrance window for light)

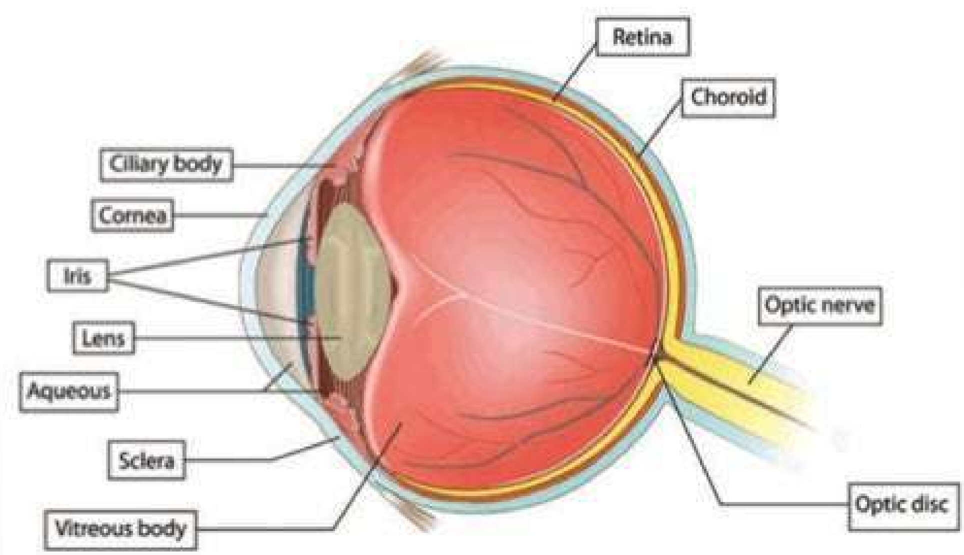
2.) Iris and the pupil regulate the amount of light entering the eye.

3.) The image is then focussed through the lens on the retina.

4.) The pigmented choroid darkens the interior of the eye. This reduces scattering and reflection of light.

5.) The image then stimulates the receptors present in the rod and cones of retina.

6.) These impulses are then carried through optic nerve. The optic nerves of both sides cross at optic chiasma. From the optic chiasma, the impulses are carried by optic tract to visual cortex present in the occipital lobe (of brain). Here the image is perceived.



Accomodation:

- It is the focussing of the lens for near vision. Ciliary muscles which are attached to the lens(through suspensory ligaments of lens) contribute to the mechanism of accomodation. The contraction and relaxation of these muscles alter the focal length of the lens. Contraction of these muscles focusses the lens for near vision. Relaxation of these muscles focusses the lens for distant vision. Focussing the lens for distant vision is called as paralysis of accomodation or cycloplegia.

Diseases of the eye:

1.) Myopia(short sight)

- This occurs due to an increase in the antero-posterior diameter of the eyeball. So the image is formed in front of the retina.
- The patient can see the near objects without difficulty. But distant objects cannot be seen clearly. This is corrected by using concave lens.

2.) Hypermetropia(long sight)

- This occurs due to a decrease in antero-posterior diameter of the eyeball. So the image falls behind the retina. The near objects cannot be seen clearly. This is corrected by using convex lens.

3.) Presbyopia:

- It is a defect in accomodation. It occurs in old age due to loss of elasticity of the lens.

4.) Glaucoma:

- It is an increase in intraocular tension produced due to excessive collection of aqueous humour (in the anterior chamber). Unless properly treated, it may lead to blindness due to retinal damage.

5.) Colour blindness:

- It is a defect of retina in which the patient cannot see one or more colour. Some patients are totally colour blind and they see everything only in black and white. Some patients are partially colour blind and can see only a few colours.

6.) Night blindness (Nyctalopia)

- It is the inability to see in dim light and it is due to deficiency of vitamin A.

7.) Cataract:

- Opacity of the lens is termed as cataract. It is caused by degenerative changes in the cells of the lens.

EAR

- Ear is concerned with the functions of hearing and equilibrium. It is divided into the following three parts:

1.) External ear

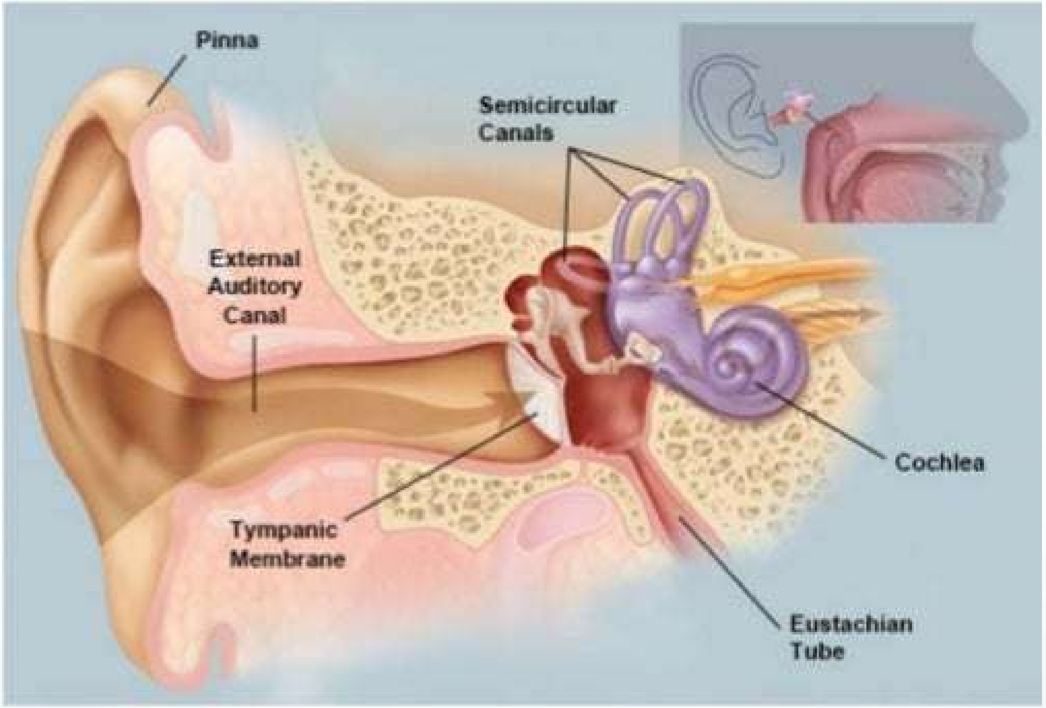
2.) Middle ear

3.) Internal ear

1.) External ear:

It is the only part which lies outside the skull. It contains the following structures:

- Pinna or auricle which is a funnel shaped organ made of elastic fibrocartilage. It helps to collect the sound waves.
- External auditory meatus which is a small channel lined by skin and wax secreting glands. It conveys the vibrations of sound to the tympanic membrane.



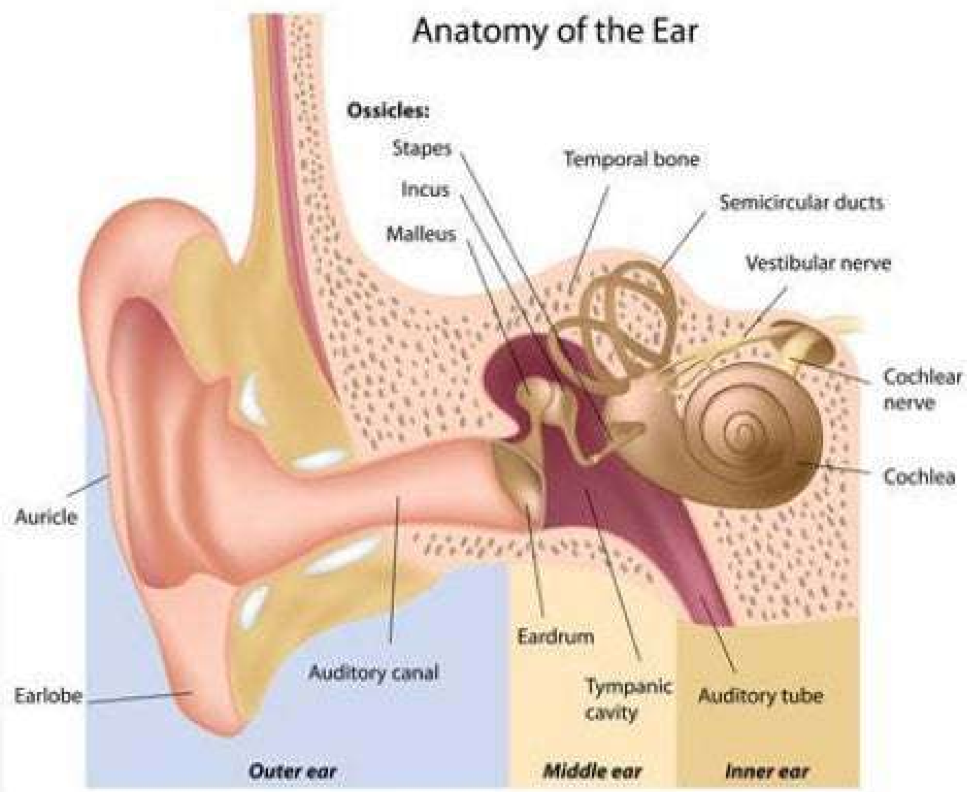
2.) Middle ear(Tympanic cavity):

- It is a small cavity in the temporal bone. It contains

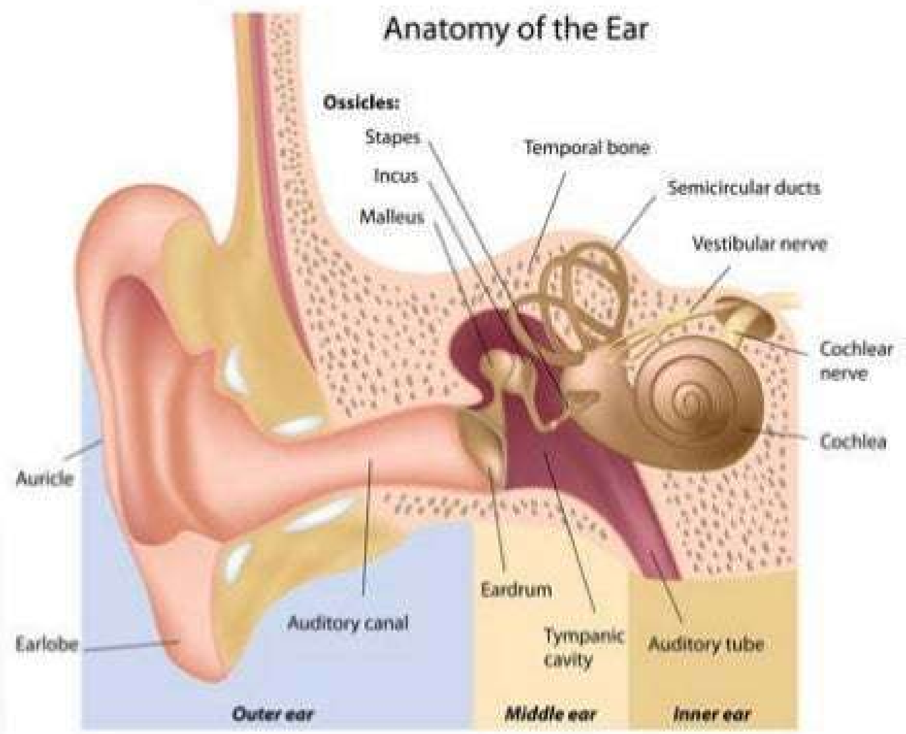
1. Tympanic membrane or ear drum which forms the lateral wall.
2. Two foramina in the inner or medial wall called

i. Fenestra ovalis or oval window

ii. Fenestra rotundum or round window

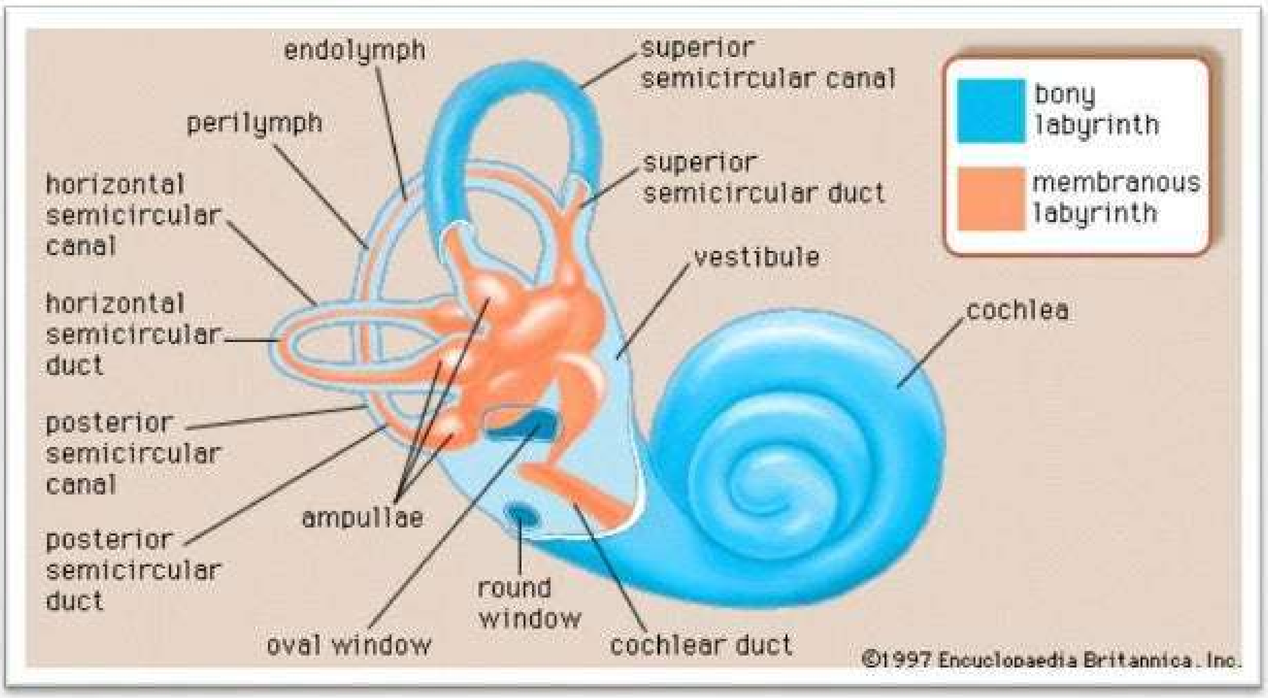


3. Eustachian tube through which middle ear communicates anteriorly with nasopharynx.
4. Auditus, a narrow channel which connects the middle ear posteriorly with mastoid antrum (present in the mastoid process of temporal bone).
5. The auditory ossicles which are three small bones arranged across the middle ear. The three ossicles are malleus, incus and stapes. The handle of maleus is fixed to the ear drum. The head of malleus is connected to incus which in turn is connected to stapes.



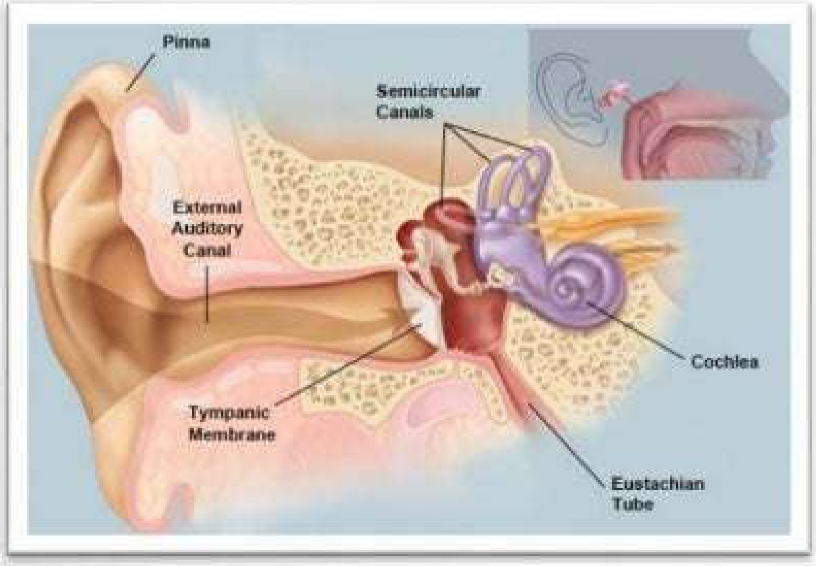
3.) Internal ear:

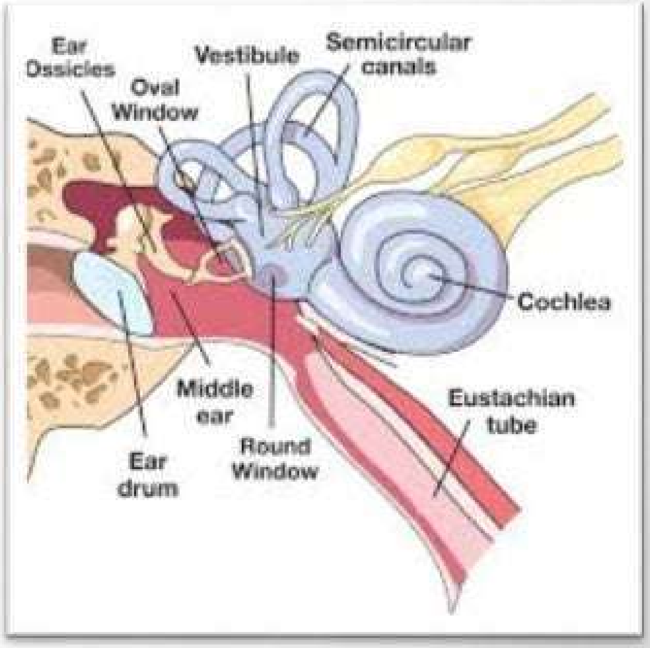
1. Bony labyrinth which consists of a series of channels (present in the petrous portion of temporal bone). The bony labyrinth contains a fluid called perilymph.
2. Membranous labyrinth which lies within the bony labyrinth. The membranous labyrinth is filled with a fluid called endolymph.



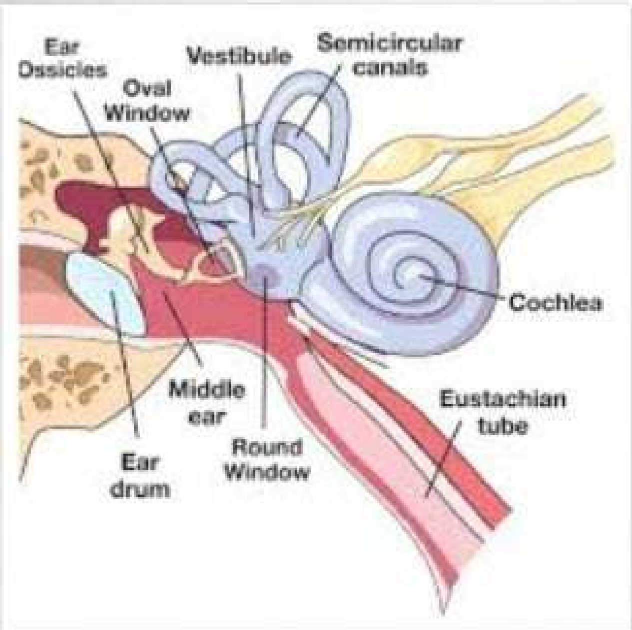
The bony labyrinth contains three structures :

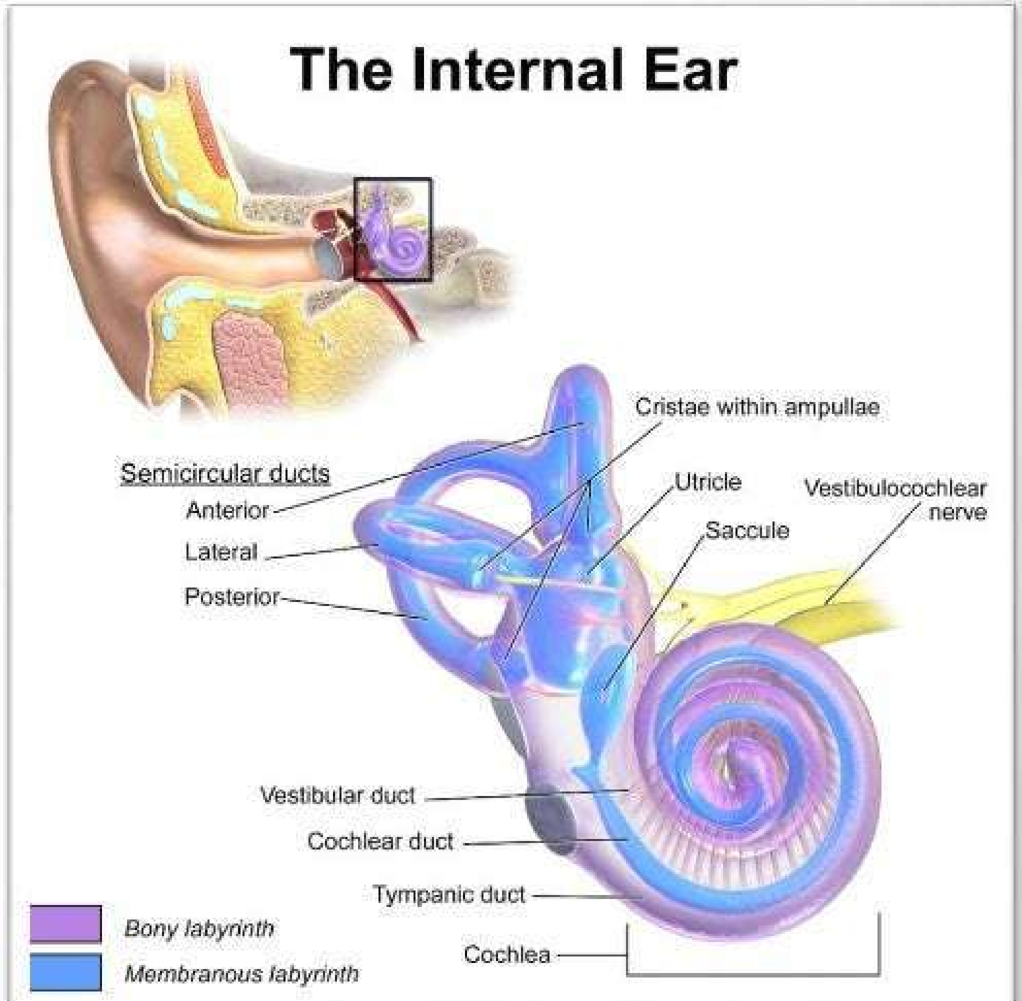
- ✓ Vestibule
- ✓ Cochlea (organ of hearing)
- ✓ Semicircular canals (organ of equilibrium)





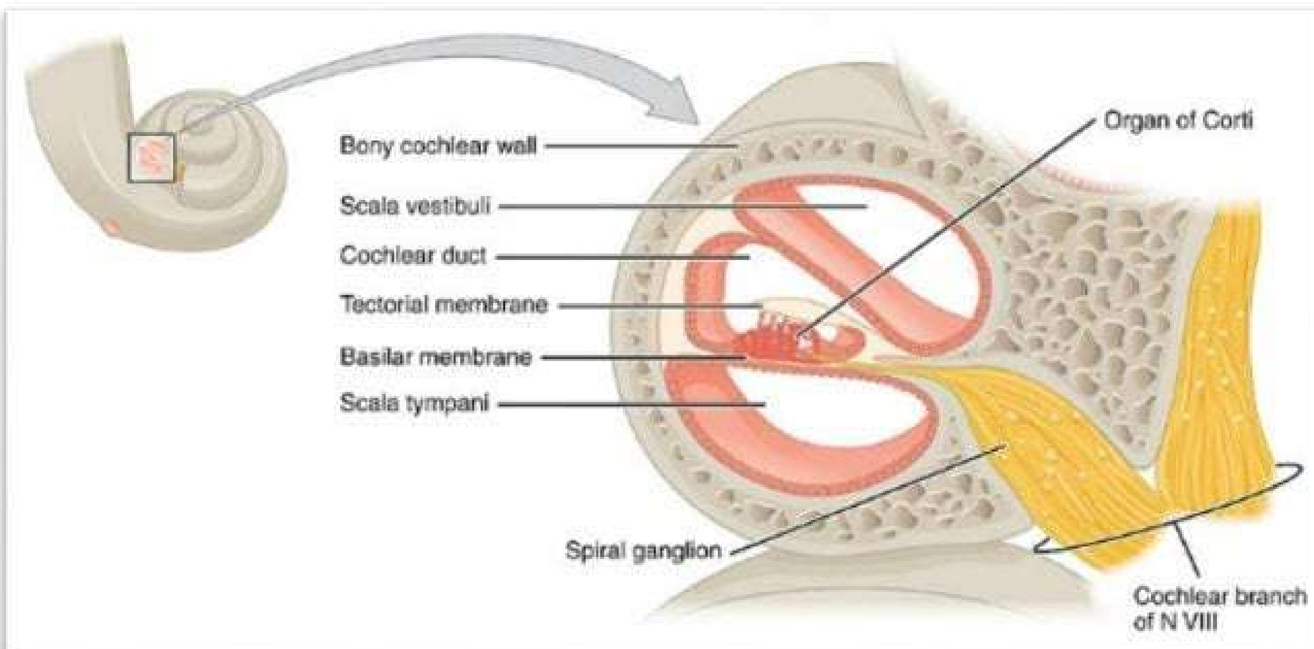
Vestibule: It is the central part. It lies between cochlea in front and semicircular canals behind. It contains utricle and saccule which are parts of membranous labyrinth.





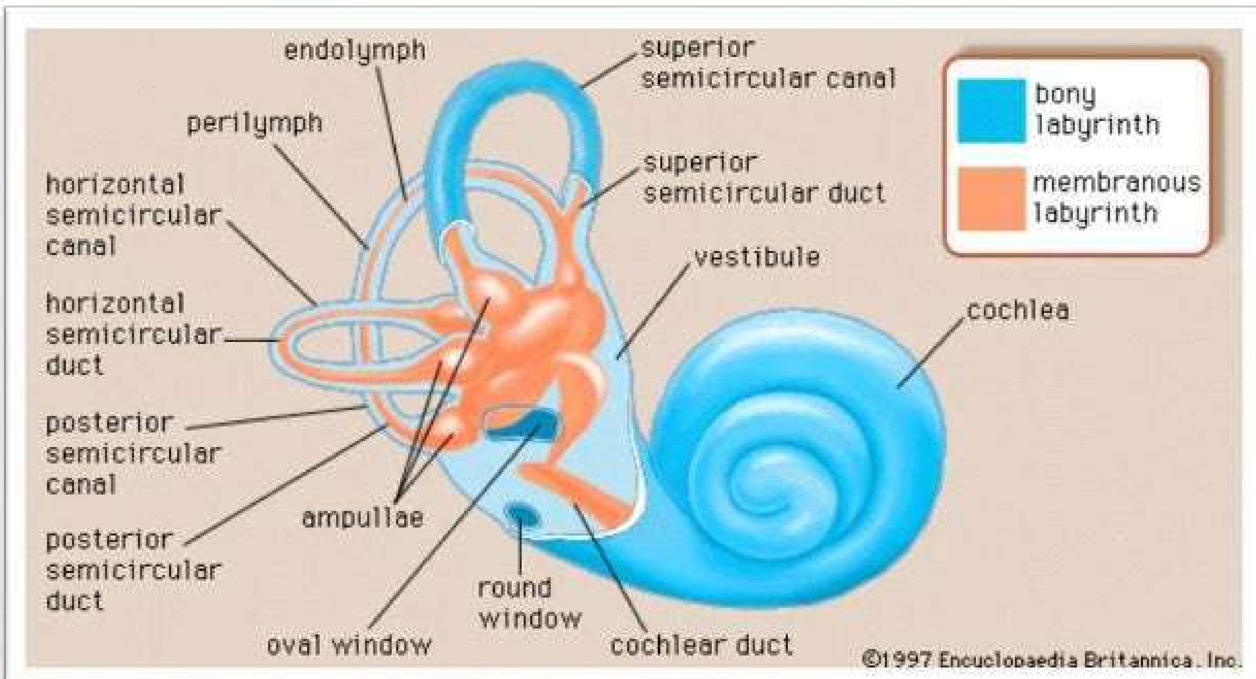
Cochlea: It is a spiral canal which looks like the shell of snail.

1. Modiolus is a central column of spongy bone around which the spiral canal twines
2. Basilar membrane is a membranous septum which divides the cochlea into two parts : An upper part called scala vestibule, lower part called scala media/tympani
3. Organ of corti is the auditory receptor which rests on the basilar membrane. The organ of corti contains rows of elongated hair cells. The fibres of cochlear nerve are in contact with these hair cells.



Semicircular canals: Each ear has three semicircular canals which are placed at right angles to each other. They are posterior, superior and lateral semicircular canals.

- Each semicircular canal has an enlarged end called ampula. The ampula has endings of vestibular nerve and also some hair like projections.



Mechanism of hearing:

1. Sound waves in air are collected by pinna
2. The external auditory meatus directs these waves to the tympanic membrane which then vibrates .
3. The vibrations are transmitted by malleus, incus and stapes to the membrane covering fenestra ovalis.
4. From the inner surface of this membrane, vibrations are transmitted to organ of corti through perilymph and endolymph.
5. From the organ of corti, the impulses (produced by vibrations) are carried to brain stem through cochlea portion of 8^{th} nerve .
6. The impulses are then carried to auditory centre of brain which is present in the temporal lobe of the opposite side.

Mechanism of equilibrium:

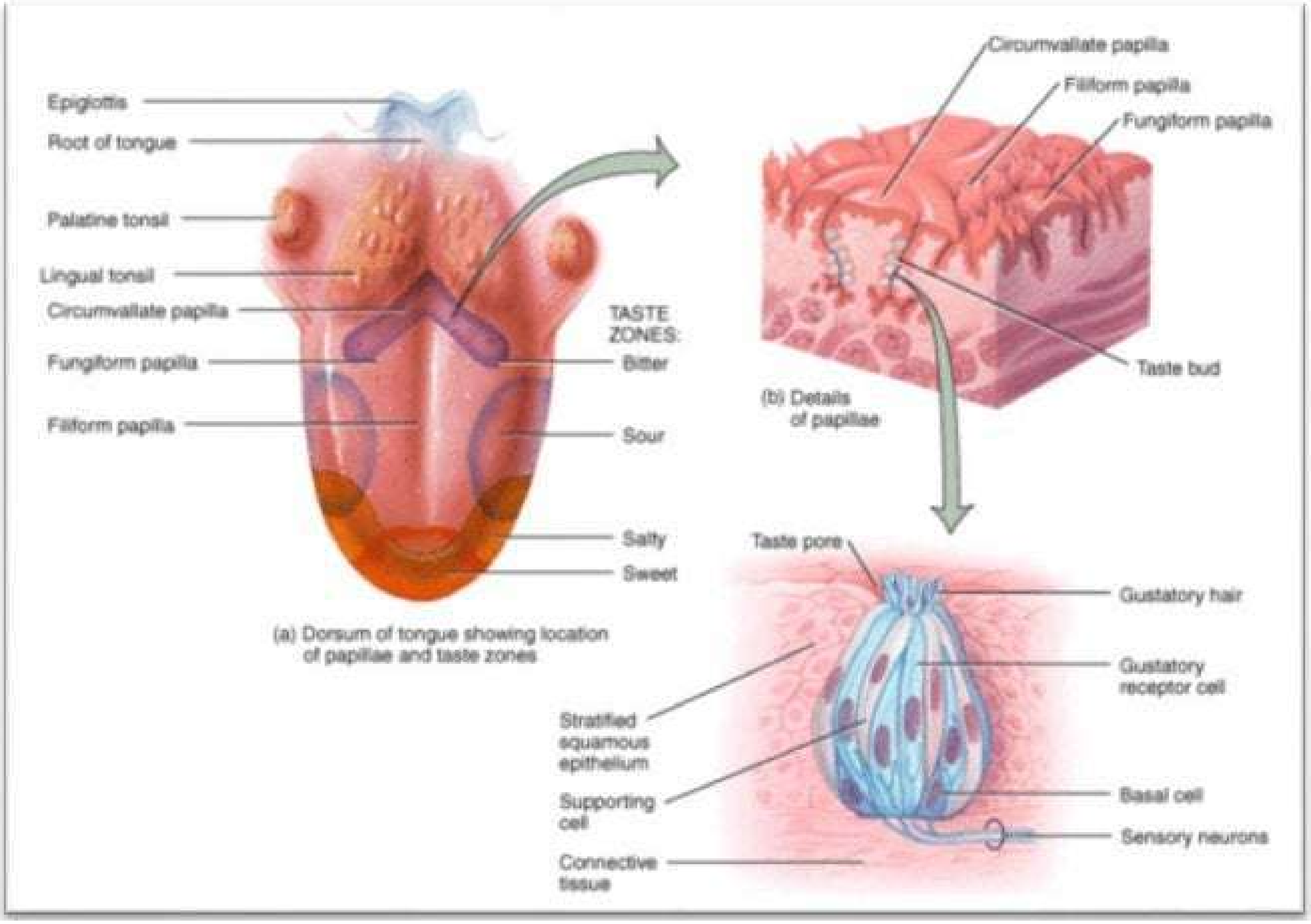
- Movement of head or alteration in its position produce movement of endolymph present in the semicircular canals.
- The movement of endolymph stimulates the nerve endings in ampullae.
- The impulses are carried to brain through the vestibular portion of 8^{th} nerve.
- These impulse produce sensations which make us conscious about the position of the head.
- If the position of head is disoriented, we can then adjust it so as to maintain balance and equilibrium.

SENSATION OF TASTE

- Sensation of Taste also known as **GUSTATION**
- The receptors for the sensation of taste are taste buds.
- The taste buds are present at the sides and base of the tongue.

There are four different types of tastes which are felt at different areas of tongue as follows:

- Sweet taste is felt at the tip
- Bitter taste is felt at the back
- Sour taste is felt at the back edge
- Salt taste is felt at the front edge

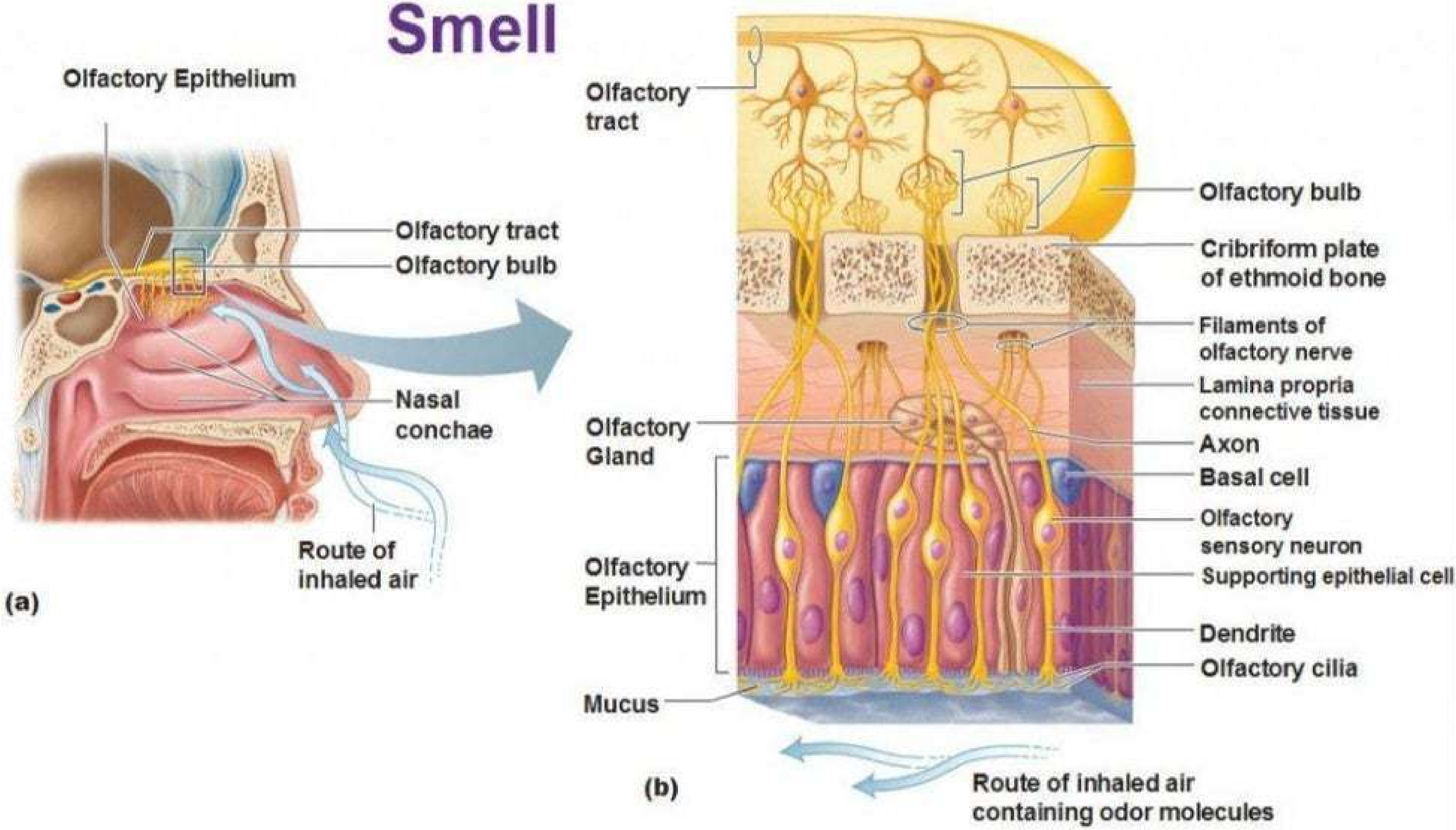


- The sensory nerves originating from the taste buds are carried through facial and glossopharyngeal nerves. The impulses are carried to taste centre in the medulla and from there to thalamus and then to motor cortex. The impulses are interpreted in the cortex as sensation of taste.

SENSATION OF SMELL

- Sensation of smell also known as **Olfaction**
- Nose is the organ of the sense of smell. The sensory nerves of smell are the olfactory nerves (first cranial nerve)
- The receptors for smell are olfactory rods. They are present in the mucous membrane of upper part of nasal cavity. The ends of olfactory rods collect to form the olfactory nerve (1^{st} cranial nerve). This nerve passes through the root of nose and ends in olfactory bulb. From the olfactory bulb, the sensations are carried through olfactory tract to olfactory area in the temporal lobe of cerebral cortex. The perception of smell occurs in this area.

Smell



Olfactory Epithelium
Olfactory tract
Olfactory bulb
Nasal conchae
Route of inhaled air
(a)
Olfactory tract
Olfactory bulb
Cribriform plate of ethmoid bone
Filaments of olfactory nerve
Lamina propria connective tissue
Olfactory Gland
Axon
Basal cell
Olfactory sensory neuron
Olfactory Epithelium
Supporting epithelial cell
Dendrite
Olfactory cilia
Mucus
(b)
Route of inhaled air containing odor molecules

SKIN

- Skin is the outer covering of body which is in contact with external environment.

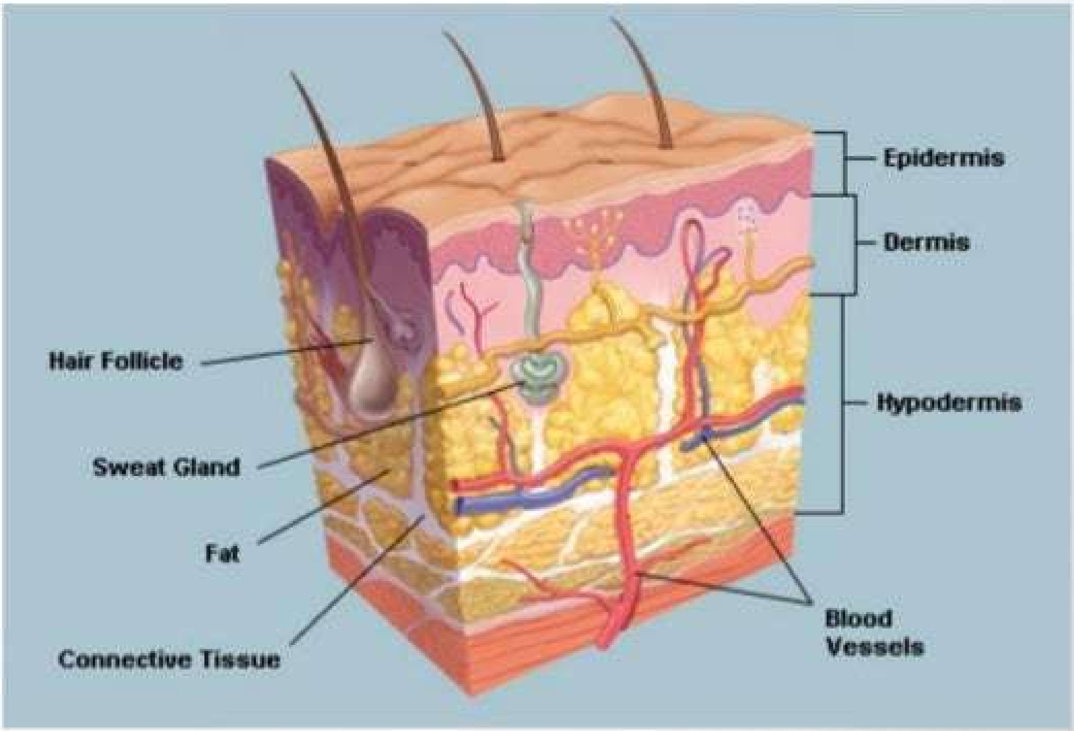
Functions of Skin:

- Protection of underlying structures from injury.
- Excretion of salts like sodium chloride and metabolites like urea.
- Provides sensation which gives the awareness of environment.
- Secretion of sweat and sebum
- Regulation of body temperature
- Synthesis of vitamin D from ergosterol of skin by the action of ultraviolet rays of sun.

Structure of skin:

Skin consists of

- An outer layer called **Epidermis**
- An inner layer called **Dermis**



Epidermis:

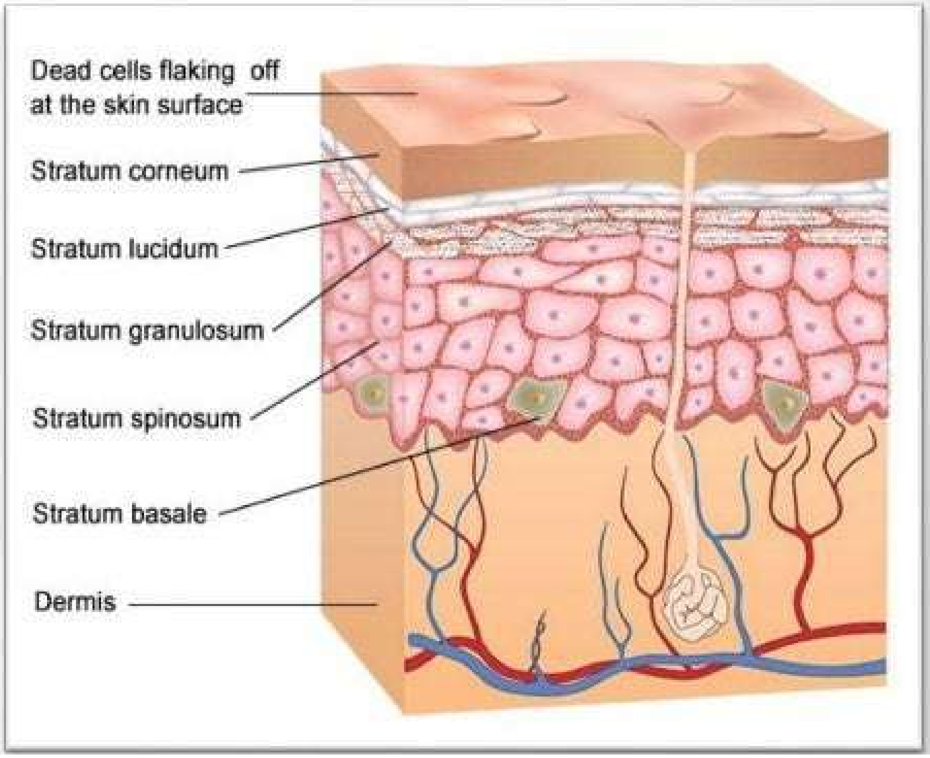
It is made of stratified epithelium and contains the following layers:

i.) **Stratum corneum**-containing scale like cells which are constantly replaced. These cells have a protein called keratin.

ii.) **Stratum lucidum**-a glistening layer

iii.) **Stratum granulosum**-has spindle shaped cells with granules in the cytoplasm

iv.) **Stratum germinativum(Stratum spinosum & basale)** -contains cuboidal cells. The skin cells multiply in this layer



Dermis:

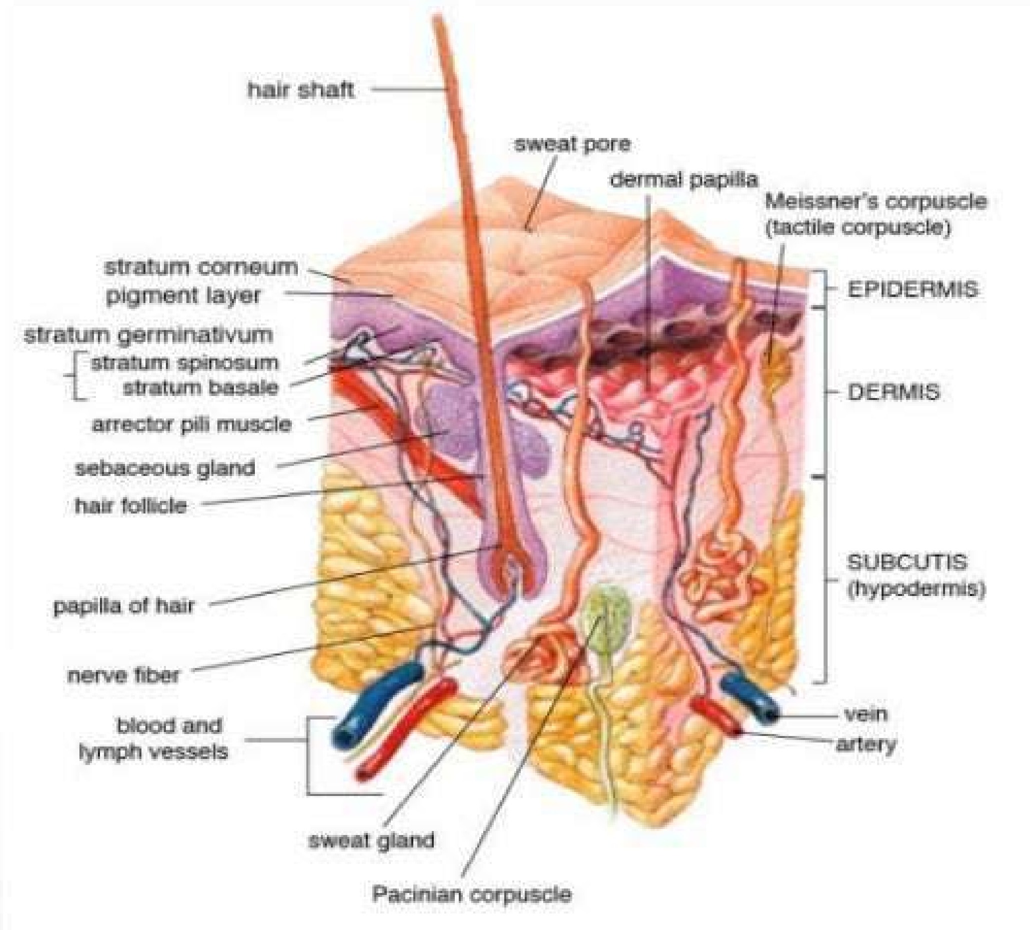
It is the inner layer which forms true skin. It contains the following structures:

i.) **Melanophore cells** containing melanin pigment and some elastic fibres which maintain the texture of skin.

ii.) **Arterial and venous capillaries** and sensory nerve endings.

iii.) **Sweat and sebaceous glands**.

iv.) **Hair roots and arrector pili muscles** (contraction of these muscles produce straightening of the hair)

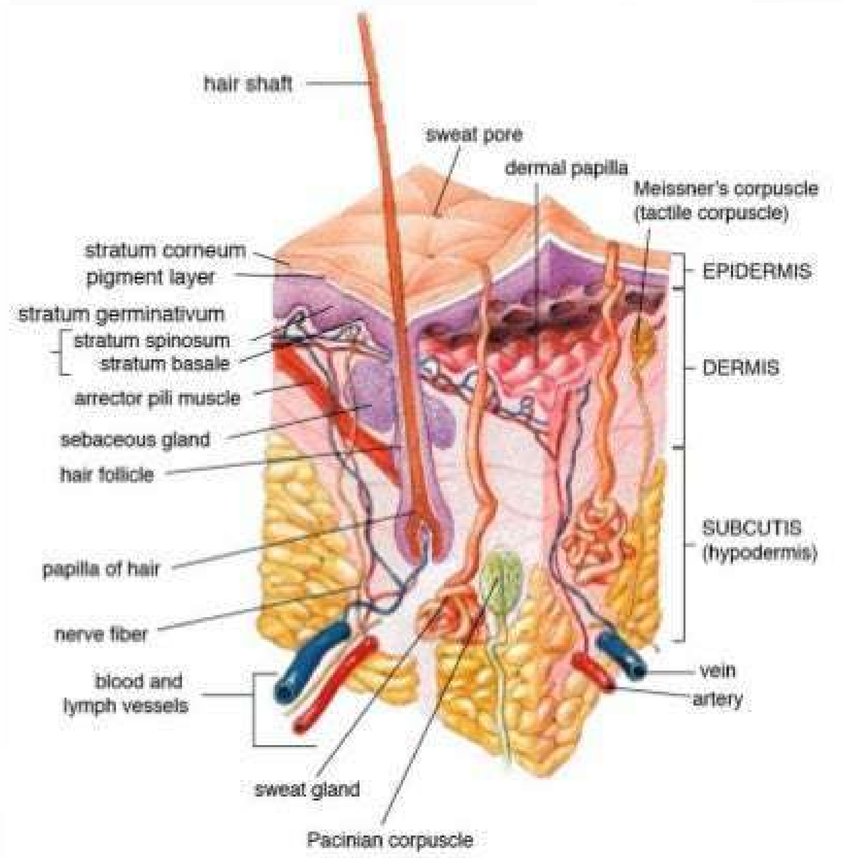


SECRETIONS OF SKIN

The two secretions of skin are sweat and sebum

Secretions of sweat:

Sweat is secreted by sweat glands which arise from dermis. They are twisted tubular glands and their ducts open in epidermis. Sweat glands are more numerous in the palms of hands and sole of feet. About 500 ml of sweat is formed in 24 hours.



Sweat contains mainly water, some salts and trace of other waste products.

Perspiration or sweating can be classified into:

1.) **Insensible perspiration** which evaporates quickly and so it is not observed.

2.) **Sensible perspiration** which occurs during excessive sweating. So production of sweat is more than evaporation.

- The secretion of sweat is controlled by sympathetic nerves.

Secretion of sebum:

- Sebum is a greasy secretion produced by sebaceous glands. They are small, flask shaped glands present in dermis. They have a duct which opens into a hair follicle.
- The sebaceous glands are present in the skin of many parts except the palm of hands and sole of feet. Sebum keeps the skin oily and prevents it from drying.


Thank you

Structure and functions of cell

By
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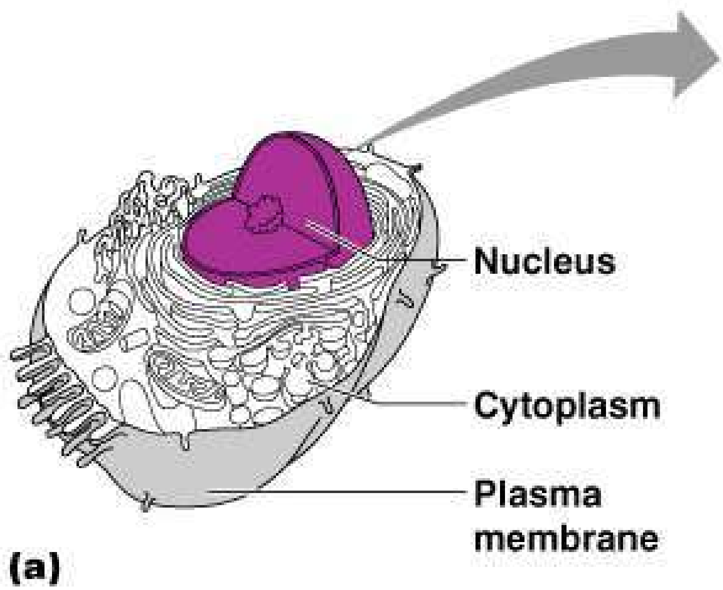
Cell

- Carry out all chemical activities needed to sustain life
- Cells are the building blocks of all living things
- Cell is the structural and functional unit of living organism.

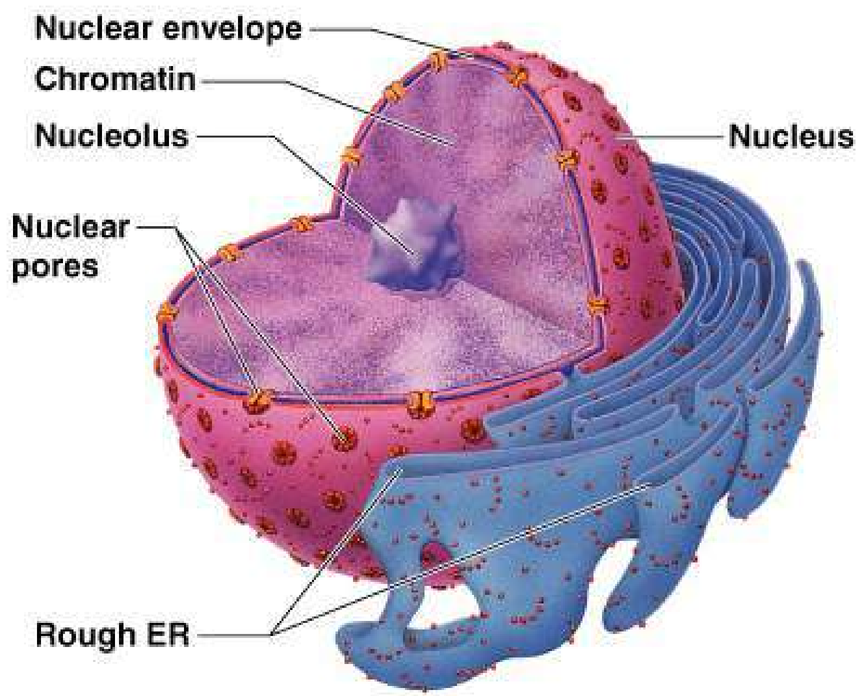
Anatomy of the Cell

- Cells are not all the same
- All cells share general structures
- Cells are organized into three main regions
  - Nucleus
  - Cytoplasm
  - Plasma membrane



The Nucleus

- Control center of the cell
  - Contains genetic material (DNA)
- Three regions
  - Nuclear membrane
  - Nucleolus
  - Chromatin



(b)

Nuclear Membrane

- Barrier of nucleus
- Consists of a double phospholipid membrane
- Contain nuclear pores that allow for exchange of material with the rest of the cell

Nucleoli

- Nucleus contains one or more nucleoli
- Sites of ribosome production
  - Ribosomes then migrate to the cytoplasm through nuclear pores

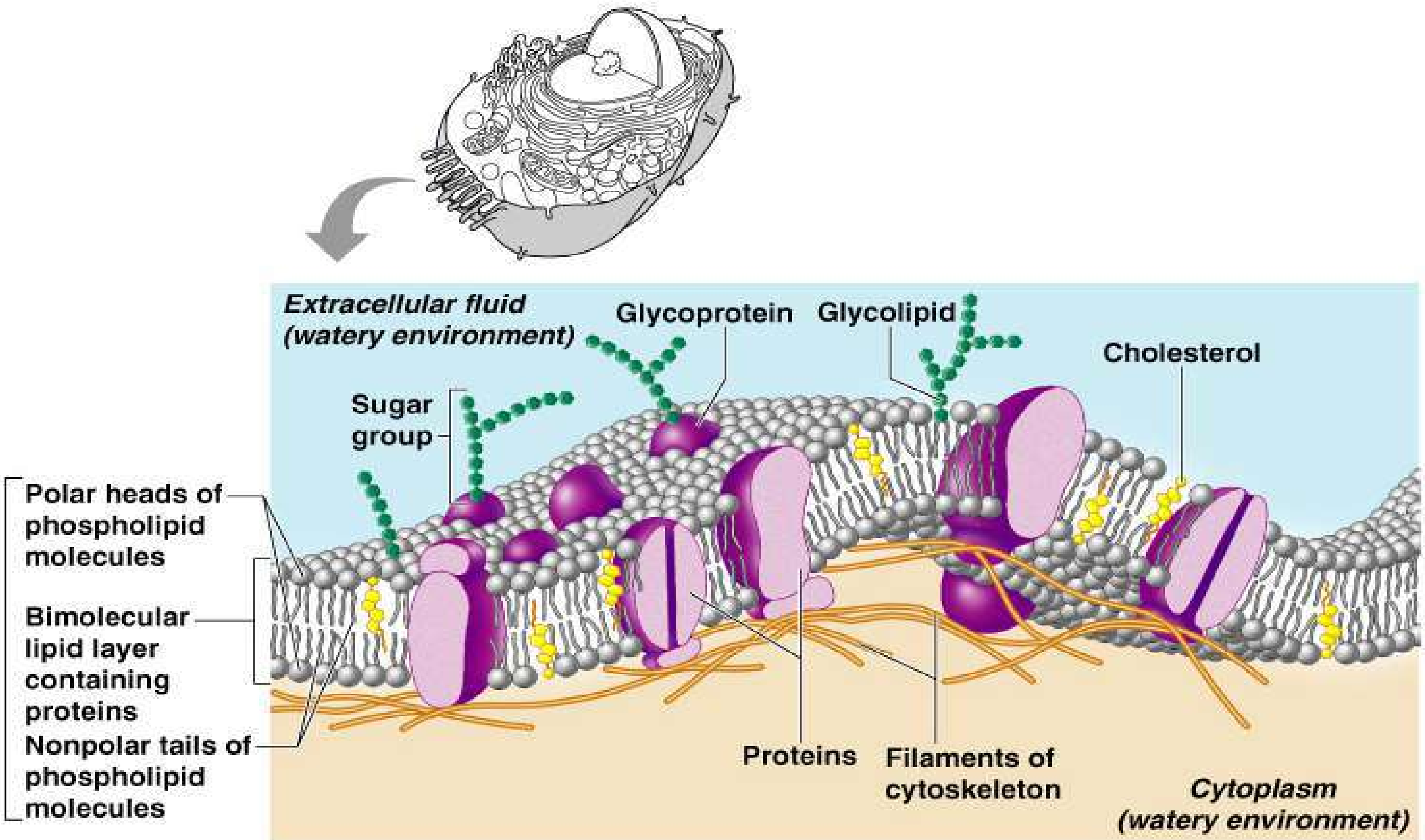
Chromatin

- Composed of DNA and protein
- Scattered throughout the nucleus
- Chromatin condenses to form chromosomes when the cell divides

Plasma Membrane

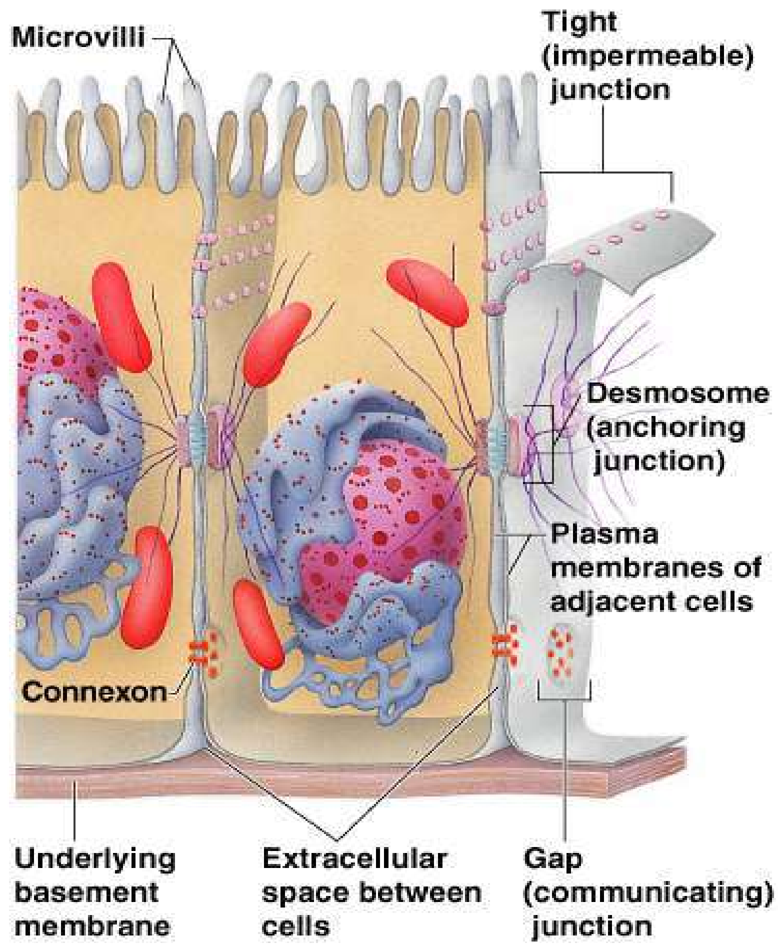
- Barrier for cell contents
- Double phospholipid layer
  - Hydrophilic heads
  - Hydrophobic tails
- Also contains protein, cholesterol, and glycoproteins

Plasma Membrane



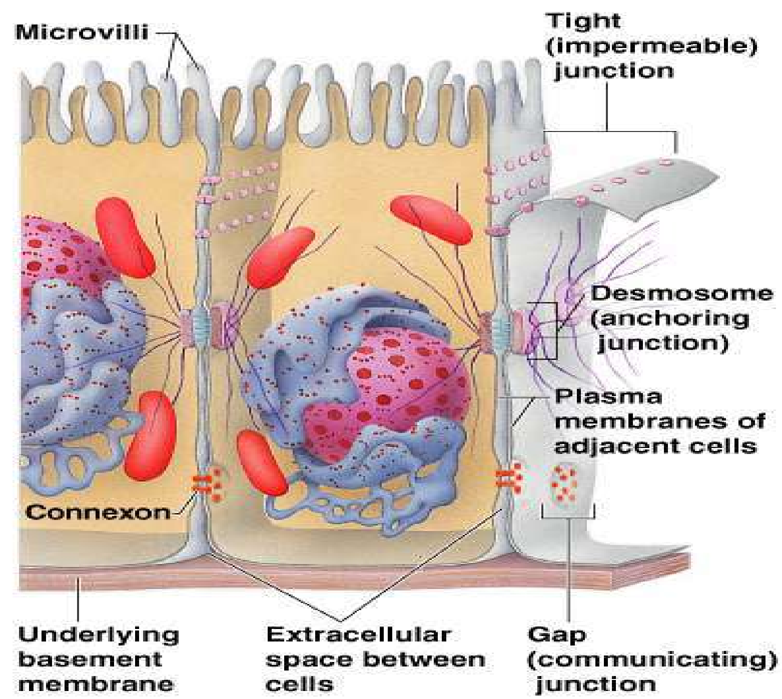
Plasma Membrane Specializations

- Microvilli
  - Finger-like projections that increase surface area for absorption



Plasma Membrane Specializations

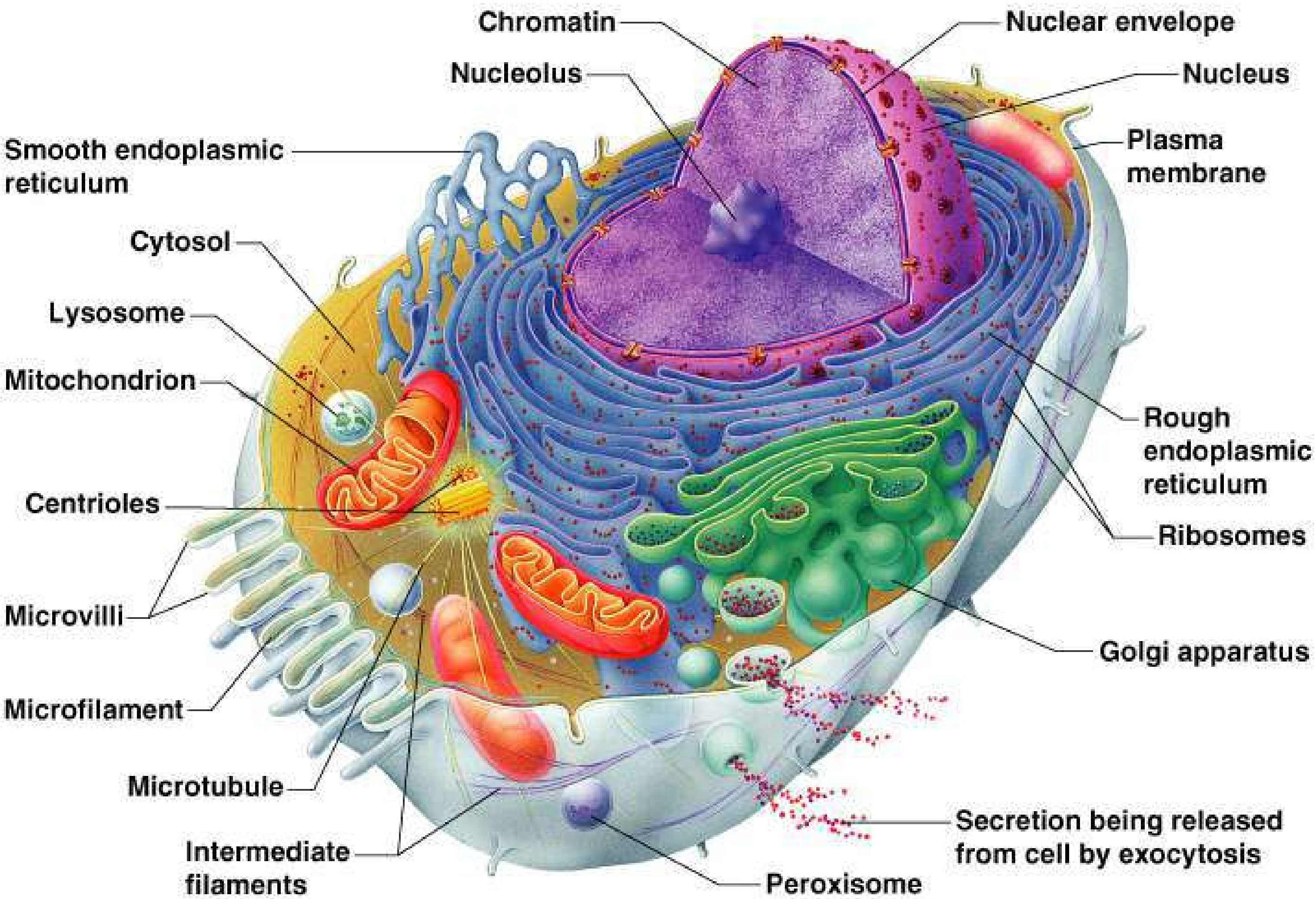
- Membrane junctions
  - Tight junctions
  - Desmosomes
  - Gap junctions



Cytoplasm

- Material outside the nucleus and inside the plasma membrane
  - Cytosol
    - Fluid that suspends other elements
  - Organelles
    - Metabolic machinery of the cell
  - Inclusions
    - Non-functioning units

Cytoplasmic Organelles



Cytoplasmic Organelles

- Ribosomes
  - Made of protein and RNA
  - Sites of protein synthesis
  - Found at two locations
    - Free in the cytoplasm
    - Attached to rough endoplasmic reticulum

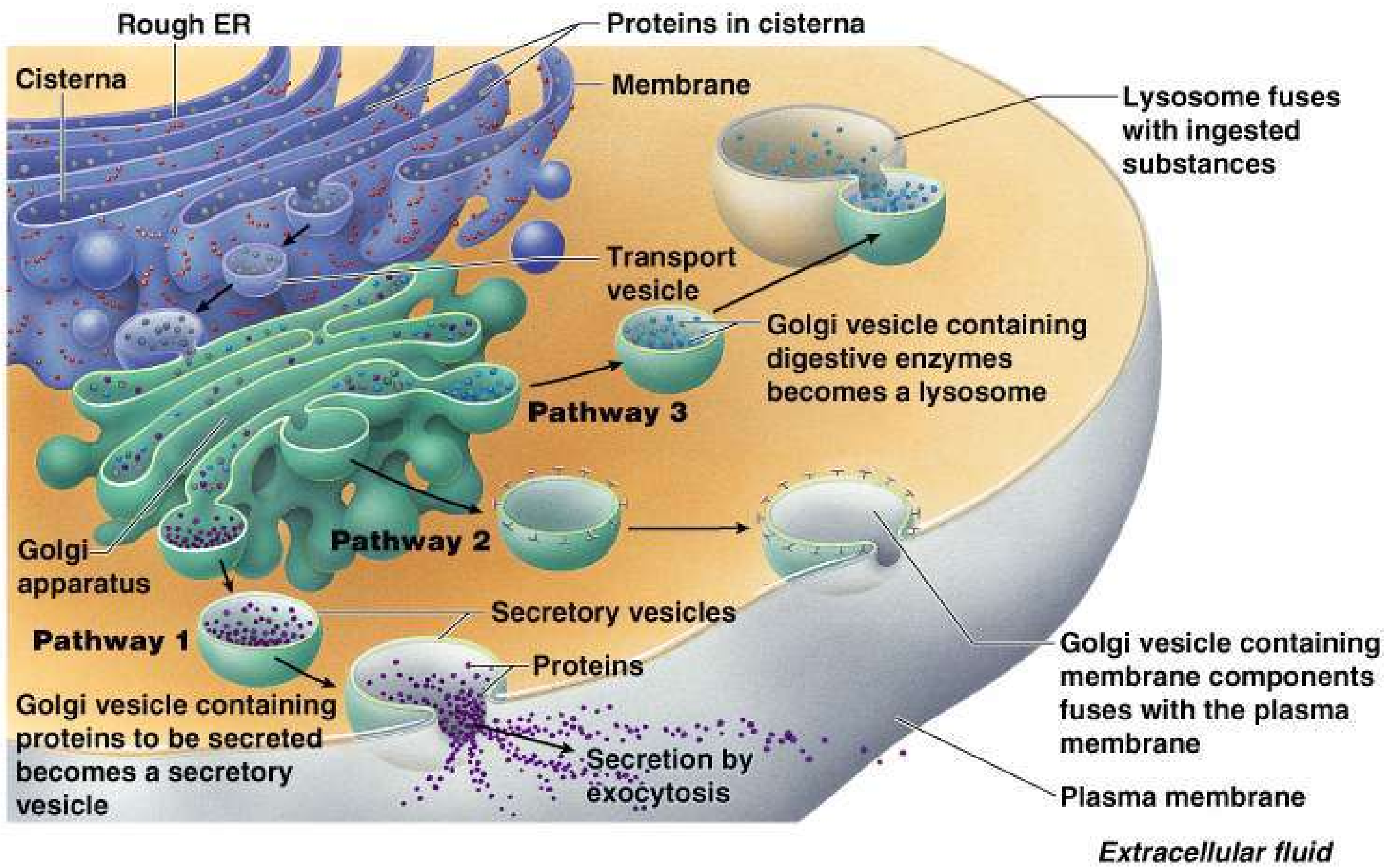
Cytoplasmic Organelles

- Endoplasmic reticulum (ER)
  - Fluid-filled tubules for carrying substances
  - Two types of ER
    - Rough Endoplasmic Reticulum
      - Studded with ribosomes
      - Site where building materials of cellular membrane are formed
    - Smooth Endoplasmic Reticulum
      - Functions in cholesterol synthesis and breakdown, fat metabolism, and detoxification of drugs

Cytoplasmic Organelles

- Golgi apparatus
  - Modifies and packages proteins
  - Produces different types of packages
    - Secretory vesicles
    - Cell membrane components
    - Lysosomes

Golgi Apparatus



Cytoplasmic Organelles

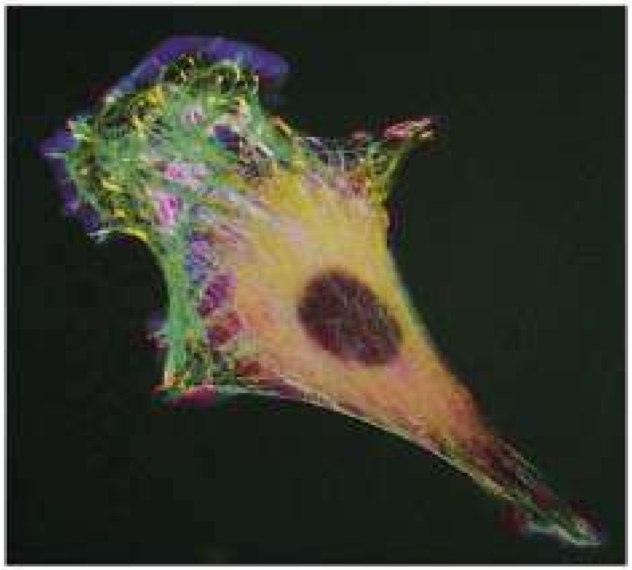
- Lysosomes
  - Contain enzymes that digest nonusable materials within the cell
- Peroxisomes
  - Membranous sacs of oxidase enzymes
    - Detoxify harmful substances
    - Break down free radicals (highly reactive chemicals)
  - Replicate by pinching in half

Cytoplasmic Organelles

- Mitochondria
  - "Powerhouses" of the cell
  - Change shape continuously
  - Carry out reactions where oxygen is used to break down food
  - Provides ATP for cellular energy

Cytoplasmic Organelles

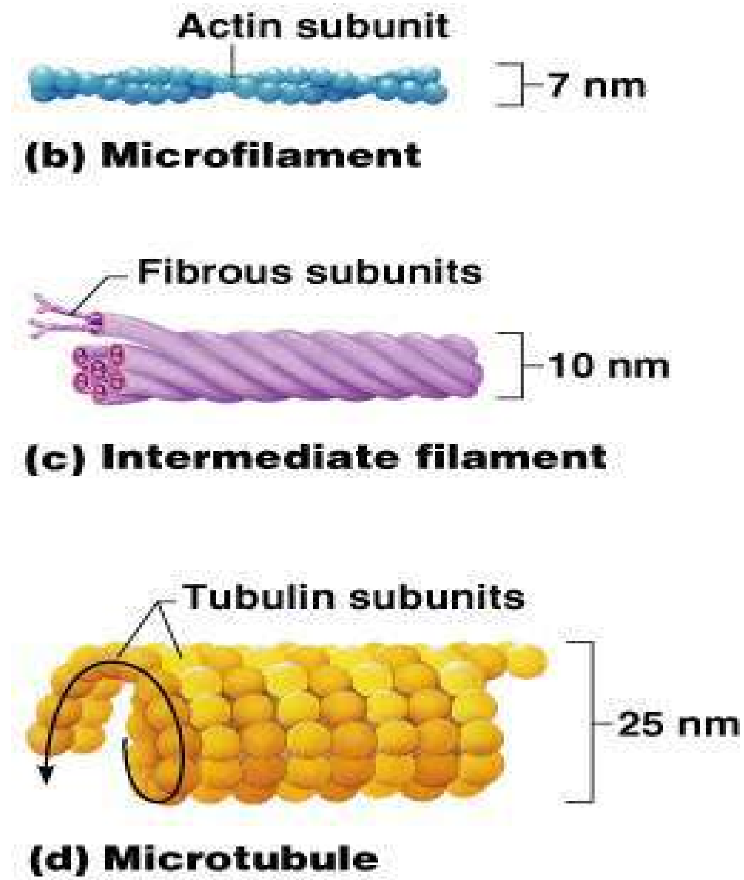
- Cytoskeleton
  - Network of protein structures that extend throughout the cytoplasm
  - Provides the cell with an internal framework



(a)

Cytoplasmic Organelles

- Cytoskeleton
  - Three different types
    - Microfilaments
    - Intermediate filaments
    - Microtubules



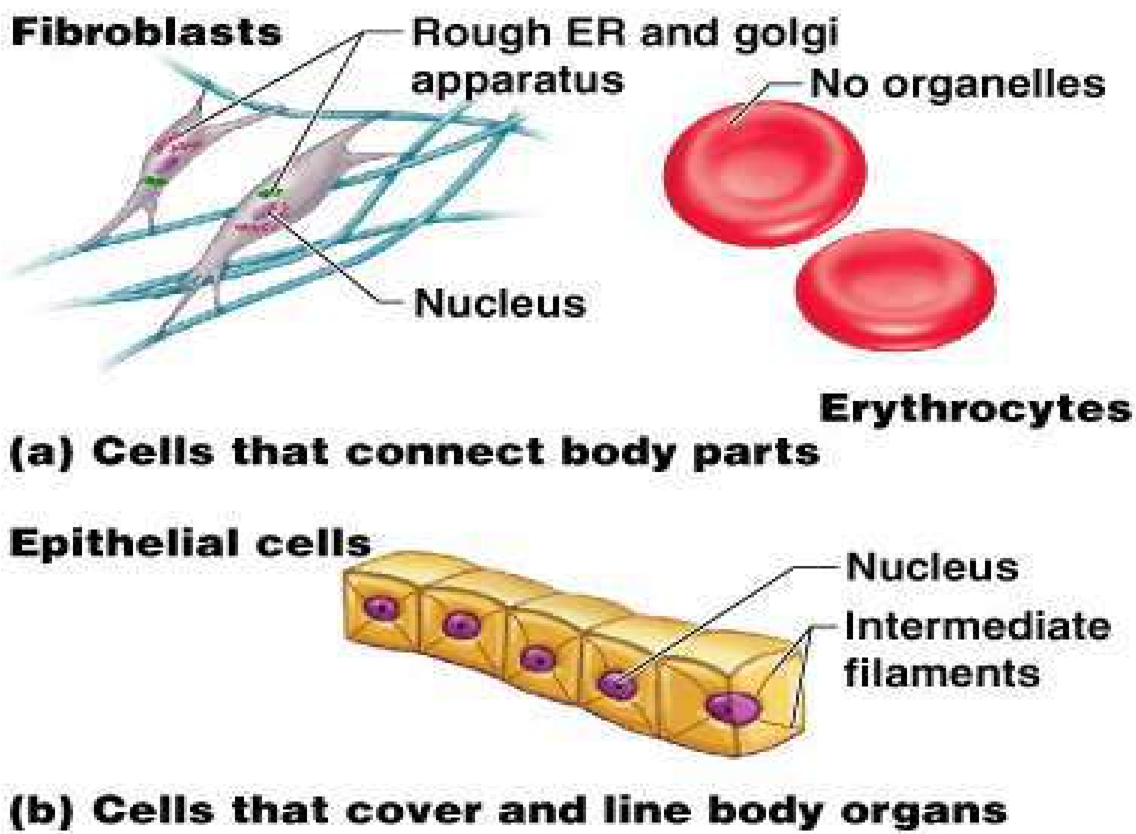
Cytoplasmic Organelles

- Centrioles
  - Rod-shaped bodies made of microtubules
  - Direct formation of mitotic spindle during cell division

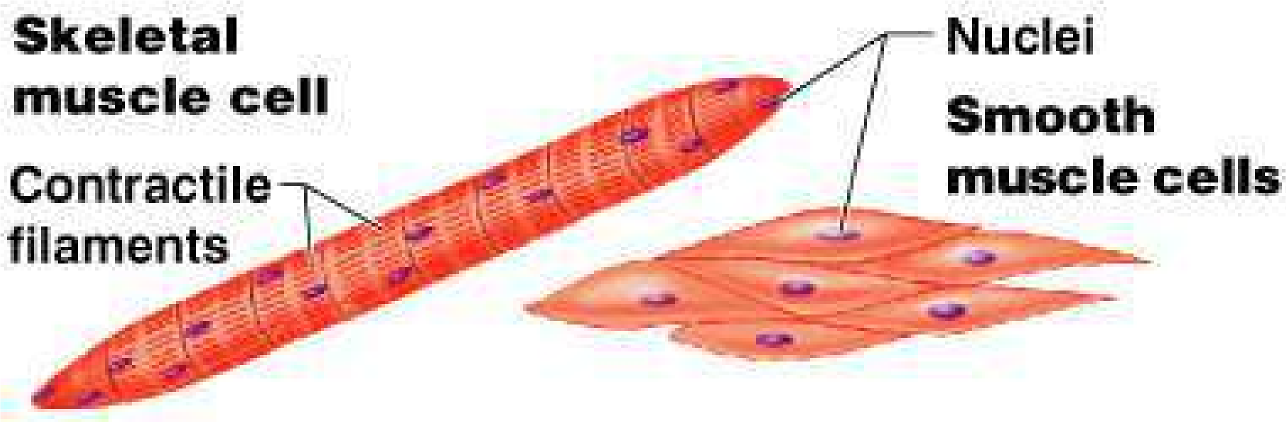
Cellular Projections

- Not found in all cells
- Used for movement
  - Cilia moves materials across the cell surface
  - Flagellum propels the cell

Cell Diversity



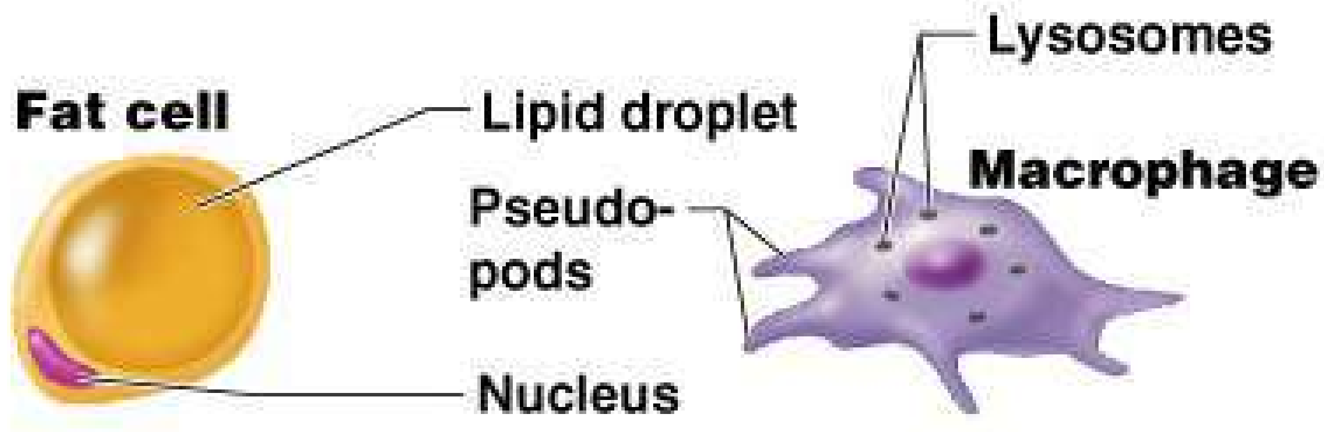
Cell Diversity



(c) Cells that move organs and body parts

Figure 3.8c

Cell Diversity



(d) Cell that stores nutrients

(e) Cell that fights disease

Cellular Physiology: Membrane Transport

- Membrane Transport – movement of substance into and out of the cell
- Transport is by two basic methods
  - Passive transport
    - No energy is required
  - Active transport
    - The cell must provide metabolic energy

Solutions and Transport

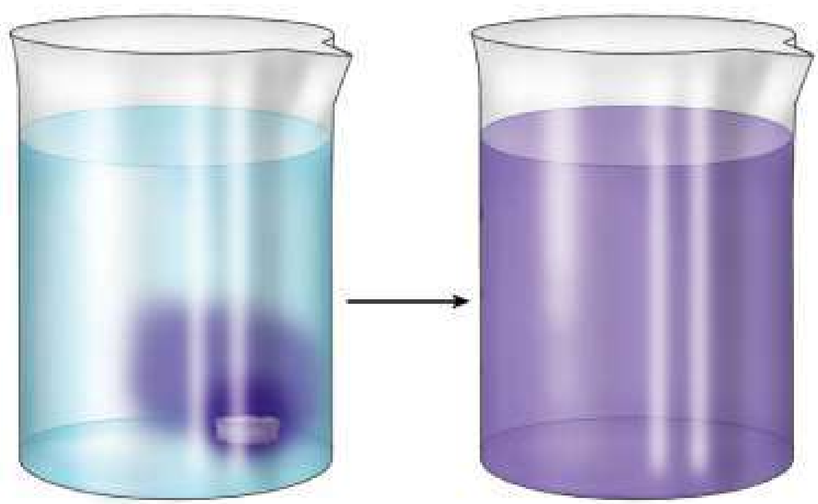
- Solution – homogeneous mixture of two or more components
  - Solvent – dissolving medium
  - Solutes – components in smaller quantities within a solution
- Intracellular fluid – nucleoplasm and cytosol
- Interstitial fluid – fluid on the exterior of the cell

Selective Permeability

- The plasma membrane allows some materials to pass while excluding others
- This permeability includes movement into and out of the cell

Passive Transport Processes

- Diffusion
  - Particles tend to distribute themselves evenly within a solution
  - Movement is from high concentration to low concentration, or down a concentration gradient



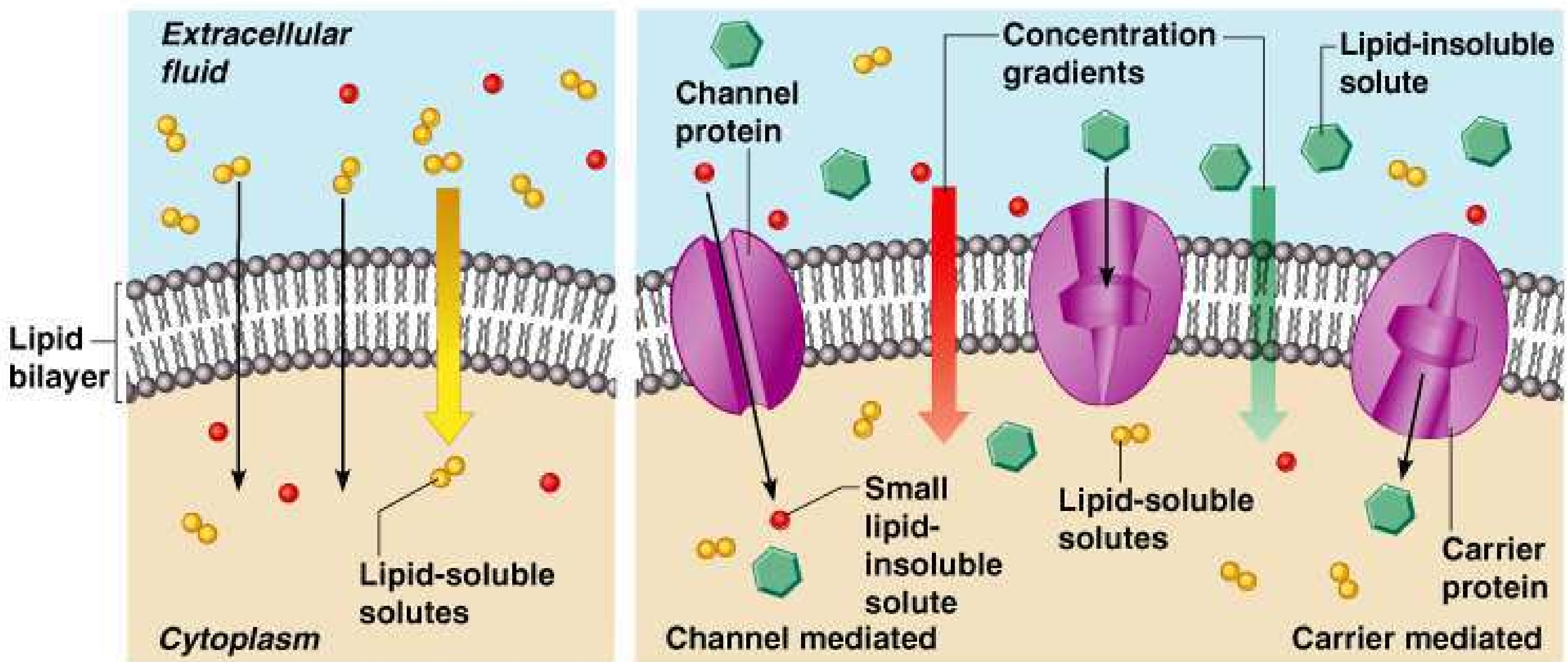
Passive Transport Processes

- Types of diffusion
  - Simple diffusion
    - Unassisted process
    - Solutes are lipid-soluble materials or small enough to pass through membrane pores

Passive Transport Processes

- Types of diffusion
  - Osmosis – simple diffusion of water
    - Highly polar water easily crosses the plasma membrane
  - Facilitated diffusion
    - Substances require a protein carrier for passive transport

Diffusion through the Plasma Membrane



(a) Simple diffusion **(b) Facilitated diffusion**

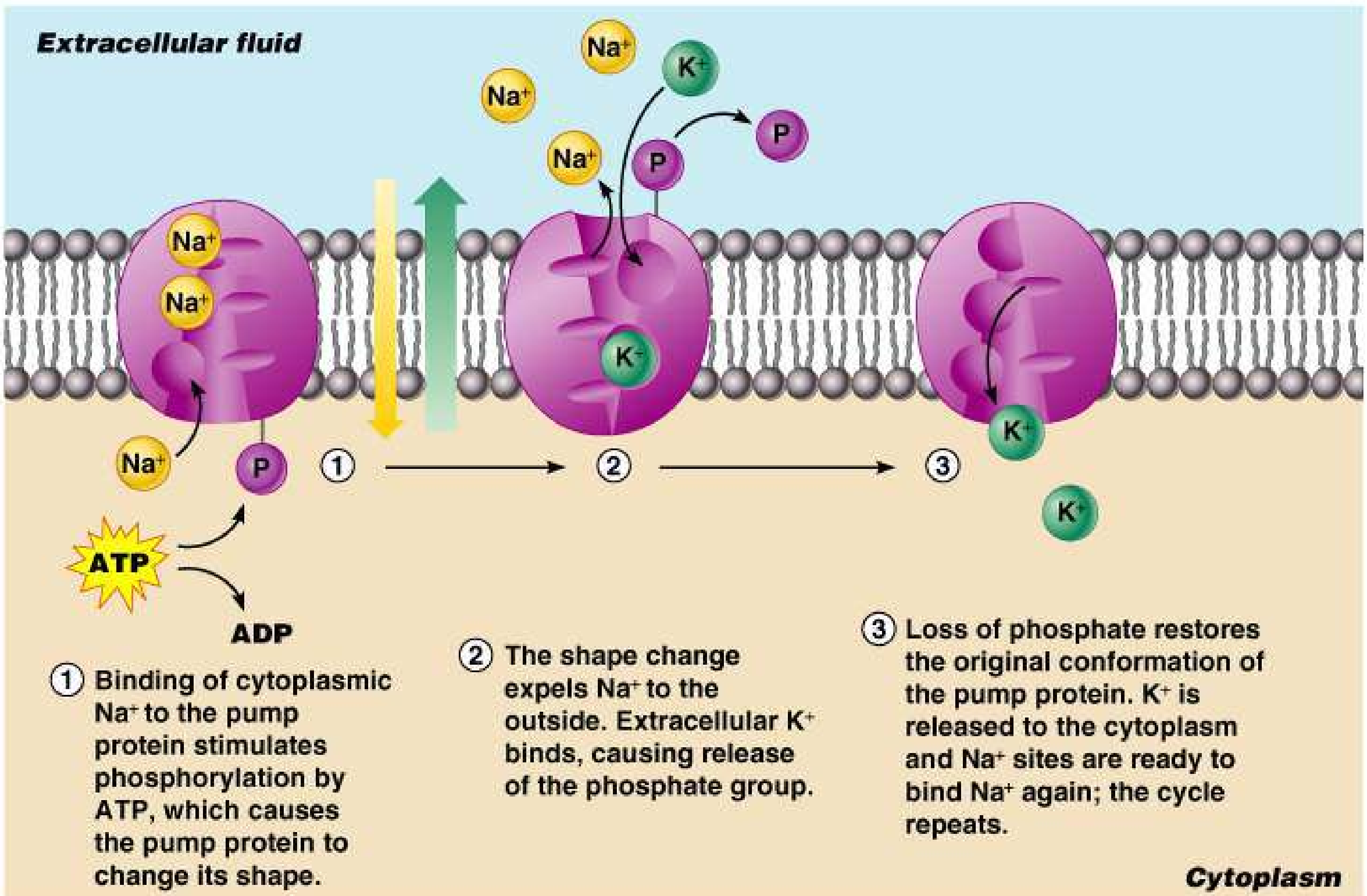
Passive Transport Processes

- Filtration
  - Water and solutes are forced through a membrane by fluid, or hydrostatic pressure
  - A pressure gradient must exist
    - Solute-containing fluid is pushed from a high pressure area to a lower pressure area

Active Transport Processes

- Transport substances that are unable to pass by diffusion
  - They may be too large
  - They may not be able to dissolve in the fat core of the membrane
  - They may have to move against a concentration gradient
- Two common forms of active transport
  - Solute pumping – chemical exchanges
  - Bulk transport - exocytosis

Active Transport Processes



Exocytosis

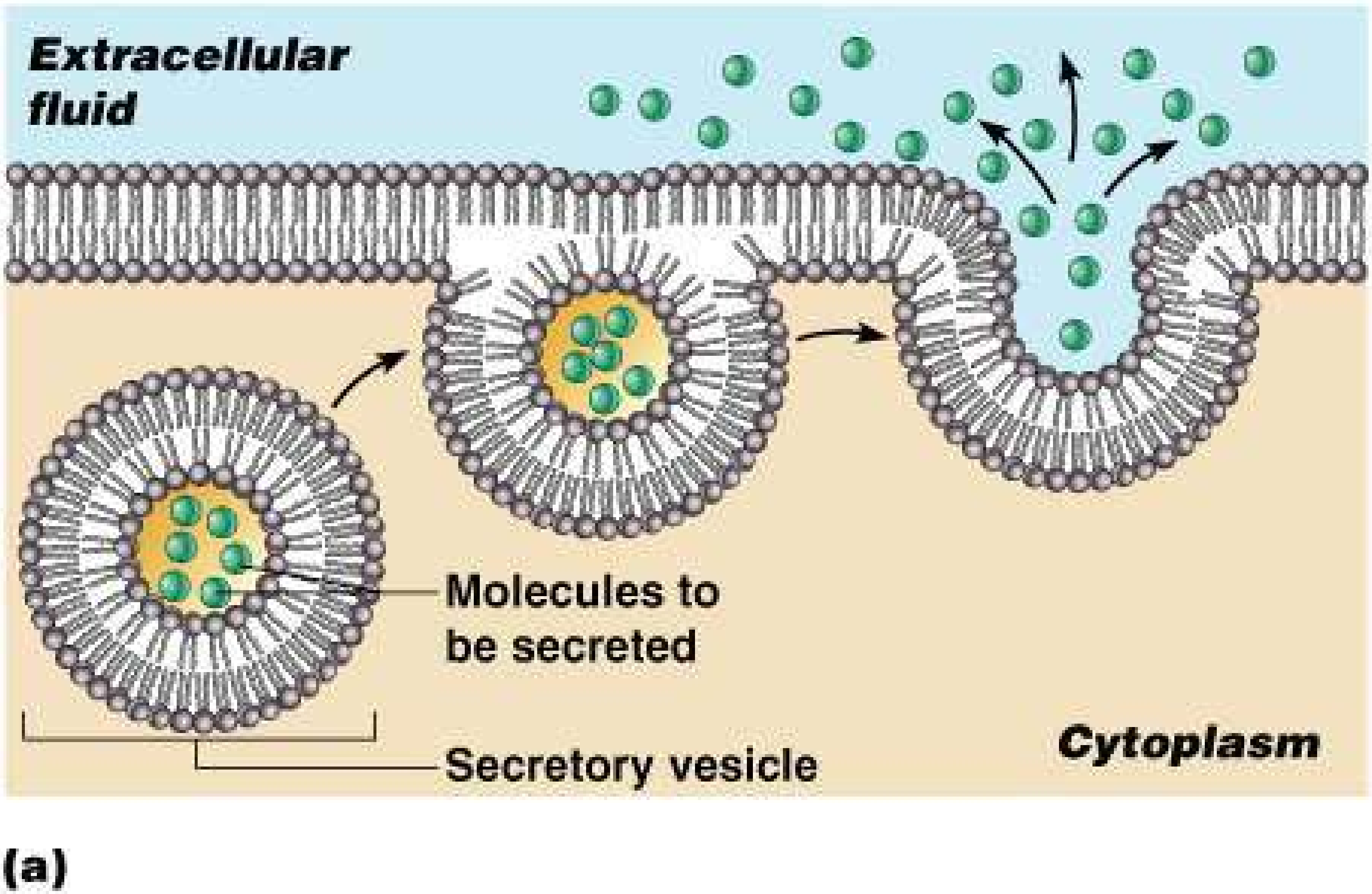


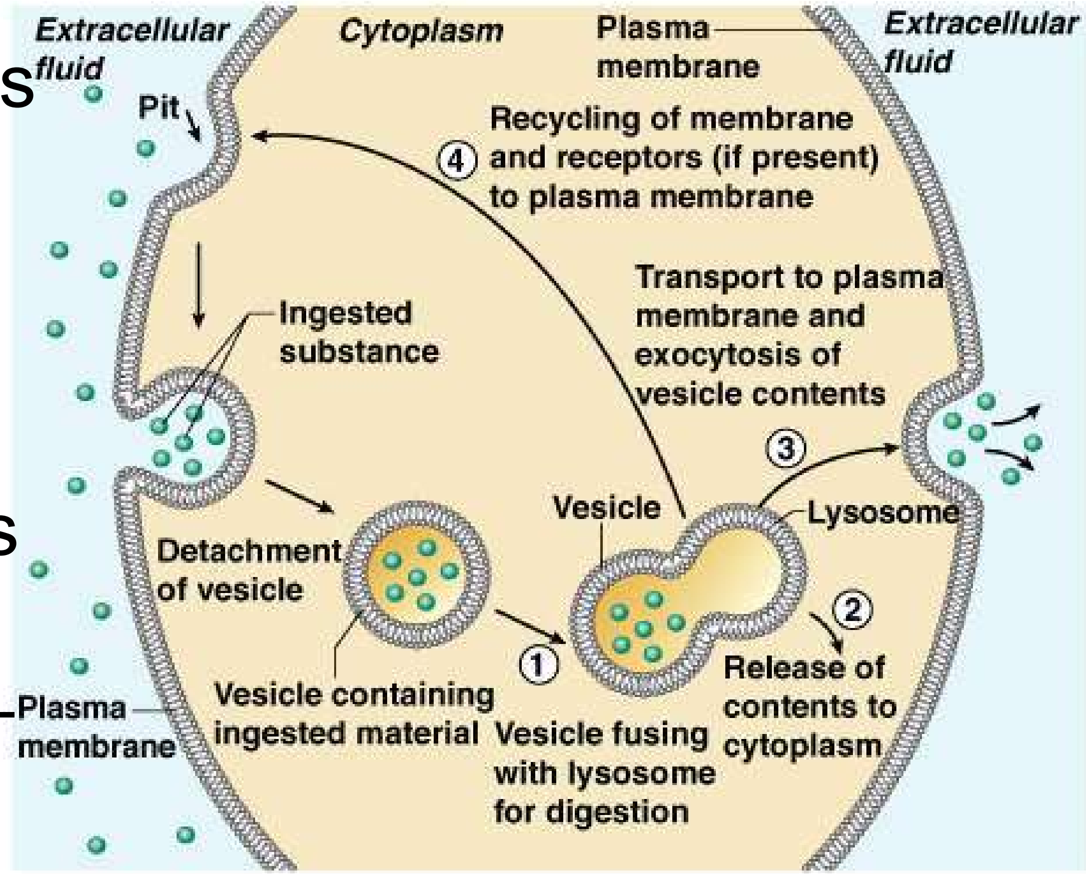
Figure 3.12a

Endocytosis

Extracellular - engulfs substances by enclosing in a membranous vescicle

<u>2 types</u>

1. Phagocytosis cell eating
2. Pinocytosis – cell drinking



(a)

Cell Life Cycle

- Cells have two major periods
  - Interphase
    - Cell grows
    - Cell carries on metabolic processes
  - Cell division
    - Cell replicates itself
    - Function is to produce more cells for growth and repair processes

DNA Replication

- Genetic material duplicated and readies a cell for division into two cells
- Occurs toward the end of interphase
- DNA uncoils and each side serves
  as a template

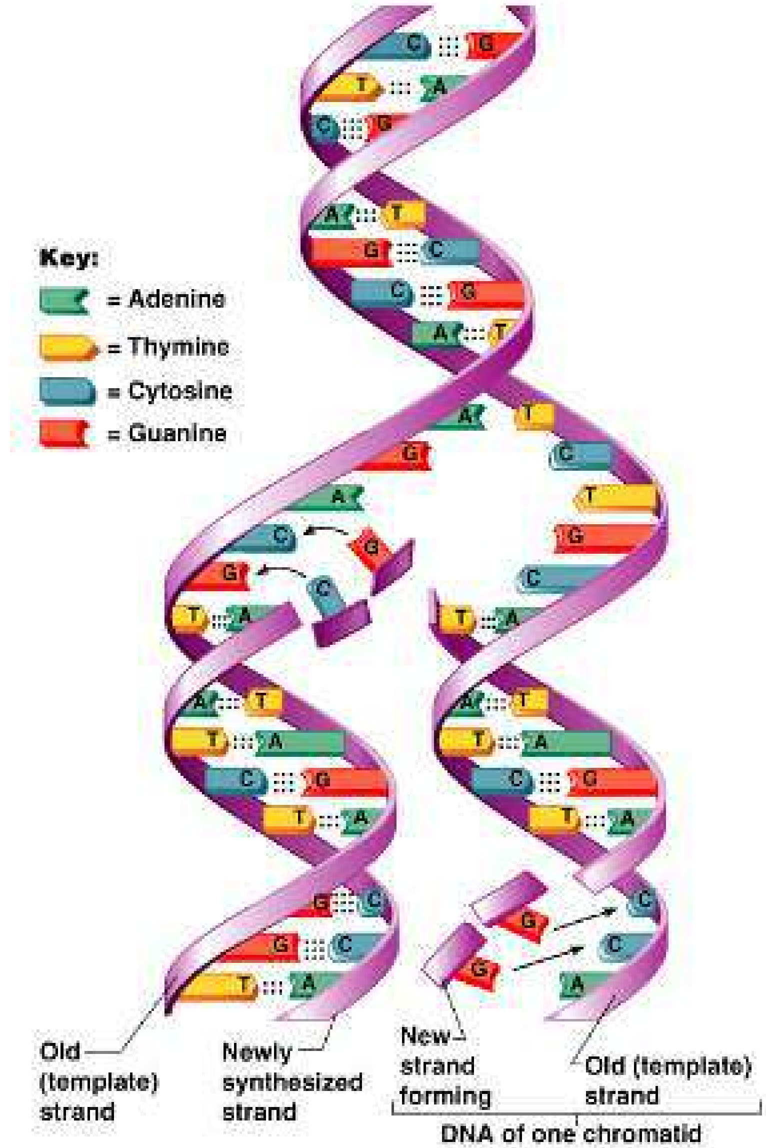


Figure 3.14

Events of Cell Division

- Mitosis
  - Division of the nucleus
  - Results in the formation of two daughter nuclei
- Cytokinesis
  - Division of the cytoplasm
  - Begins when mitosis is near completion
  - Results in the formation of two daughter cells

Stages of Mitosis

- Interphase
  - No cell division occurs
  - The cell carries out normal metabolic activity and growth
- Prophase
  - First part of cell division
  - Centromeres migrate to the poles

Stages of Mitosis

- Metaphase
  - Spindle from centromeres are attached to chromosomes that are aligned in the center of the cell

Stages of Mitosis

- Anaphase
  - Daughter chromosomes are pulled toward the poles
  - The cell begins to elongate
- Telophase
  - Daughter nuclei begin forming
  - A cleavage furrow (for cell division) begins to form

Stages of Mitosis

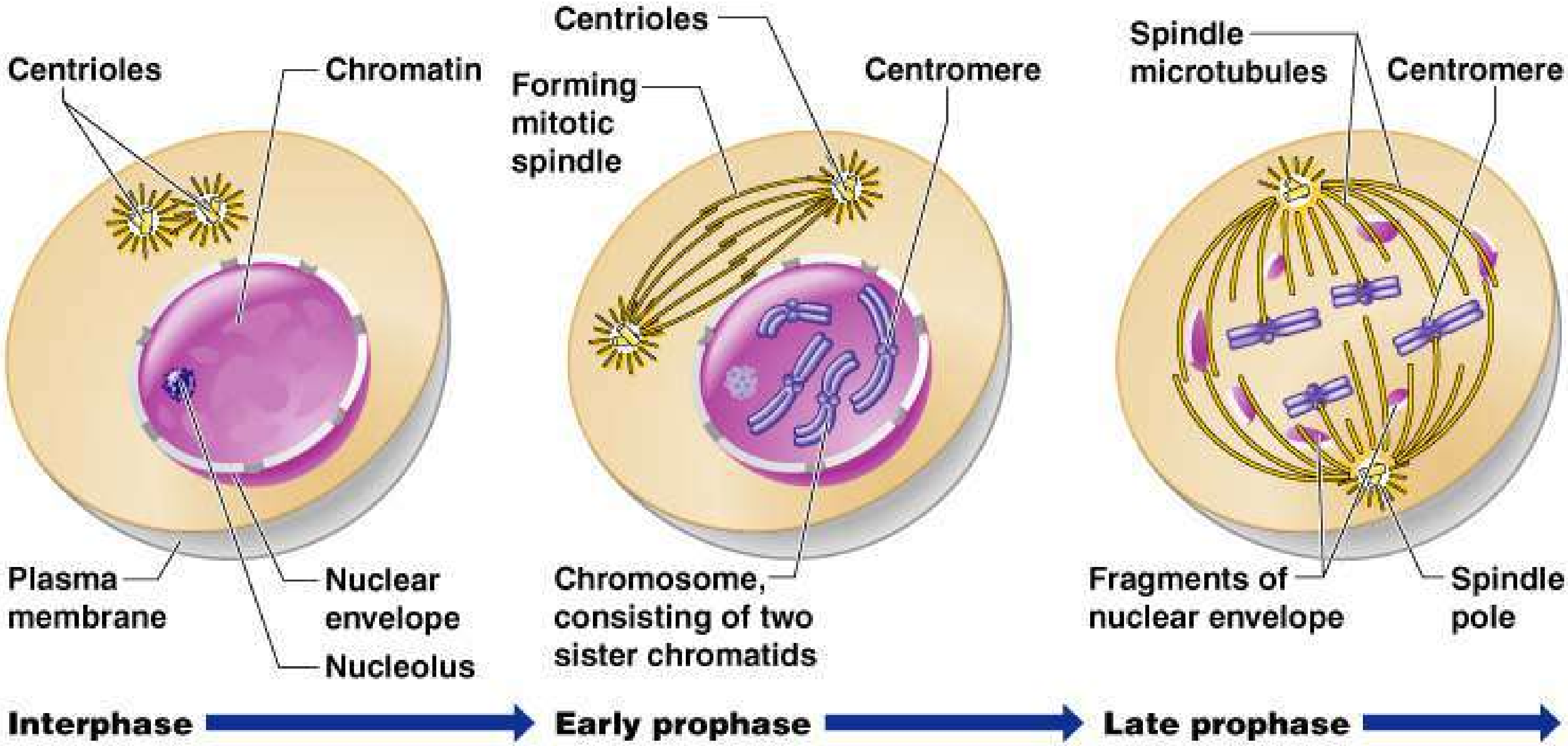


Figure 3.15

Stages of Mitosis

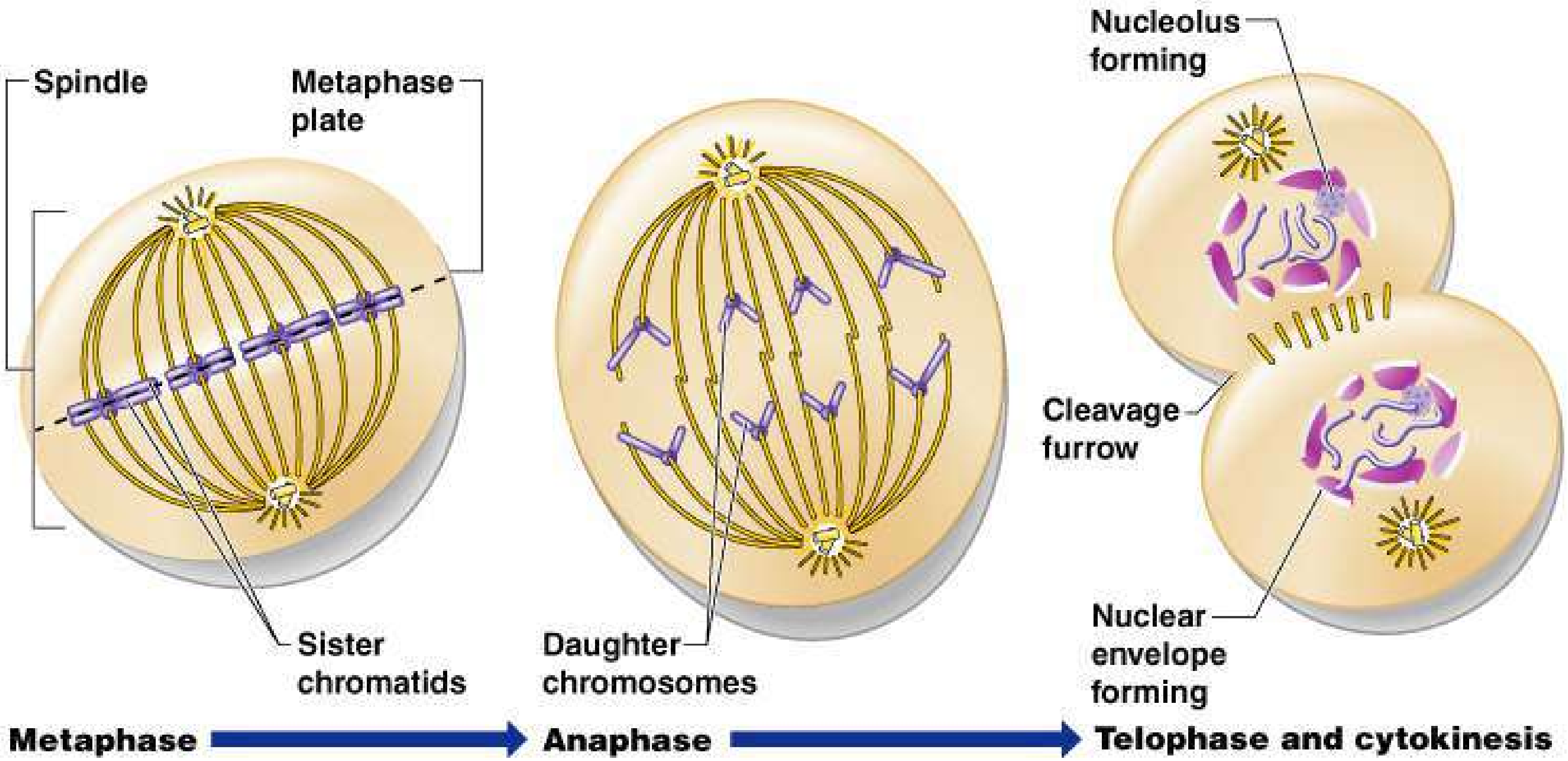


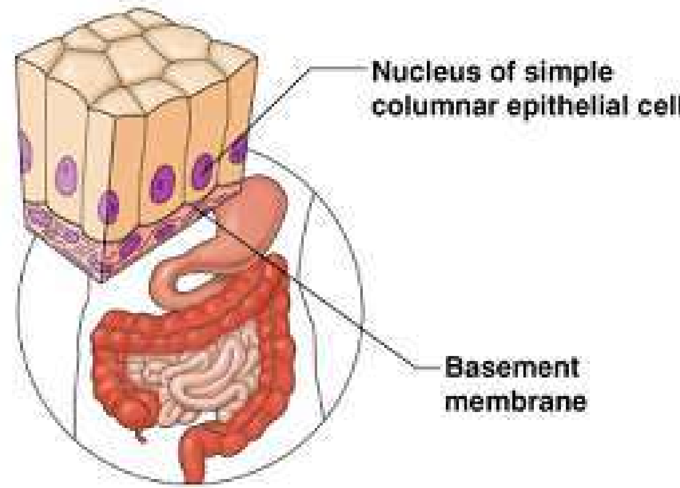
Figure 3.15(cont)

Protein Synthesis

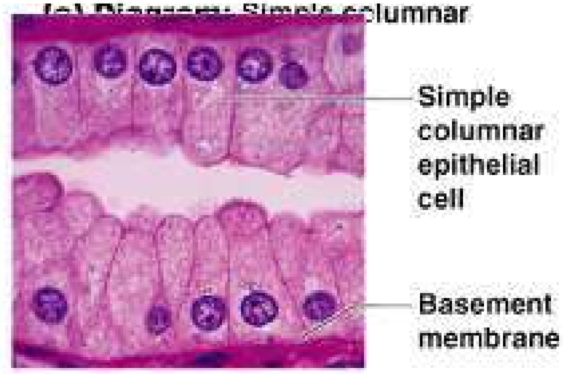
- Gene – DNA segment that carries a blueprint for building one protein
- Proteins have many functions
  - Building materials for cells
  - Act as enzymes (biological catalysts)
- RNA is essential for protein synthesis

Simple Epithelium

- Simple columnar
  - Single layer of tall cells
  - Often includes goblet cells, which produce mucus
  - Lines digestive tract



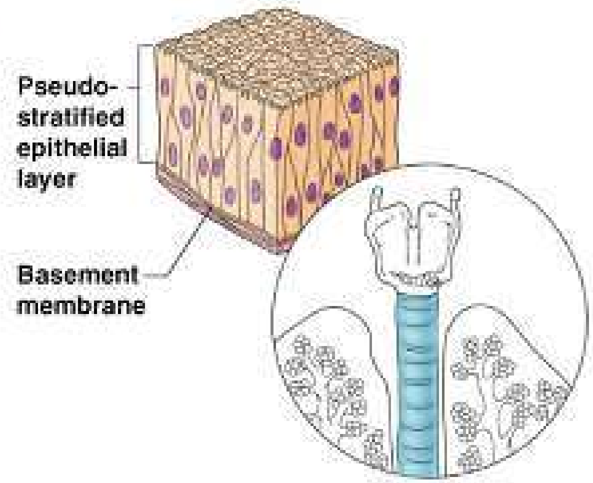
(a) Diagram: Simple columnar



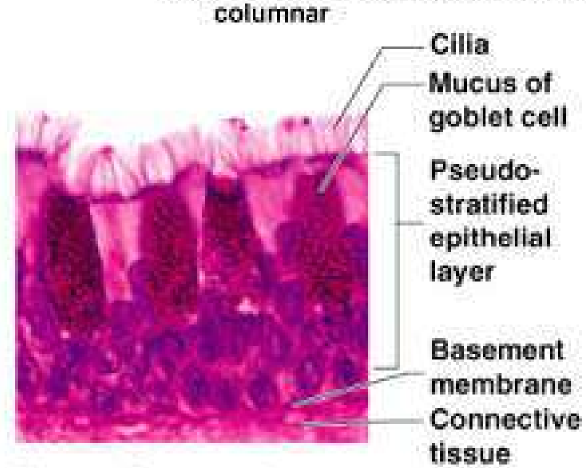
Photomicrograph: Simple columnar epithelium of the stomach lining (1300x).

Simple Epithelium

- Pseudostratified
  - Single layer, but some cells are shorter than others
  - Often looks like a double cell layer
  - Sometimes ciliated, such as in the respiratory tract
  - May function in absorption or secretion



(d) Diagram: Pseudostratified (ciliated) columnar



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

Connective Tissue

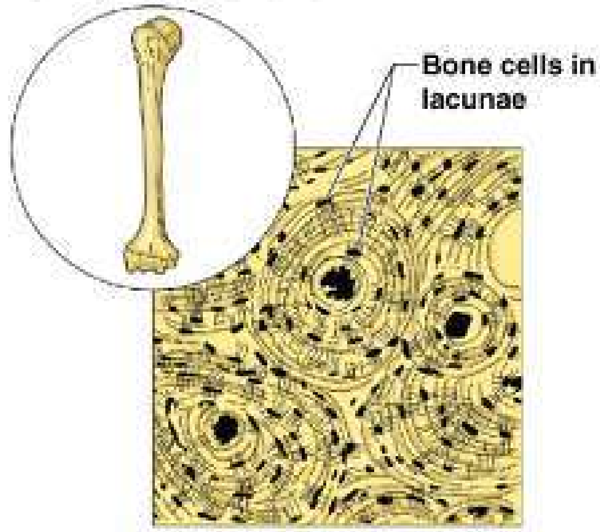
- Found everywhere in the body
- Includes the most abundant and widely distributed tissues
- Functions
  - Binds body tissues together
  - Supports the body
  - Provides protection

Connective Tissue Characteristics

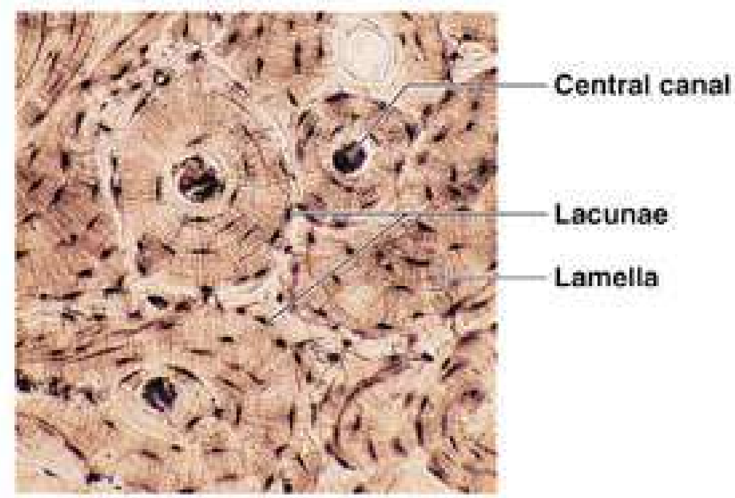
- Variations in blood supply
  - Some tissue types are well vascularized
  - Some have poor blood supply or are avascular
- Extracellular matrix
  - Non-living material that surrounds living cells

Connective Tissue Types

- Bone (osseous tissue)
  - Composed of:
    - Bone cells in lacunae (cavities)
    - Hard matrix of calcium salts
    - Large numbers of collagen fibers
  - Used to protect and support the body



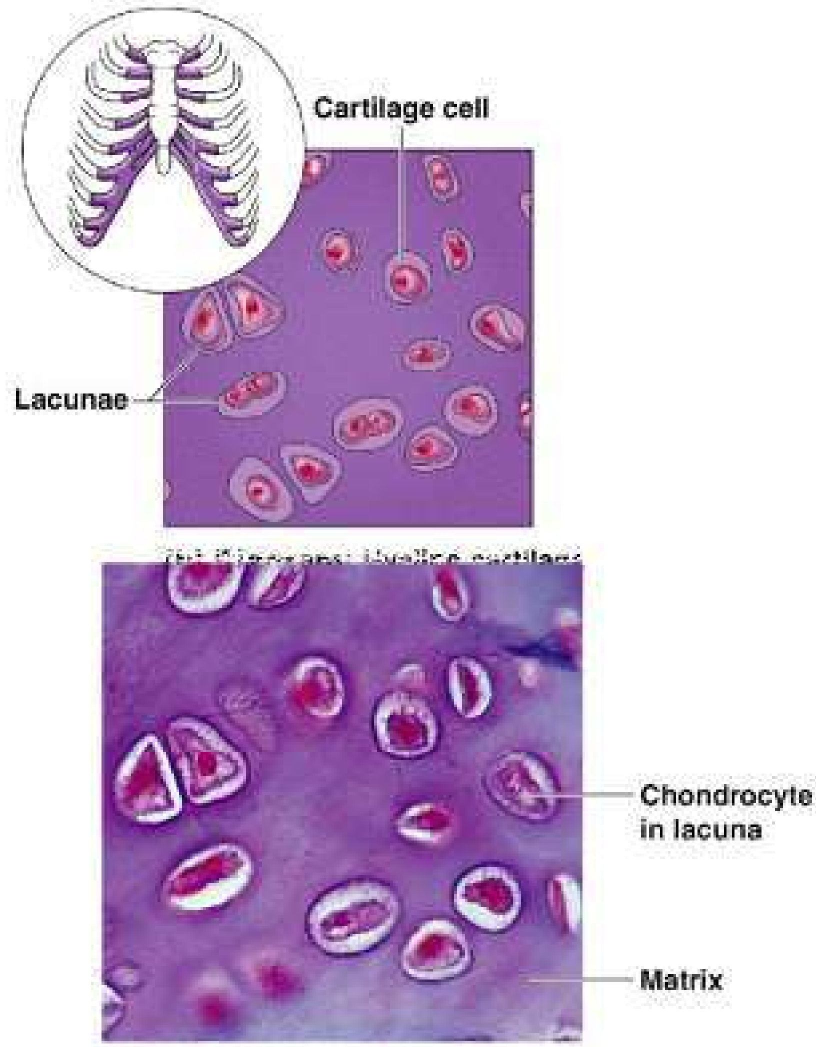
(a) Diagram: Bone



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

Connective Tissue Types

- Hyaline cartilage
  - Most common cartilage
  - Composed of:
    - Abundant collagen fibers
    - Rubbery matrix
  - Entire fetal skeleton is hyaline cartilage



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

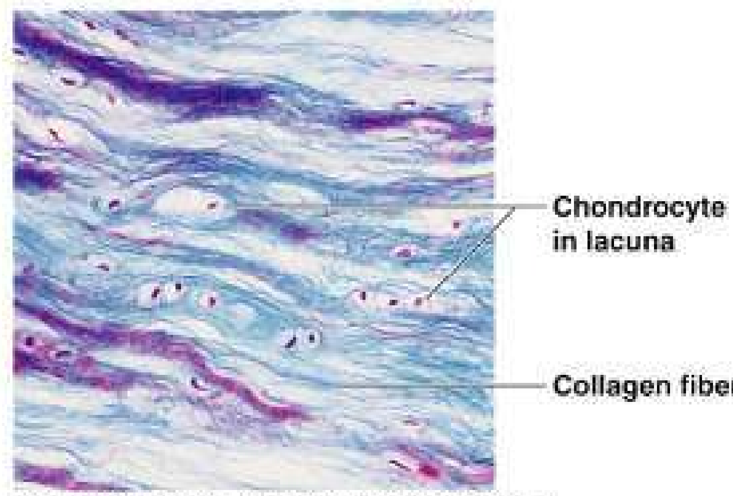
Connective Tissue Types

- Elastic cartilage
  - Provides elasticity
  - Example: supports the external ear

Connective Tissue Types

- Fibrocartilage
  - Highly compressible
  - Example: forms cushion-like discs between vertebrae

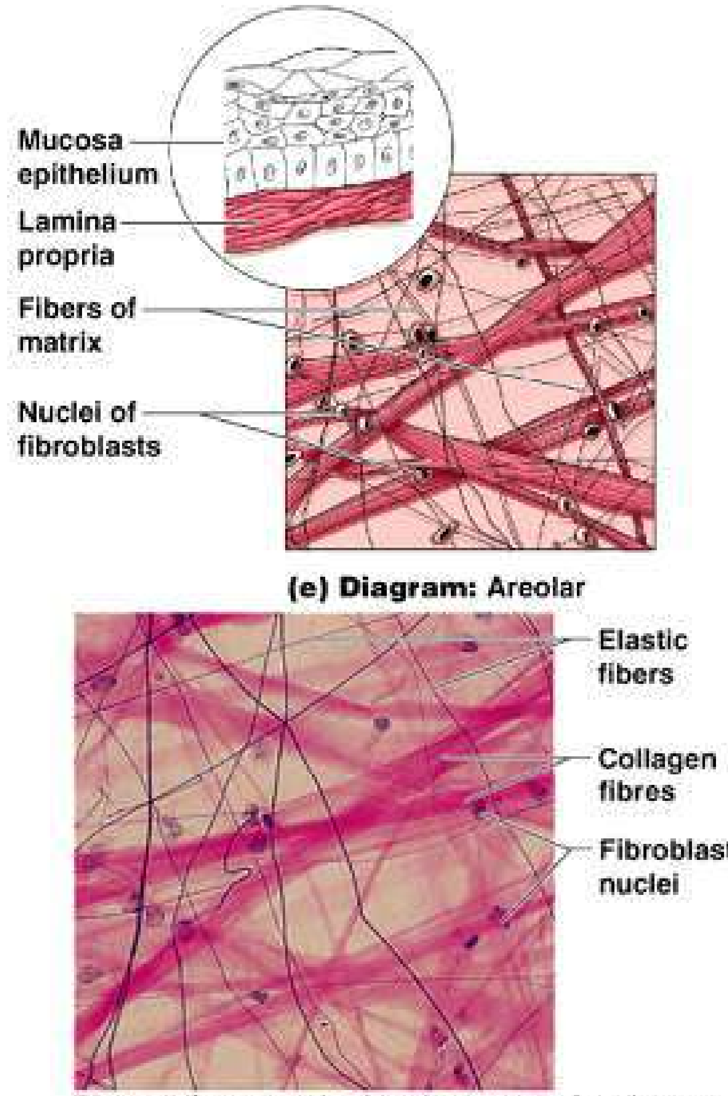
(c) Diagram: Fibrocartilage



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

Connective Tissue Types

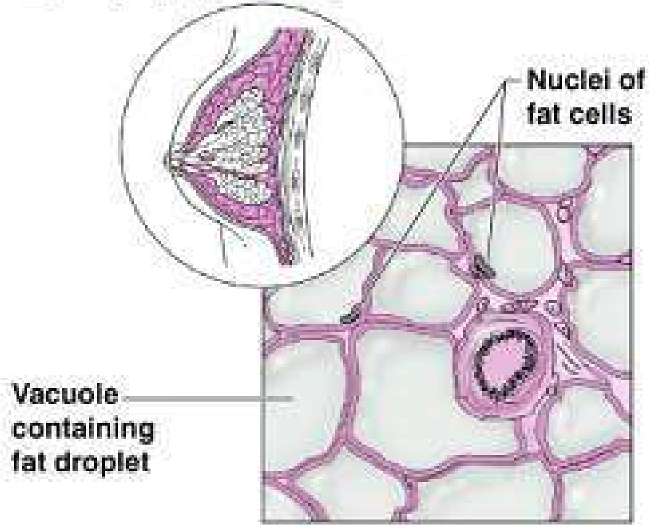
- Areolar connective tissue
  - Most widely distributed connective tissue
  - Soft, pliable tissue
  - Contains all fiber types
  - Can soak up excess fluid



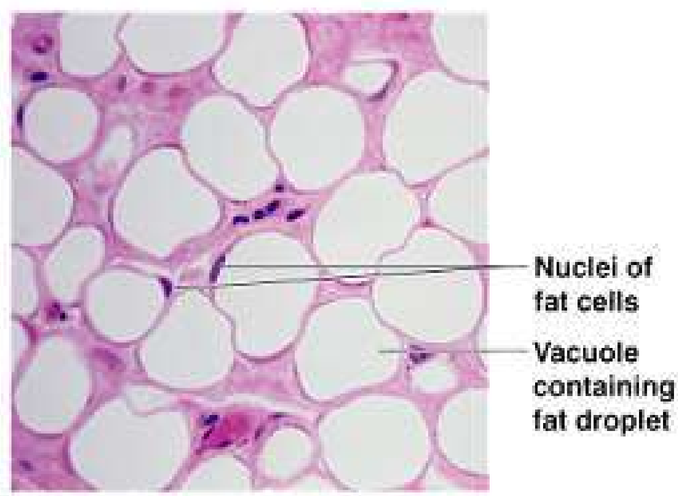
Photomicrograph: Areolar connective tissue, a soft packaging tissue of the body (400x).

Connective Tissue Types

- Adipose tissue
  - Matrix is an areolar tissue in which fat globules predominate
  - Many cells contain large lipid deposits
  - Functions
    - Insulates the body
    - Protects some organs
    - Serves as a site of fuel storage



(f) **Diagram:** Adipose

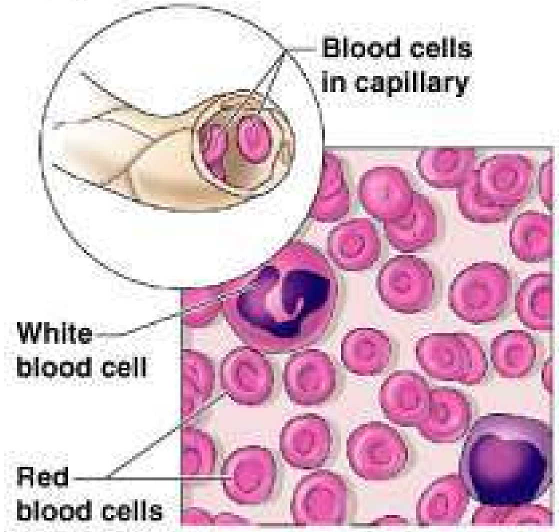


Photomicrograph: Adipose tissue from the subcutaneous layer beneath the skin (600x).

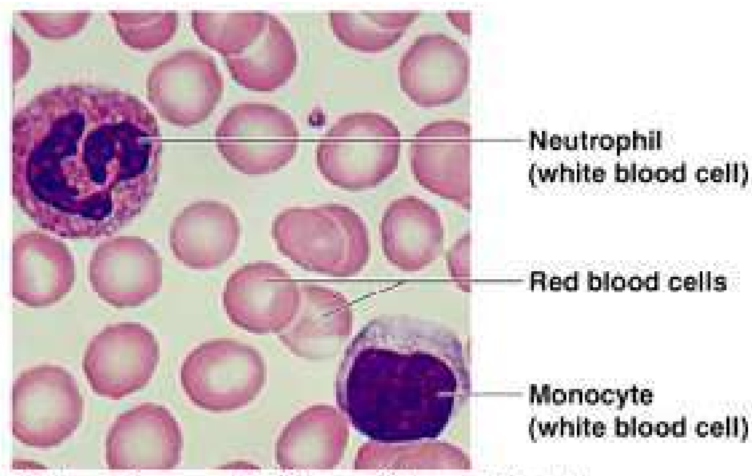
Figure 3.19f

Connective Tissue Types

- Blood
  - Blood cells surrounded by fluid matrix
  - Fibers are visible during clotting
  - Functions as the transport vehicle for materials



(h) Diagram: Blood



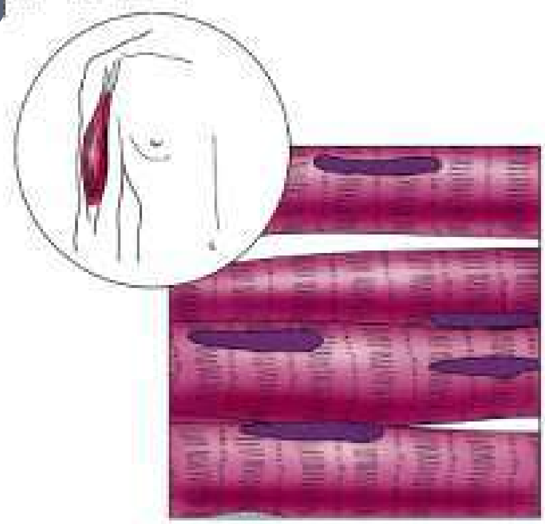
Photomicrograph: Smear of human blood (1500x); two white blood cells are seen among the red blood cells.

Muscle Tissue

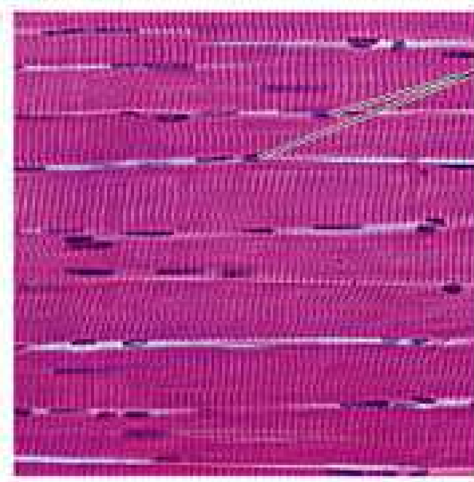
- Function is to produce movement
- Three types
  - Skeletal muscle
  - Cardiac muscle
  - Smooth muscle

Muscle Tissue Types

- Skeletal muscle
  - Can be controlled voluntarily
  - Cells attach to connective tissue
  - Cells are striated
  - Cells have more than one nucleus



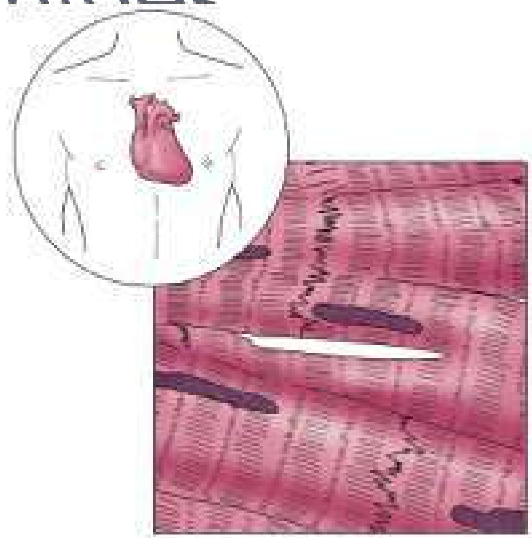
(a) **Diagram:** Skeletal muscle



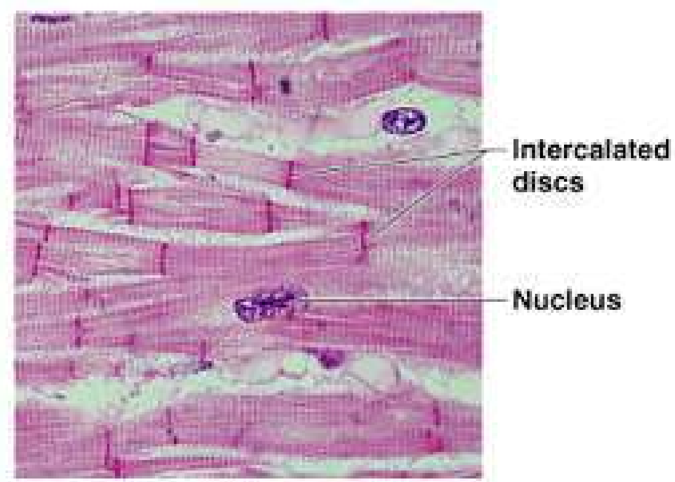
Photomicrograph: Skeletal muscle (approx. 300x).

Muscle Tissue Types

- Cardiac muscle
  - Found only in the heart
  - Function is to pump blood (involuntary)
  - Cells attached to other cardiac muscle cells at intercalated disks
  - Cells are striated
  - One nucleus per cell



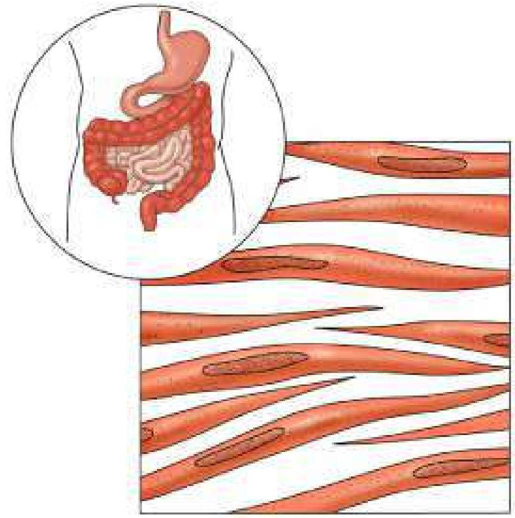
(b) **Diagram:** Cardiac muscle



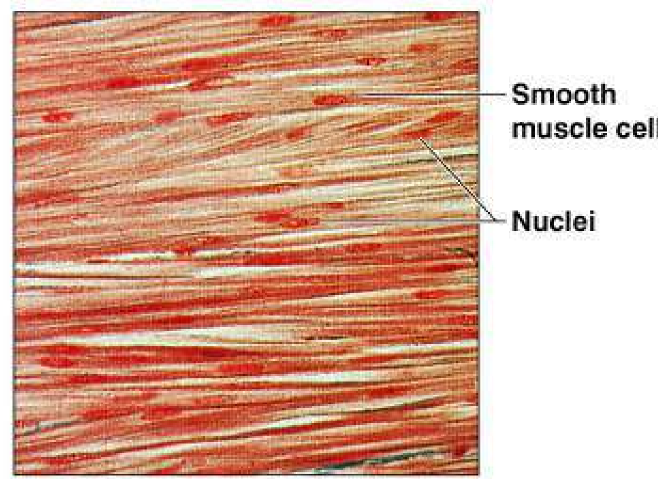
Photomicrograph: Cardiac muscle (800x).

Muscle Tissue

- Smooth muscle
  - Involuntary muscle
  - Surrounds hollow organs
  - Attached to other smooth muscle cells
  - No visible striations
  - One nucleus per cell



(c) Diagram: Smooth muscle



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

Nervous Tissue

- Neurons and nerve support cells
- Function is to send impulses to other areas of the body
  - Irritability
  - Conductivity

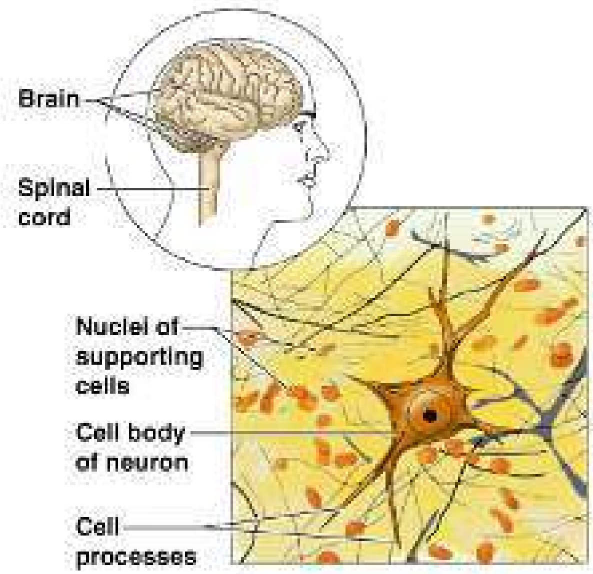
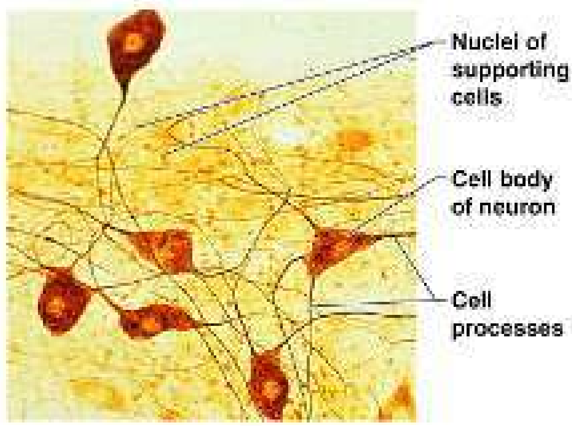


Diagram: Nervous tissue



Photomicrograph: Neurons (100x)

Regeneration of Tissues

- Tissues that regenerate easily
  - Epithelial tissue
  - Fibrous connective tissue and bone
- Tissues that regenerate poorly
  - Skeletal muscle
- Tissues that are replaced largely with scar tissue
  - Cardiac muscle
  - Nervous tissue within the brain and spinal cord

Thank you

TISSUES

BY
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DEPT OF PHARMACOLOGY

DEFINITION

- **Tissue is** a group of cells that usually have a common origin in an embryo and function together to carry out specialized activities.
- The structure and properties of a specific tissue are influenced by factors such as the nature of the extracellular material that surrounds the tissue cells and the connections between the cells that compose the tissue.

Principle Types of Tissues

Four types of tissues:

- Epithelial tissue
- Connective tissue
- Muscle tissue
- Nervous tissue

Epithelial Tissue

- Functions
  - Protection
  - Sensory functions
  - Secretion
  - Absorption
  - Excretion

Epithelial Tissue

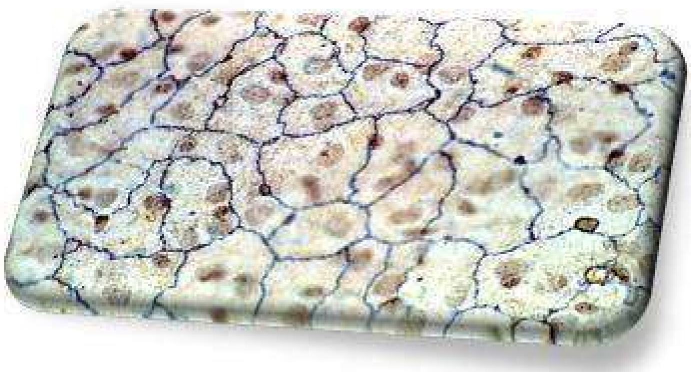
- Types and locations
  - Epithelium is divided into two types:
    - Membranous (covering or lining) epithelium
    - Glandular epithelium
  - Locations
    - Membranous epithelium—covers the body and some of its parts; lines the serous cavities, blood and lymphatic vessels, and respiratory, digestive, and genitourinary tracts
    - Glandular epithelium—secretory units of endocrine and exocrine glands

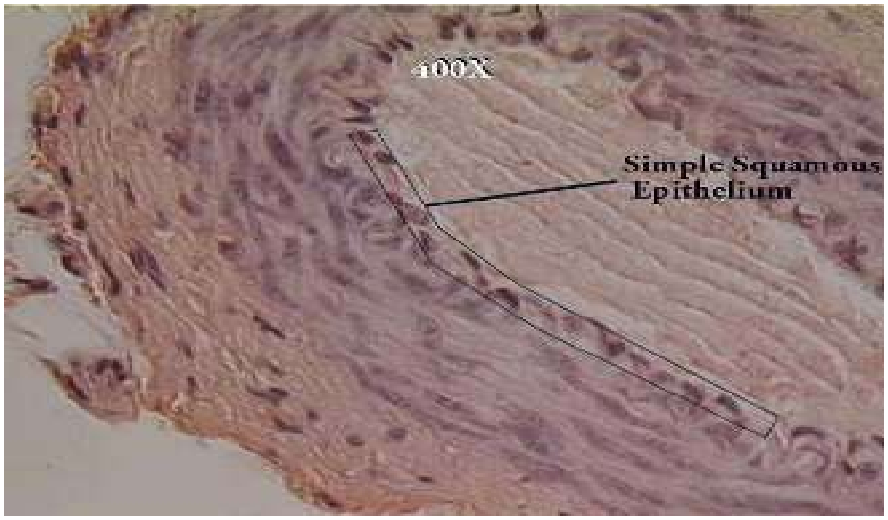
Epithelial Tissue

- Classification of epithelial tissue
  - Classification based on cell shape
    - Squamous
    - Cuboidal
    - Columnar
    - Pseudostratified columnar

Simple epithelium

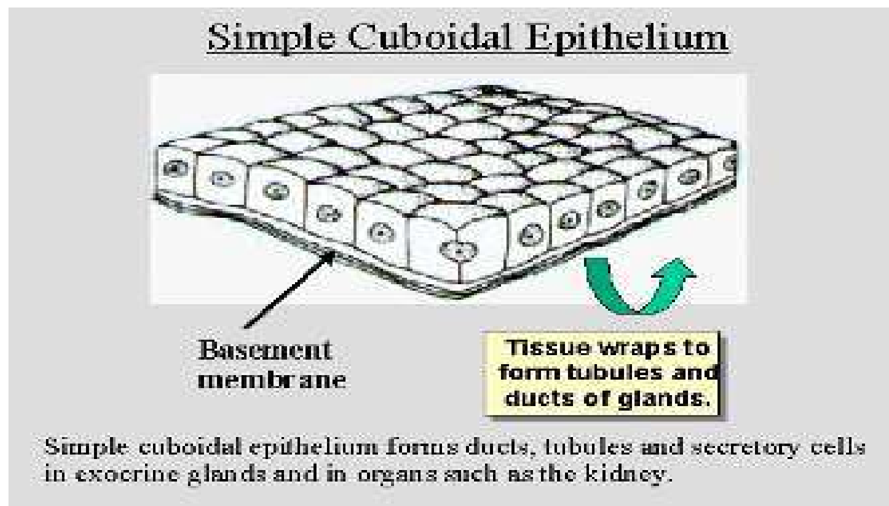
- Simple squamous epithelium
- One-cell layer of flat cells
- Permeable to many substances
- Examples: endothelium—lines blood vessels; mesothelium—pleura





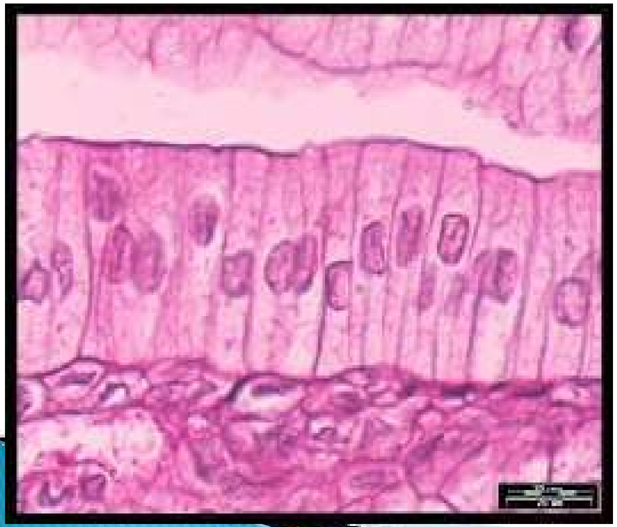
Simple epithelium

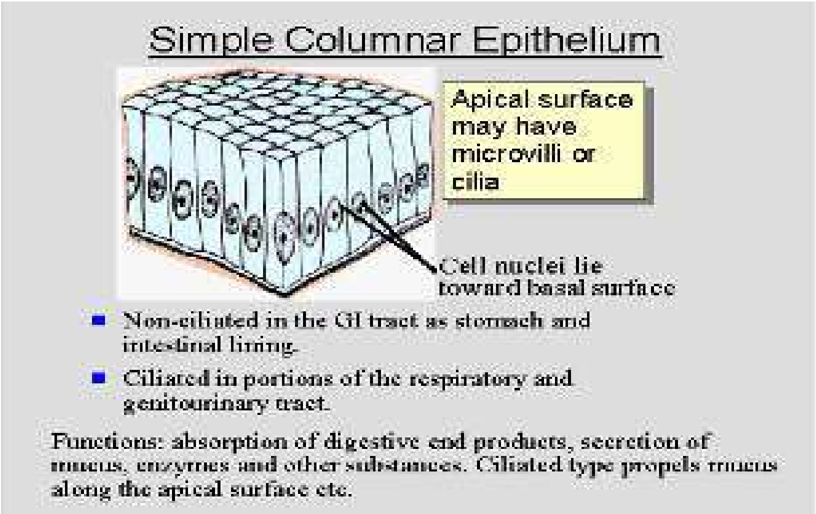
- Simple cuboidal epithelium
- One-cell layer of cuboidal cells
- Found in many glands and ducts



Simple epithelium

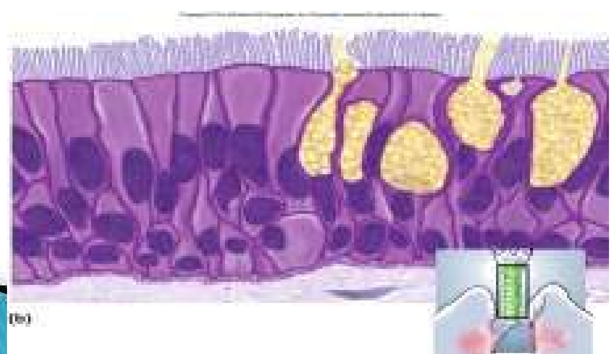
- Simple columnar epithelium
- Single layer of tall, column-shaped cells
- Cells often modified for specialized functions—e.g., goblet cells (secretion), cilia (movement), microvilli (absorption)
- Often lines hollow visceral structures

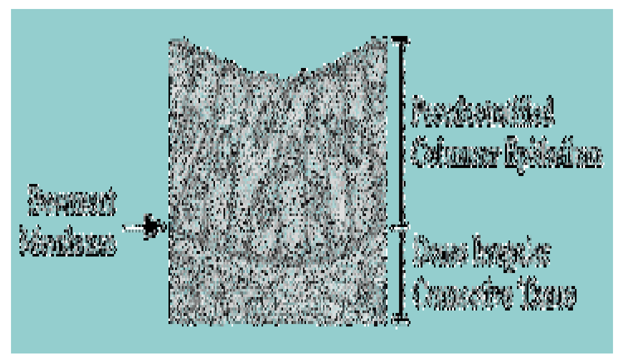




Simple epithelium

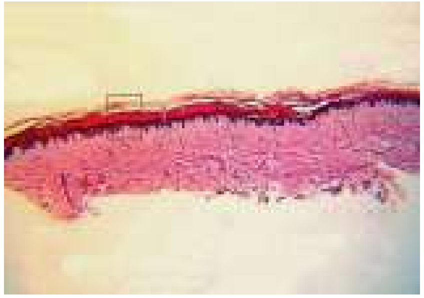
- Pseudostratified columnar epithelium
- Columnar cells of differing heights
- All cells rest on basement membrane but may not reach the free surface above
- Cell nuclei at odd and irregular levels
- Found lining air passages and segments of male reproductive system
- Motile cilia and mucus are important modifications

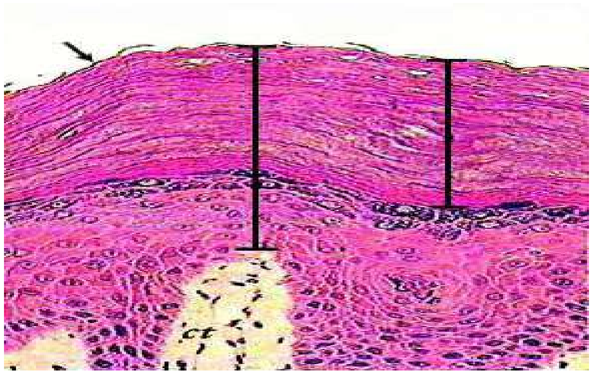




Stratified epithelium

- Stratified squamous (keratinized) epithelium
- Multiple layers of flat, squamous cells (Figure 5-9)
- Cells filled with keratin
- Covers outer skin on body surface



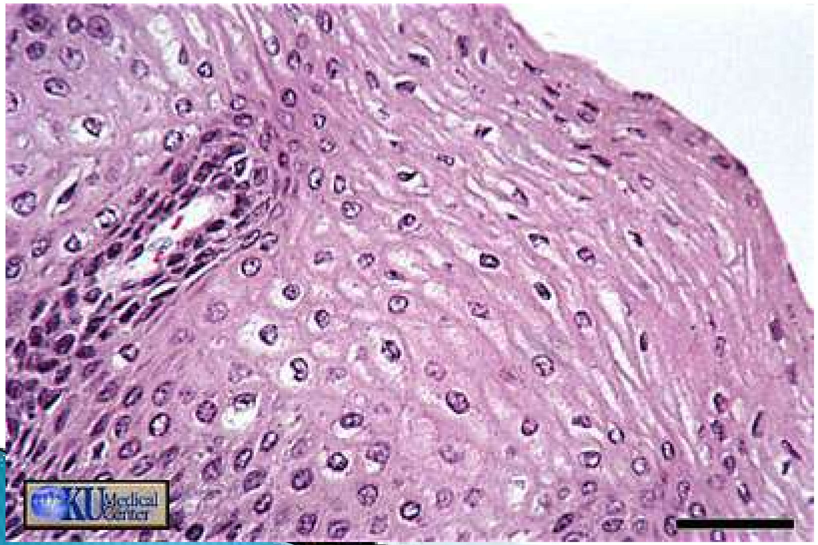


Stratified epithelium

- Stratified squamous (nonkeratinized) epithelium
- Lines vagina, mouth, and esophagus
- Free surface is moist
- Primary function is protection

Stratified epithelium

- Stratified cuboidal epithelium
- Two or more rows of cells are typical
- Basement membrane is indistinct
- Located in sweat gland ducts and pharynx

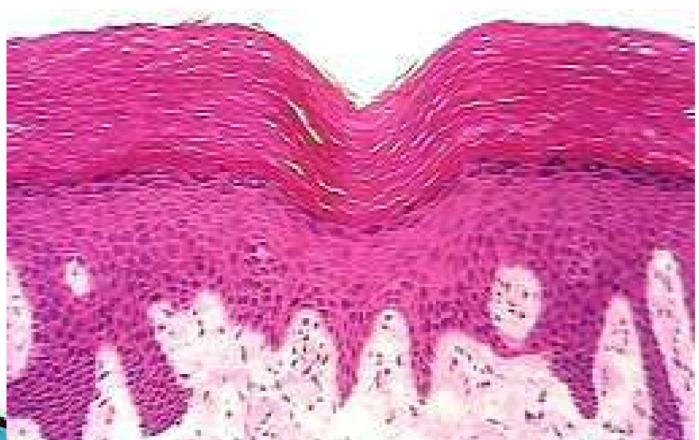


Stratified epithelium

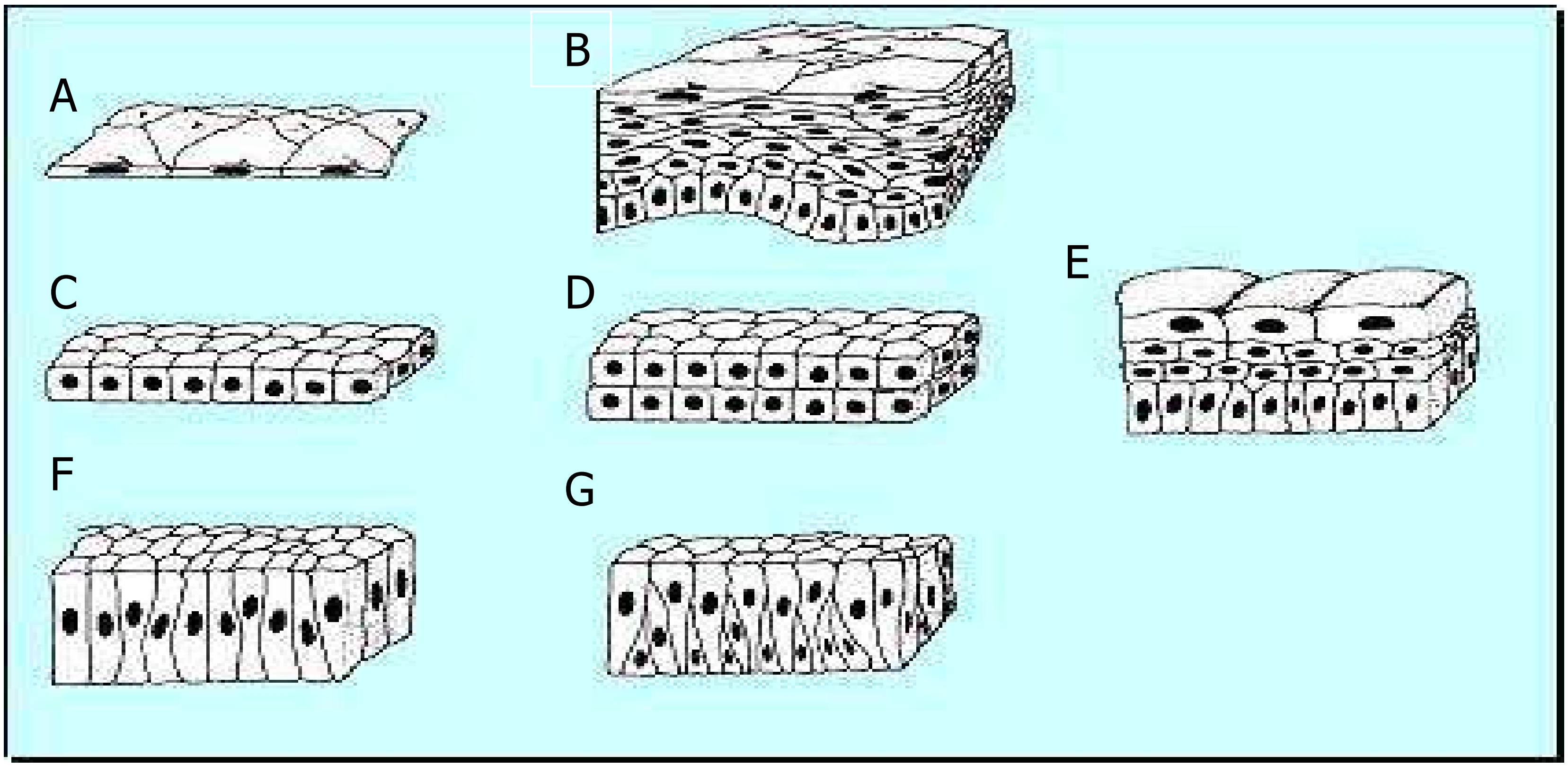
- Stratified columnar epithelium
- Multiple layers of columnar cells
- Only most superficial cells are typical in shape
- Rare
- Located in segments of male urethra and near anus

Stratified epithelium

- Stratified transitional epithelium
- Located in lining of hollow viscera subjected to stress (e.g., urinary bladder)
- Often 10 or more layers thick
- Protects organ walls from tearing



Epithelial types



Connective Tissue

- Functions, characteristics, and types
  - General function—connects, supports, transports, and protects
  - General characteristics—extracellular matrix (ECM) predominates in most connective tissues and determines its physical characteristics; consists of fluid, gel, or solid matrix, with or without extracellular fibers (collagenous, reticular, and elastic) and proteoglycans or other compounds that thicken and hold together the tissue

Classification

I. Embryonic connective tissues

A. Mesenchyme

B. Mucous connective tissue

II. Mature connective tissues

- A. Loose connective tissues
  - Areolar connective tissue
  - Adipose tissue
  - Reticular connective tissue
- B. Dense connective tissues
  - Dense regular connective tissue
  - Dense irregular connective tissue
  - Elastic connective tissue

- C. Cartilage
- Hyaline cartilage
- Fibrocartilage
- Elastic cartilage
- D. Bone tissue
- E. Liquid connective tissue

Blood tissue

Lymph

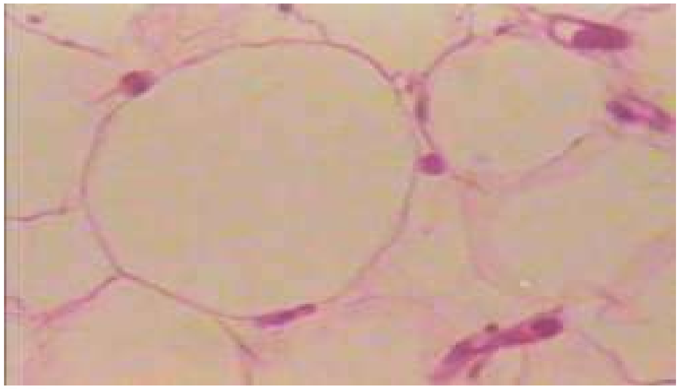
connective tissue

- Loose, ordinary (areolar) connective tissue
    - One of the most widely distributed of all tissues
    - Intercellular substance is prominent and consists of collagenous and elastic fibers loosely interwoven and embedded in soft, viscous ground substance

  Function—stretchy, flexible connection

connective tissue

- Adipose tissue
  - Similar to loose connective tissue but contains mainly fat cells
  - Functions—protection, insulation, support, and food reserve



connective tissue

- Reticular tissue
  - Forms framework of spleen, lymph nodes, and bone marrow
  - Consists of network of branching reticular fibers with reticular cells overlying them
  - Functions—defense against microorganisms and other injurious substances; reticular meshwork filters out injurious particles, and reticular cells phagocytose them

Dense fibrous tissue

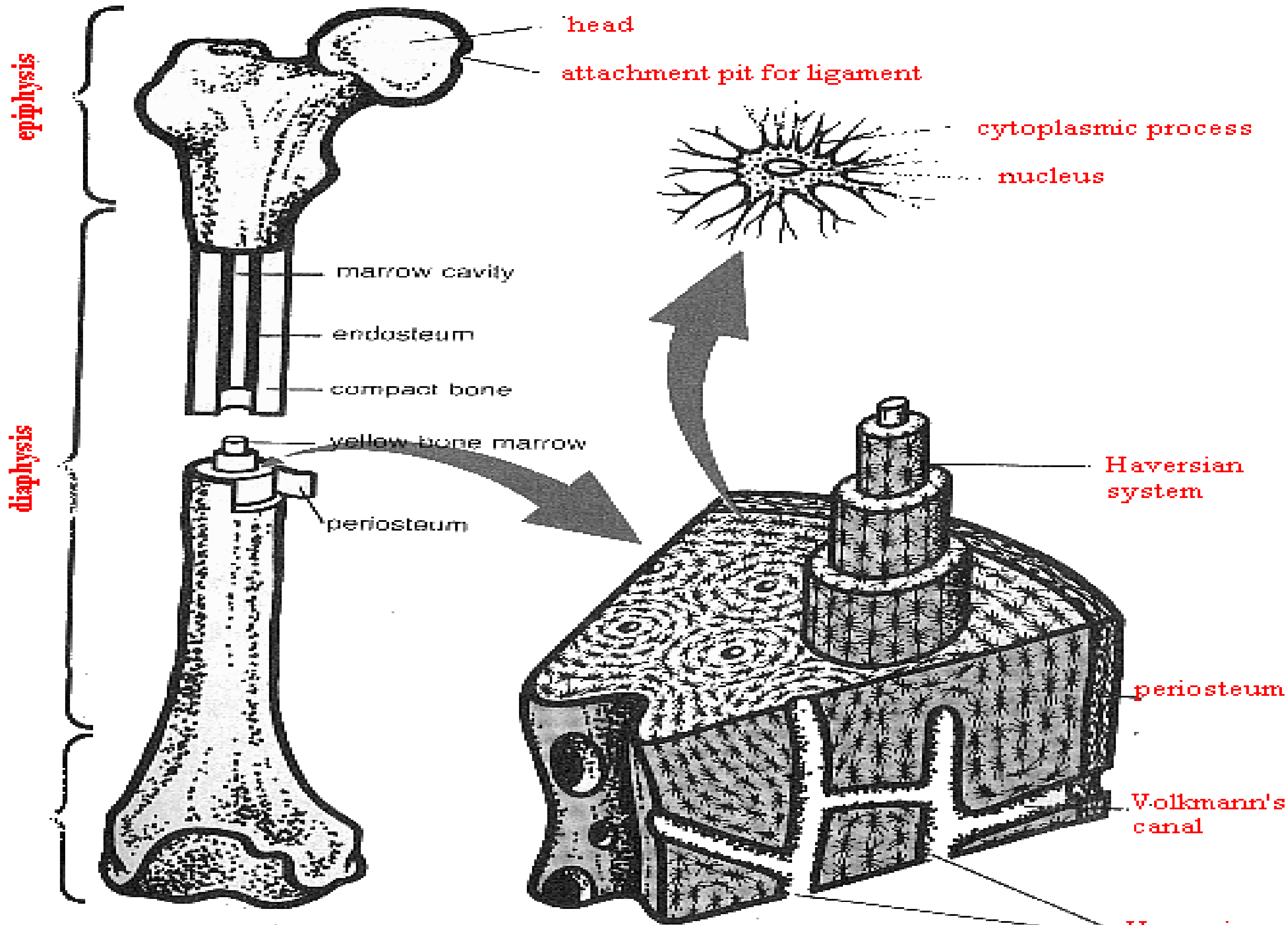
- Matrix consists mainly of fibers packed densely and relatively few fibroblast cells
  - Irregular—fibers intertwine irregularly to form a thick mat
  - Regular—bundles of fibers are arranged in regular, parallel rows
    - Collagenous—mostly collagenous fibers in ECM
    - Elastic—mostly elastic fibers in ECM
- Locations—composes structures that need great tensile strength, such as tendons and ligaments; also dermis and outer capsule of kidney and spleen
- Function—furnishes flexible connections that are strong or stretchy

Bone tissue

- Highly specialized connective tissue type
    - Cells—osteocytes—embedded in a calcified matrix
    - Inorganic component of matrix accounts for 65% of total bone tissue
  - Functions:
    - Support
    - Protection
    - Point of attachment for muscles
    - Reservoir for minerals
    - Supports blood-forming tissue

Compact bone

- Osteon (Haversian system)
  - Structural unity of bone
  - Spaces for osteocytes called lacunae
  - Matrix present in concentric rings called lamellae
  - Canaliculi are canals that join lacunae with the central Haversian canal
- Cell types:
  - Osteocyte—mature, inactive bone cell
  - Osteoblast—active, bone-forming cell
  - Osteoclast—bone-destroying cell
- Formation (ossification)
  - In membranes—e.g., flat bones of skull
  - From cartilage (endochondral)—e.g., long bones, such as the humerus



head
attachment pit for ligament
epiphysis
marrow cavity
endosteum
compact bone
yellow bone marrow
diaphysis
periosteum
cytoplasmic process
nucleus
Haversian system
periosteum
Volkmann's canal
Haversian canals

Cancellous bone

- Trabeculae—thin beams of bone
  - Supports red bone marrow
    - Myeloid tissue—a type of reticular tissue
    - Produces blood cells
  - Called spongy bone because of its spongelike appearance

Cartilage

- Chondrocyte is only cell type present
- Lacunae house cells, as in bone
- Avascular—therefore, nutrition of cells depends on diffusion of nutrients through matrix
- Heals slowly after injury because of slow nutrient transfer to the cells
- Perichondrium is membrane that surrounds cartilage

Types of Cartilage

- Hyaline
  - Appearance is shiny and translucent
  - Most prevalent type of cartilage
  - Located on the ends of articulating bones
- Fibrocartilage
  - Strongest and most durable type of cartilage
  - Matrix is semirigid and filled with strong, white fibers
  - Found in intervertebral disks and pubic symphysis
  - Serves as shock-absorbing material between bones at the knee (menisci)
- Elastic
  - Contains many fine, elastic fibers
  - Provides strength and flexibility
  - Located in external ear and larynx

Blood

- A liquid tissue
- Contains neither ground substance nor fibers
- Composition of whole blood
  - Liquid fraction (plasma) is the matrix—55% of total blood volume
  - Formed elements contribute 45% of total blood volume
    - Red blood cells, erythrocytes
    - White blood cells, leukocytes
    - Platelets, thrombocytes

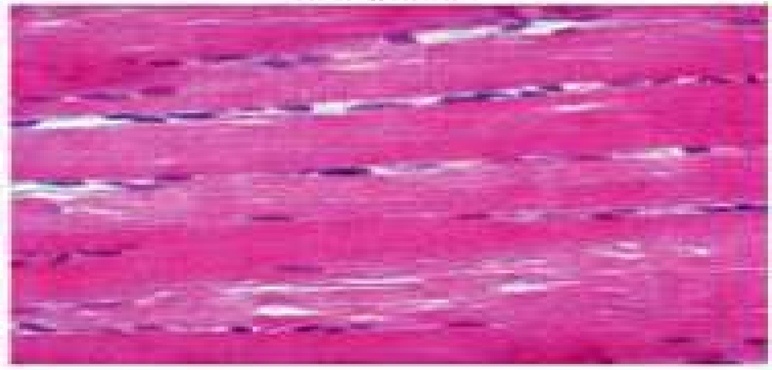
Blood (cont.)

- Functions
  - Transportation
  - Regulation of body temperature
  - Regulation of body pH
  - White blood cells destroy bacteria
- Circulating blood tissue is formed in the red bone marrow by a process called hematopoiesis; the blood-forming tissue is sometimes called hematopoietic tissue

Muscle Tissue

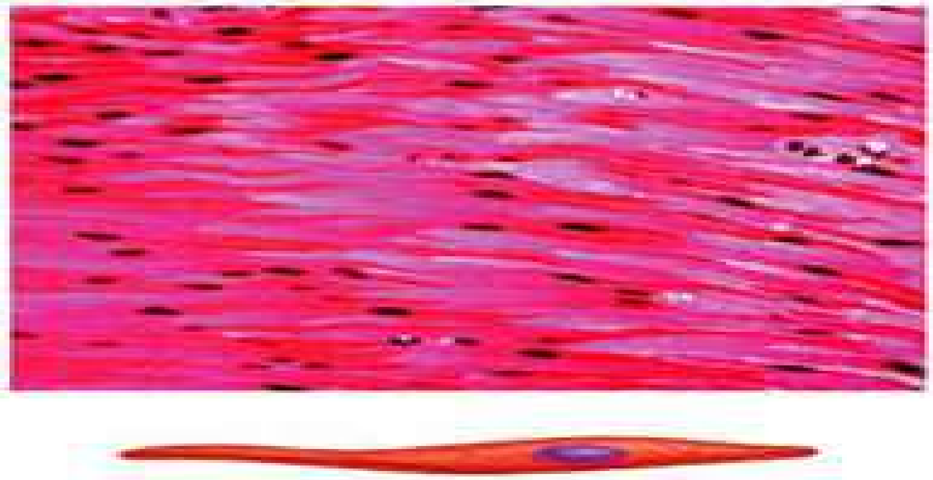
- Types
  - Skeletal, or striated voluntary
  - Smooth, or nonstriated involuntary, or visceral
  - Cardiac, or striated involuntary

Skeletal



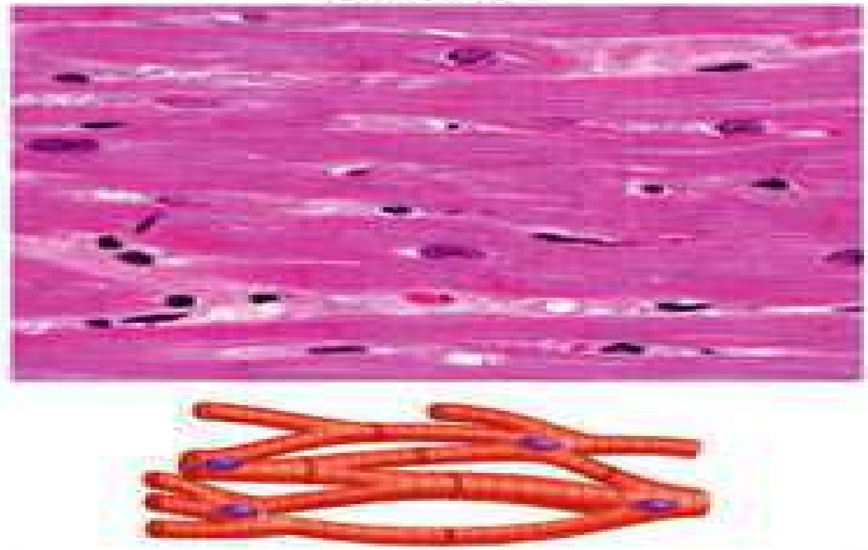
Location:	Attached to bones
Function:	Move skeleton
Characteristics of cells:	• Multinucleate • Unbranched • Activity is "voluntary," meaning that signal from motor neuron is required

Smooth



Location:	Intestines, arteries, other
Function:	Move food, help regulate blood pressure, etc.
Characteristics of cells:	• Single nucleus • Unbranched • Activity is "non-voluntary," meaning that signal from motor neuron is not required

Cardiac



Location:	Heart
Function:	Pump blood
Characteristics of cells:	• Single nucleus • Branched; form direct cytoplasmic connection end to end • Activity is "non-voluntary," meaning that signal from motor neuron is not required

Muscle Tissue

- Microscopic characteristics
  - Skeletal muscle—threadlike cells with many cross striations and many nuclei per cell
  - Smooth muscle—elongated, narrow cells, no cross striations, one nucleus per cell
  - Cardiac muscle—branching cells with intercalated disks (formed by abutment of plasma membranes of two cells)

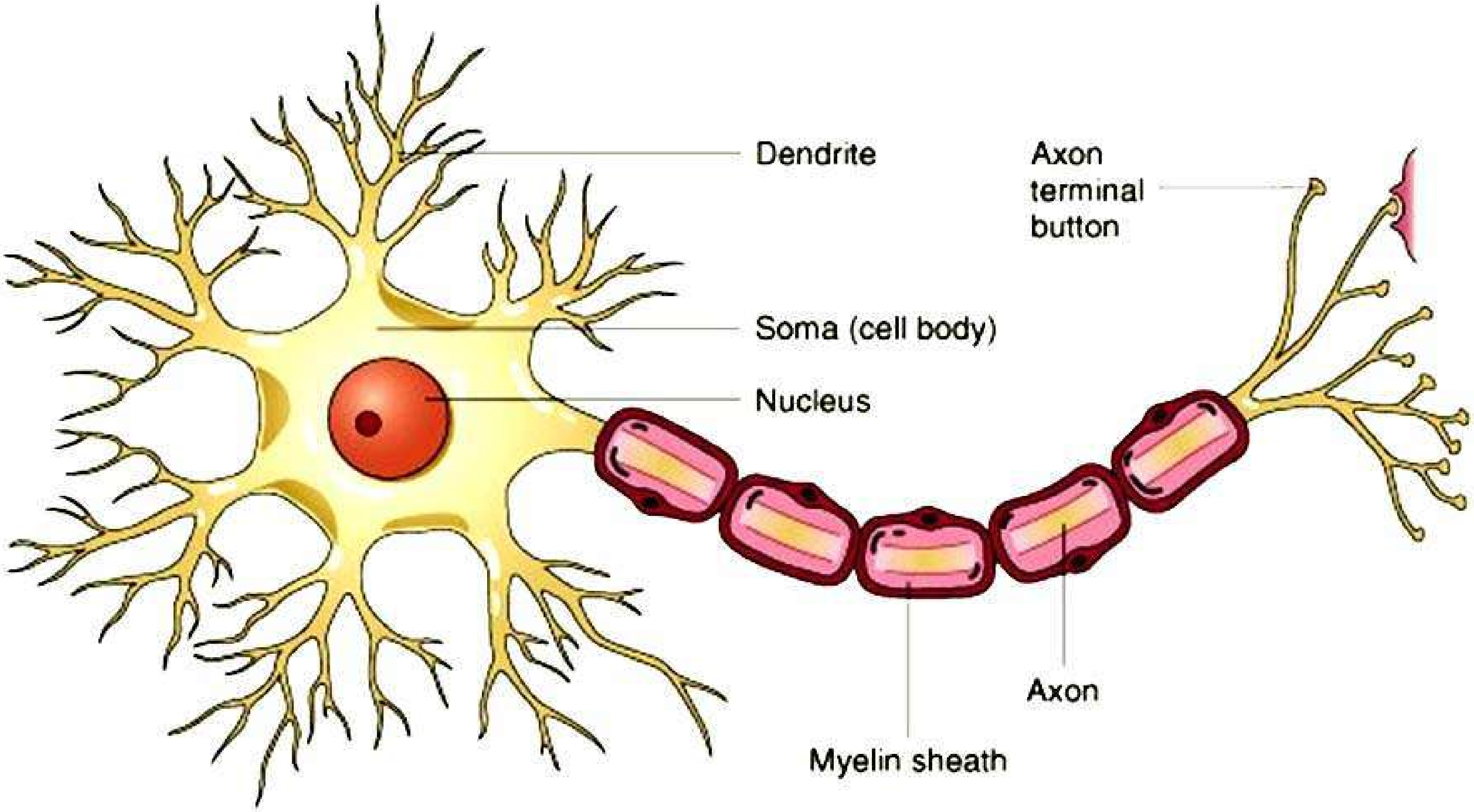
Nervous Tissue

- Functions—rapid regulation and integration of body activities
- Specialized characteristics
  - Excitability
  - Conductivity
- Organs
  - Brain
  - Spinal cord
  - Nerves

Nervous Tissue

- Neuron—conducting unit of system
  - Cell body, or soma
  - Processes
    - Axon (single process)—transmits nerve impulse away from the cell body
    - Dendrites (one or more)—transmit nerve impulse toward the cell body and axon
- Neuroglia—special connecting, supporting, coordinating cells that surround the neurons

Neuron


Dendrite
Axon
terminal
button
Soma (cell body)
Nucleus
Axon
Myelin sheath

Neuroglia

- Supporting Cells (Neuroglia or Glia) =

Macroglia + Microglia

- **Ependymal** cells
  - Line cavities of the brain and spinal cord
    Synthesize cerebrospinal fluid
- **Astrocytes**
  - Star-shaped cells
  - Support neurons
  - Form barrier between capillaries and neurons (BBB)
  - Control the chemical environment of
    the brain (CNS)

Microglia

- Arise from monoblast of the blood
  - Spider-like
  - phagocytes
  - Dispose of debris
- ***Oligodendrocytes***

Produce myelin sheath around nerve fibers in the central nervous system

  - Nourish neurons

Supporting Cells of the PNS

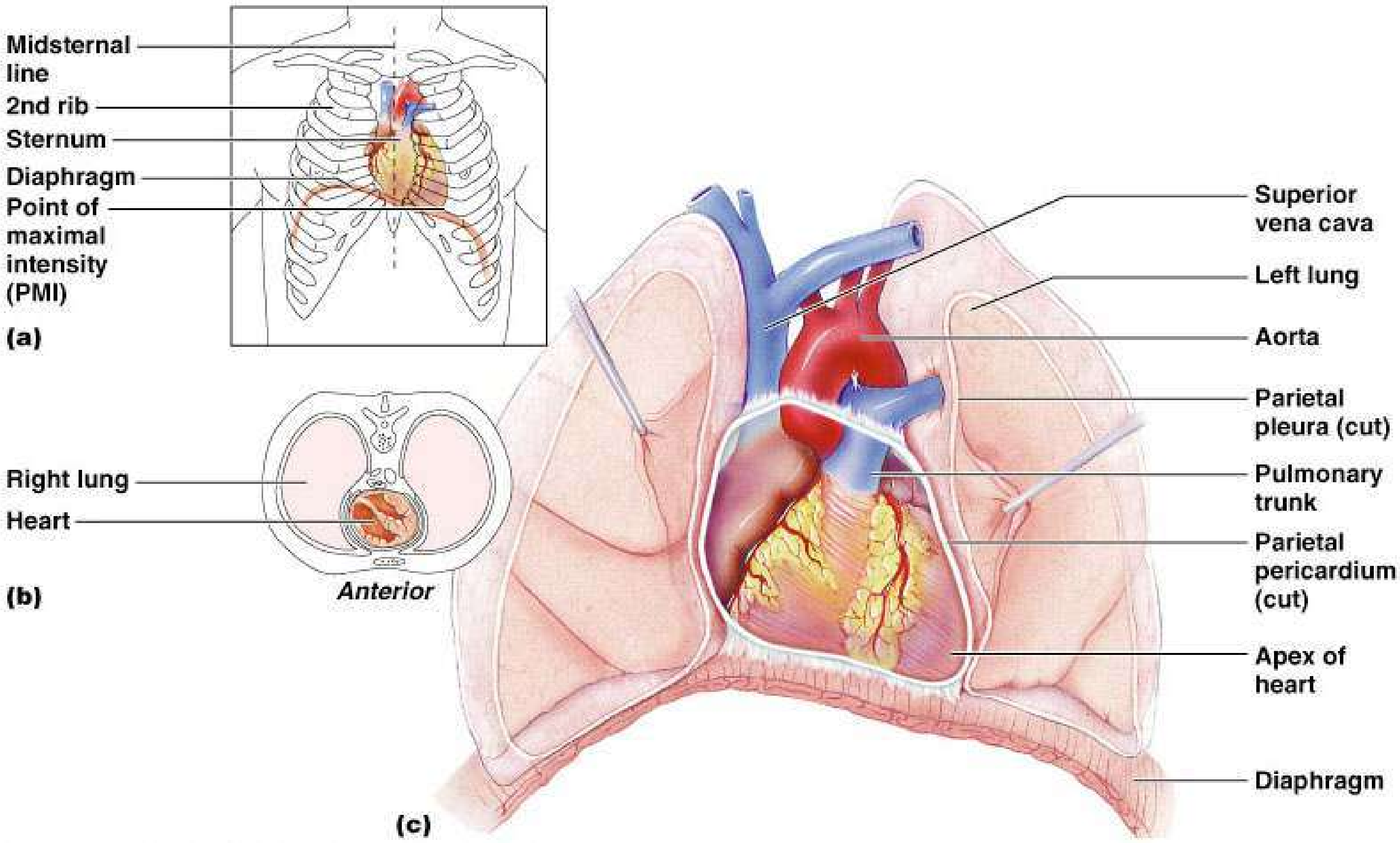
- Schwann cells - form myelin sheath in the peripheral nervous system.
- Satellite cells – surround cell bodies of neurons in sensory ganglia

The Heart

Heart Anatomy

- Approximately the size of your fist
- Location
  - Superior surface of diaphragm
  - Left of the midline
  - Anterior to the vertebral column, posterior to the sternum

Heart Anatomy



Coverings of the Heart: Anatomy

- **Pericardium** – a double-walled sac around the heart composed of:

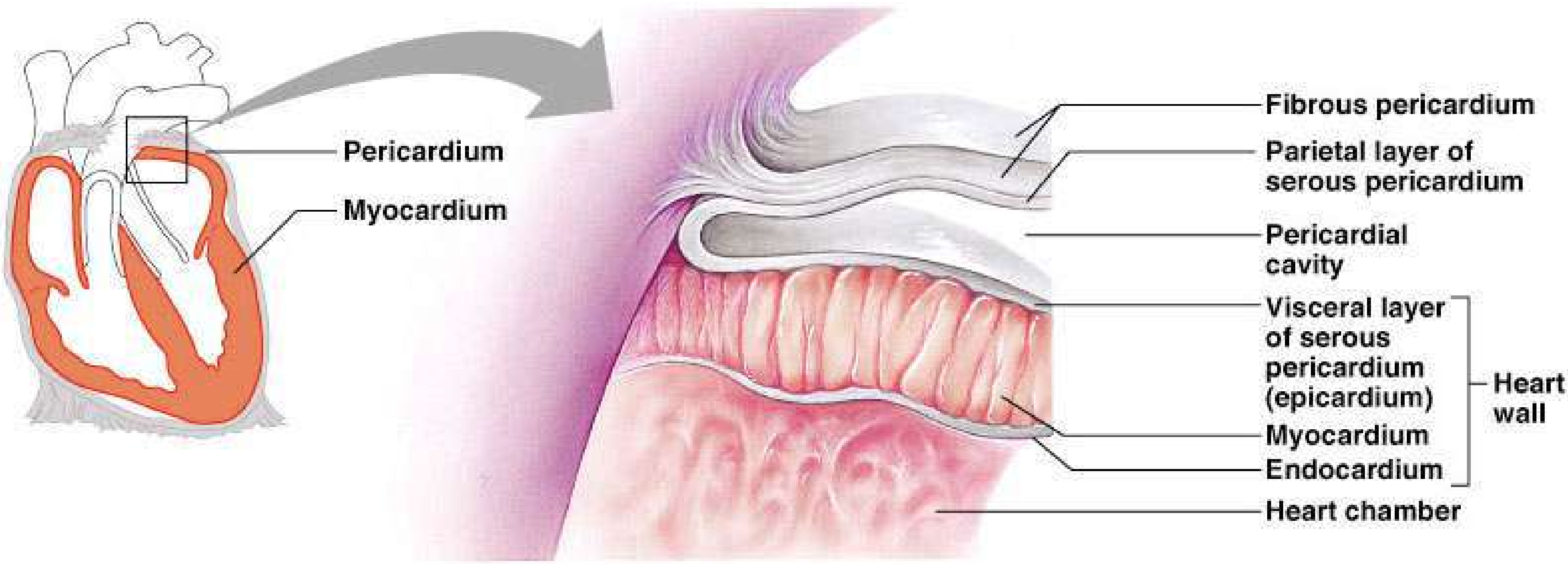
  1. A superficial fibrous pericardium
  2. A deep two-layer serous pericardium
     a. The parietal layer lines the internal surface of the fibrous pericardium
     b. The visceral layer or epicardium lines the surface of the heart

     - They are separated by the fluid-filled pericardial cavity

Coverings of the Heart: Physiology

- The Function of the Pericardium:
  - Protects and anchors the heart
  - Prevents overfilling of the heart with blood
  - Allows for the heart to work in a relatively friction-free environment

Pericardial Layers of the Heart



Heart Wall

- **Epicardium** – visceral layer of the serous pericardium
- **Myocardium** – cardiac muscle layer forming the bulk of the heart
- **Fibrous skeleton** of the heart – crisscrossing, interlacing layer of connective tissue
- **Endocardium** – endothelial layer of the inner myocardial surface

External Heart: Major Vessels of the Heart (Anterior View)

- Vessels **returning blood to the heart** include:
  1. Superior and inferior venae cavae
  2. Right and left pulmonary veins
- Vessels conveying **blood away from the heart** include:
  1. Pulmonary trunk, which splits into right and left pulmonary arteries
  2. Ascending aorta (three branches) –
     a. Brachiocephalic
     b. Left common carotid
     c. Subclavian arteries

External Heart: Vessels that Supply/Drain the Heart (Anterior View)

- **Arteries** – right and left coronary (in atrioventricular groove), marginal, circumflex, and anterior interventricular arteries
- **Veins** – small cardiac, anterior cardiac, and great cardiac veins

External Heart: Anterior View

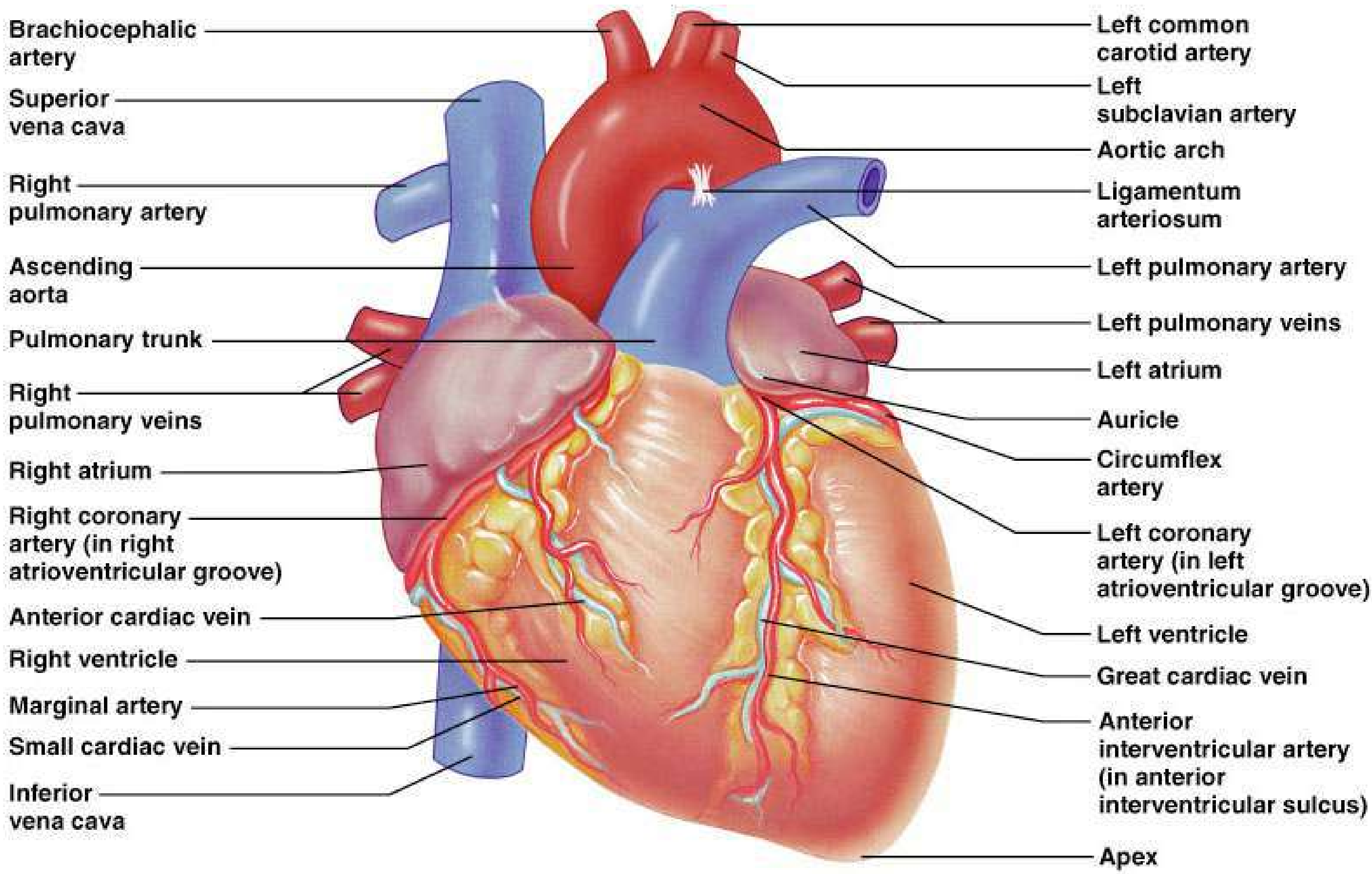


Figure 18.4b

External Heart: Major Vessels of the Heart (Posterior View)

- Vessels **returning blood to the heart** include:

1. Right and left pulmonary veins
2. Superior and inferior venae cavae

- Vessels **conveying blood away from the heart** include:

1. Aorta
2. Right and left pulmonary arteries

External Heart: Vessels that Supply/Drain the Heart (Posterior View)

- **Arteries** – right coronary artery (in atrioventricular groove) and the posterior interventricular artery (in interventricular groove)

- **Veins** – great cardiac vein, posterior vein to left ventricle, coronary sinus, and middle cardiac vein

External Heart: Posterior View

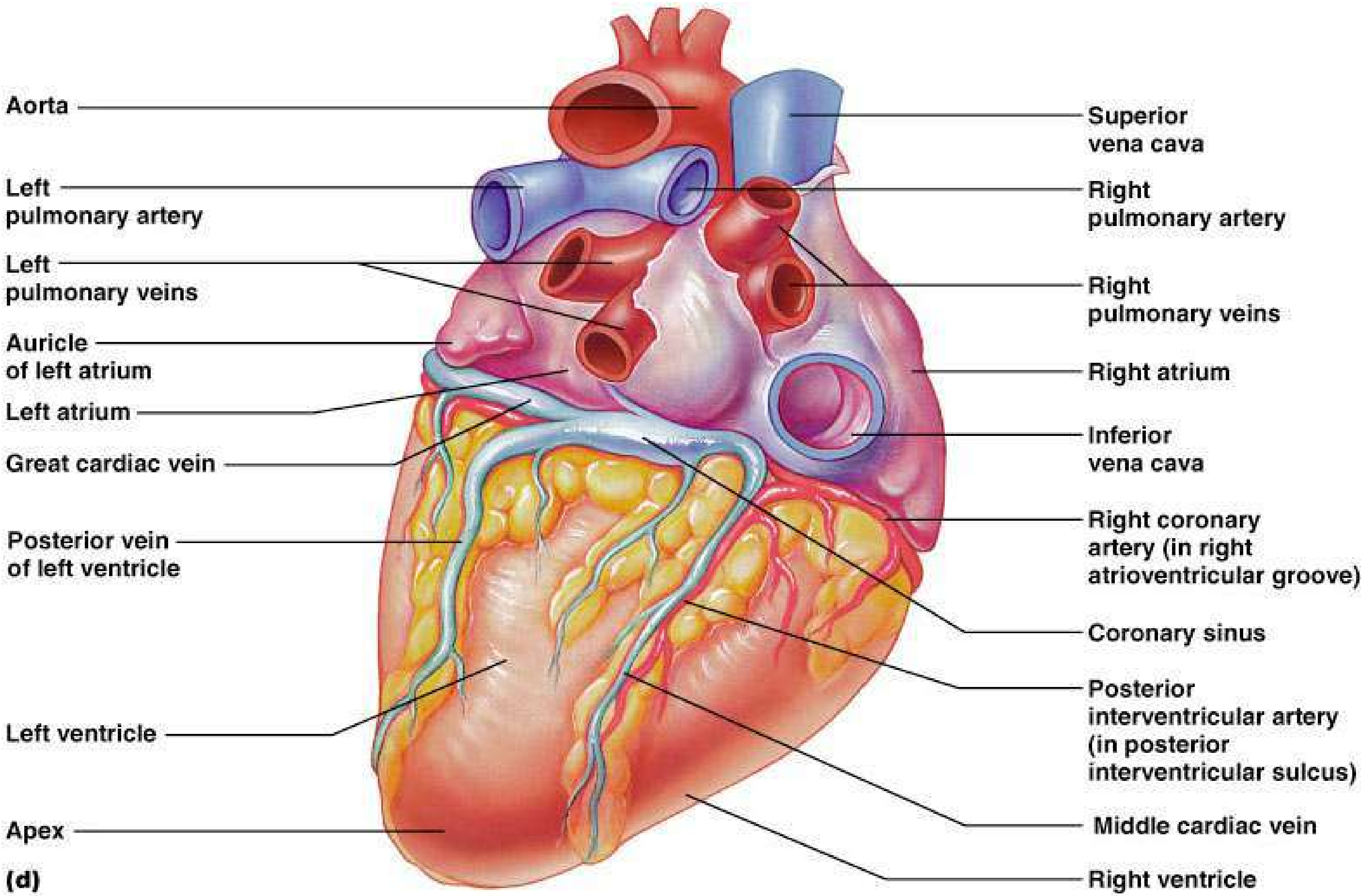


Figure 18.4d

Gross Anatomy of Heart: Frontal Section

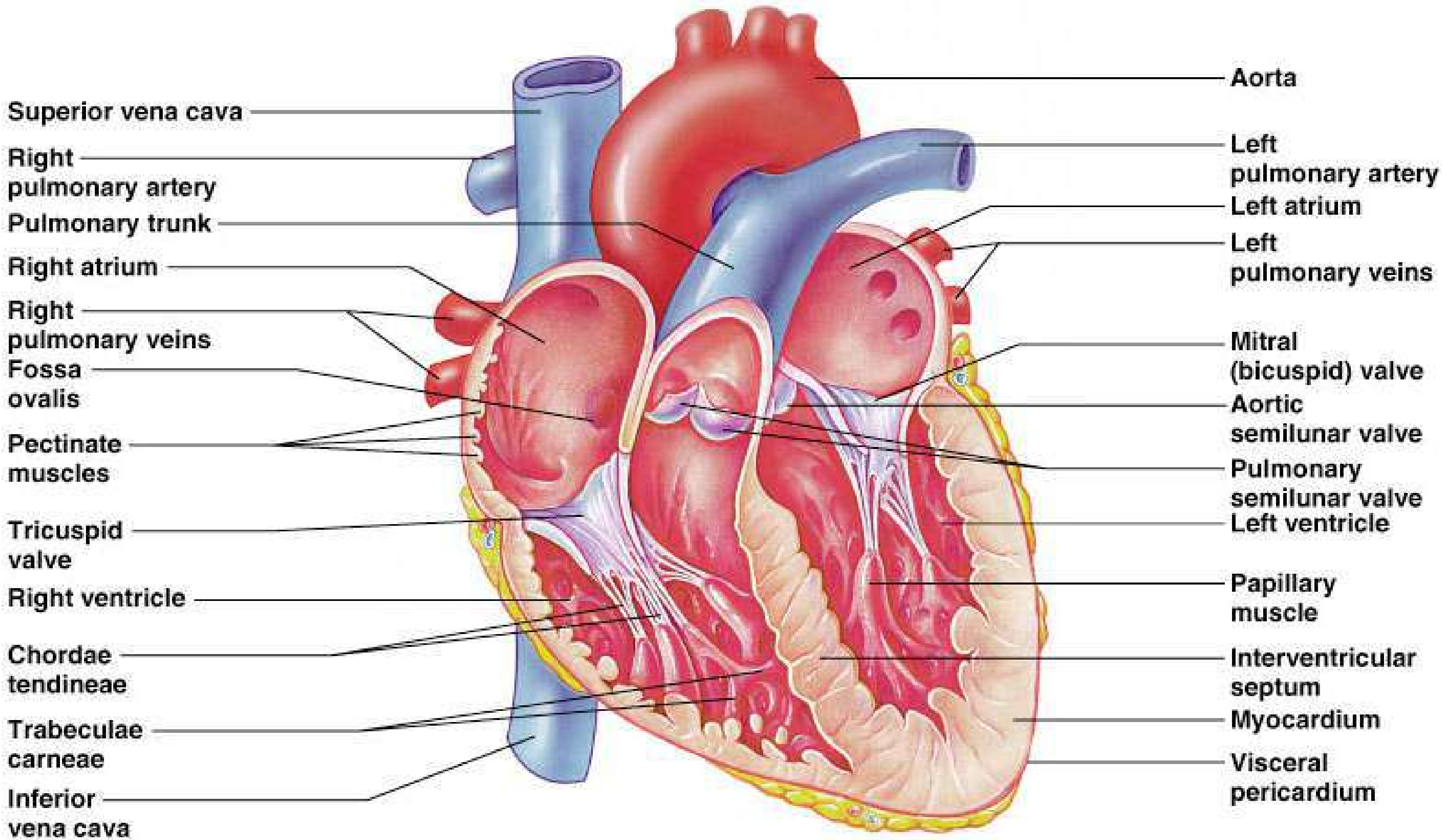


Figure 18.4e

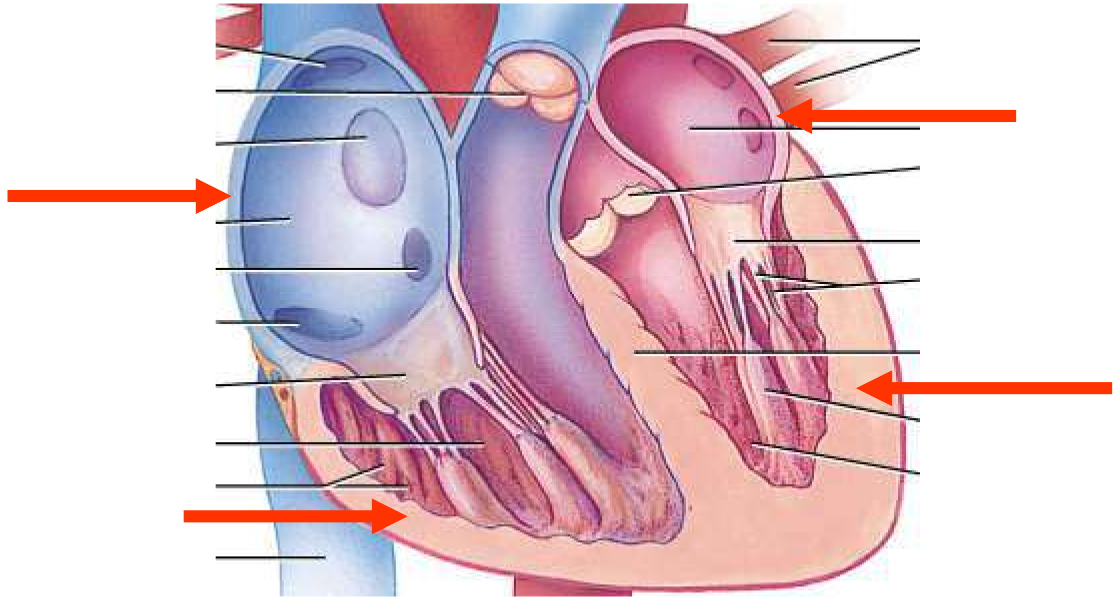
Atria of the Heart

- Atria are the receiving chambers of the heart
- Each atrium has a protruding auricle
- **Pectinate muscles** mark atrial walls
- Blood enters right atria from superior and inferior venae cavae and coronary sinus
- Blood enters left atria from pulmonary veins

Ventricles of the Heart

- Ventricles are the discharging chambers of the heart
- **Papillary muscles** and **trabeculae carneae** muscles mark ventricular walls
- **Right ventricle** pumps blood into the pulmonary trunk
- **Left ventricle** pumps blood into the aorta

Myocardial Thickness and Function



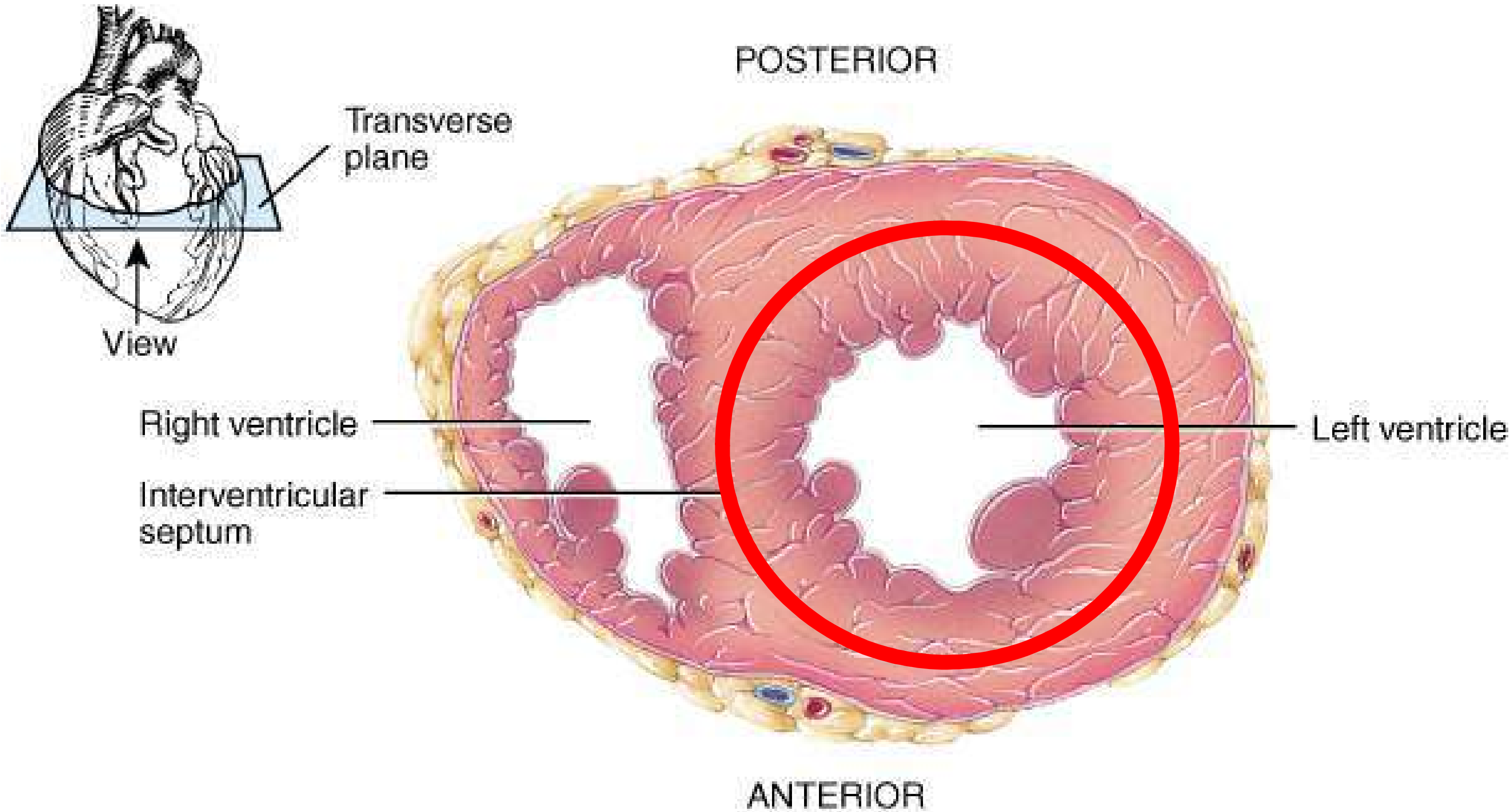
Thickness of myocardium varies according to the function of the chamber

Atria are thin walled, deliver blood to adjacent ventricles

Ventricle walls are much thicker and stronger

- right ventricle supplies blood to the lungs (little flow resistance)
- left ventricle wall is the thickest to supply systemic circulation

Thickness of Cardiac Walls

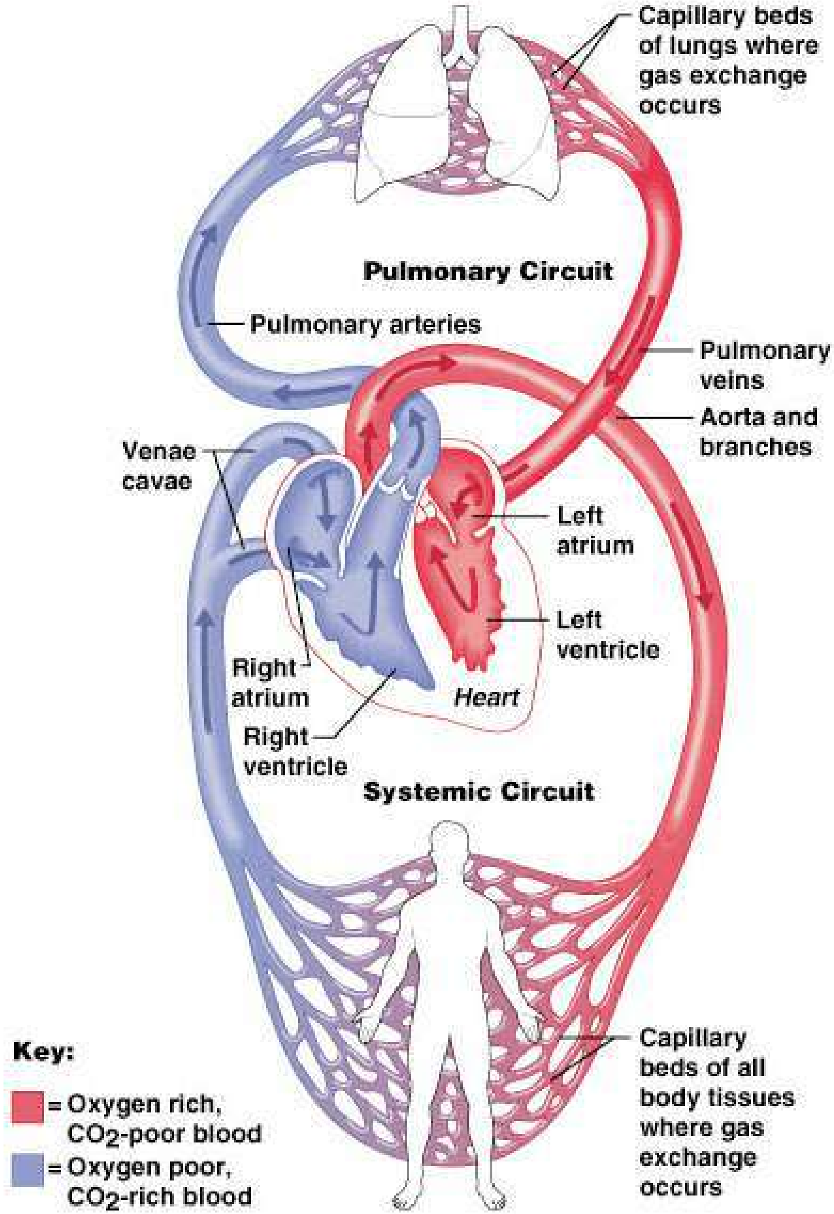


Myocardium of left ventricle is much thicker than the right.

Pathway of Blood Through the Heart and Lungs

- Right atrium → tricuspid valve → right ventricle
- Right ventricle → pulmonary semilunar valve → pulmonary arteries → lungs
- Lungs → pulmonary veins → left atrium
- Left atrium → bicuspid valve → left ventricle
- Left ventricle → aortic semilunar valve → aorta
- Aorta → systemic circulation

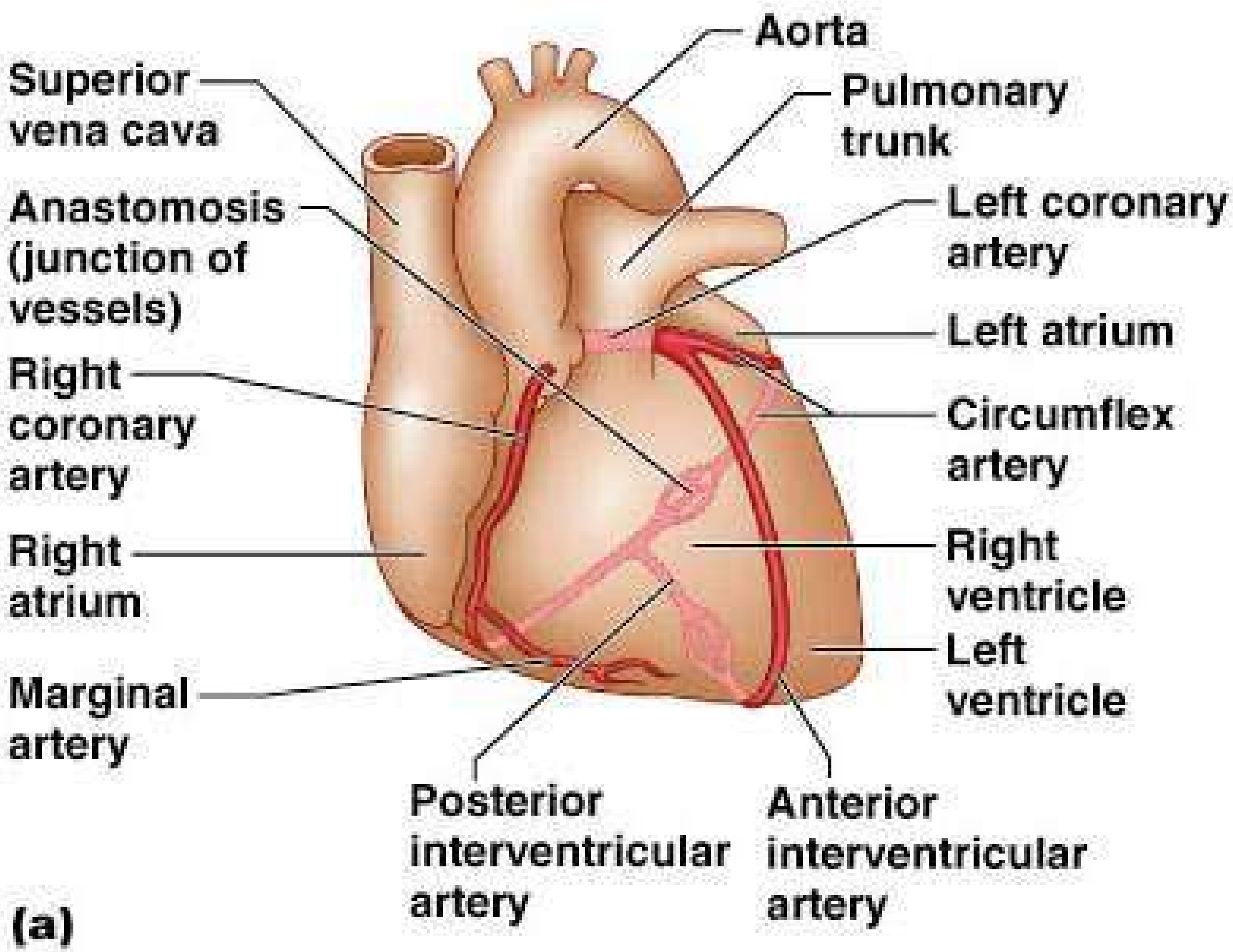
Pathway of Blood Through the Heart and Lungs



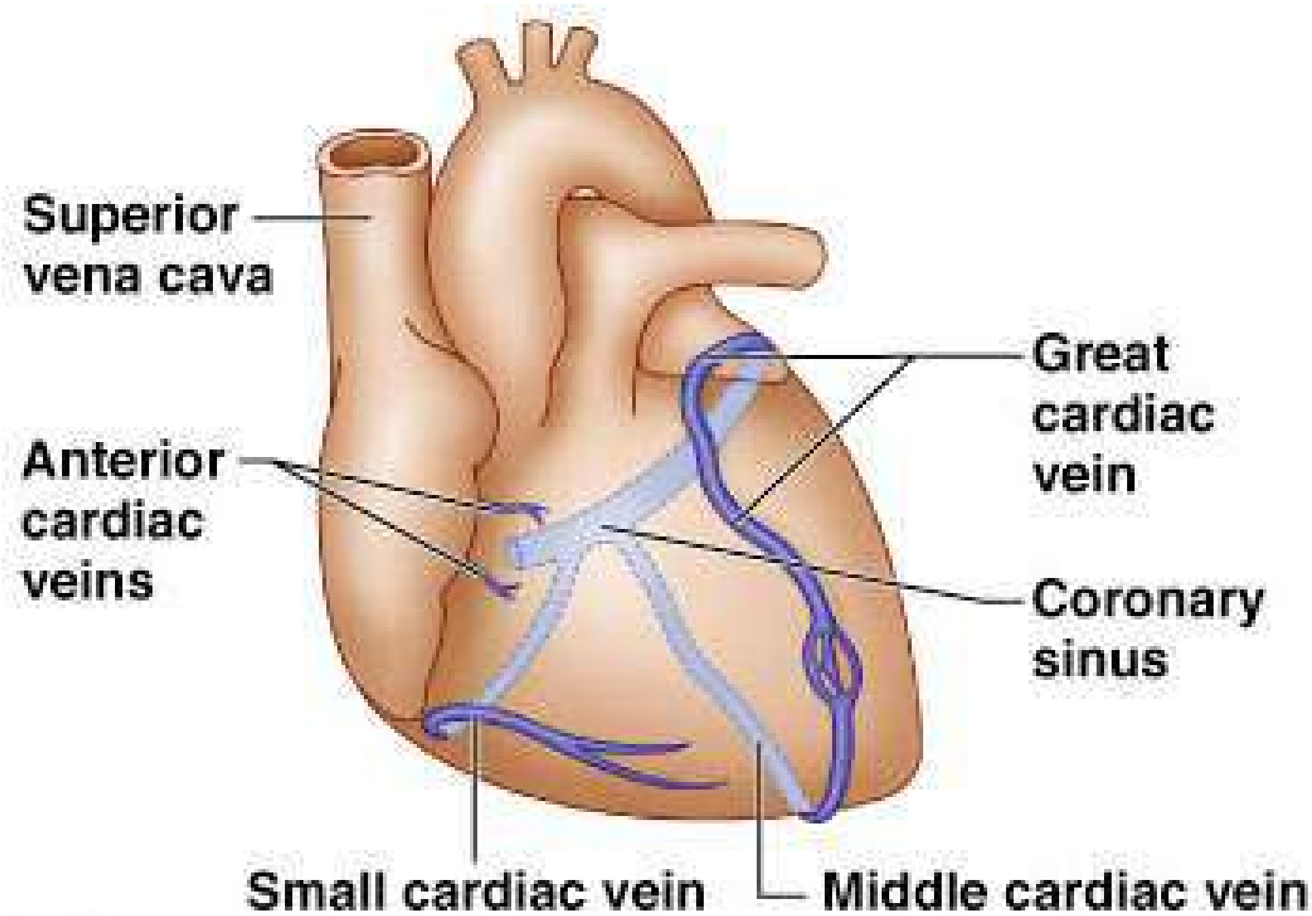
Coronary Circulation

- **Coronary circulation** is the functional blood supply to the heart muscle itself
- **Collateral routes** ensure blood delivery to heart even if major vessels are occluded

Coronary Circulation: Arterial Supply



Coronary Circulation: Venous Supply



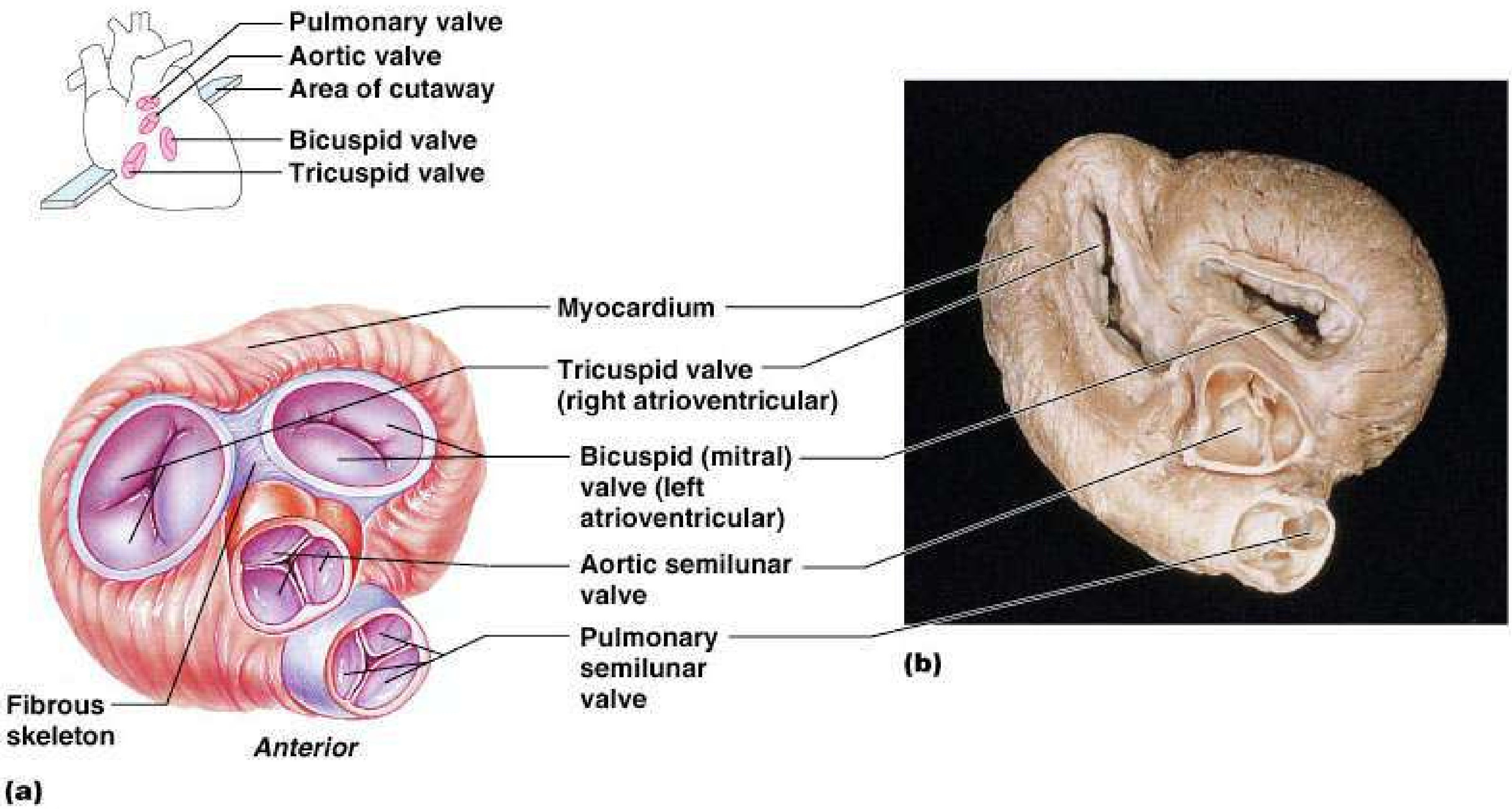
Heart Valves

- Heart valves ensure unidirectional blood flow through the heart
- **Atrioventricular (AV)** valves lie between the atria and the ventricles
  - AV valves prevent backflow into the atria when ventricles contract
- Chordae tendineae anchor AV valves to papillary muscles

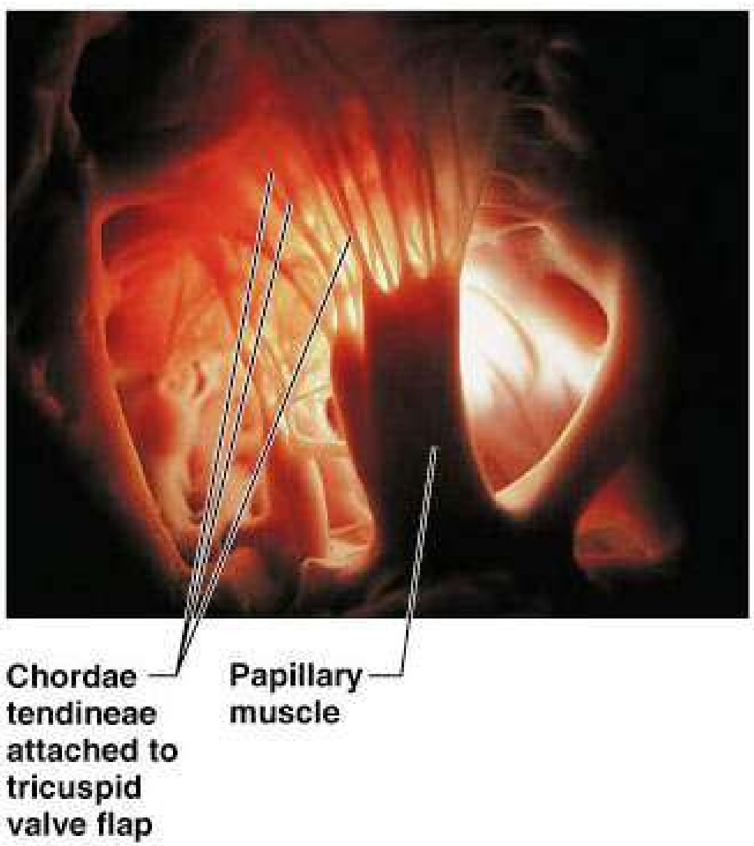
Heart Valves

- Semilunar valves prevent backflow of blood into the ventricles
- **Aortic semilunar** valve lies between the left ventricle and the aorta
- **Pulmonary semilunar** valve lies between the right ventricle and pulmonary trunk

Heart Valves



Heart Valves



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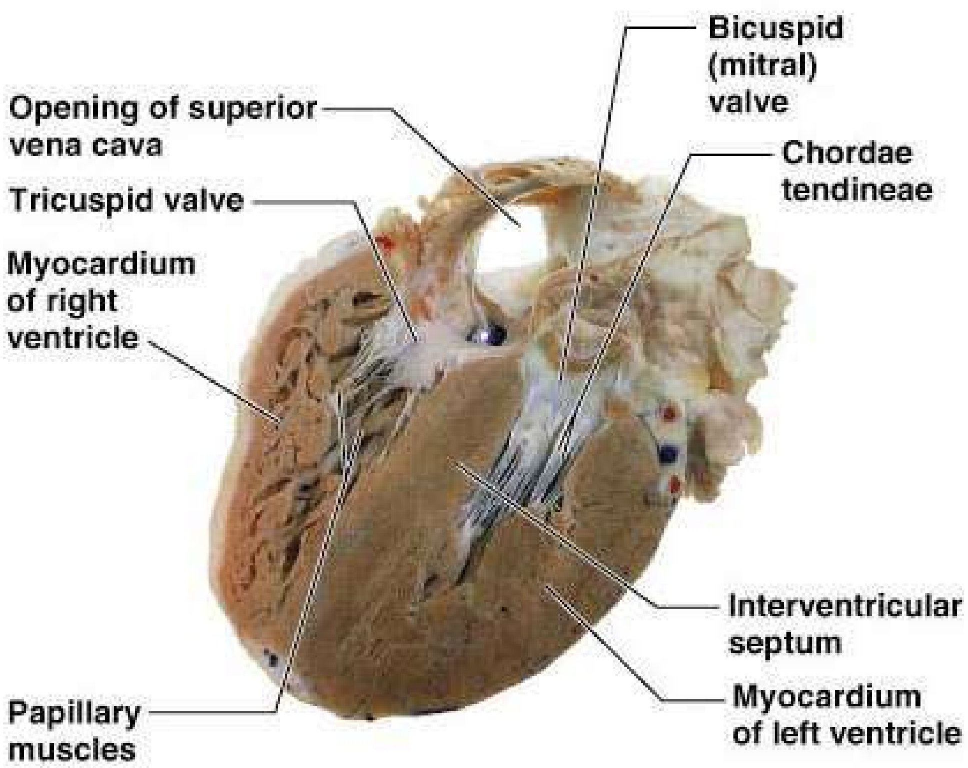

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Atrioventricular Valve Function

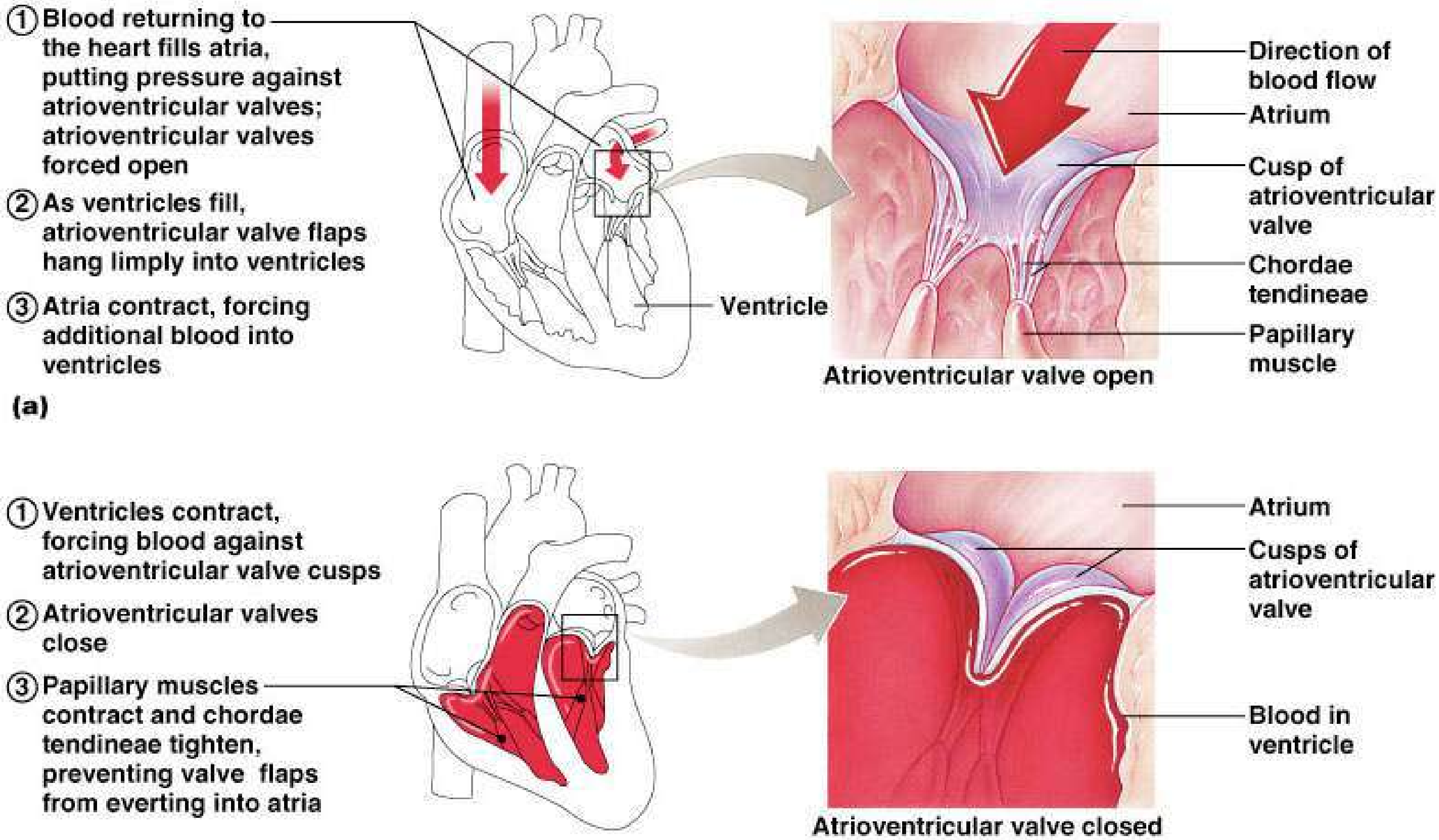
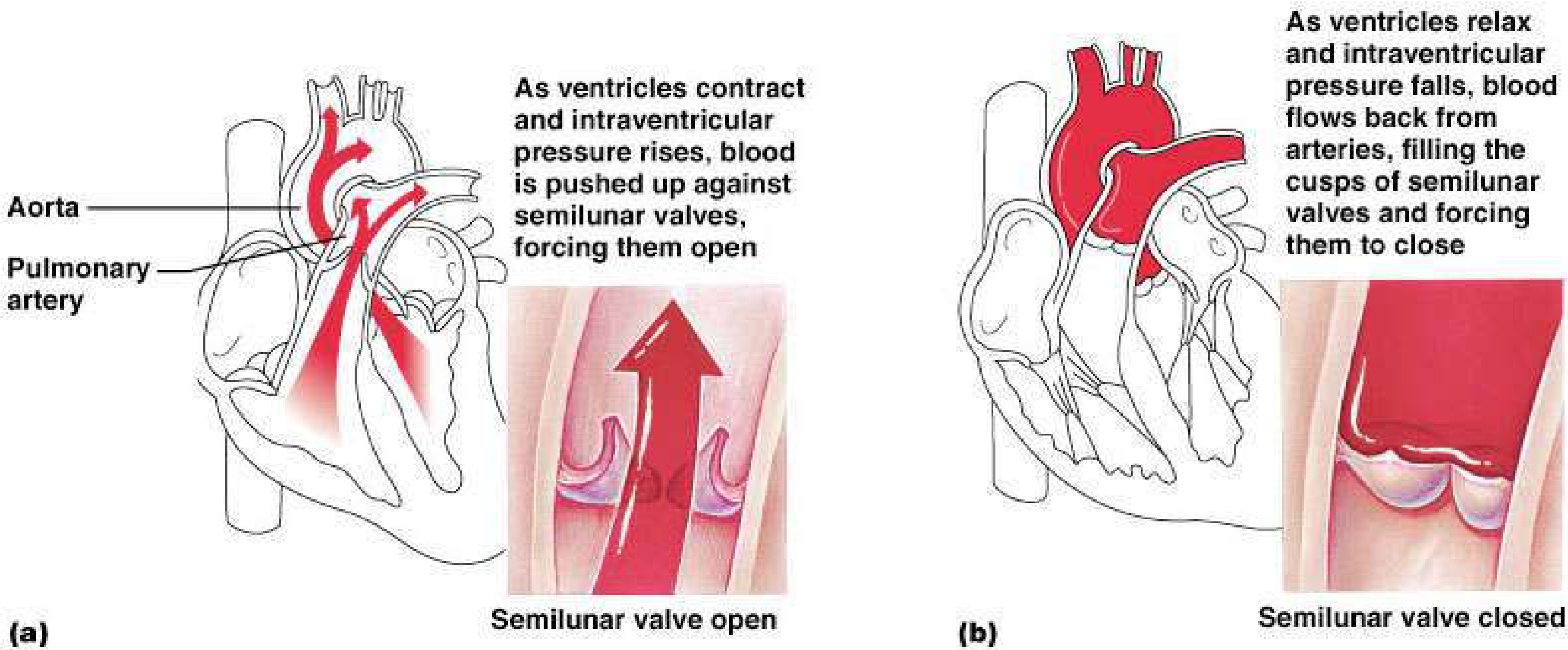


Figure 18.9

Semilunar Valve Function



Microscopic Anatomy of Heart Muscle

- Cardiac muscle is striated, short, fat, branched, and interconnected
- The connective tissue endomysium acts as both tendon and insertion
- Intercalated discs anchor cardiac cells together and allow free passage of ions
- Heart muscle behaves as a functional syncytium

Microscopic Anatomy of Heart Muscle

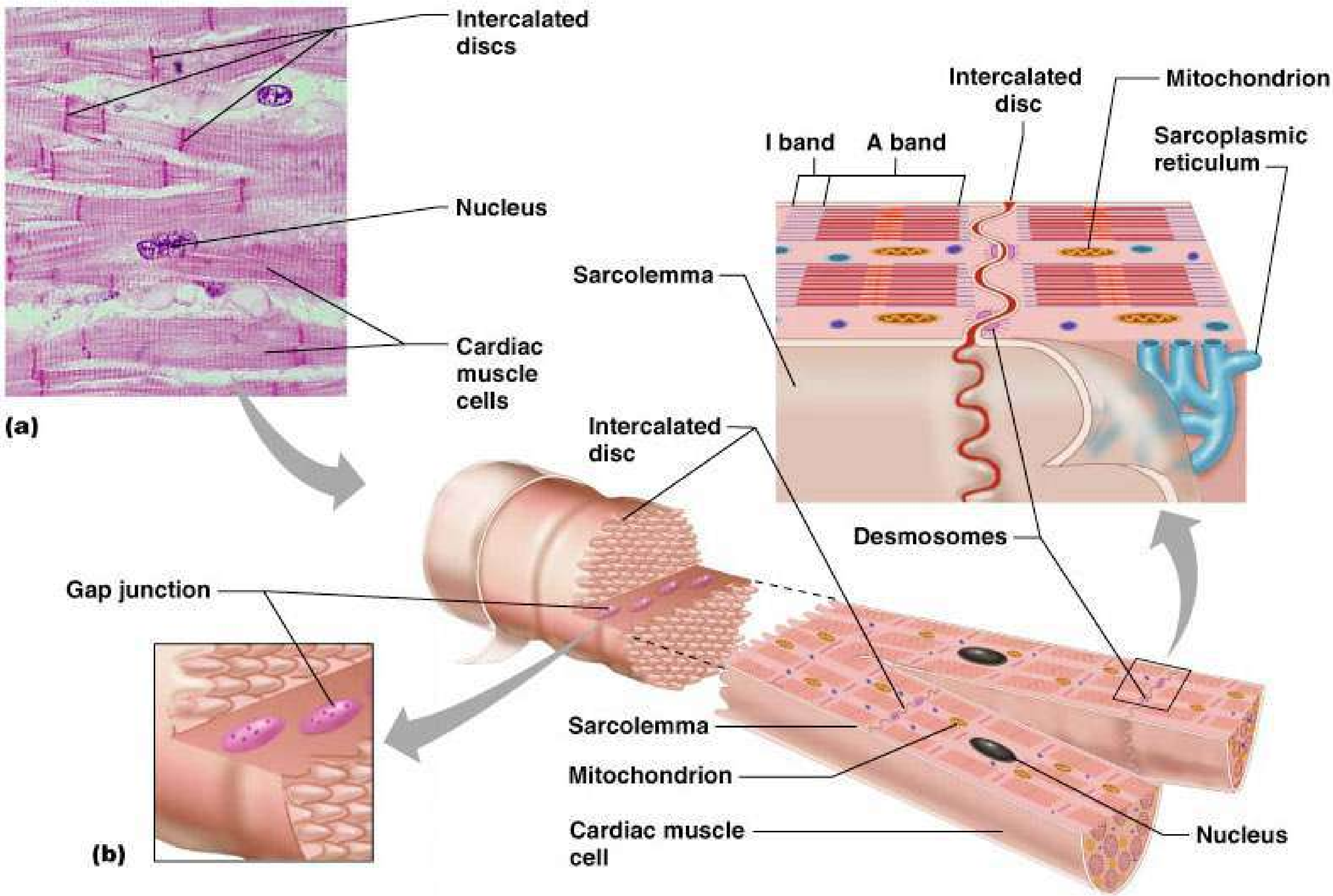


Figure 18.11

The Cardiovascular System: The Heart

Physiology

Cardiac Muscle Contraction

- Heart muscle:
  - Is stimulated by nerves and is self-excitable (**automaticity**)
  - Contracts as a unit
  - Has a long (250 ms) absolute refractory period
- Cardiac muscle contraction is similar to skeletal muscle contraction

Heart Physiology: Intrinsic Conduction System

- **Autorhythmic cells:**
  - Initiate action potentials
  - Have unstable resting potentials called **pacemaker potentials**
  - Use **calcium influx** (rather than sodium) for rising phase of the action potential

Pacemaker and Action Potentials of the Heart

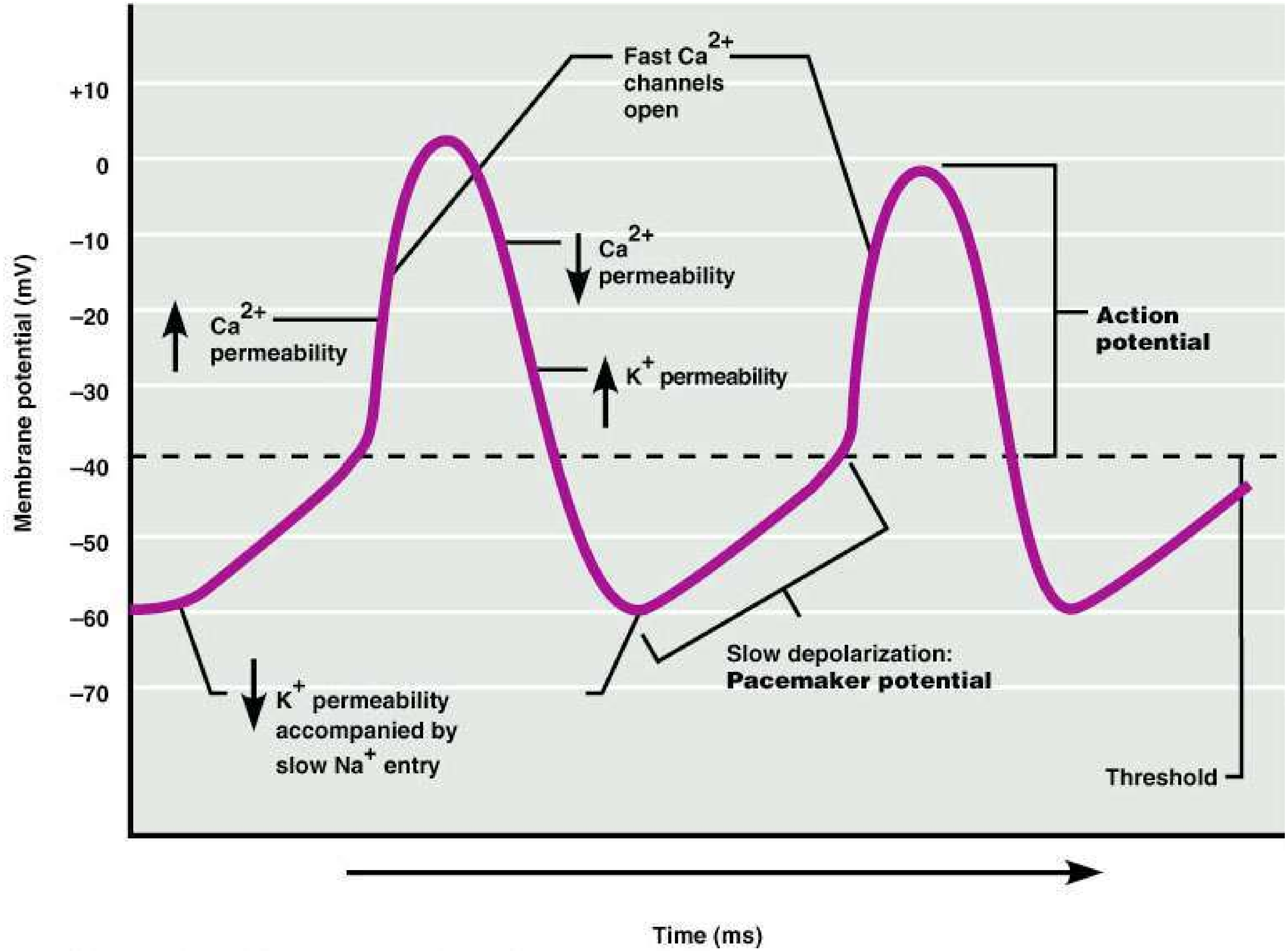


Figure 18.13

Heart Physiology: Sequence of Excitation

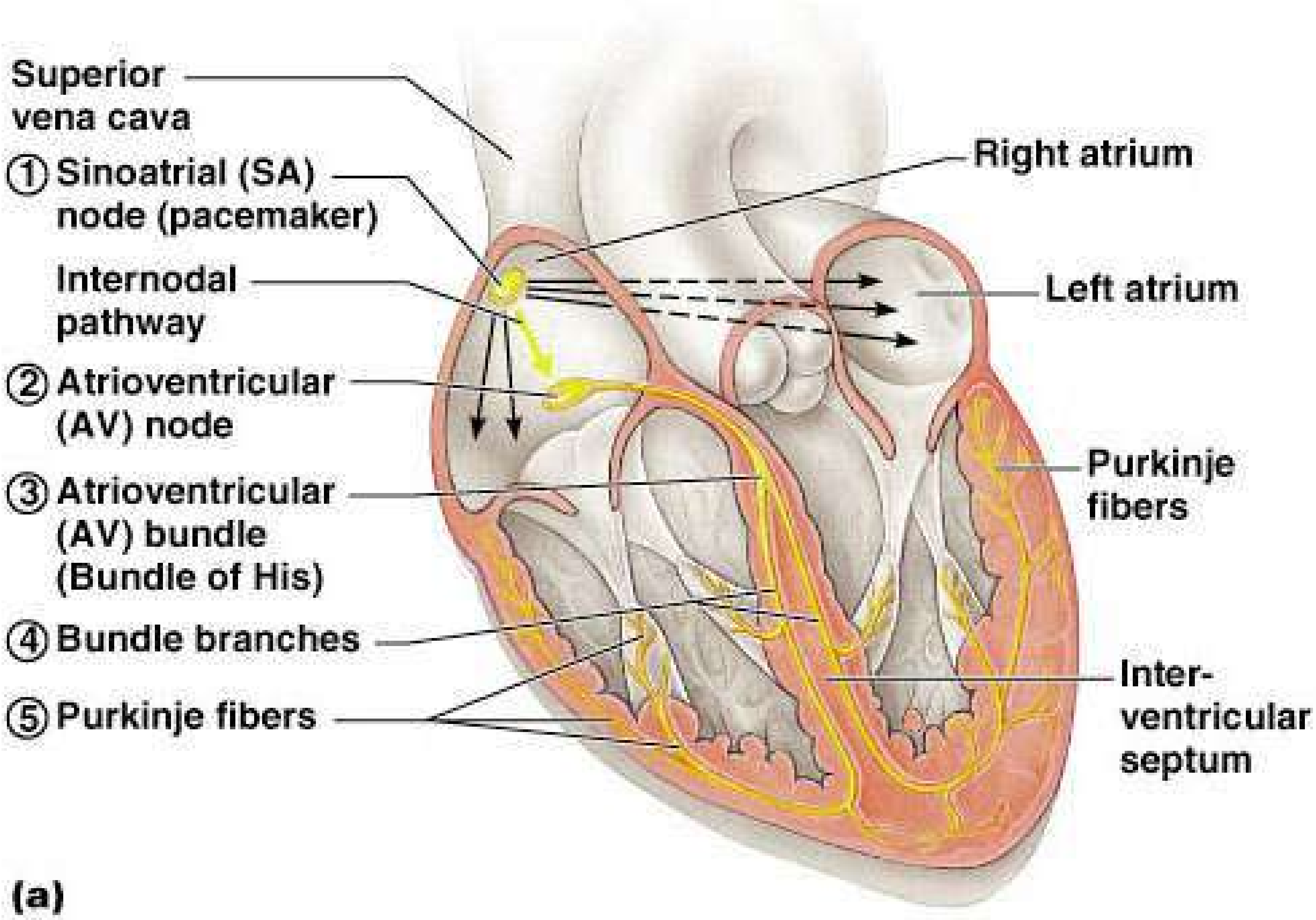
- **Sinoatrial (SA) node** generates impulses about 75 times/minute
- **Atrioventricular (AV) node** delays the impulse approximately 0.1 second

Heart Physiology: Sequence of Excitation

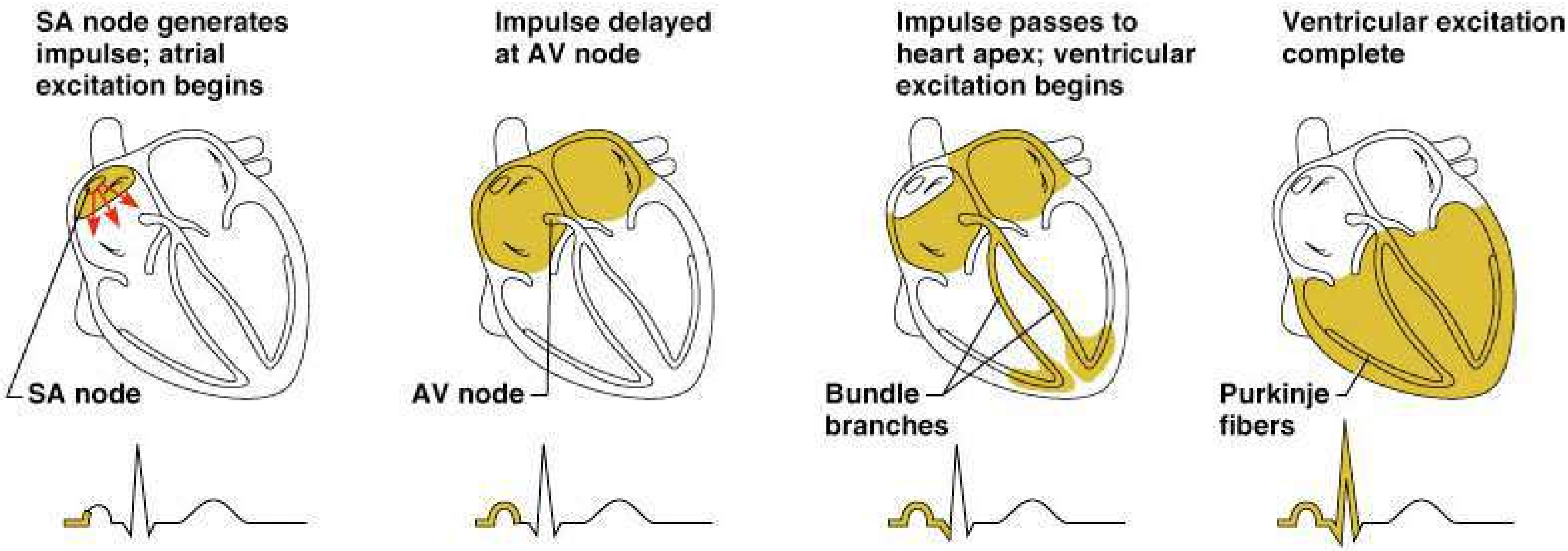
- Impulse passes from atria to ventricles via the **atrioventricular bundle (bundle of His)**
  - AV bundle splits into two pathways in the interventricular septum (bundle branches)

1. **Bundle branches** carry the impulse toward the apex of the heart
2. **Purkinje fibers** carry the impulse to the heart apex and ventricular walls

Heart Physiology: Sequence of Excitation

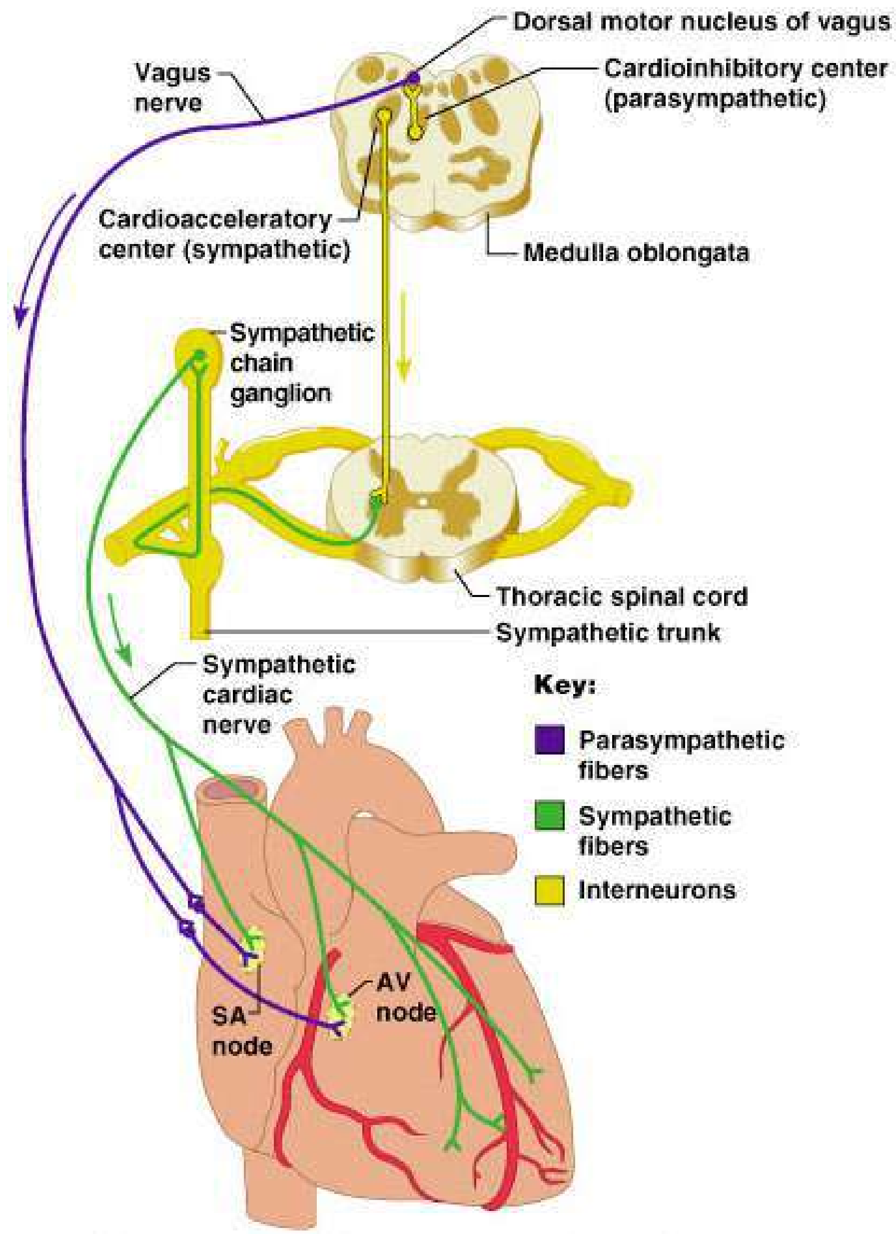


Heart Excitation Related to ECG



Extrinsic Innervation of the Heart

- Heart is stimulated by the sympathetic cardioacceleratory center
- Heart is inhibited by the parasympathetic cardioinhibitory center



Electrocardiography

- Electrical activity is recorded by electrocardiogram (ECG)
- P wave corresponds to depolarization of SA node
- QRS complex corresponds to ventricular depolarization
- T wave corresponds to ventricular repolarization
- Atrial repolarization record is masked by the larger QRS complex

Electrocardiography

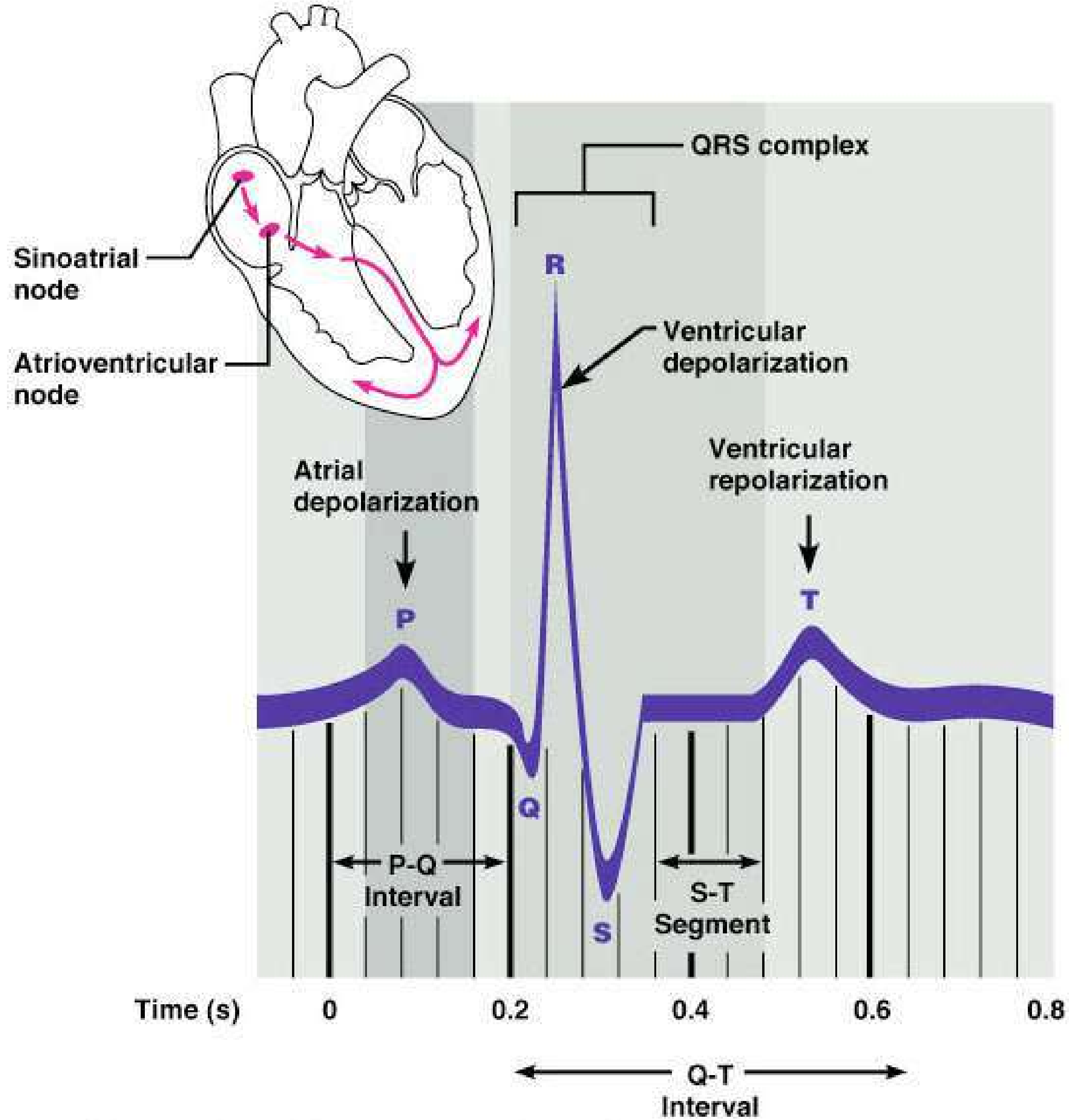


Figure 18.16

Heart Sounds

- Heart sounds (lub-dup) are associated with closing of heart valves
  - **First sound** occurs as AV valves close and signifies beginning of systole (contraction)
  - **Second sound** occurs when SL valves close at the beginning of ventricular diastole (relaxation)

Cardiac Cycle

- Cardiac cycle refers to all events associated with blood flow through the heart
  - **Systole** – contraction of heart muscle
  - **Diastole** – relaxation of heart muscle

Phases of the Cardiac Cycle

- **Ventricular filling** – mid-to-late diastole
  - Heart blood pressure is low as blood enters atria (passively) and flows into ventricles
  - AV valves are open, then atrial systole occurs

Phases of the Cardiac Cycle

- **Ventricular systole (contraction)**
  - Atria relax
  - Rising ventricular pressure results in closing of AV valves
  - *Isovolumetric contraction* phase
  - Ventricular ejection phase opens semilunar valves

Phases of the Cardiac Cycle

- **Isovolumetric relaxation** – early diastole
  - Ventricles relax
  - Backflow of blood in *aorta and pulmonary trunk* closes semilunar valves
- **Dicrotic notch** – brief rise in aortic pressure caused by backflow of blood rebounding off semilunar valves

Phases of the Cardiac Cycle

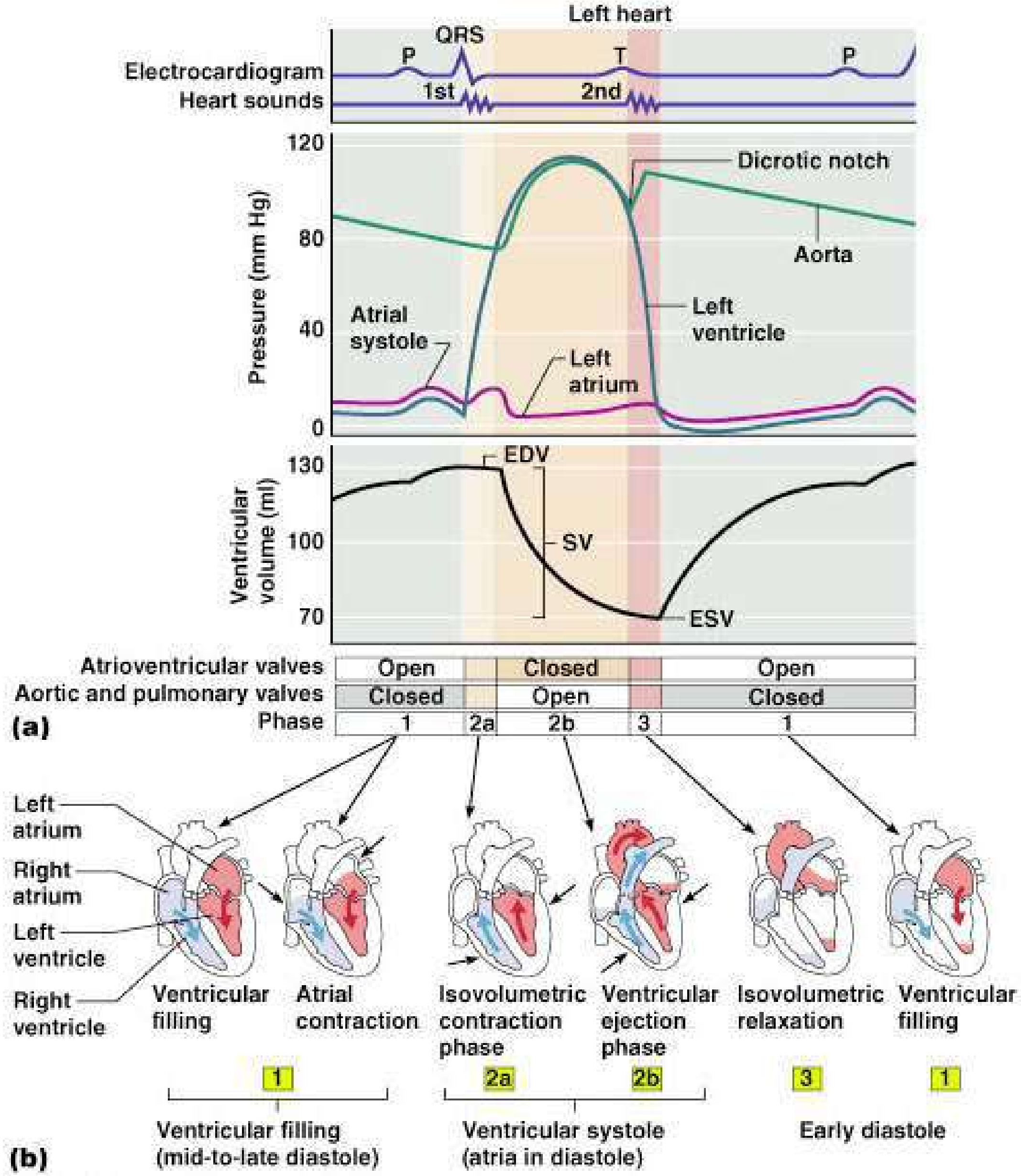


Figure 18.20

Cardiac Output (CO) and Reserve

- **Cardiac Output** is the amount of blood pumped by each ventricle in one minute
  - CO is the product of heart rate (HR) and stroke volume (SV)
    - HR is the number of heart beats per minute
    - SV is the amount of blood pumped out by a ventricle with each beat
- **Cardiac reserve** is the difference between resting and maximal CO

Cardiac Output

- CO (ml/min) = HR (75 beats/min) x SV (70 ml/beat)
- CO = 5250 ml/min (5.25 L/min)

Regulation of Stroke Volume

- SV = end diastolic volume (EDV) minus end systolic volume (ESV)
  - EDV = amount of blood collected in a ventricle during diastole
  - ESV = amount of blood remaining in a ventricle after contraction

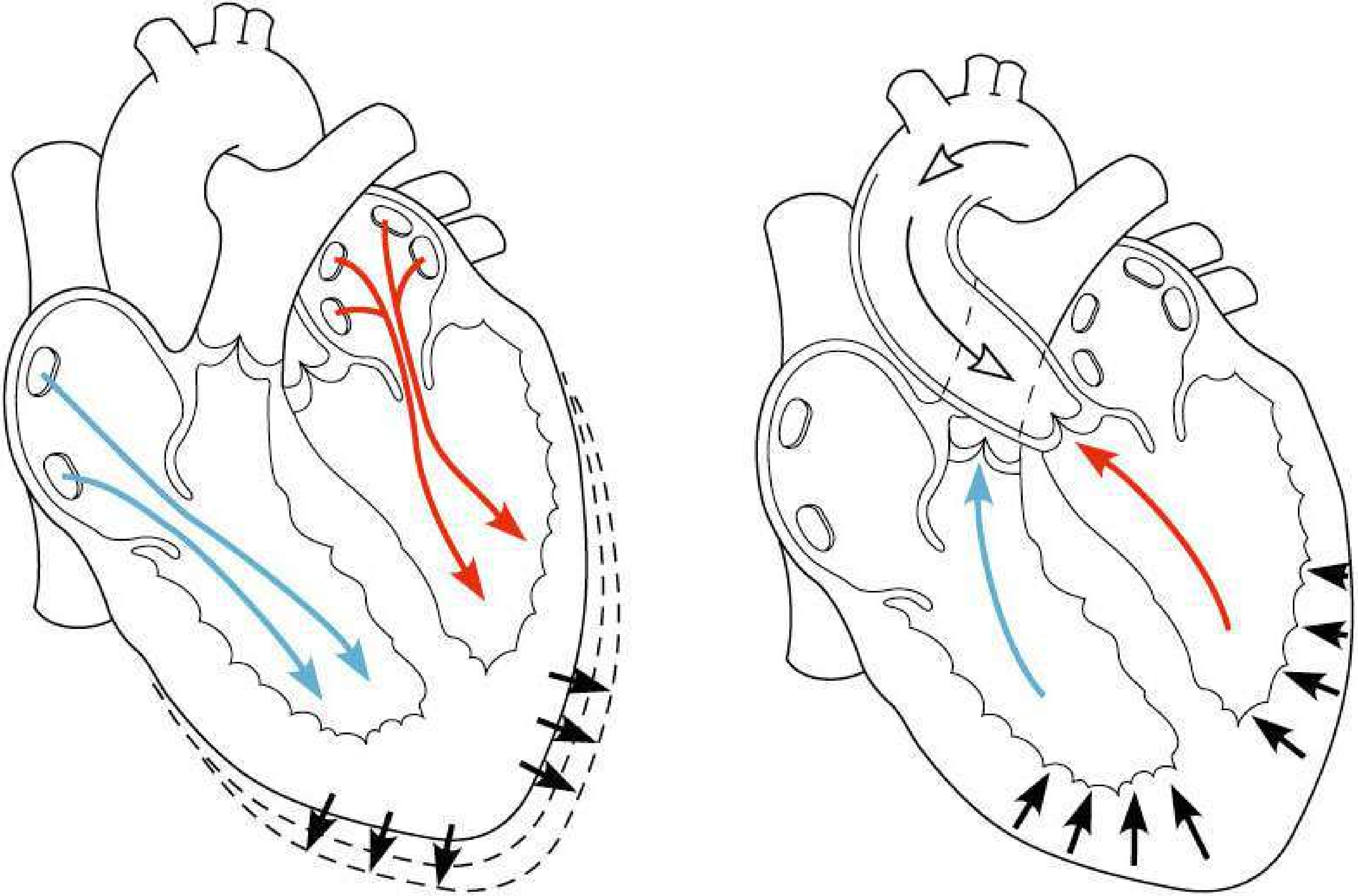
Factors Affecting Stroke Volume

- **Preload** – amount ventricles are stretched by contained blood
- **Contractility** – cardiac cell contractile force due to factors other than EDV
- **Afterload** – back pressure exerted by blood in the large arteries leaving the heart

Frank-Starling Law of the Heart

- Preload, or degree of stretch, of cardiac muscle cells before they contract is the critical factor controlling stroke volume
- Slow heartbeat and exercise increase venous return to the heart, increasing SV
- Blood loss and extremely rapid heartbeat decrease SV

Preload and Afterload



(a) Preload (b) Afterload

Figure 18.21

Extrinsic Factors Influencing Stroke Volume

- **Contractility** is the increase in contractile strength, independent of stretch and EDV
- Increase in contractility comes from:
  - Increased sympathetic stimuli
  - Certain hormones
  - Ca^{2+} and some drugs

Extrinsic Factors Influencing Stroke Volume

- Agents/factors that decrease contractility include:
  - Acidosis
  - Increased extracellular K^+
  - Calcium channel blockers

Regulation of Heart Rate: Autonomic Nervous System

- **Sympathetic nervous system (SNS)** stimulation is activated by stress, anxiety, excitement, or exercise
- **Parasympathetic nervous system (PNS)** stimulation is mediated by acetylcholine and opposes the SNS
  - PNS dominates the autonomic stimulation, slowing heart rate and causing vagal tone
    - If the Vagus Nerve was cut, the heart would lose its tone. Thus, increasing the heart rate by 25 beats per minute.

- DISORDERS OF CVS

Congestive Heart Failure (CHF)

- Congestive heart failure (CHF) is caused by:
  - Coronary atherosclerosis
  - Persistent high blood pressure
  - Multiple myocardial infarcts
  - Dilated cardiomyopathy (DCM) – main pumping chambers of the heart are dilated and contract poorly

Developmental Aspects of the Heart

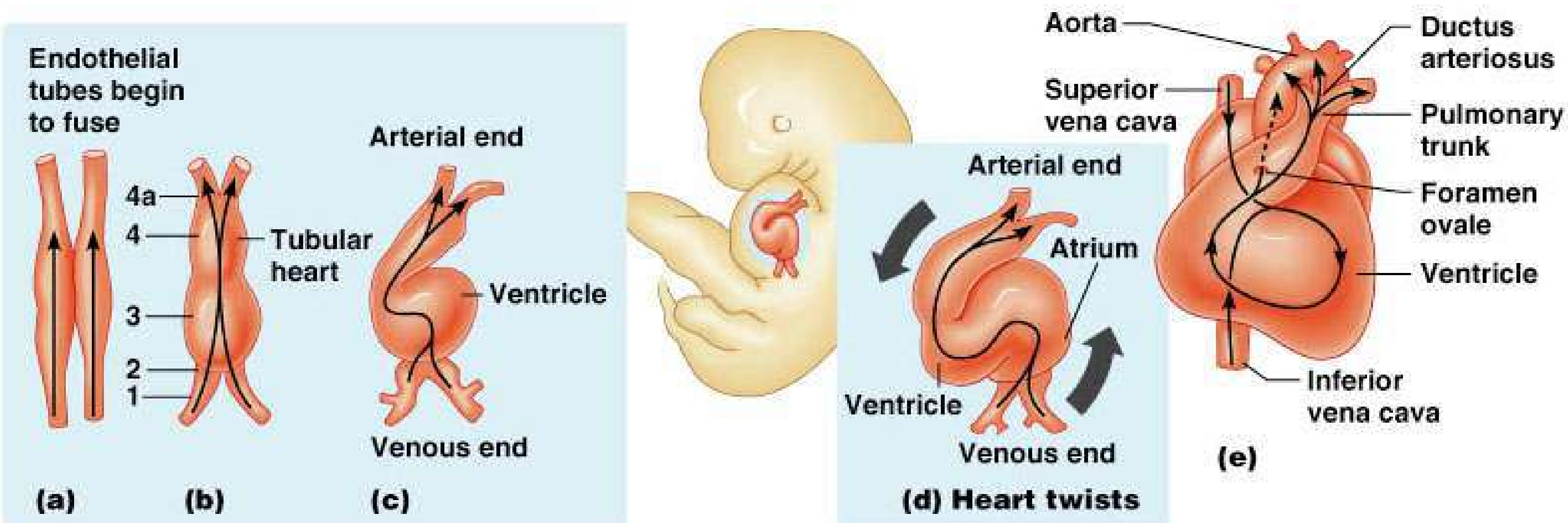
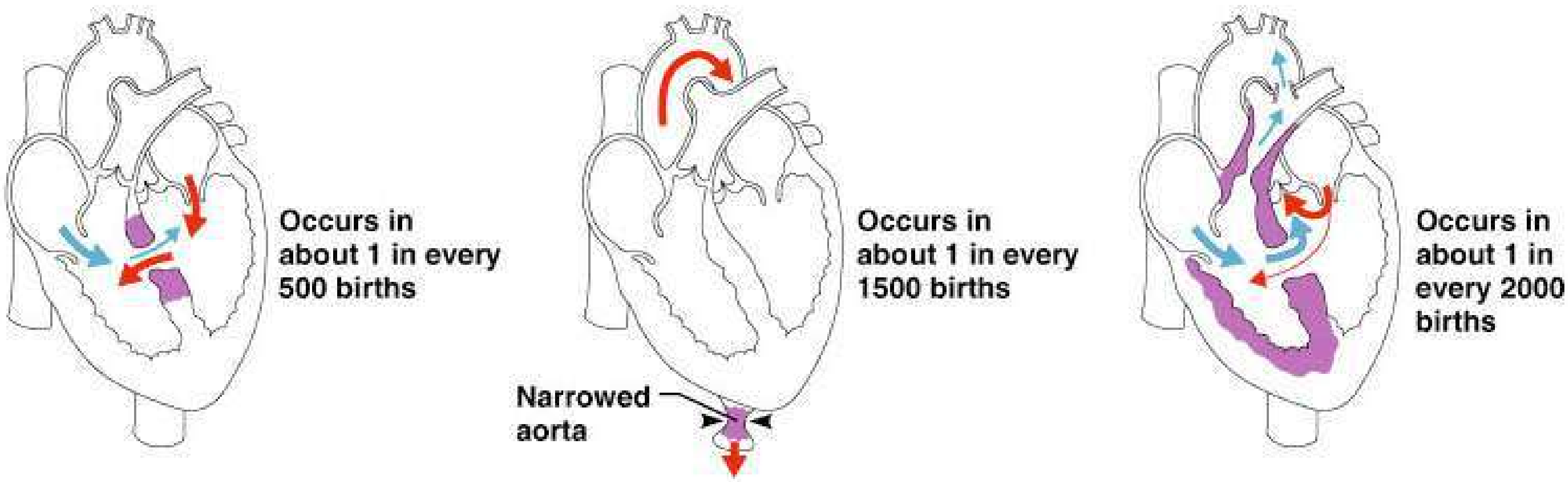


Figure 18.24

Developmental Aspects of the Heart

- Fetal heart structures that bypass pulmonary circulation
  - **Foramen ovale** connects the two atria
  - **Ductus arteriosus** connects pulmonary trunk and the aorta

Examples of Congenital Heart Defects



(a) Ventricular septal defect. The superior part of the interventricular septum fails to form; thus, blood mixes between the two ventricles, but because the left ventricle is stronger, more blood is shunted from left to right.

(b) Coarctation of the aorta. A part of the aorta is narrowed, increasing the workload on the left ventricle.

(c) Tetralogy of Fallot. Multiple defects (*tetra* = four): Pulmonary trunk too narrow and pulmonary valve stenosed, resulting in a hypertrophied right ventricle; ventricular septal defect; aorta opens from both ventricles; wall of right ventricle thickened from overwork.

Figure 18.25

Age-Related Changes Affecting the Heart

- Sclerosis and thickening of valve flaps
- Decline in cardiac reserve
- Fibrosis of cardiac muscle
- Atherosclerosis

Congestive Heart Failure

- Causes of CHF
  - coronary artery disease, hypertension, MI, valve disorders, congenital defects
- **Left side heart failure**
  - less effective pump so more blood remains in ventricle
  - heart is overstretched & even more blood remains
  - blood backs up into lungs as pulmonary edema
  - suffocation & lack of oxygen to the tissues
- **Right side failure**
  - fluid builds up in tissues as peripheral edema

Coronary Artery Disease

- Heart muscle receiving insufficient blood supply
  - narrowing of vessels---atherosclerosis, artery spasm or clot
  - atherosclerosis--smooth muscle & fatty deposits in walls of arteries
- Treatment
  - drugs, bypass graft, angioplasty, stent

Cardiac diseases

- **MI = myocardial infarction**
  - death of area of heart muscle from lack of O_2
  - replaced with scar tissue
  - results depend on size & location of damage
- **Blood clot**
  - use clot dissolving drugs streptokinase or t-PA & heparin
  - balloon angioplasty
- **Angina pectoris**
  - heart pain from ischemia (lack of blood flow and oxygen) of cardiac muscle

Blood pressure

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Arterial Pressure

Definition:

- Arterial blood pressure is defined as the lateral pressure exerted

  By the column of blood on wall of arteries.
- **LOCAL FACTORS DETERMINIG THE ARTERIAL BLOOD PRESSURE**

Arterial blood pressure	Factors
Arterial blood pressure is directly proportional to	1. Cardiac output 2. Heart rate 3. Peripheral resistance 4. Blood volume 5. Venous return 6. Velocity of blood flow 7. Viscosity of blood
Arterial blood pressure is inversely proportional to	1. Elasticity of blood vessel 2. Diameter of blood vessel

REGULATION OF ARTERIAL BLOOD PRESSURE

There are four mechanisms for regulation of the blood pressure.

1. Nervous mechanism or shortterm regulatory mechanism
2. Renal mechanism or longterm regulatory mechanism
3. Hormonal mechanism
4. Local mechanism.

NERVOUS MECHANISM FOR REGULATION OF BLOOD PRESSURE

NERVOUS MECHANISM FOR REGULATION OF BLOOD PRESSURE – SHORT-TERM REGULATION

- Most rapid among all the mechanisms
- It operates through the vasomotor system.

❑Vasomotor System

Vasomotor system includes three components:

1. Vasomotor center (control heart rate)
2. Vasoconstrictor fibers (vasoconstriction)
3. Vasodilator fibers (vasodilation)

(Receives impulses from

Baroreceptors & Chemoreceptors.)

1. Baro-receptor Mechanism

Role of baroreceptors when blood pressure increases

Rise in B.P

activation of baroreceptors

impulses to nucleus of tractus solitarius

nucleus of tractus solitarius acts on vasomotor center

inhibition of vasoconstrictor area excites vasodilator area

Reduces vasomotor tone

Redution in peripheral resistance & Vasodilatation occur

(force of contraction & Cardiac output decrease)

Blood-pressure decreases

❑Role of baro-receptors when blood pressure decreases

When blood pressure falls below normal

↓Carotid sinus and aortic arch receptor potential

↓Rate of firing in afferent nerves

Cardiovascular center

↑Sympathetic cardiac nerve activity

and

↑sympathetic vasoconstrictor nerve activity

and

↓ parasympathetic nerve activity

↑Heart rate

and

↑stroke volume

and

arteriolar and venous

↑Cardiac output

and

↑total peripheral resistance

Blood pressure increased toward normal

2. Chemoreceptor Mechanism

Decreased blood pressure

Decreased flow of blood

Decrease in O_2 & Increase in CO_2

Excitation in the chemoreceptors

Send impulses to vasoconstrictors

Blood pressure rises and

blood flow increases

RENAL MECHANISM FOR REGULATION OF BLOOD PRESSURE

RENAL MECHANISM FOR REGULATION OF BLOOD PRESSURE

- Long term regulation of Arterial B.P
- Renal Mechanism works even when nerous mechanism adapts to the new pressure.
- Two ways of regulation of B.P

1. By regulation of ECF volume
2. Through reninangiotensin mechanism.

1. By regulation of ECF volume

Increase in B.P → excretion of water (pressure diuresis) + excretion of salts (sodium) (Pressure Natriuresis)

decrease in ECF volume + decrease in blood volume → Blood pressure restored

Decrease in B.P

reabsorption from renal-tubules

Increase in ECF & Blood volumes

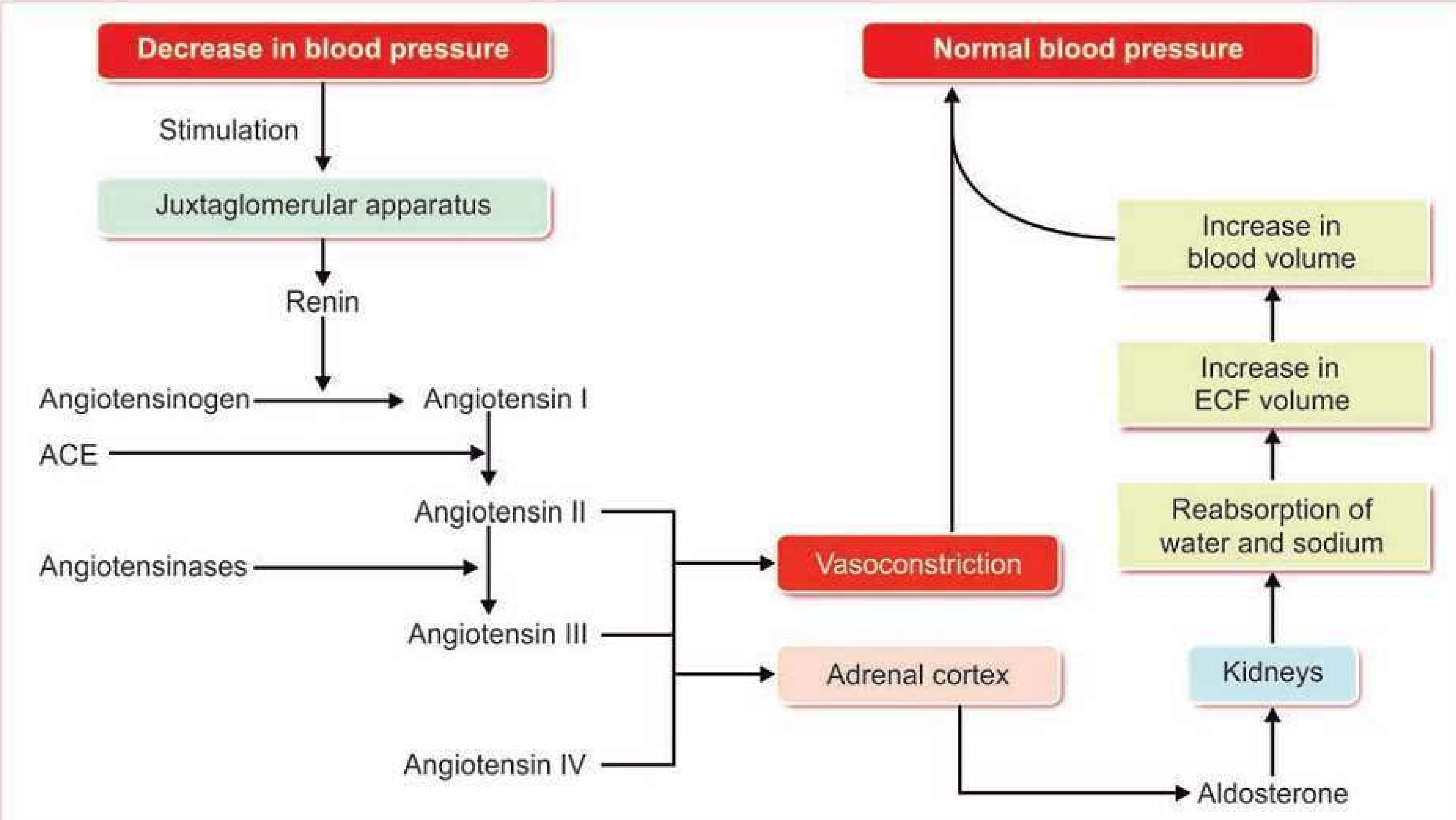
Increase in cardiac output

Blood pressure Restored

THROUGH RENIN-ANGIOTENSIN MECHANISM

Renin along with Angiotensin forms Renin-Angiotensin system, which is a hormone system that plays an important role in the maintenance of blood pressure

Renin	-	J.G Cells of Kidney
Angiotensinogen	-	Liver Cells
ACE	-	Lungs



Regulation of blood pressure by reninangiotensin mechanism. ACE = Angiotensinconverting enzyme.

❑ Hormonal mechanism for regulation of blood pressure

Hormones which increase arterial blood pressure	Hormones which decrease arterial blood pressure
1. Adrenaline*	1. Vasoactive intestinal polypeptide (VIP)
2. Noradrenaline	2. Bradykinin
3. Thyroxine*	3. Prostaglandin
4. Aldosterone	4. Histamine
5. Vasopressin	5. Acetylcholine
6. Angiotensin	6. Atrial natriuretic peptide
7. Serotonin	7. Brain natriuretic peptide
	8. C-type natriuretic peptide

*Adrenaline and thyroxine increase systolic pressure but decrease diastolic pressure.

- Local Mechanism for regulation of blood pressure

Local mechanism

- Local mechanism regulates blood pressure by Vasoconstriction & vasodilatation.

❑Local vasoconstrictors

- Are also called **EDCF** (endothelium derived constricting factors) as they are derived from vascular endothelium.
- Common EDCF are ET1, ET2 & ET3.
- Produced by stretching of blood vessels & cause vasoconstriction.

❑Local Vasodilators

❑Vasodilators of metabolic origin:

carbon monoxide, lactate, H+ & adenosine.

❑Vasodilators of Endothelial origin:

- Nitroxides
- NO_3 (nitrate)
- NO^+ (nitrosonium ion)
- NO^- (nitroxyl anion)

THANK YOU