

Circulatory System Anatomy

Dr. Yared T.

Heart

Introduction

- The heart, slightly larger than a **clenched fist**
- A double, **self adjusting** suction and pressure pump
- Work in **unison** to propel blood to all parts of the body

Mediastinum

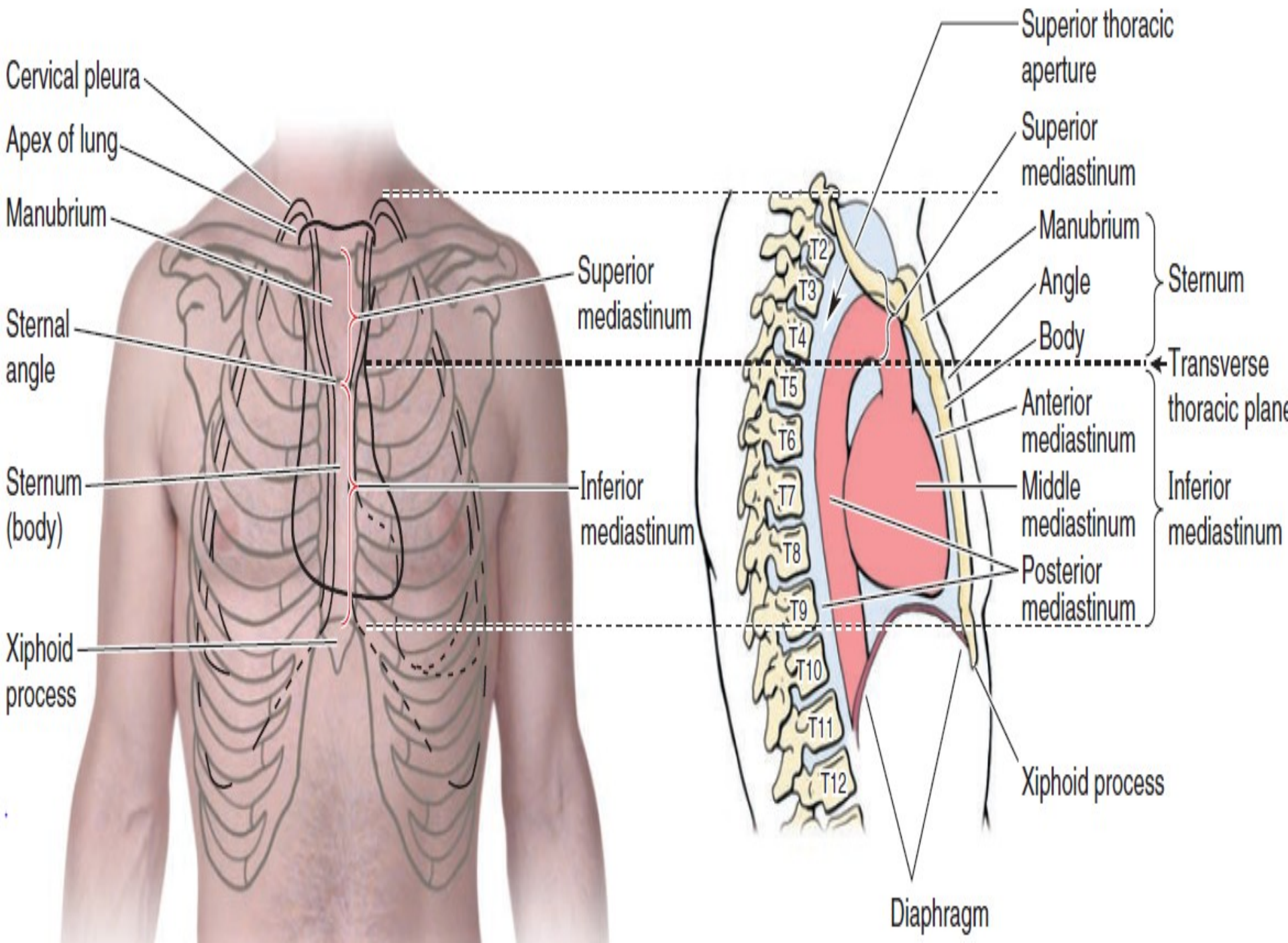
- The central compartment of the thoracic cavity
- Contains all the thoracic viscera and structures except the lungs
- Divided into two parts

Superior mediastinum

- From the superior thoracic aperture to the **horizontal plane**
- **Horizontal plane: from sternal angle to junction of T4 and T5 vertebrae**

Inferior mediastinum

- Between the transverse thoracic plane and the diaphragm
- Subdivided by the **pericardium** into **anterior**, **middle**, and **posterior** parts.
- **Pericardium** and its contents constitute the **middle mediastinum**.



Pericardium

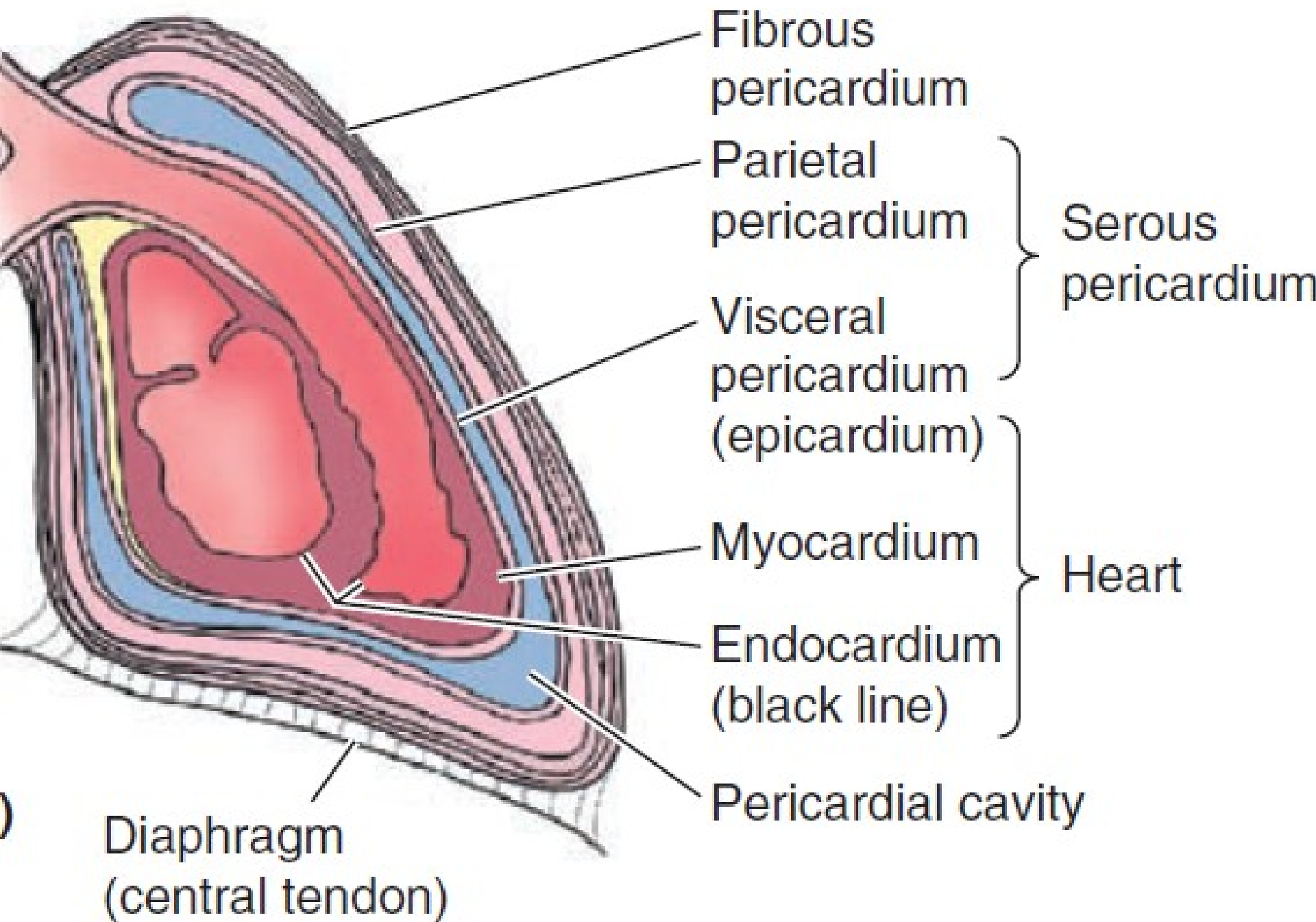
- **covers** the heart and great vessels, **ascending aorta, pulmonary trunk, and SVC**
- Closed sac composed of **two** layers

Fibrous pericardium

- The tough external layer

Serous pericardium

- Lines both the **internal surface** of the fibrous pericardium and the **external surface** of the heart.
- **Pericardial cavity:** potential space between parietal and visceral layers, contains a thin of **fluid**



Heart wall

- Consists of **three layers**

1. **Endocardium**

- A thin **internal** layer
- Lining the heart and **valves**.

2. **Myocardium**

- Largest and middle layer composed of cardiac muscle.

3. **Epicardium,**

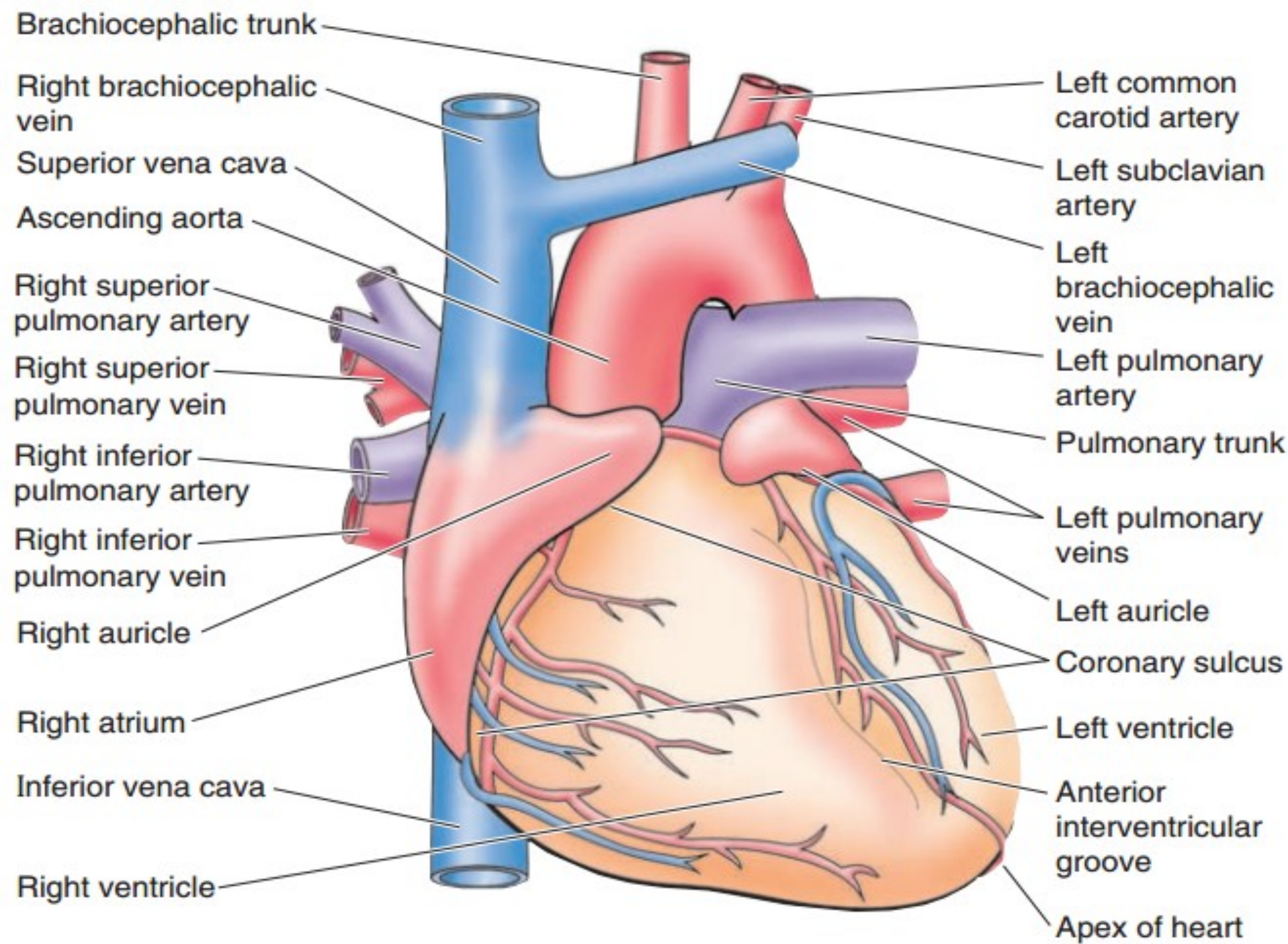
- Formed by the **visceral layer** of serous pericardium

External parts of heart

- **Apex: Inferolateral** part of the left ventricle.
- **Base: Posterior** aspect, mainly **left atrium**, lesser right atrium.

Heart surfaces

- Four surfaces
- **1. Anterior surface:** mainly by the **right ventricle**.
- **2. Diaphragmatic (inferior) surface:** Formed mainly by the **left ventricle** and partly by the right ventricle
- **3. Right pulmonary surface:** mainly **right atrium**.
- **4. Left pulmonary surface:** mainly **left ventricle**



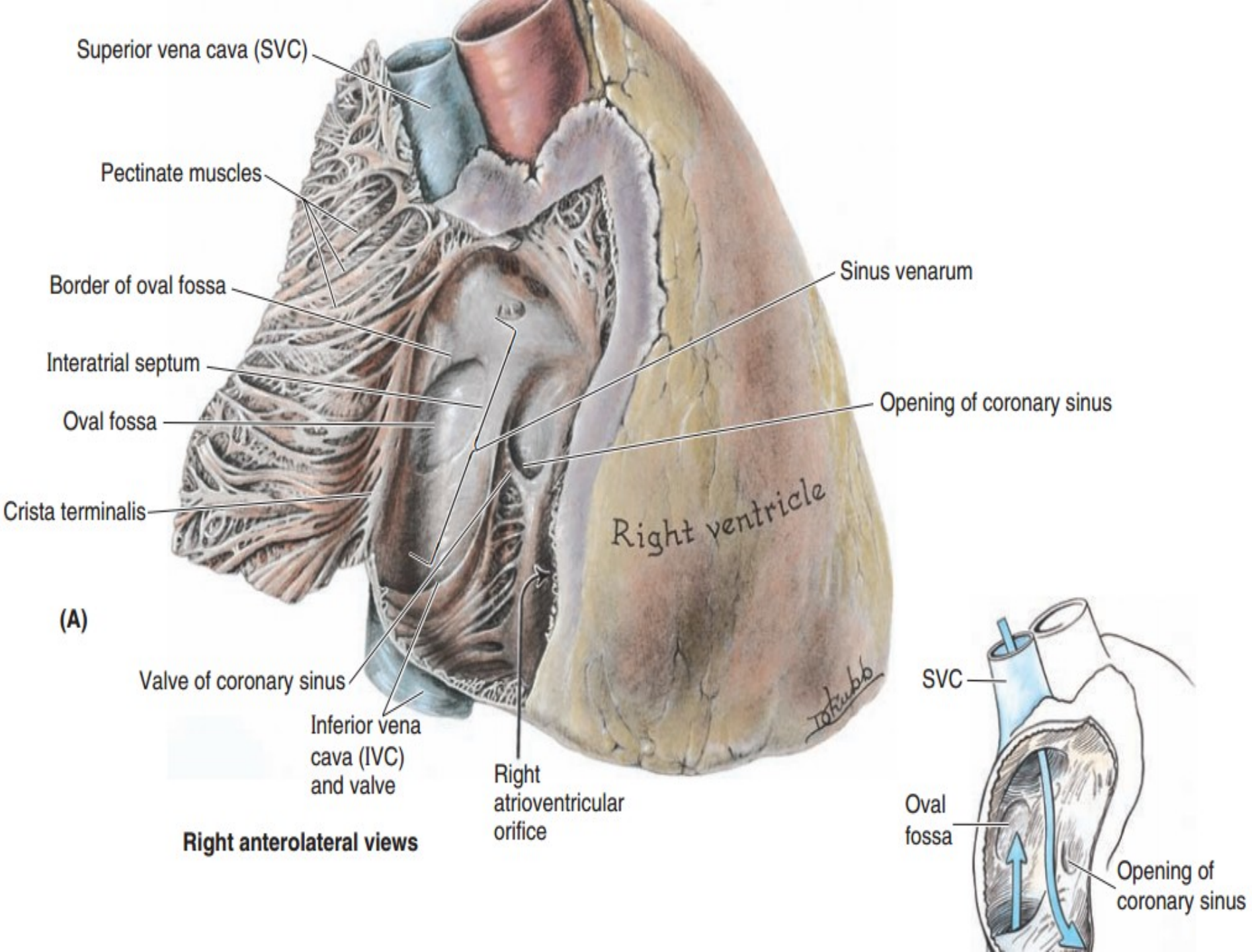
Heart chambers

Has **four** chambers

- Right and left atria, **receiving chambers** that pump blood into the ventricles
- Right and left ventricles, **discharging chambers**

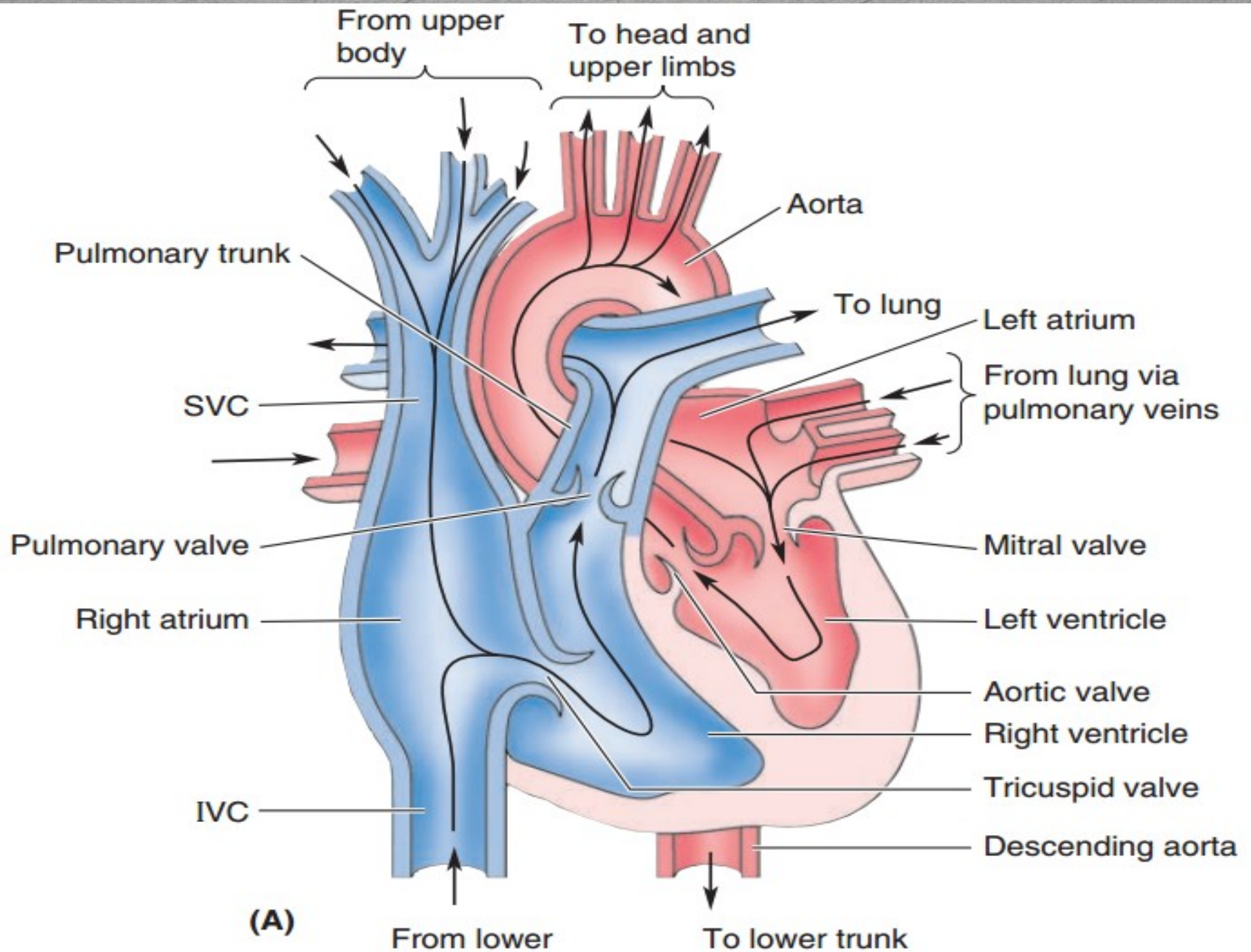
1. **Right atrium**

- Forms the right border of the heart
- Receives **venous** blood from the **SVC, IVC,** and **coronary sinus**
- Pumps blood to **right ventricle**



2. Right ventricle

- Superiorly it tapers to the **pulmonary trunk, the to lungs**
- **The interventricular septum (IVS)** separate it from left ventricle



3. Left atrium

- Right and left **pulmonary veins** enter atrium
- Pumps blood to **left ventricle**

4. Left ventricle

- Pump blood through **aorta** in to systemic circulation
- Performs **more work** than the right ventricle, so thicker

Heart valves

Tricuspid valve

- Between right atrium and right ventricle
- 3 cusps

Mitral valve

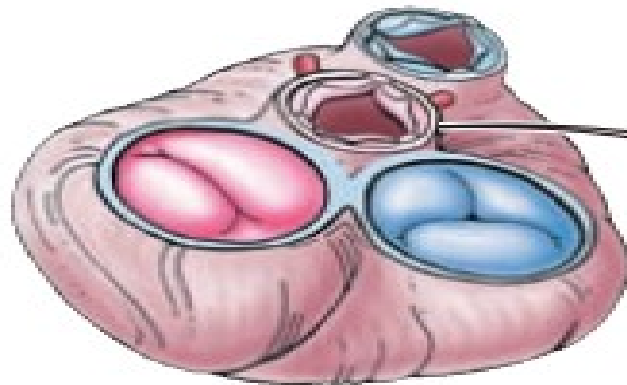
- Between left atrium and left ventricle
- has **two** cusps
- The mitral valve is located posterior to the **sternum** at the level of the **4th costal cartilage**

Aortic valve

- Semilunar valve
- Between **left ventricle** and **aorta**

Pulmonary valve

- Semilunar valve
- Between **right ventricle** and **pulmonary artery**



Lunule

Nodule

Right
coronary
artery

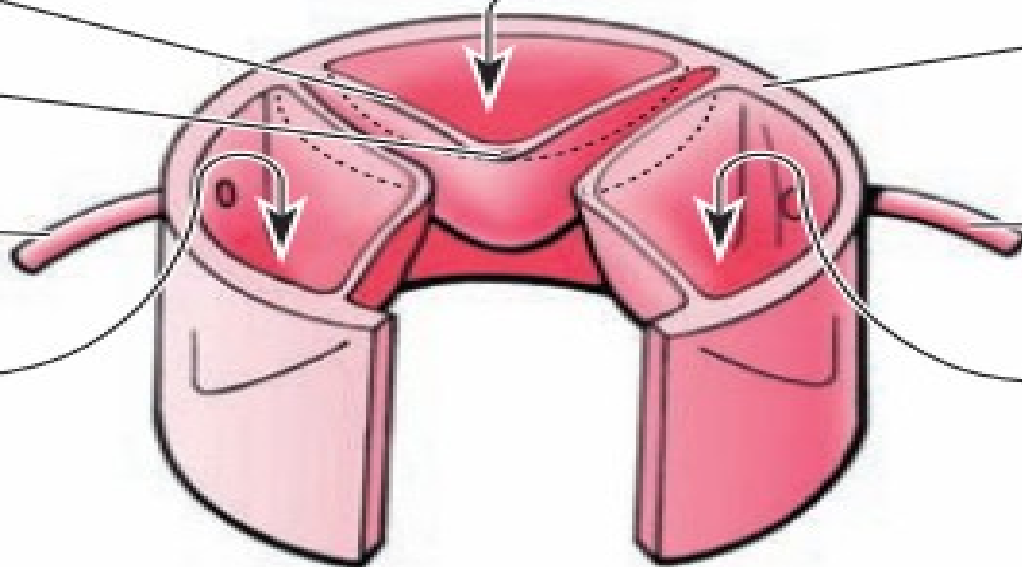
Right
aortic
sinus

Posterior
aortic sinus

Beginning of
ascending
aorta

Left
coronary
artery

Left
aortic
sinus



Blood supply of the heart

Arteries

Right and left coronary arteries

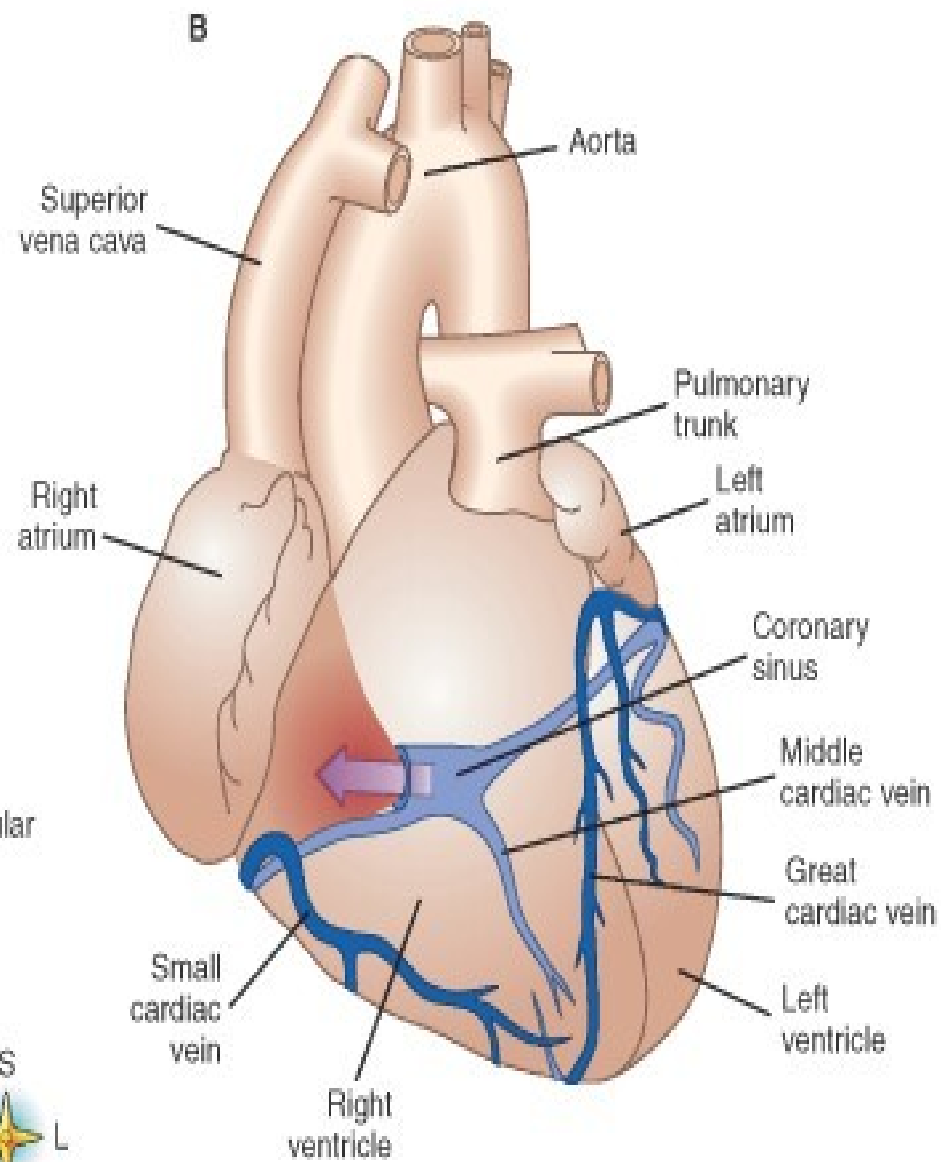
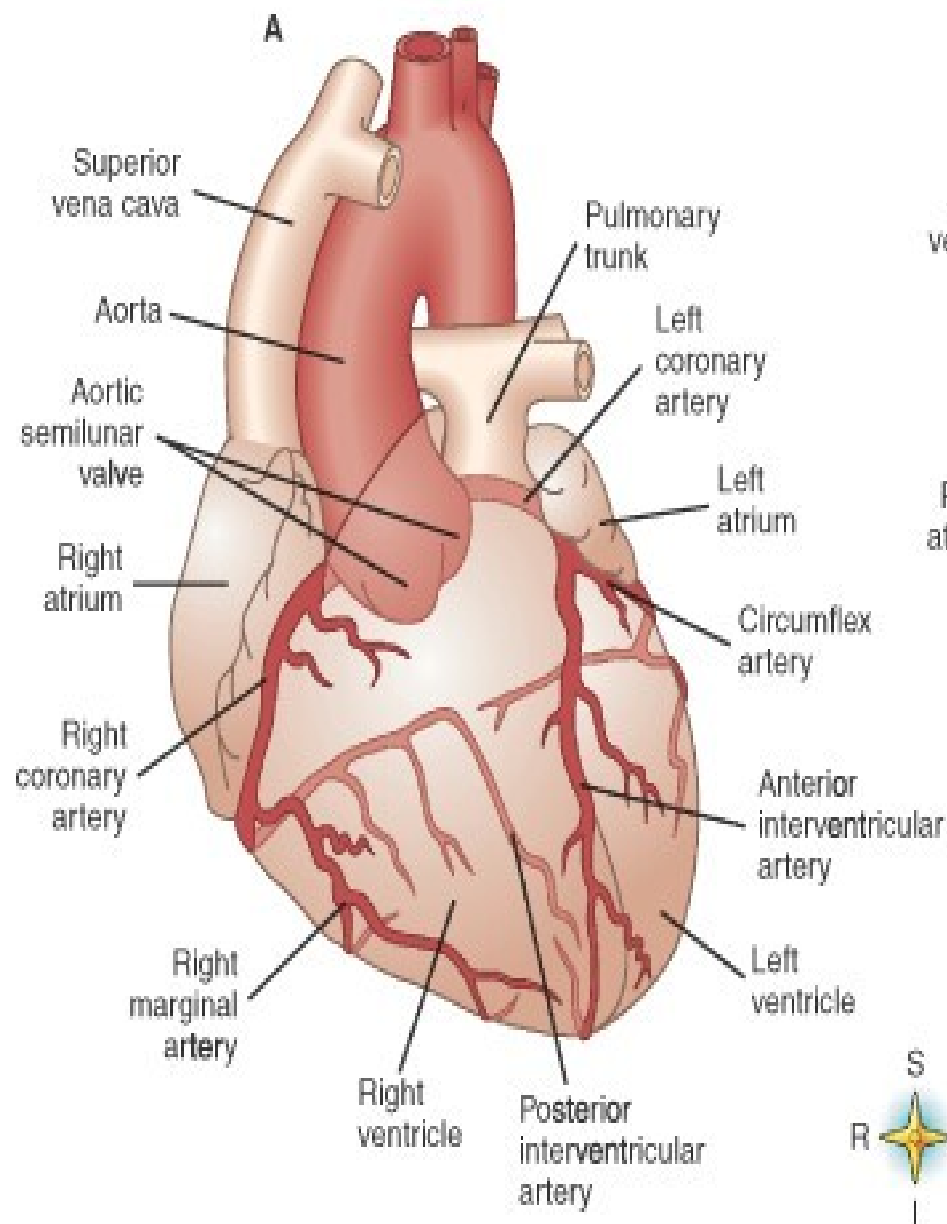
- First branches off **aorta**
- **Right coronary artery** → **right marginal artery** & **posterior interventricular artery**
- **Left coronary artery** → **circumflex artery** & **anterior interventricular artery**
- Most of the blood goes to the **L ventricle**
- In 50% of the population, the **R coronary artery** is dominant

Veins

- **coronary sinus coronary sinus** is a **wide** venous channel

Lymphatic Drainage

- **subepicardial lymphatic plexus**
- **inferior tracheobronchial** lymph nodes



Conduction System of the Heart

- Four structures composed of modified cardiac muscle

Sinoatrial Node (SA Node)

- **Pacemaker** of the heart
- **R atrium** near the opening of the **superior vena cava**

Atrioventricular Node (AV Node)

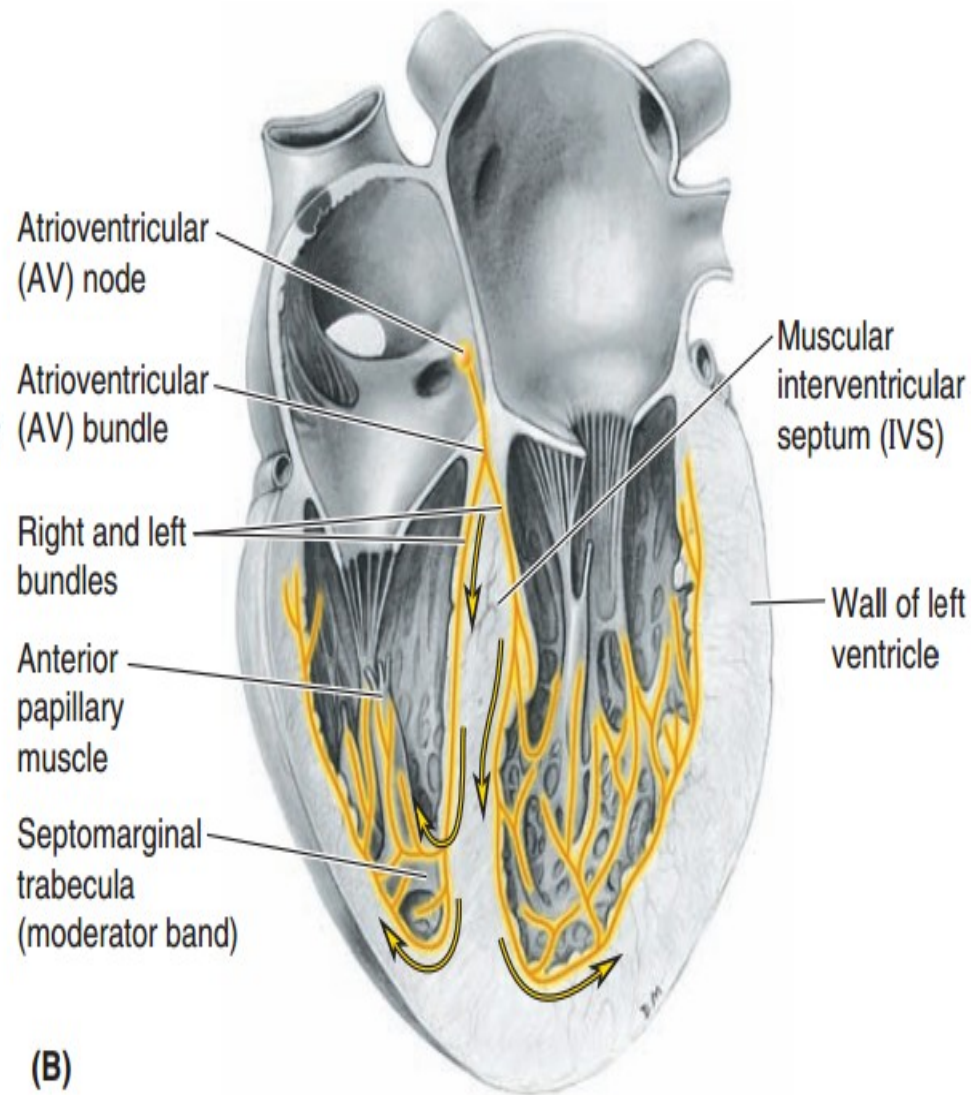
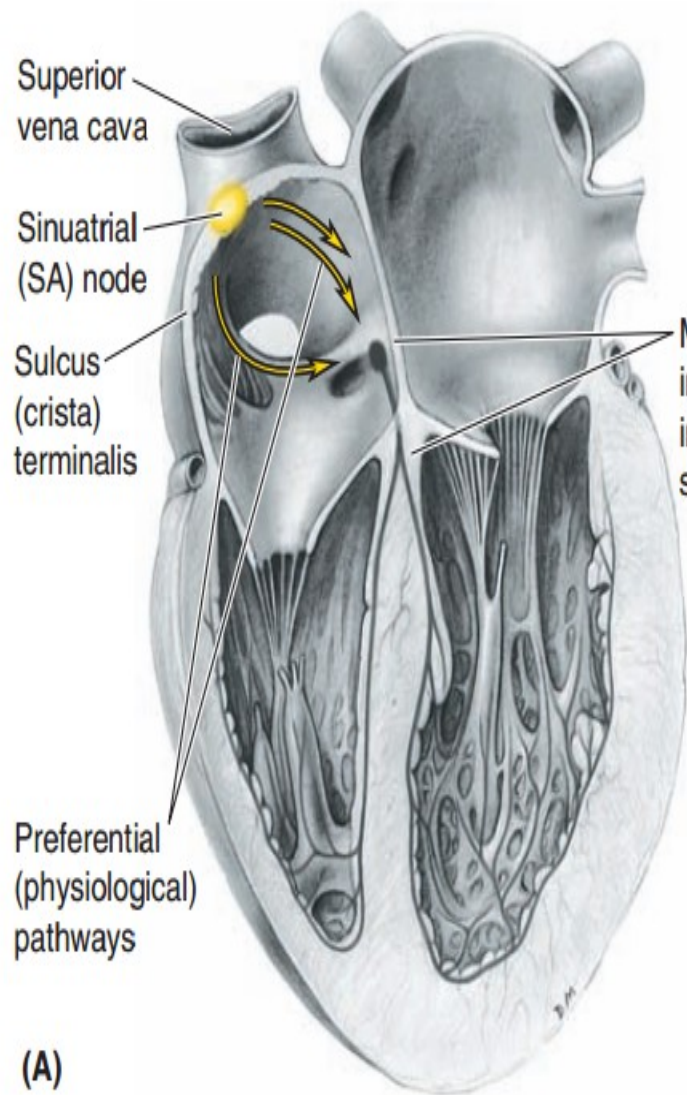
- **Left lower** border of R atrium

Atrioventricular Bundle (Bundle of His)

- originating in the **AV node**
- Branches into R and L branches eventually becoming **Purkinje fibers**

Purkinje fibers

- Extend into the walls of the **ventricles** and **papillary muscles**



Anterosuperior views

Innervation of the Heart

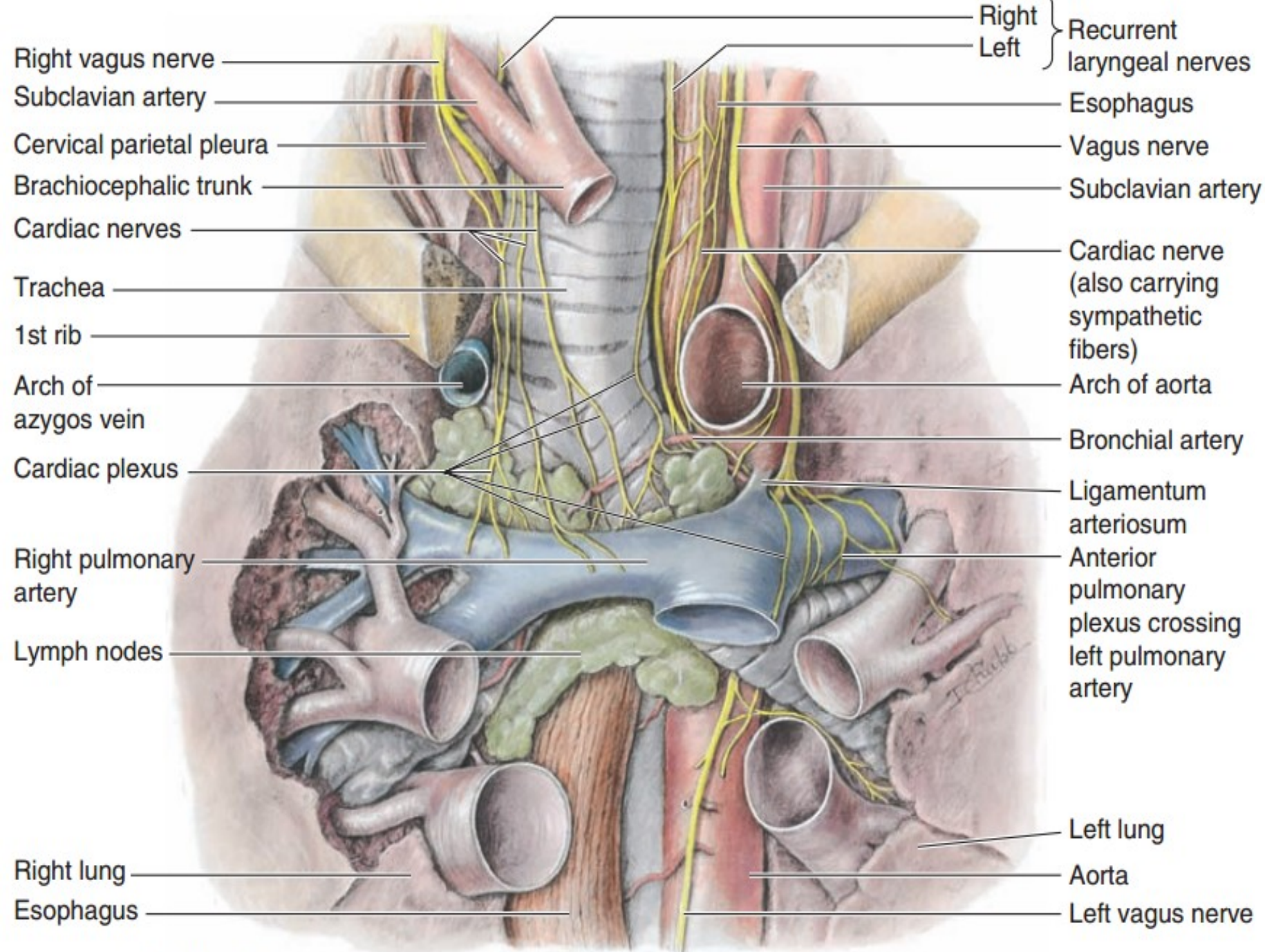
- autonomic nerve from the **cardiac plexus**

Sympathetic supply

- **cervical** and **superior thoracic** sympathetic trunks
- increased **heart rate**, impulse **conduction**, force of **contraction**

Parasympathetic supply

- **Vagus (CN X)** nerves
- **slows** the **heart rate**, reduces the force of the **contraction**, and constricts the **coronary arteries**

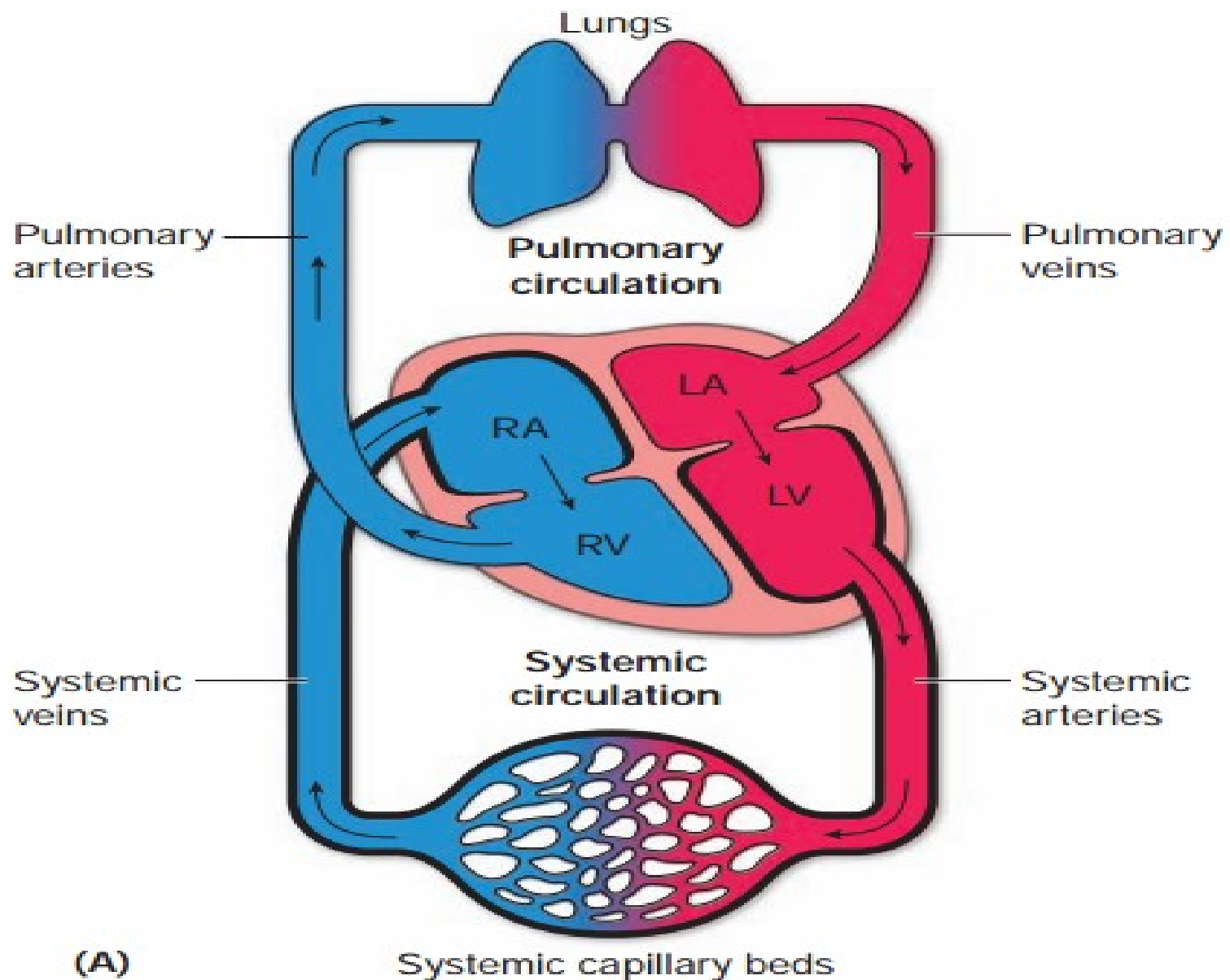


Anterior view

Blood Vessels

Introduction

- Blood is carried in a closed system of vessels that begins and ends at the **heart**
- The three major types of vessels are **arteries**, **capillaries**, and **veins**
- Arteries carry blood **away** from the heart
- veins carry blood **toward** the heart
- **Capillaries contact** tissue cells and directly serve cellular needs



Chambers of heart:

RA = right atrium

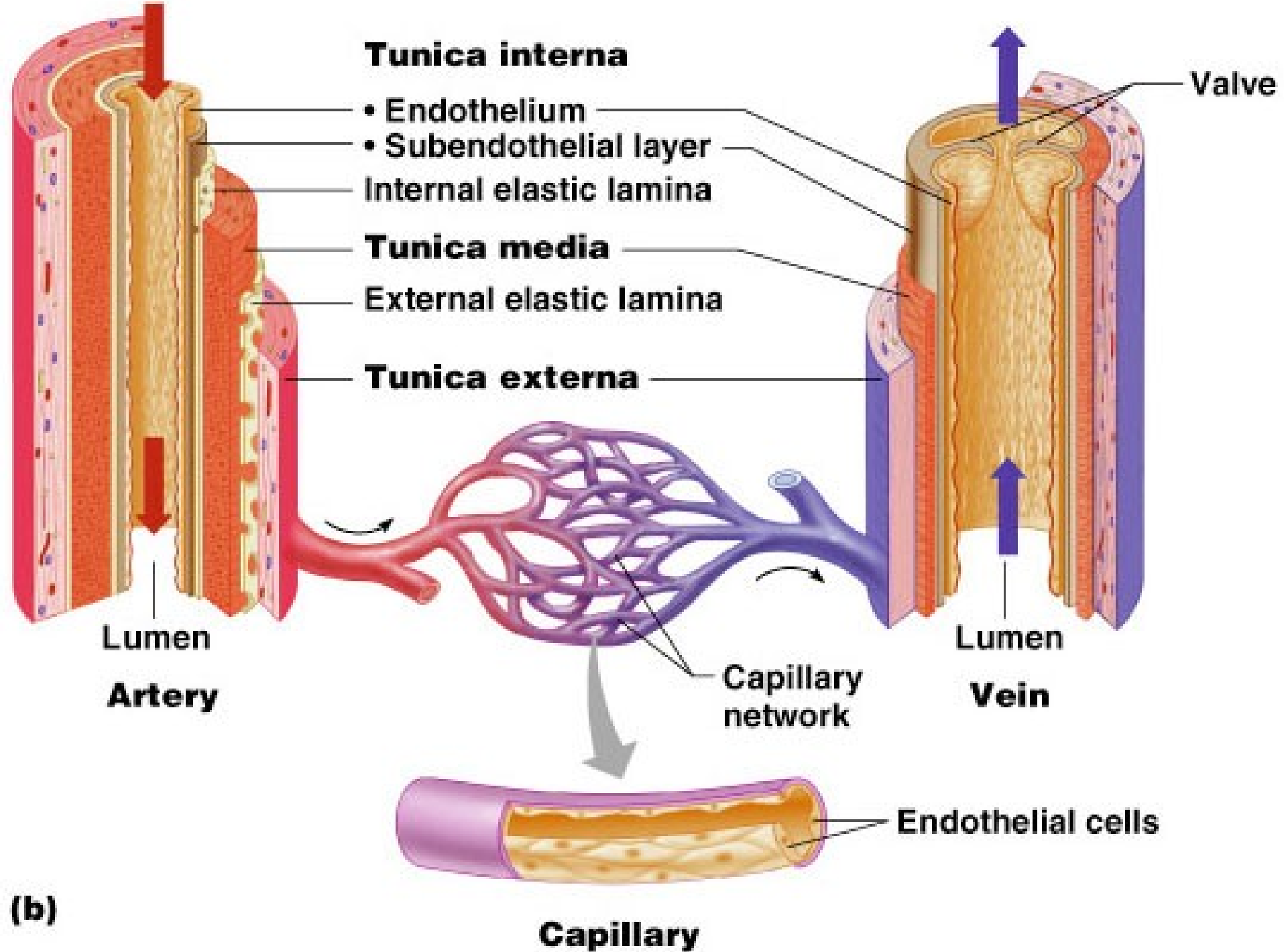
LA = left atrium

RV = right ventricle

LV = left ventricle

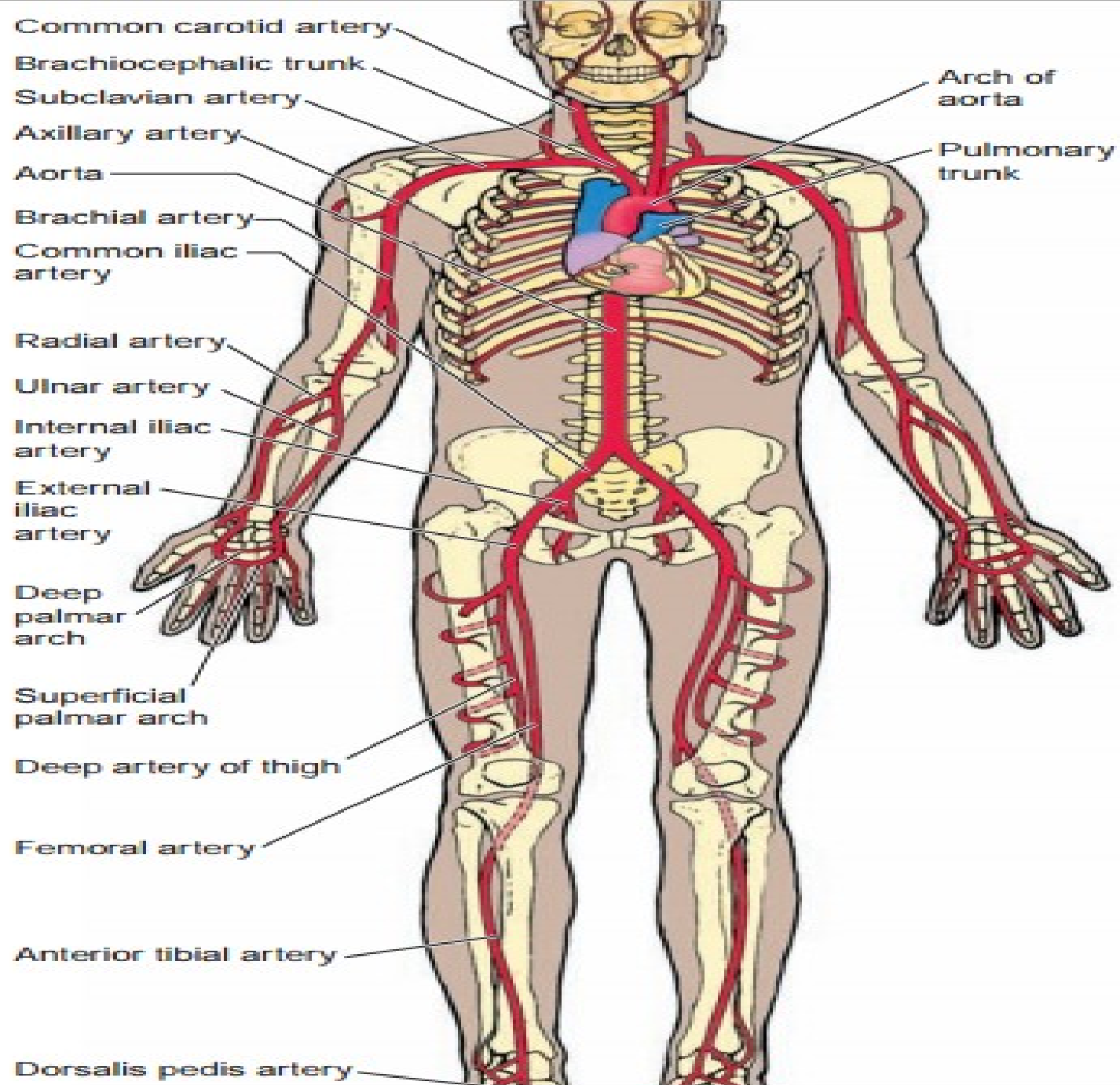
Generalized structure

- Arteries and veins are composed of **three** tunics
- Tunica **interna**, tunica **media**, and tunica **externa**
- **Lumen** – central blood-containing space surrounded by tunics
- Capillaries are composed of **endothelium** with sparse basal lamina



Arteries

- **high pressure**
- From the heart and distribute it to the body
- The blood passes through arteries of **decreasing caliber.**
- Different types of arteries,
- **Elastic arteries: Conducting**, Contain **elastin** in all **three** tunics
- **Muscular arteries and arterioles:** **Distributing**, more smooth muscle, distal to elastic



Capillaries

- **exchange** of nutrients and gases between the blood and tissue cells.
- **smallest** blood vessels
- Walls consisting of a thin **tunica interna**, one cell thick and **Pericytes**
- Allow only a **single** RBC to pass at a time
- There are three structural types of capillaries: **continuous**, **fenestrated**, and **sinusoids**

Veins

Venules

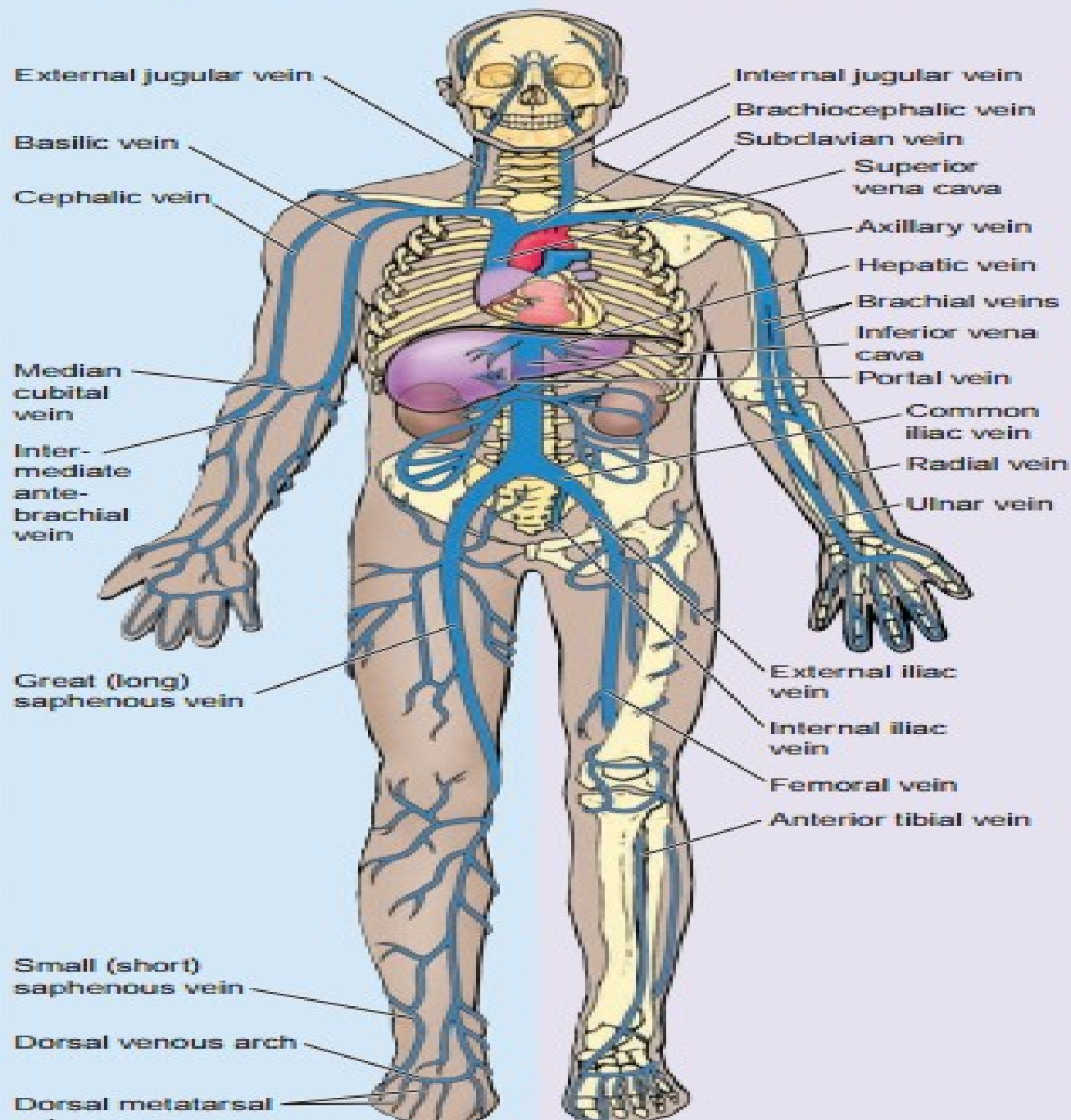
- Are formed when **capillary beds unite**
- Allow fluids and WBCs to pass **from** the **bloodstream** to **tissues**

Veins

- Formed when venules **converge**
- **thin** tunica **media** and a **thick** tunica **externa**
- consisting of collagen fibers and elastic networks
- 65% of the blood supply

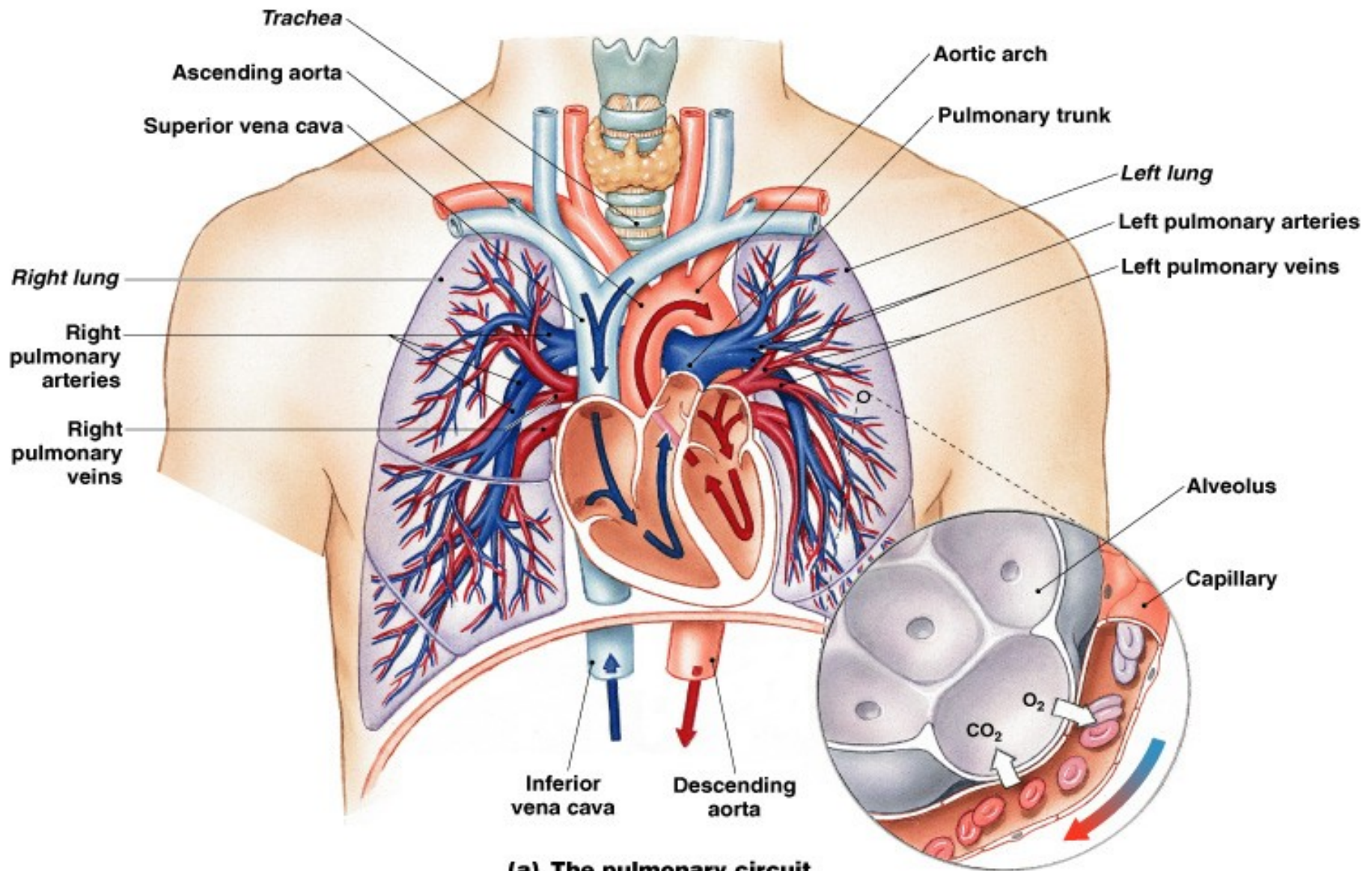
Superficial veins

Deep veins



Pulmonary circulation

- **Pulmonary artery:** carry **deoxygenated** blood from the **right ventricle** to the **lungs**
- only arteries that carry deoxygenated blood.
- In lungs, branches divide and subdivide until finally they form **capillaries** around the air sacs (alveoli)
- **Pulmonary vein:** returns **oxygenated** blood from the air sacs to the **left atrium**

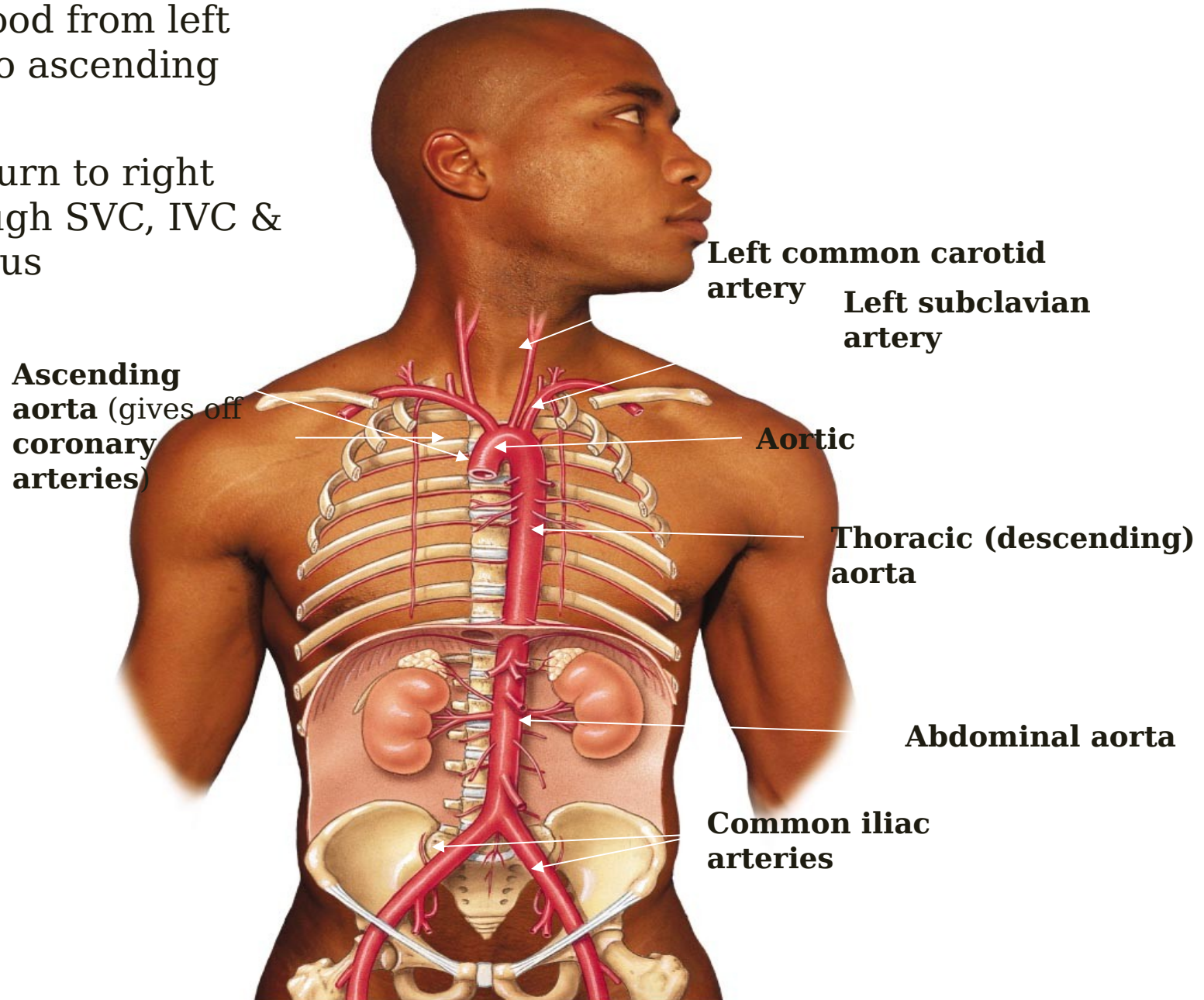


(a) The pulmonary circuit

Systemic circuit

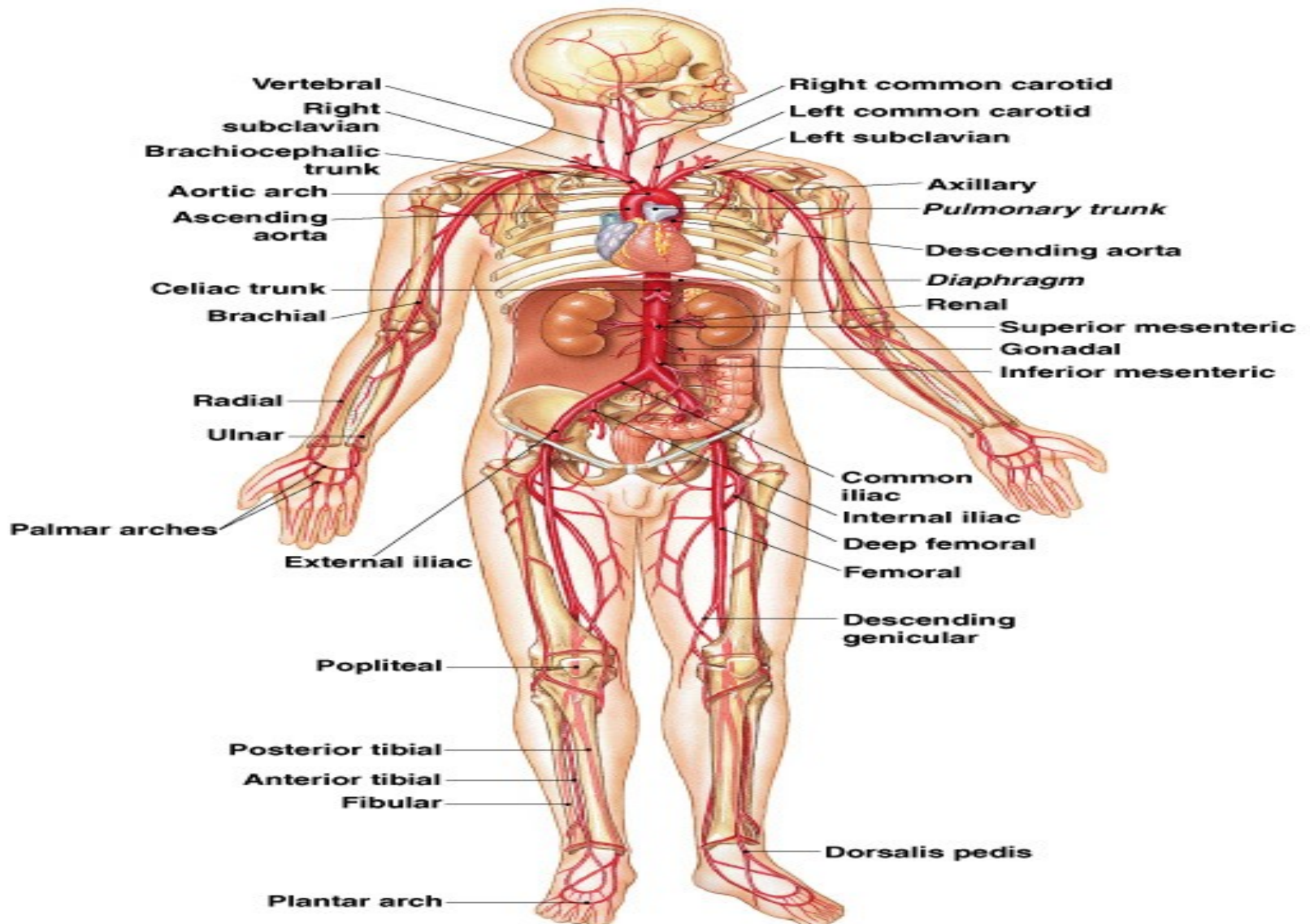
- Arteries and arterioles that carry oxygenated blood from the **left ventricle** (through **aorta**) to **systemic capillaries**
- veins and venules that return **deoxygenated** blood to the **right atrium**
- all the veins drain into the **superior vena cava**, the **inferior vena cava**, or the **coronary sinus**
- The **bronchial arteries**, are part of the systemic circulation

- Arterial blood from left ventricle into ascending aorta
- Venous return to right atrium through SVC, IVC & coronary sinus

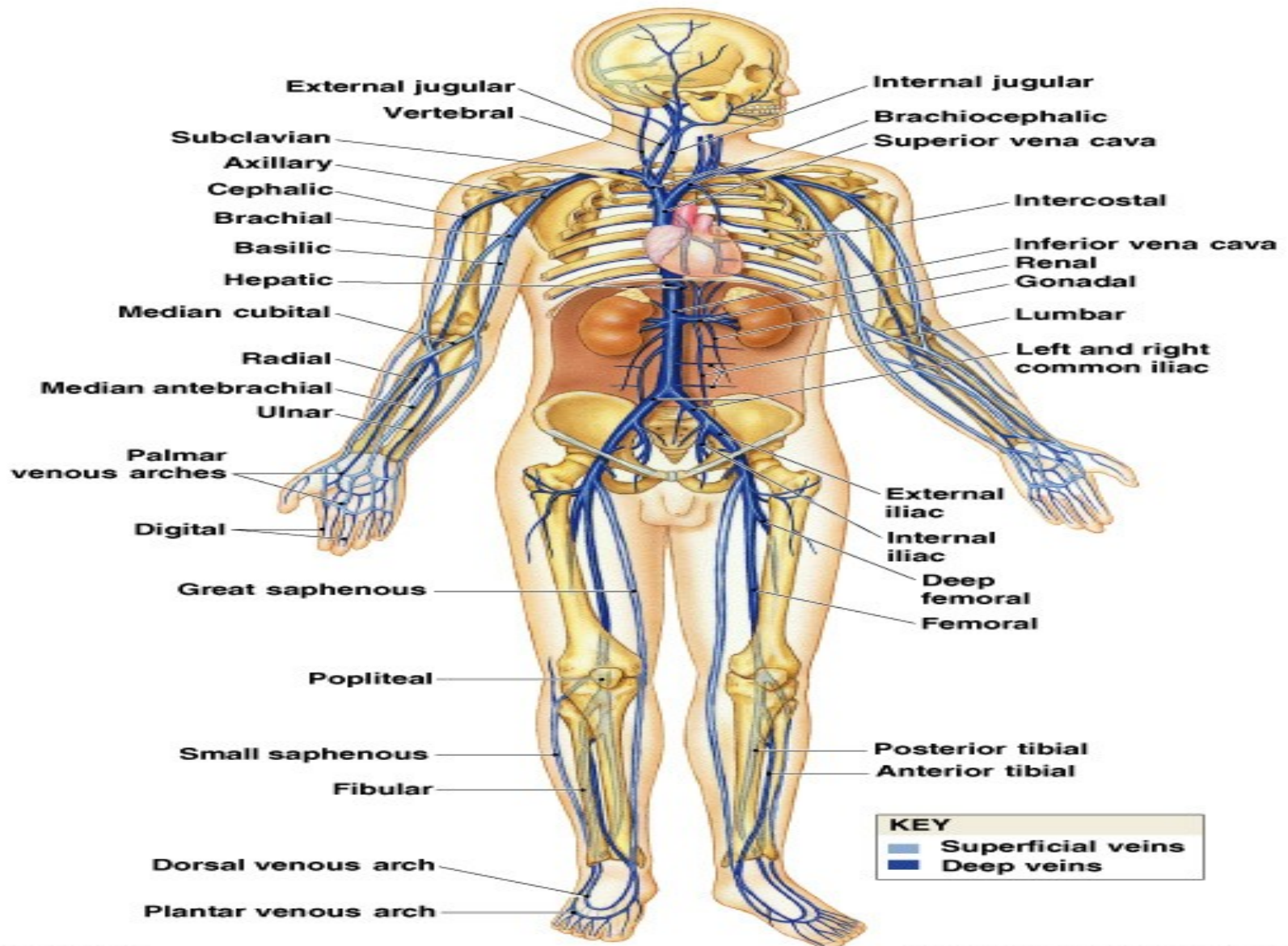


(a)

Systemic circuit - Arteries

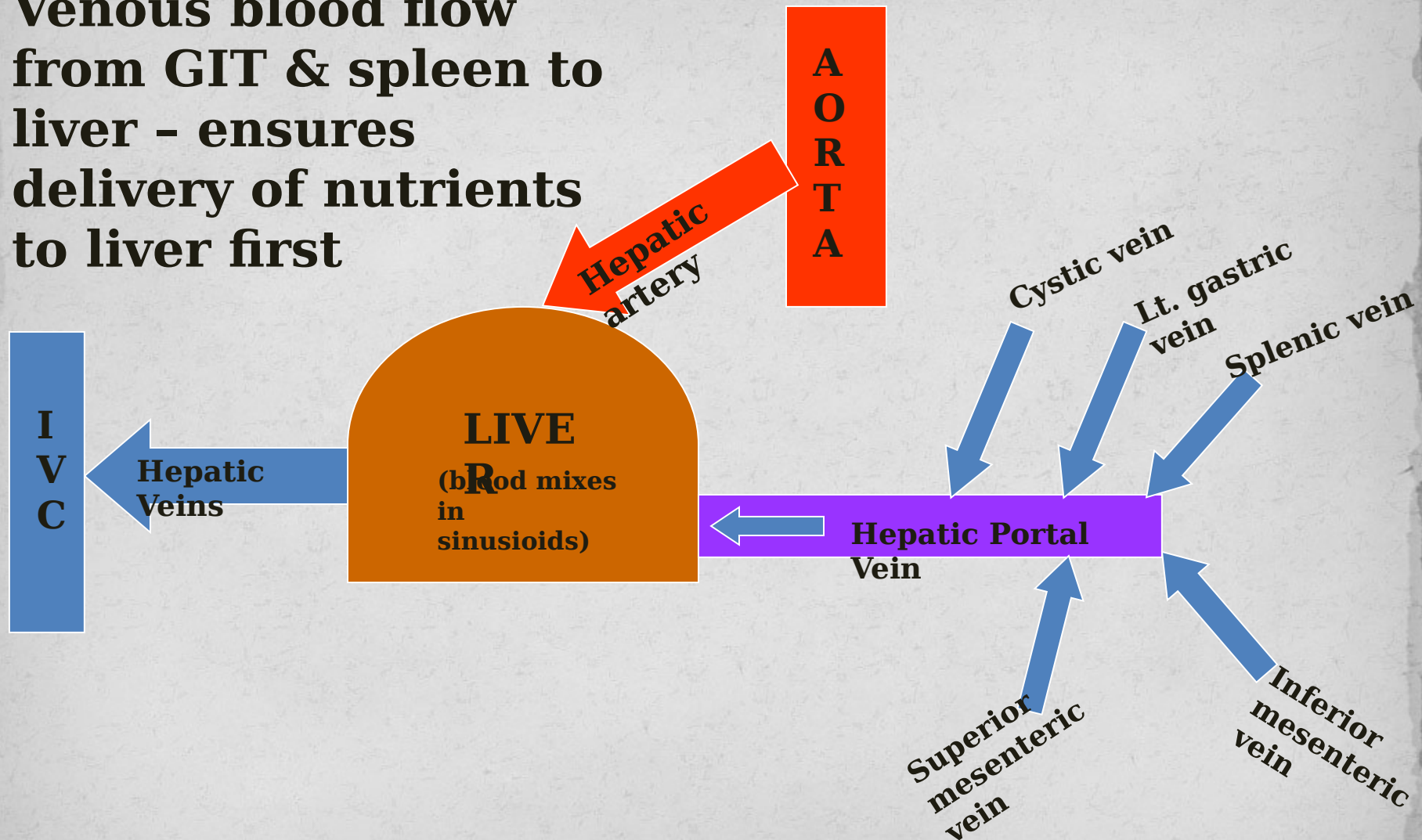


Systemic circuit - Veins



Hepatic portal circulation

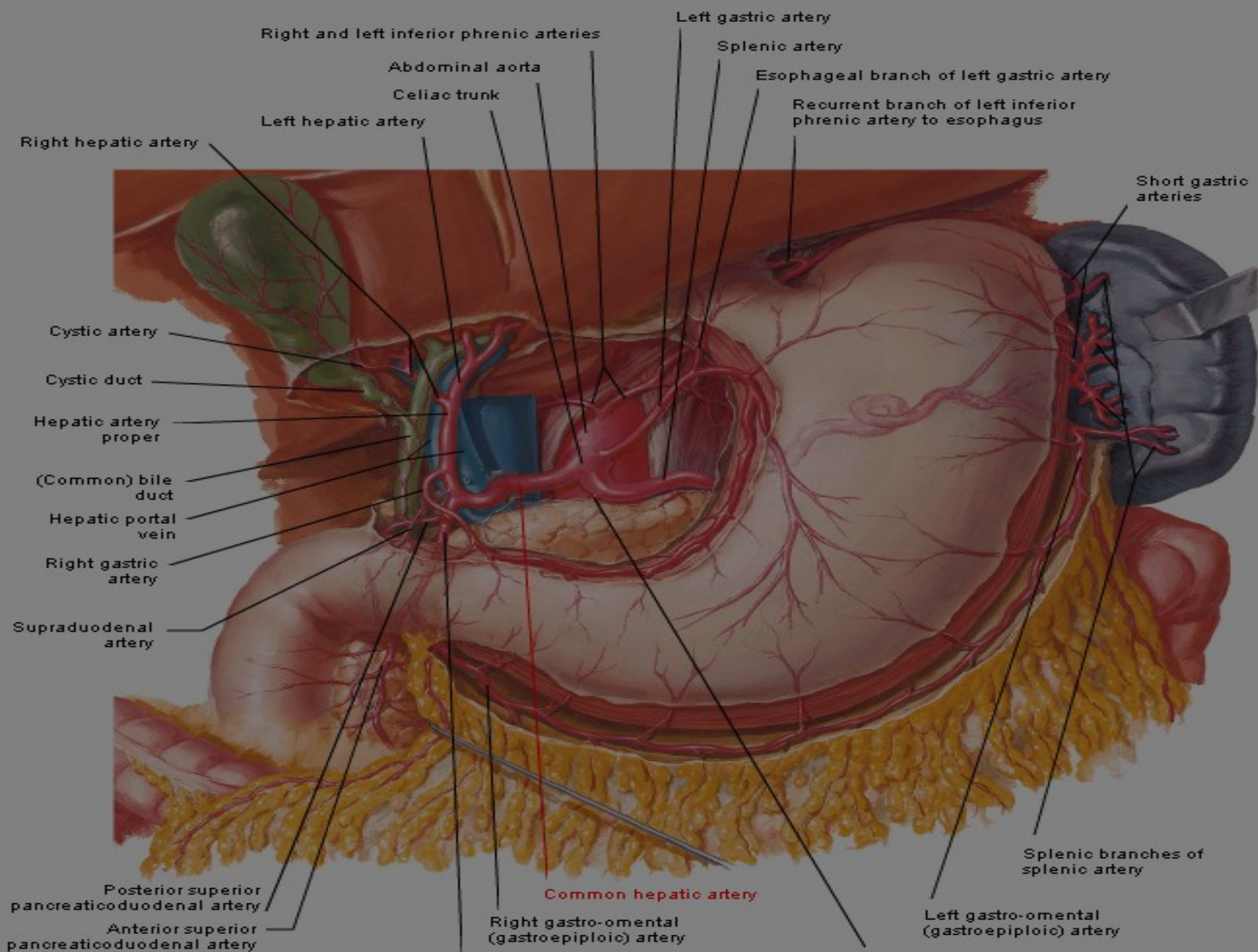
**Venous blood flow
from GIT & spleen to
liver - ensures
delivery of nutrients
to liver first**

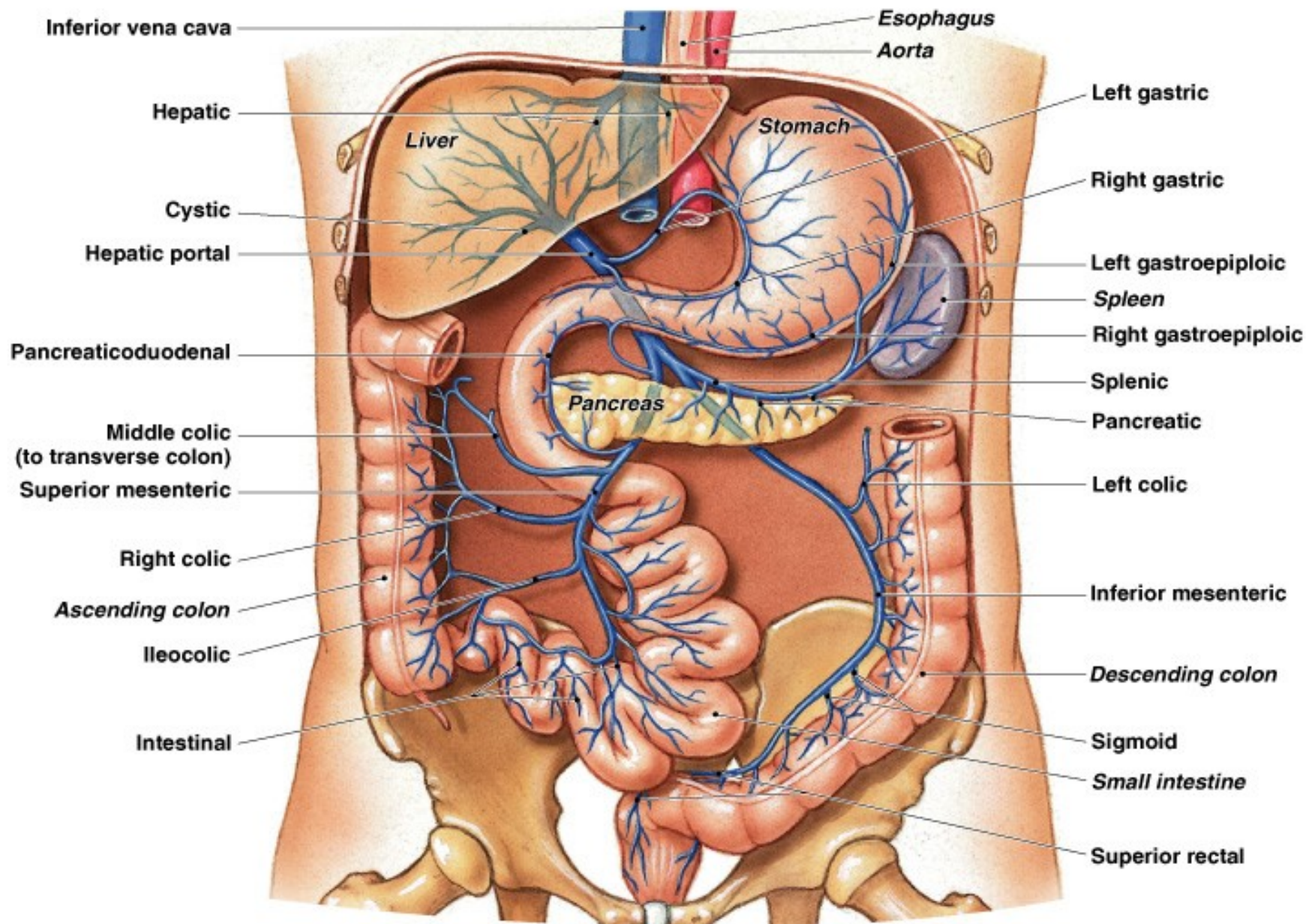


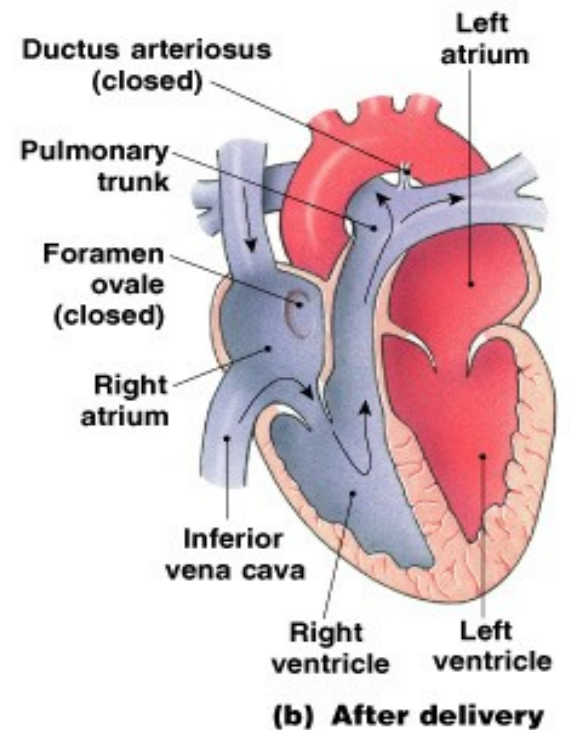
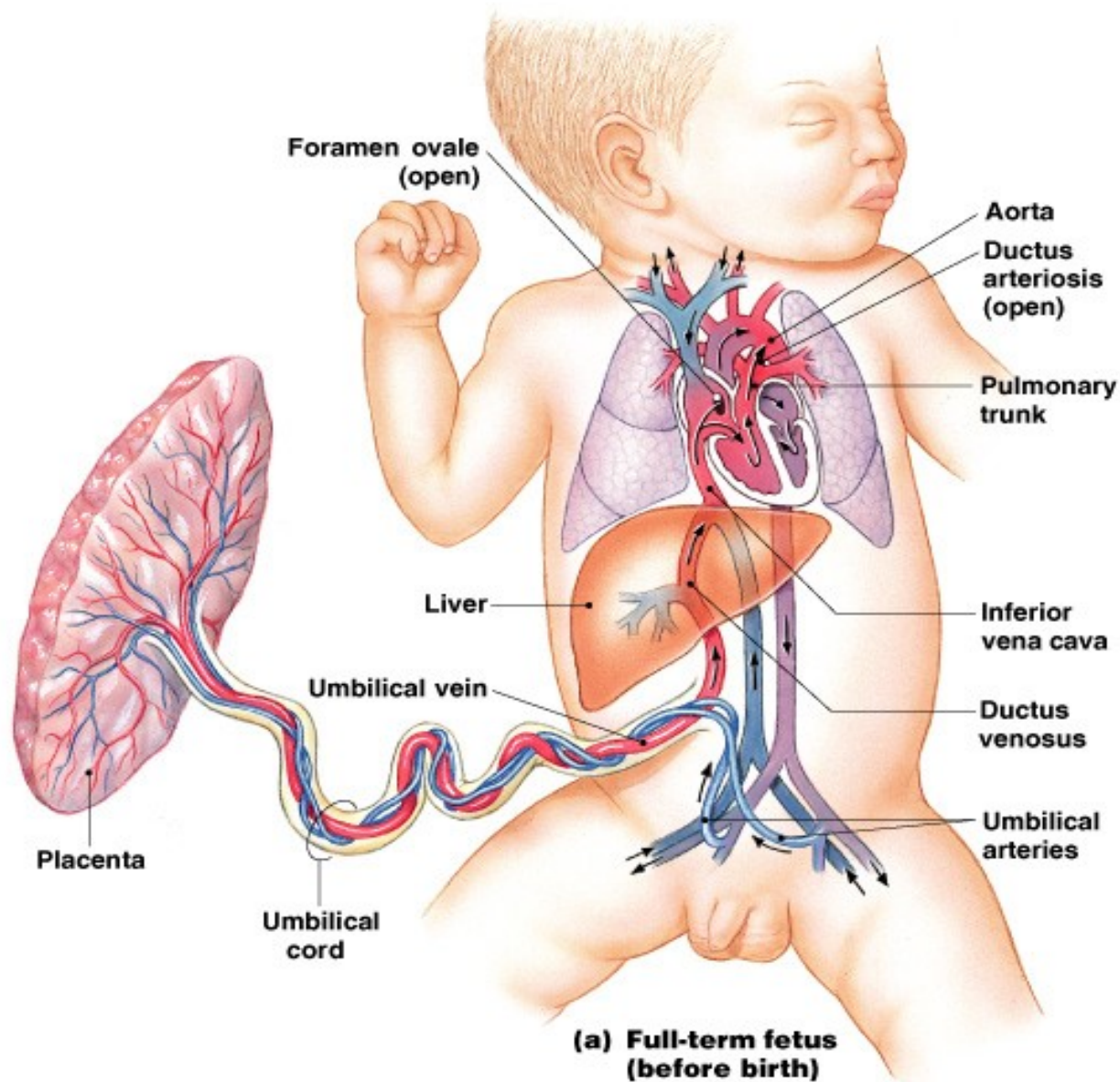
- Cystic vein, left gastric vein, splenic vein, inferior & superior mesenteric veins □

Hepatic portal vein

- Hepatic portal vein
(**deoxygenated/nutrient rich** blood) +
Hepatic artery (oxygenated blood) □ sinusoids
of liver
- Sinusoids of liver □ Hepatic veins □ **IVC**



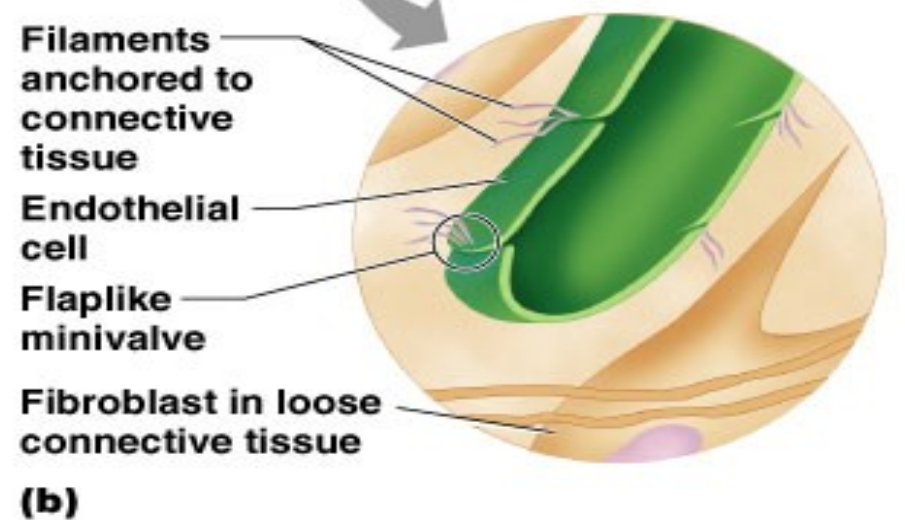
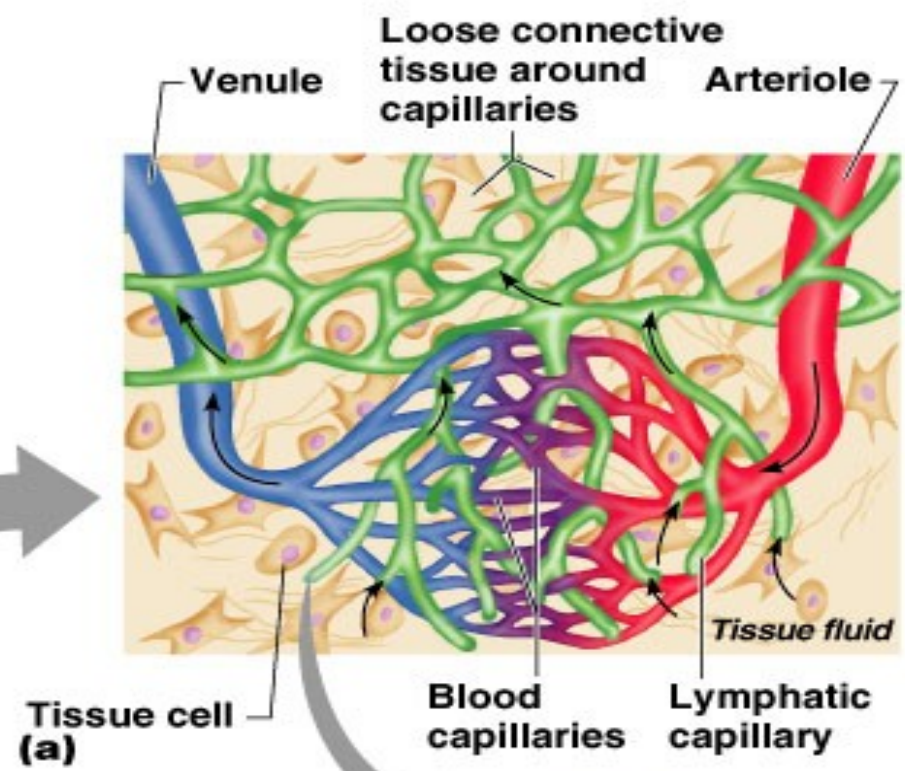
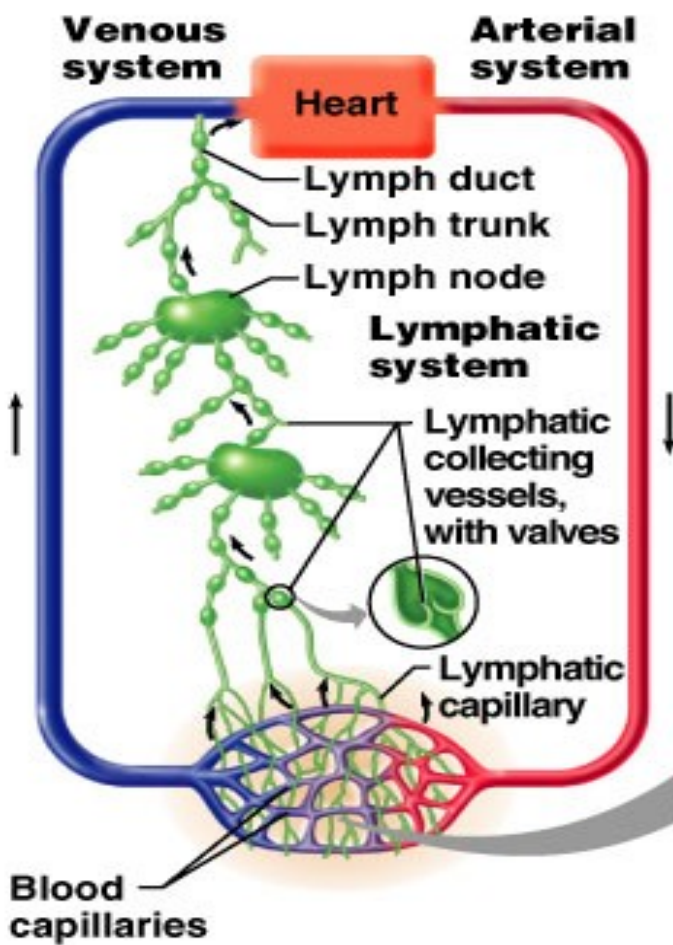


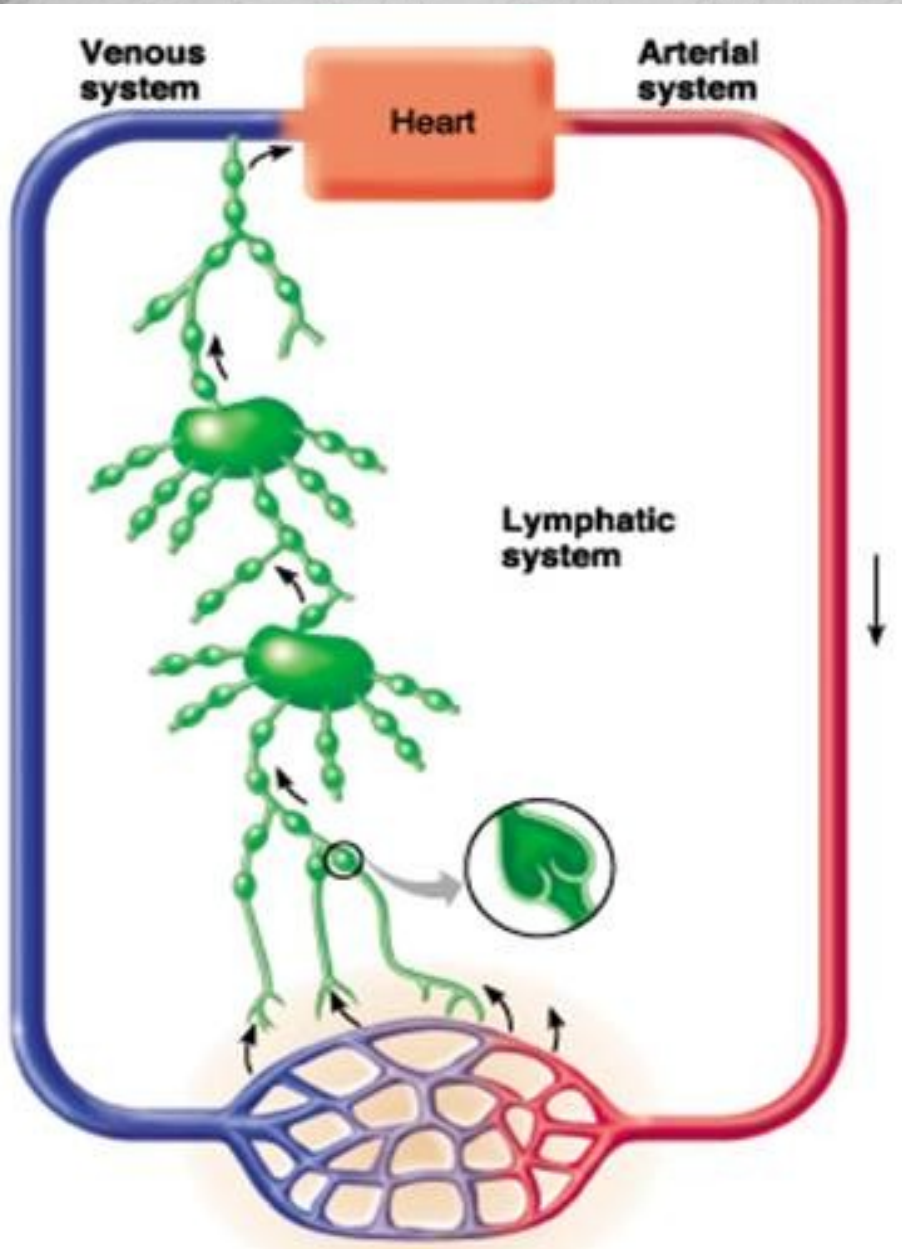


Lymphatic system

Lymph

- Tissue **fluid** (interstitial fluid) that enters the lymphatic vessels
- Usually **clear, watery**, and slightly **yellow**, lymph is similar in composition to blood plasma.





***Essentially a
drainage system
accessory to
venous system***

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

Functions

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

Components

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

Lymphatic Capillaries

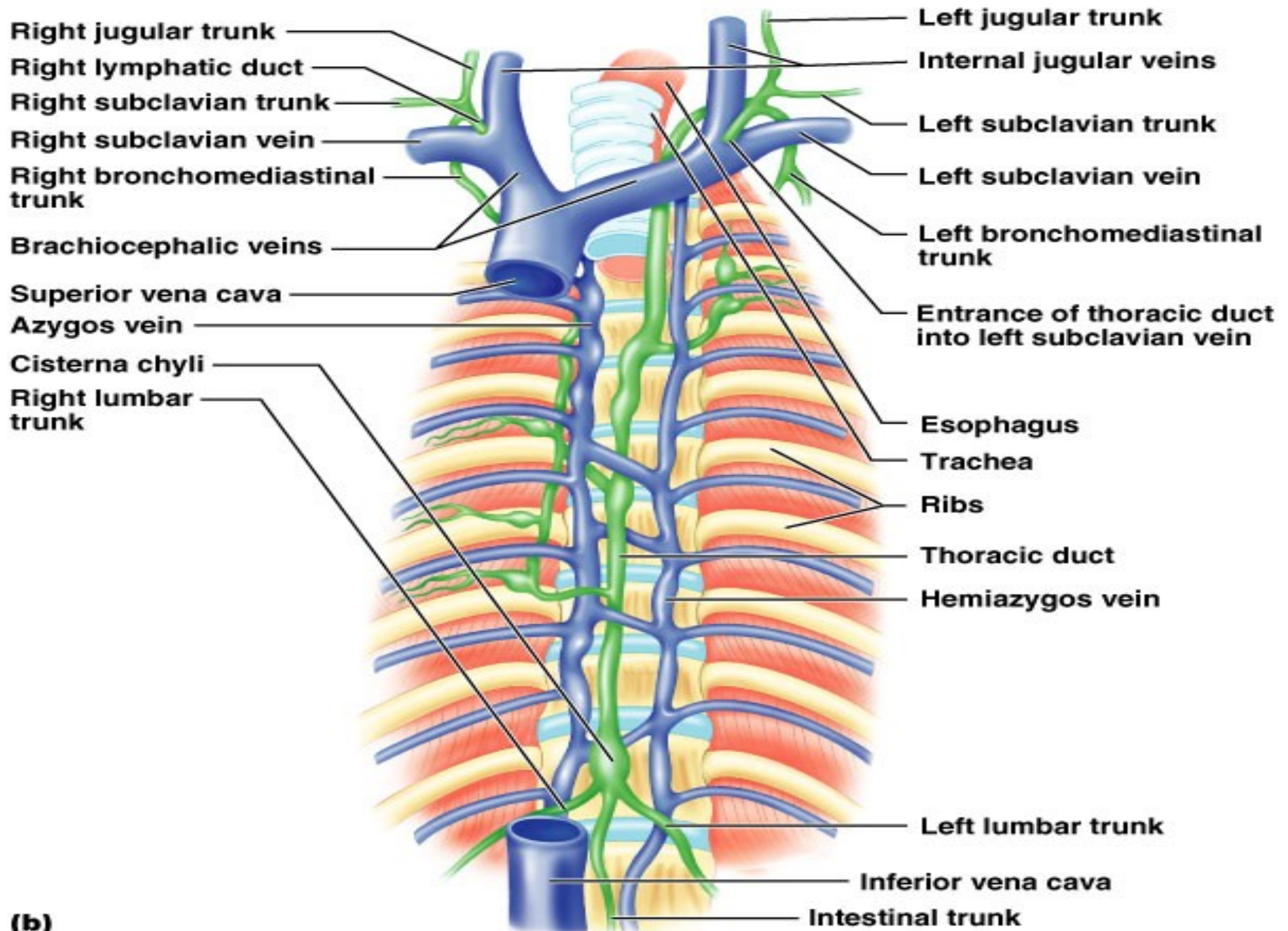
- **Blind end**
- **Single** layer of overlapping endothelial cells
- Lacteals: in small intestine also pick up dietary **lipids** and **lipid-soluble vitamins**

Lymphatic Vessels

- More numerous **valves** than in vein
- Interposed by **lymph nodes** at intervals
- Arranged in **superficial** and **deep** sets

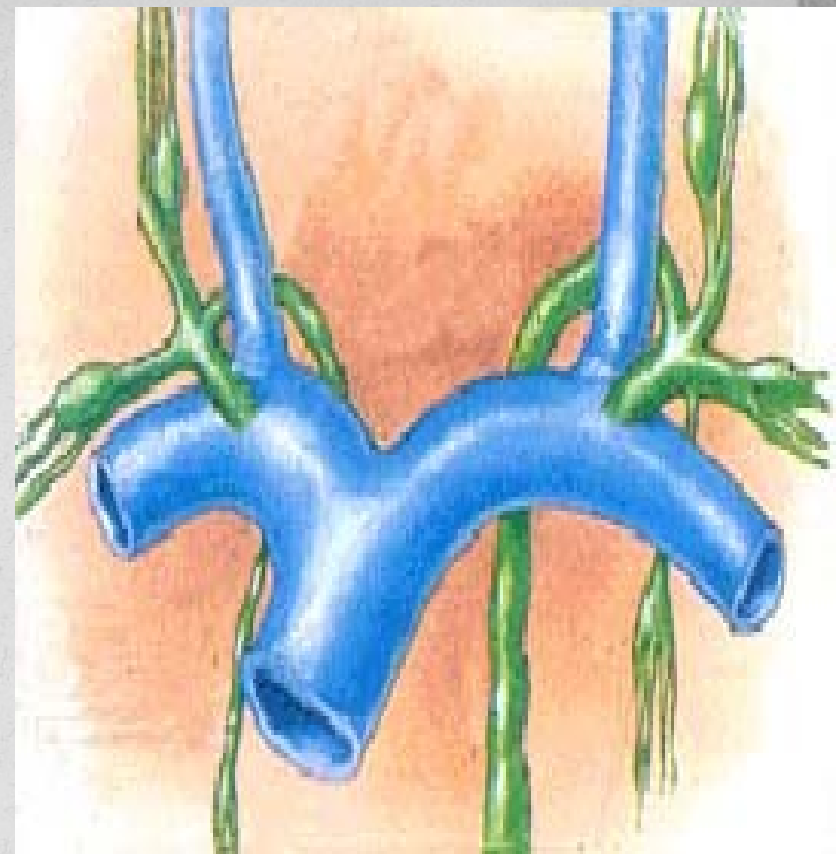
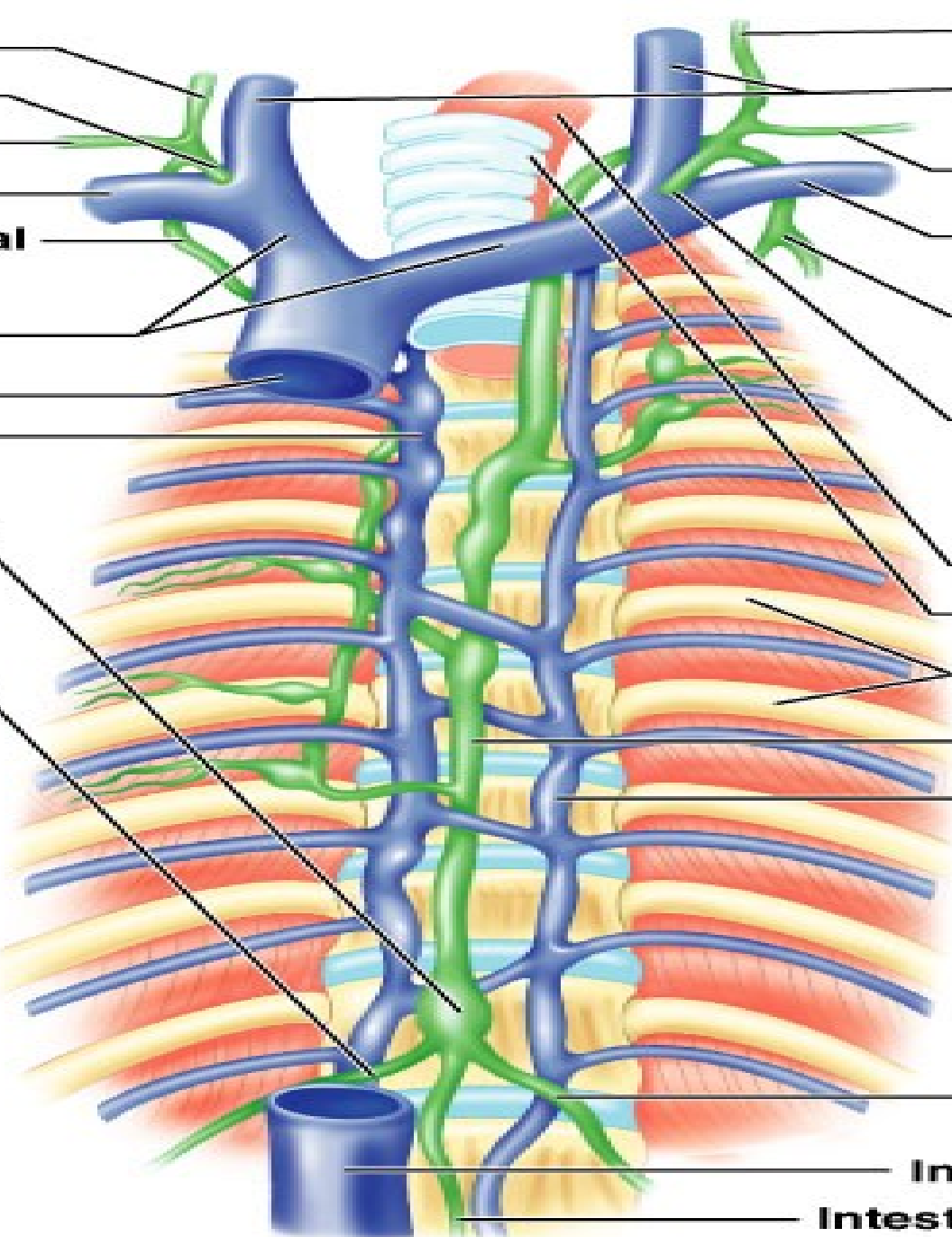
Lymph trunks

- Collect lymph from lymphatic vessels
- Right and left **jugular** trunks, right and left **subclavian** trunks, right and left **bronchomediastinal** trunks, right and left **lumbar** trunks, **intestinal** trunk



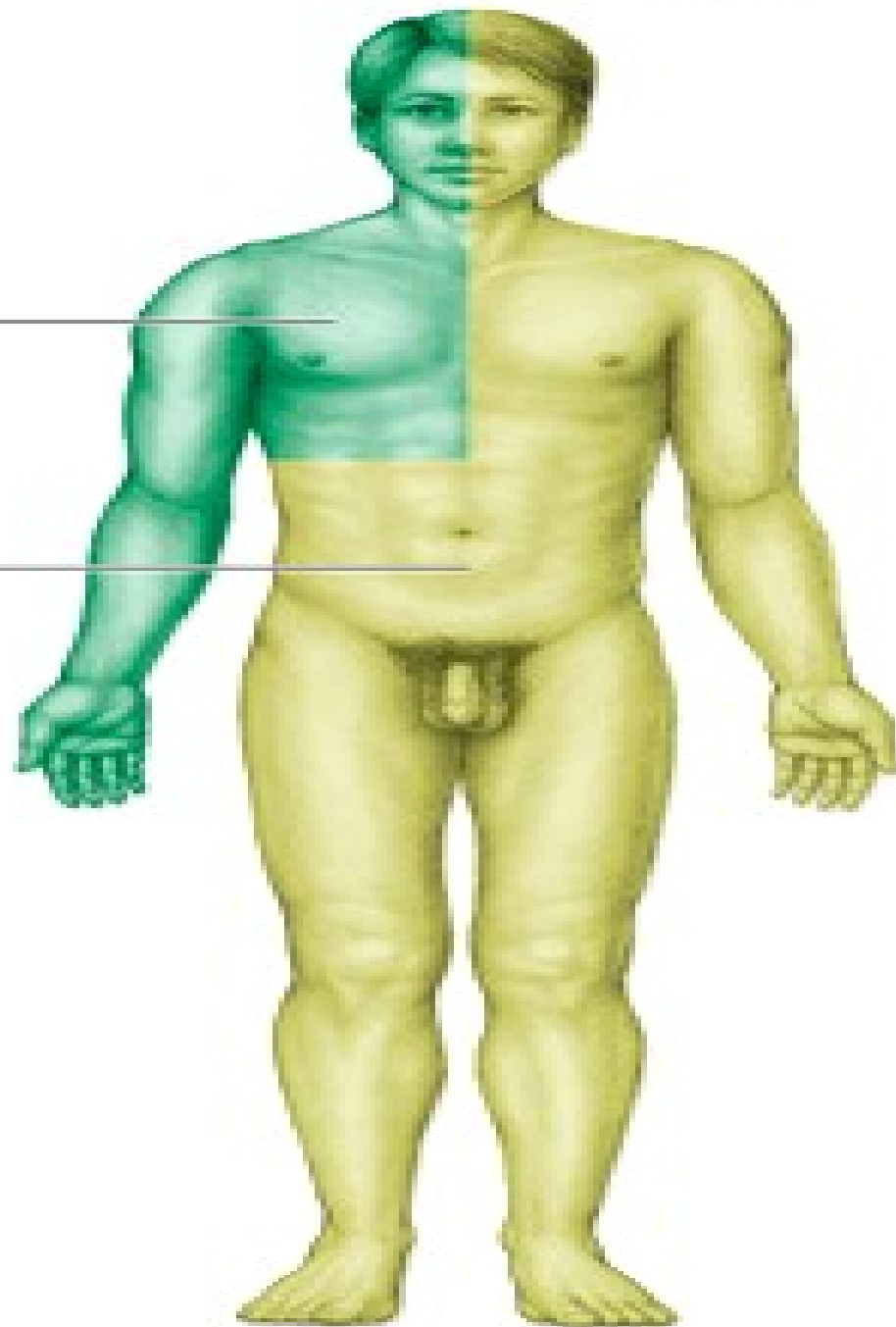
Lymphatic duct

- **Right lymphatic duct:** union of **right jugular, subclavian, and bronchomediastinal** trunks
- Ends by entering the **right venous angle**
- **Thoracic duct:** formed by **left and right lumbar trunks and intestinal trunk**
- **Receive left jugular, Subclavian and broncho-mediastinal trunk**
- enter the **left venous angle**



Area drained by —
right lymphatic duct

Area drained —
by thoracic duct



(b) Lymph drainage pattern

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

Primary organs

- Red bone marrow
- Thymus gland

Secondary organs

- Lymph nodes
- Lymph nodules
- Spleen

Lymph nodes

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

**Thoracic
cavity
nodes**

**Axillary
nodes**

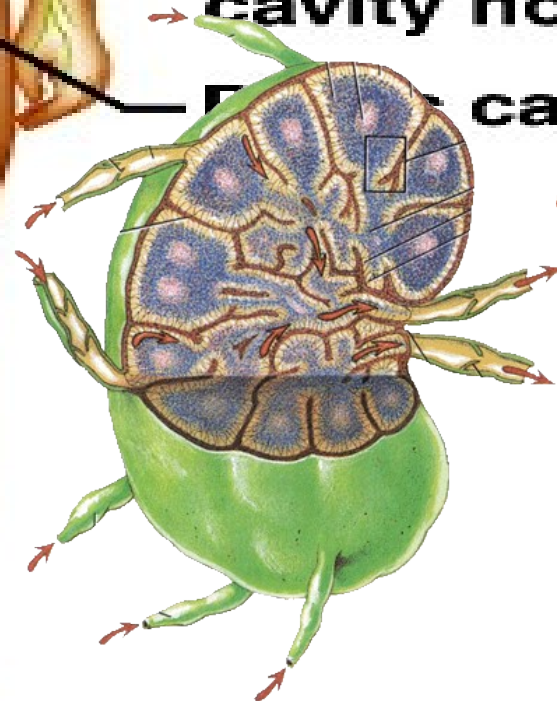
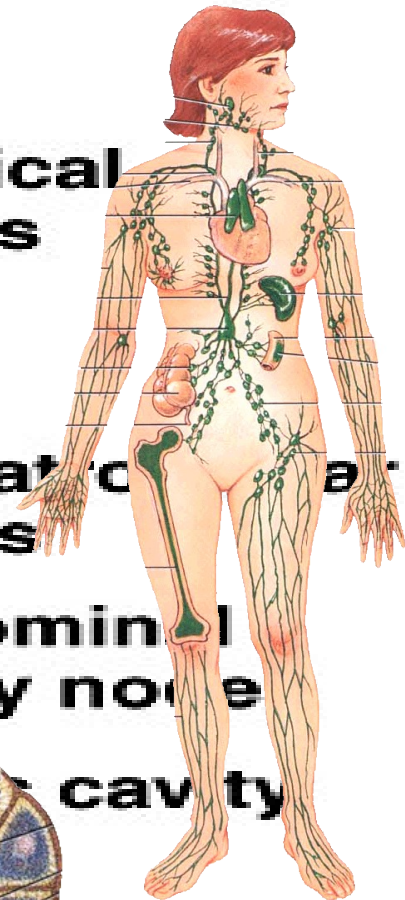
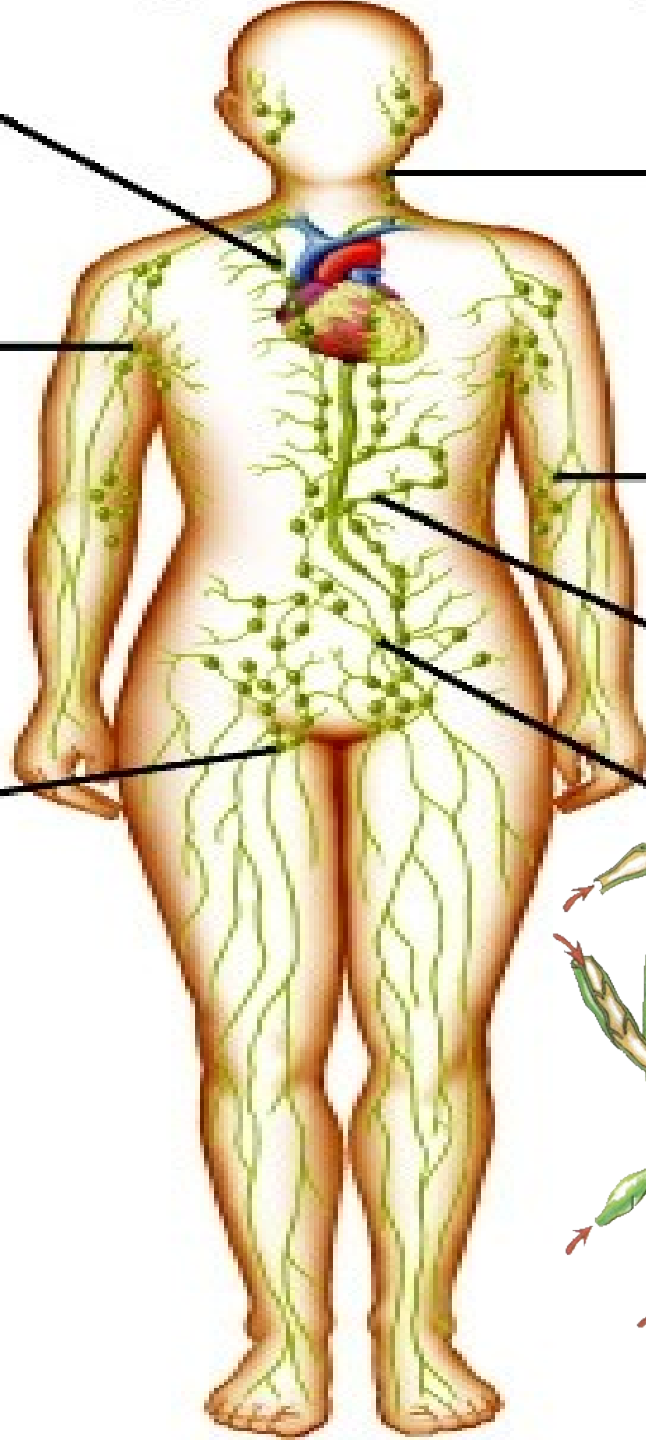
**Inguinal
nodes**

**Cervical
nodes**

**Supratrochanteric
nodes**

**Abdominal
cavity nodes**

Peritoneal cavity



Lymphatic nodules

- **Oval clusters** of lymphatic **cells** with some **extracellular matrix**
- **Filter** and **attack antigens**.
- **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**

Thank You!