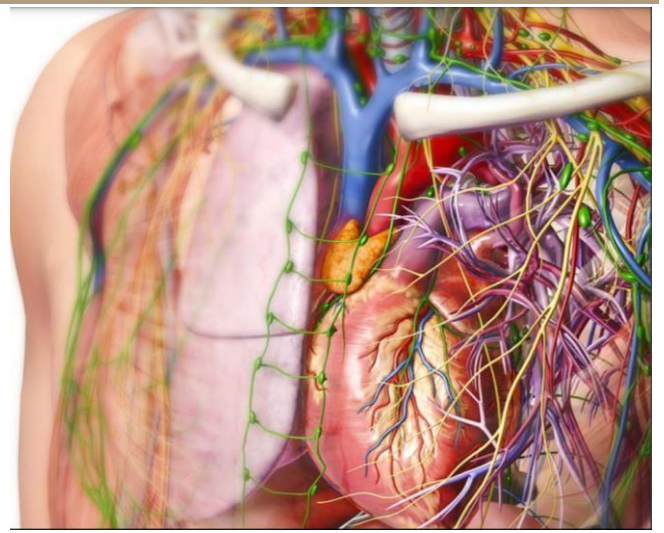


THE CIRCULATORY SYSTEM: ANATOMY OF THE CARDIOVASCULAR SYSTEM

HUMAN ANATOMY

College of Pharmacy

Dr. Abeer Abdullah

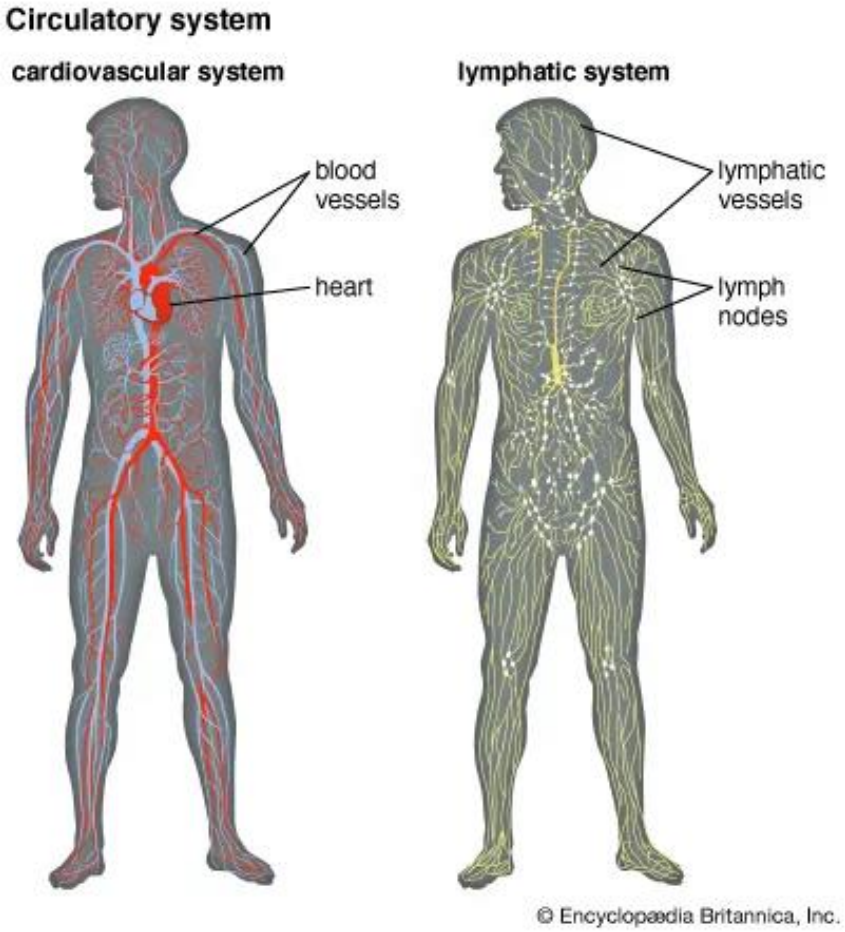
LEARNING OBJECTIVES

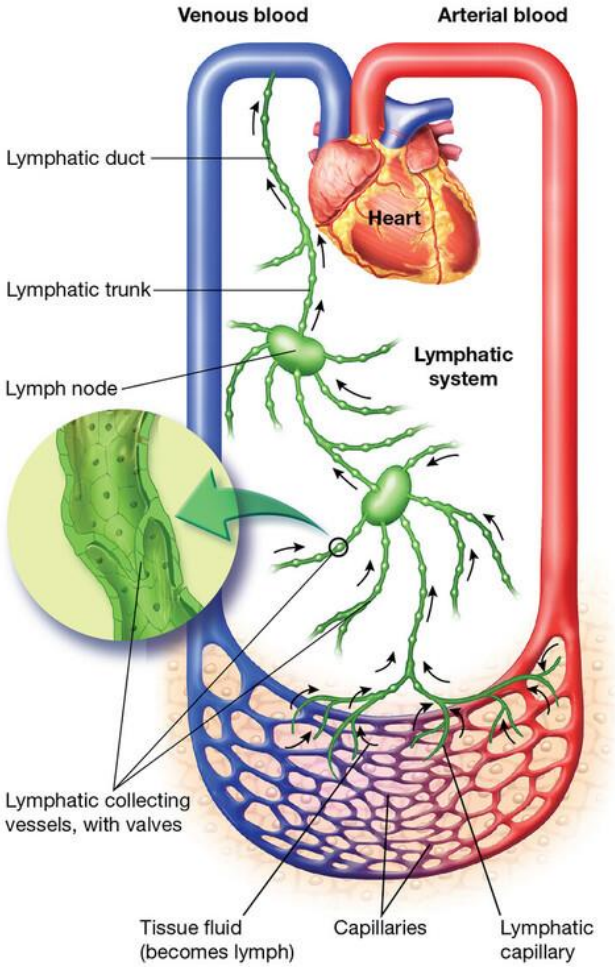
- Describe the location of the heart in the body.
- Identify the walls of the heart.
- Identify the external and internal features of the heart.
- Compare pulmonary vs. systemic circulation.
- Identify the body's major arteries and veins, and name the body region supplied by each.

THE CIRCULATORY SYSTEM OVERVIEW

- The **circulatory system** is divided into two main components:

1. **Cardiovascular System.**
2. **Lymphatic System.**



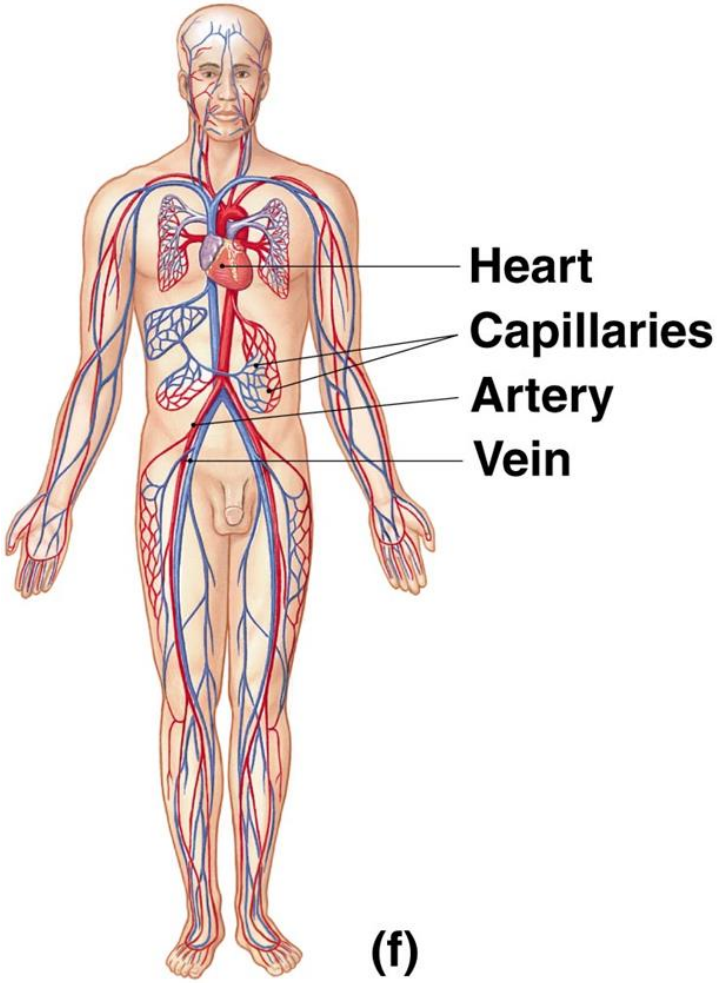


COMPONENTS OF THE CARDIOVASCULAR SYSTEM

- **Heart:** A muscular pump with four chambers that circulates blood to body tissue capillaries (that drives blood flow).
- **Blood Vessels:** Network of arteries, veins, and capillaries.

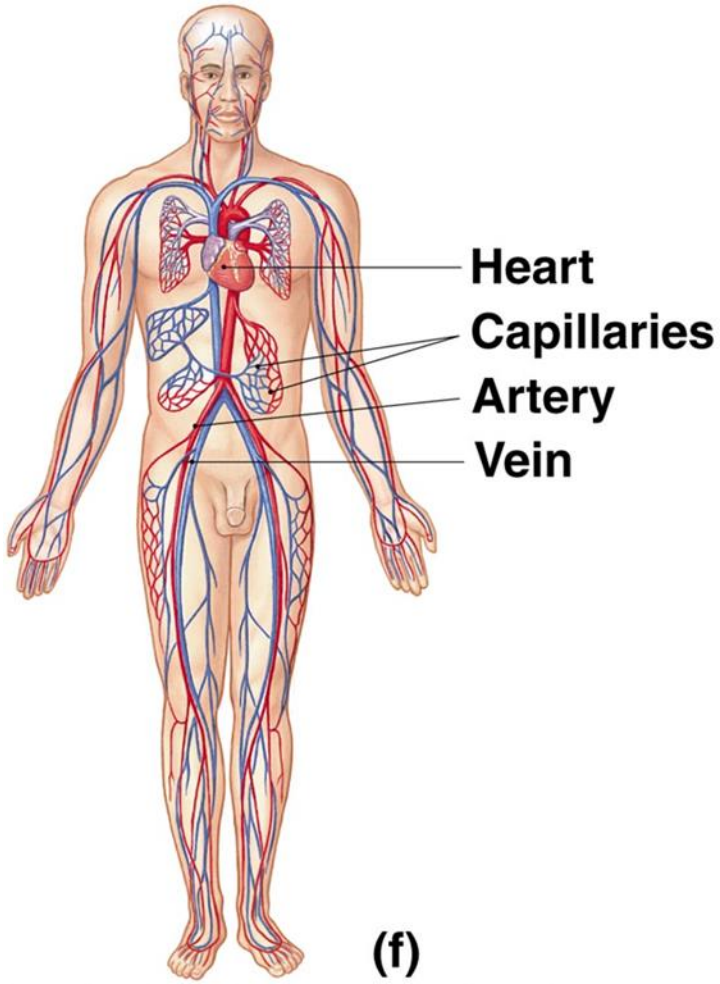
1. Arteries (carry blood Away from the heart).
2. Veins (return blood to the heart).
3. Capillaries (sites of gas/nutrient exchange).

- **Blood:** The fluid medium that transports oxygen, nutrients, hormones, and waste products throughout the body.



COMPONENTS OF THE CARDIOVASCULAR SYSTEM

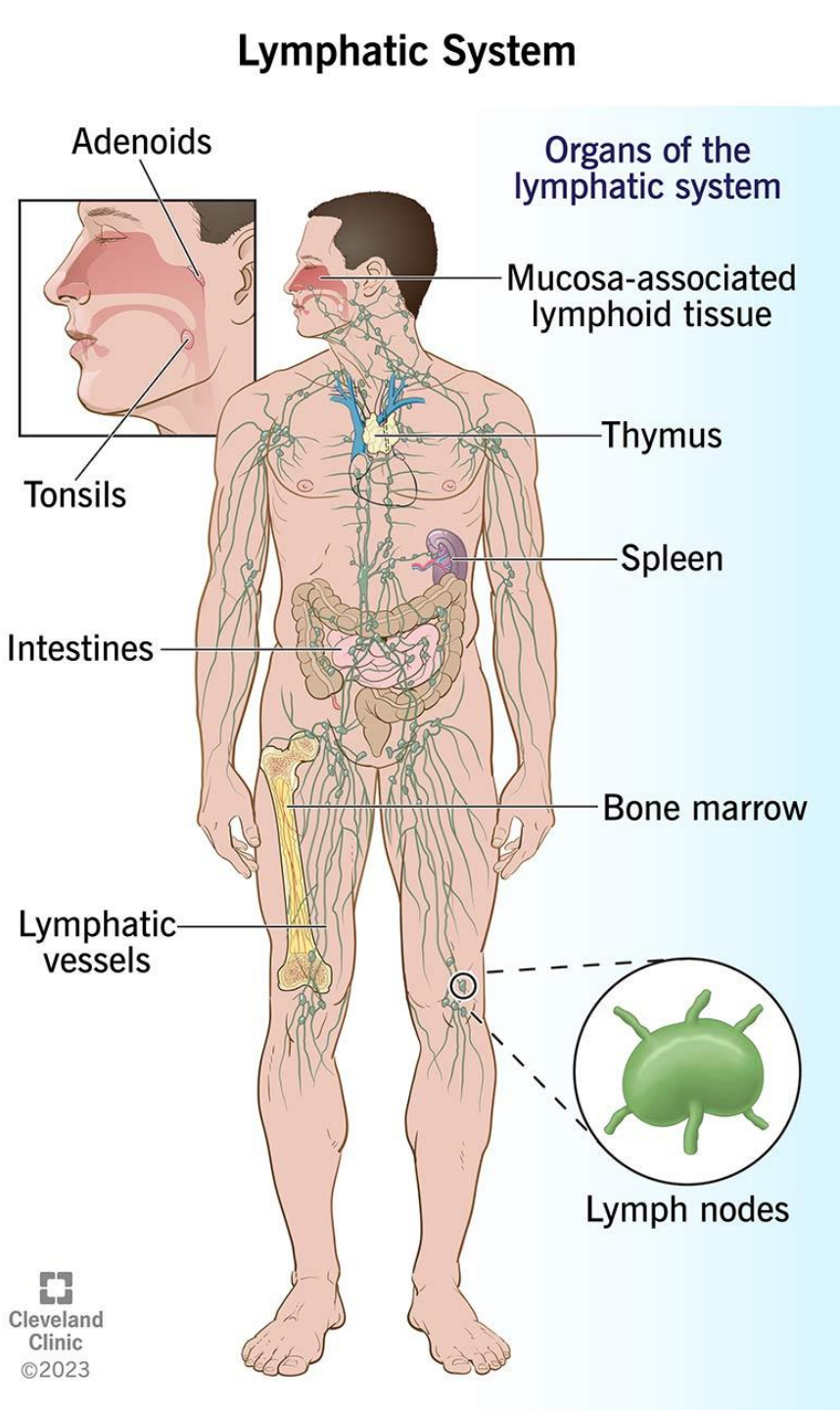
- Blood Vessels: Form an extensive network through which blood flows.
- Divided into two circuits:
  - **Pulmonary circuit**: Carries blood to and from the lungs.
  - **Systemic circuit**: Delivers blood to and from all body tissues.



💡 Clinical Correlation: Blood flow determines drug distribution and efficacy.

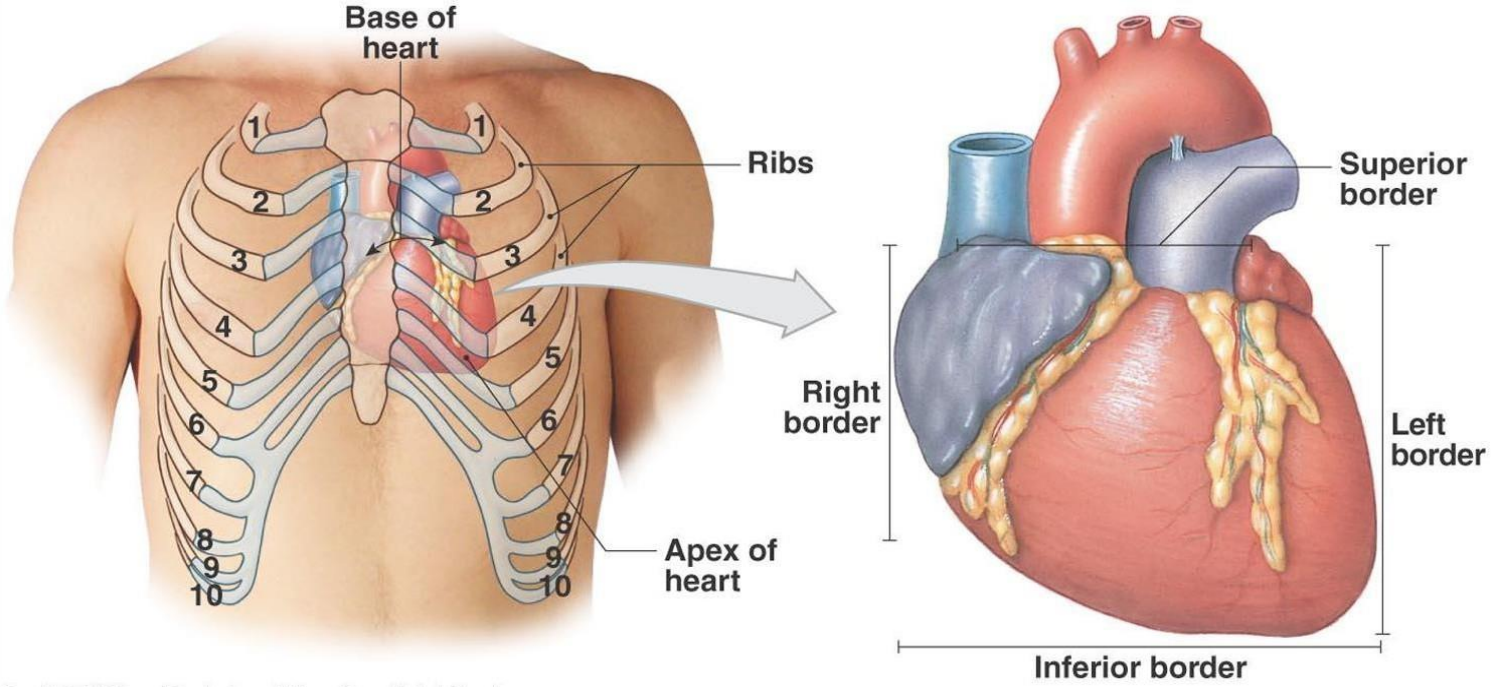
COMPONENTS OF THE LYMPHATIC SYSTEM

- **Lymphatic Vessels:** Drain interstitial fluid and return it to circulation.
- **Lymphoid Tissues:** Includes:
  - **Spleen** (filters blood, immune response).
  - **Thymus** (T-cell maturation).
  - **Tonsils** (oral/pharyngeal immunity).
  - **Lymph Nodes** (filter lymph, activate immune cells).



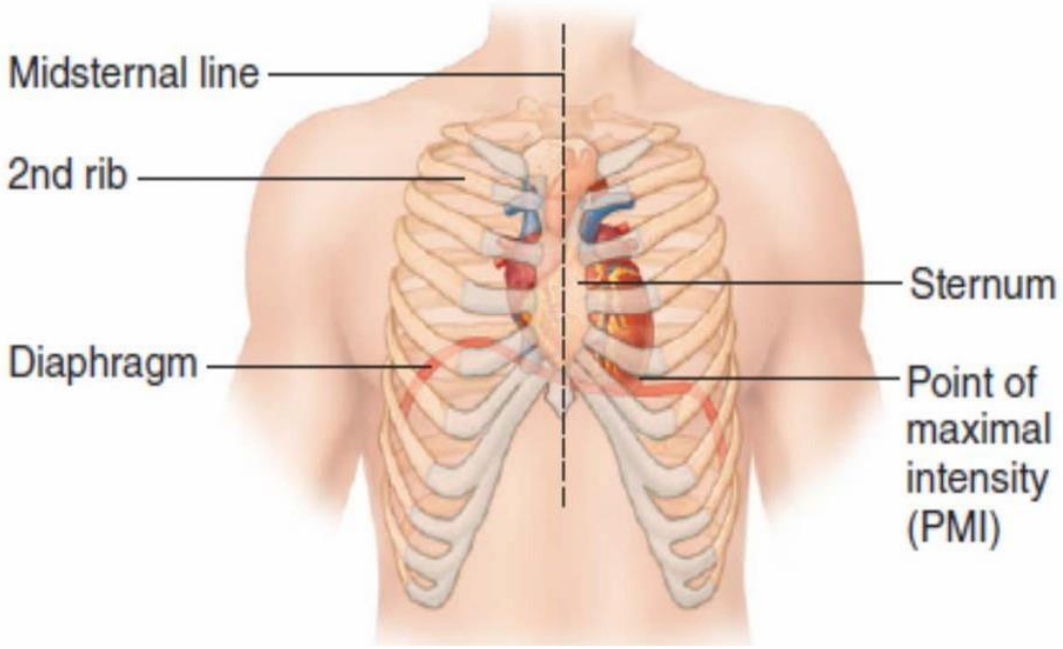
SIZE AND SHAPE OF THE HEART

- **Size:** Approximately the size of your FIST (250-300g).
- **Shape:** Cone-shaped; **base** (superior) to **apex** (inferior).
  - Narrow at the tip (Apex)
  - Flat at the top (Base).



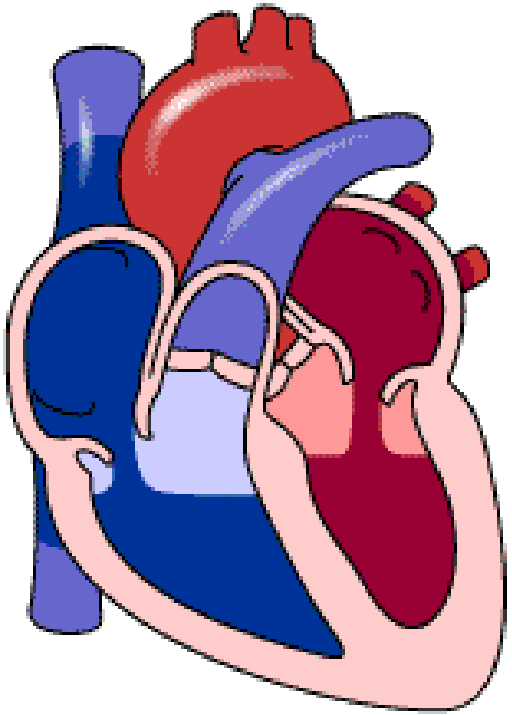
LOCATION OF THE HEART

- **Position:** Thoracic cavity (**mediastinum**), between lungs, rests on diaphragm.
- Located directly **posterior to the sternum**, anterior to the vertebral column in **between the 2nd and 6th ribs** (costal bones), and it **rests on the diaphragm**.



HEART FUNCTIONS

- **Dual-Pump System:**
  - Separates oxygenated/deoxygenated blood.
  - Unidirectional flow (valves prevent backflow).
  - Generates blood pressure, which moves the blood through the circuits.
  - Adjusts output (i.e., blood supply) to body demands.

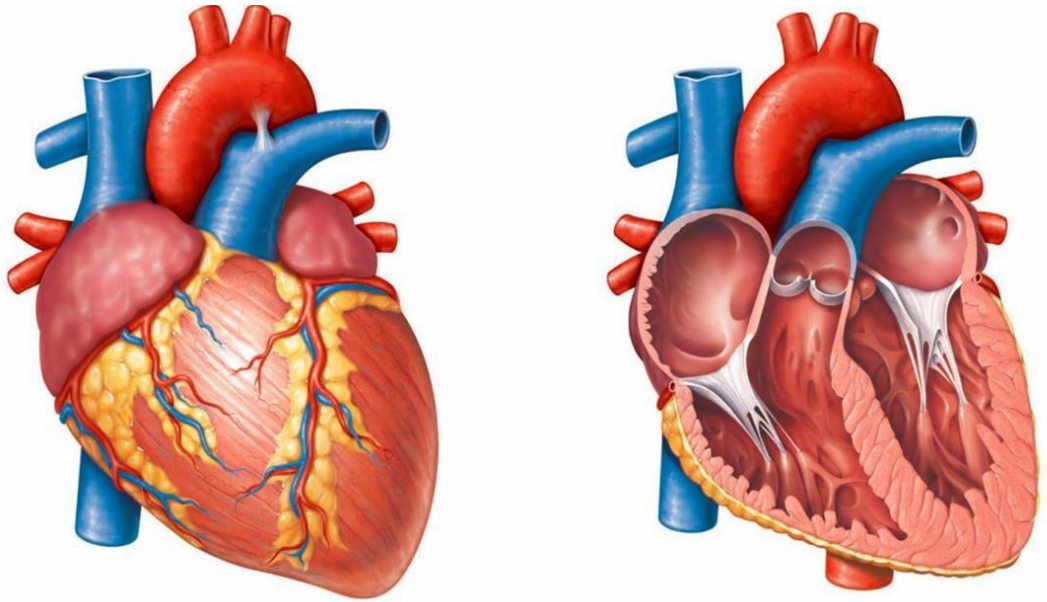


💡 Clinical Correlation:

1. High cardiac output (sepsis) → Rapid drug distribution.
2. Low output (heart failure) → Delayed absorption (e.g., lidocaine).
3. Fluid retention in heart failure → RAAS activation → Diuretics/ACE inhibitors.

OVERVIEW OF THE HEART

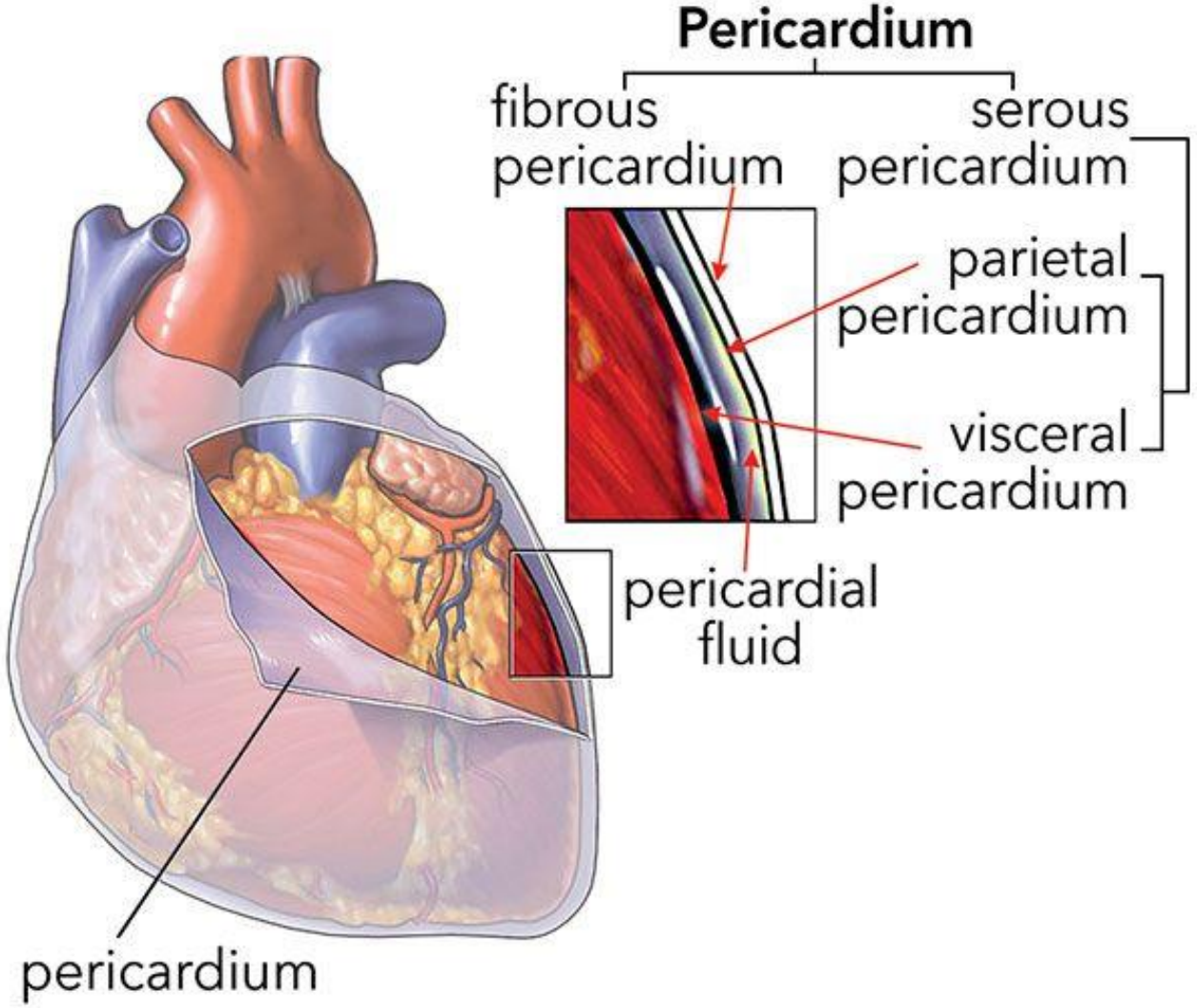
- A large muscular organ surrounded by a protective sac (**pericardium**).
- Consists of:
  - Mostly cardiac muscle tissue (**myocardium**).
  - Four **chambers:** 2 atria and 2 ventricles.
  - Two sets of **valves:** semilunar and atrioventricular valves.



THE PERICARDIUM

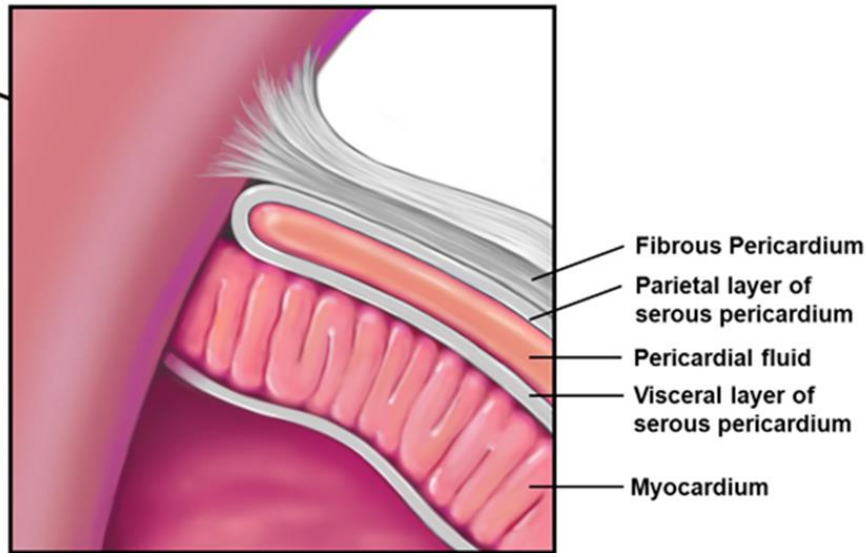
- The **membrane** that surrounds and protects the heart; fused with base of great vessels.
- **Key Functions:**

1. **Protection:** Shields the heart from infections and mechanical trauma.
2. **Anchoring:** Fixes the heart in mediastinum via ligamentous attachments.
3. **Prevents overfilling** of the heart with blood.
4. **Friction reduction: P**ericardial fluid; near-frictionless environment for the beating heart.



PERICARDIUM

- **Protective Layers**



Layer	Composition	Location	Function
Fibrous Pericardium	**Tough**, inelastic dense irregular **connective tissue**	**Superficial**	• Anchors heart • Prevents sudden dilation
Serous Pericardium	Parietal + Visceral layers (double-layered membrane): 1. **Parietal:** Fused to fibrous pericardium 2. **Visceral (Epicardium):** Covers heart surface	**Deeper**	Reduces friction

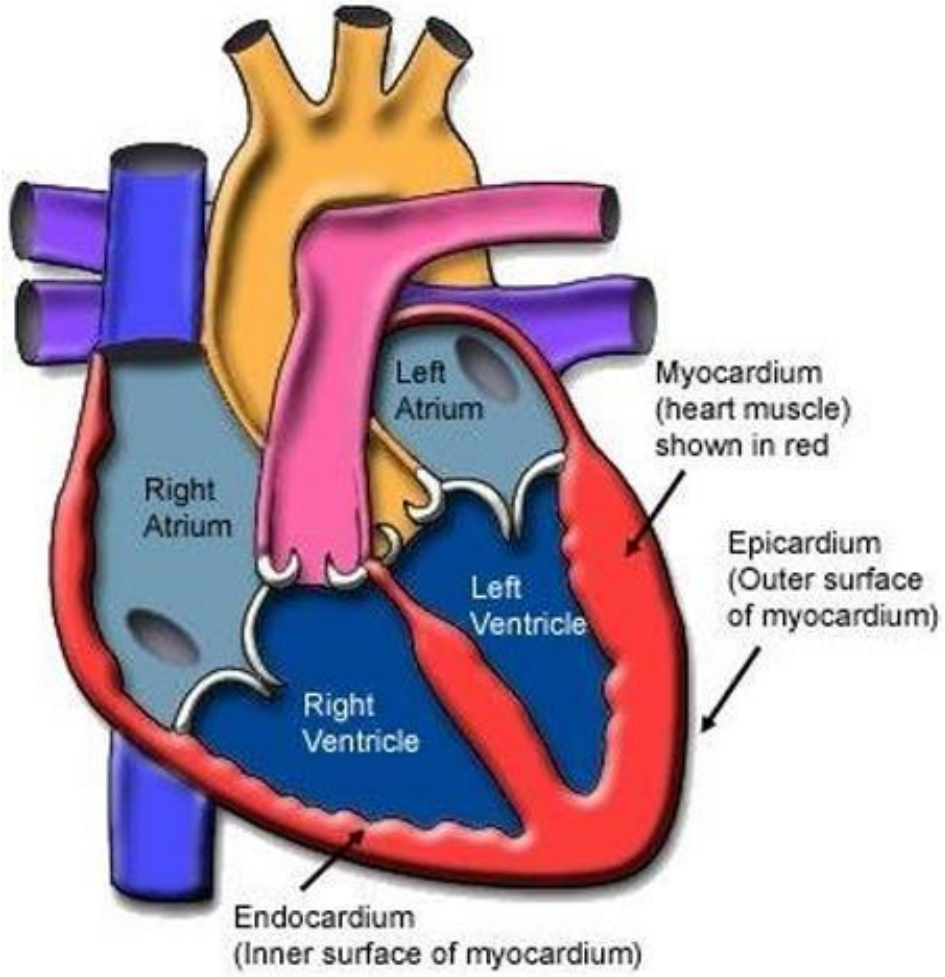
- **Pericardial Cavity**: Space between parietal & visceral layers.
- **Pericardial fluid** prevents friction during beats.
- 💡 Clinical Correlation: Pericarditis = Inflammation → Painful rubbing.

THE WALLS OF THE HEART

- **Heart wall layers** (from outer to inner):

1. **Epicardium** (visceral pericardium).
2. **Myocardium** (thick cardiac muscle).
3. **Endocardium** (smooth endothelial lining).

💡 Clinical Correlation: Myocardium thickness determines drug penetration.

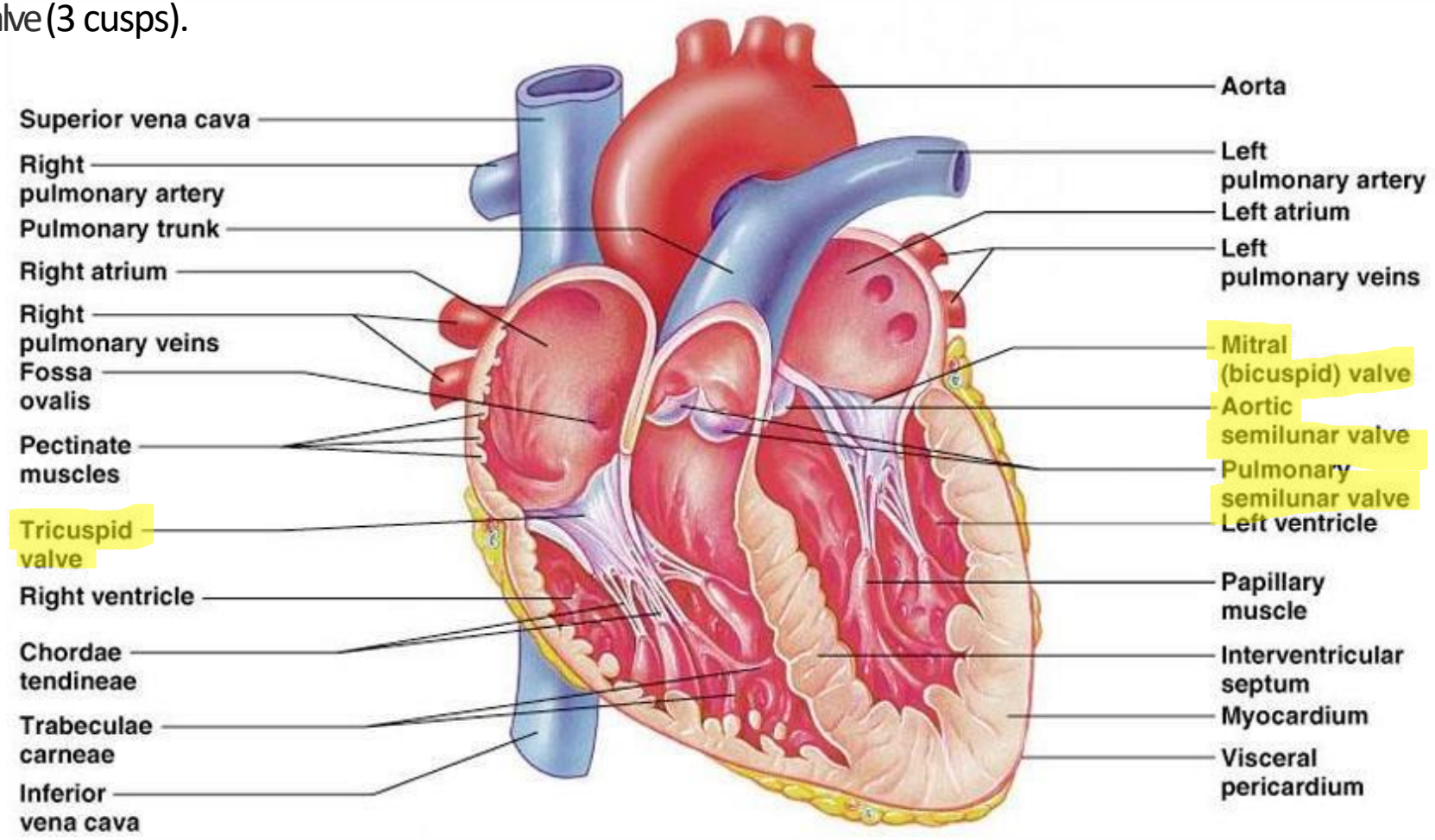


CHAMBERS OF THE HEART

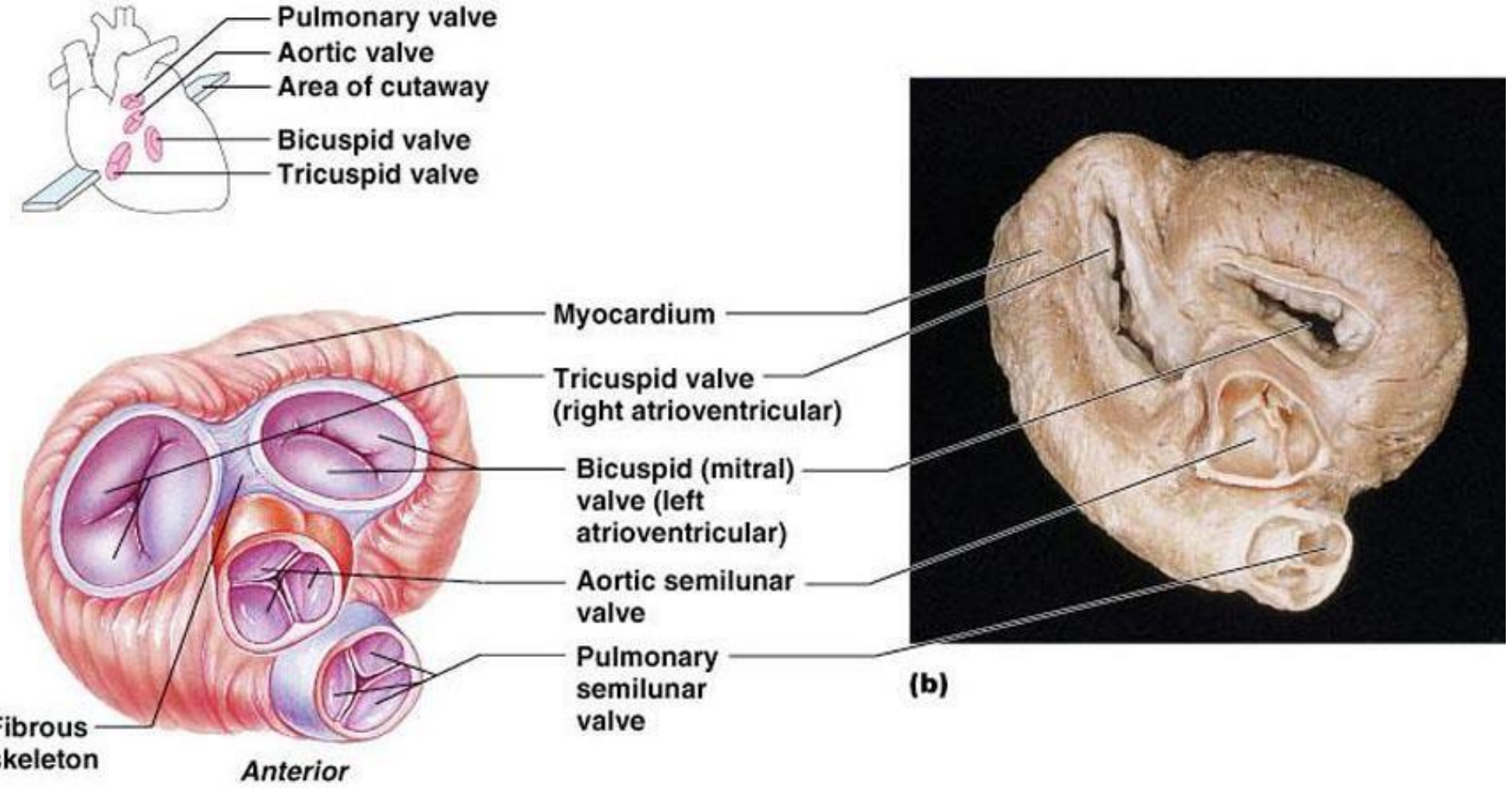
Feature	Atria (Superior Chambers)	Ventricles (Inferior Chambers)
Number	2 (Right & Left)	2 (Right & Left)
Wall Thickness	Thin	-Thick (LV > RV) - The thickness of a chamber's myocardium is suited to it function
Structure	-Interatrial septum -Auricles (wrinkled pouches)	-Interventricular septum -Trabeculae carneae (muscular ridges)
Primary Function	Receive blood: - RA: Body (via SVC/IVC) - LA: Lungs (via pulmonary veins)	Pump blood: - RV: Lungs (low pressure; nearby) - LV: Systemic circulation (high pressure)

VALVES OF THE HEART

Right Atrium → **Tri**cuspid valve (3 cusps).



VALVES OF THE HEART



VALVES OF THE HEART

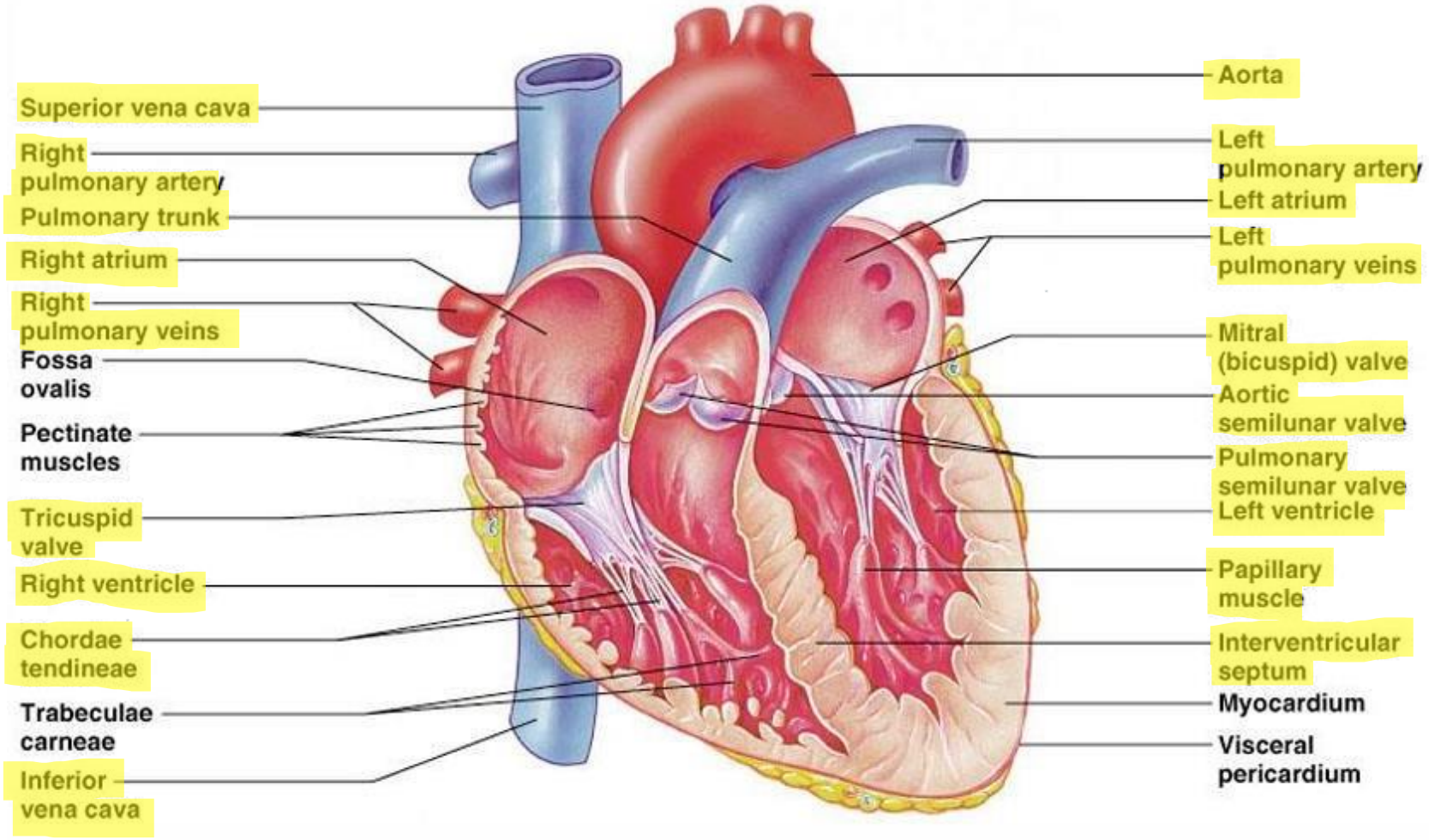
- Atria:

1. **Tri**cuspid valve (3 cusps): RA → RV.
2. Bicuspid or Mitral valve (2 cusps): LA → LV.

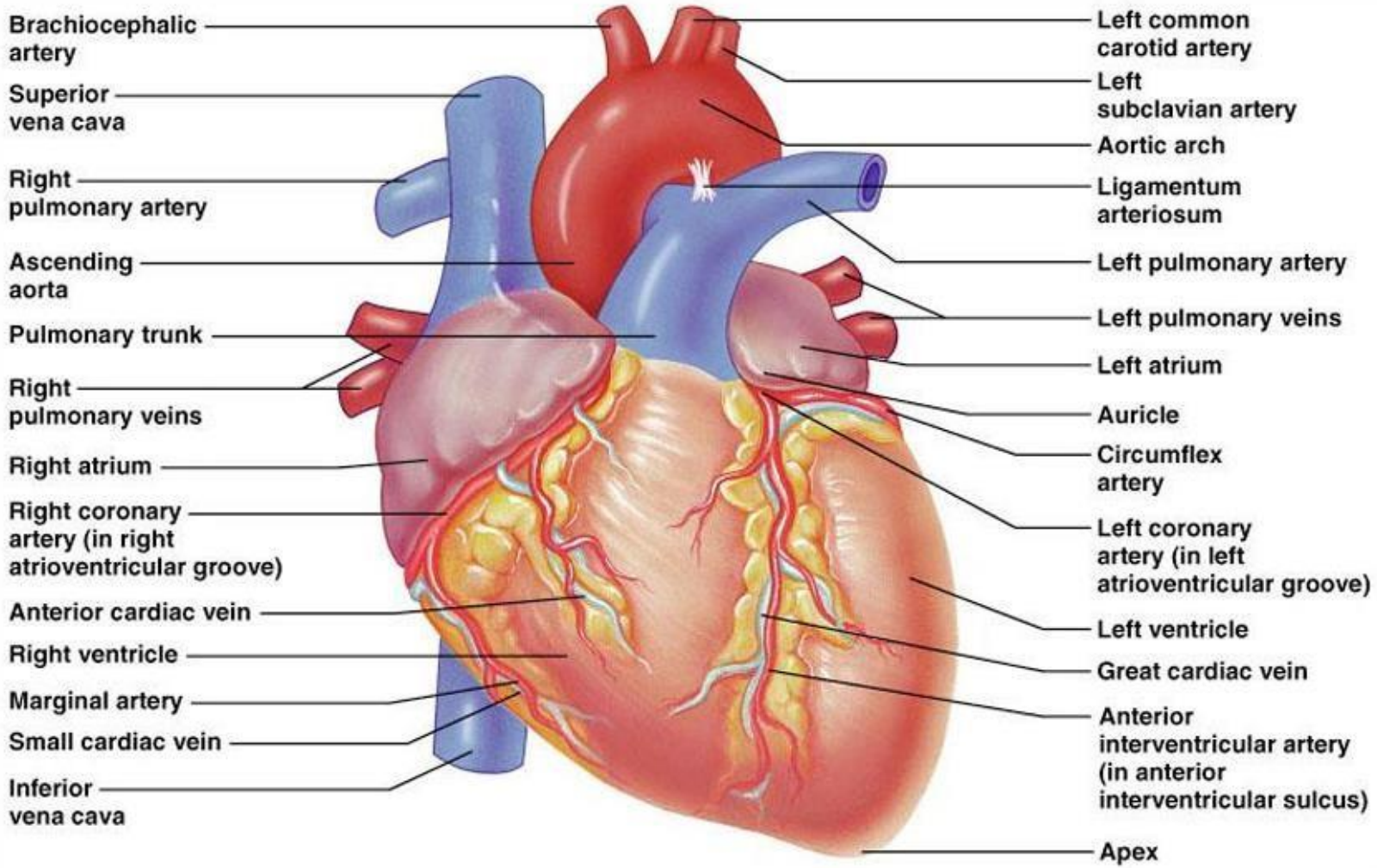
- Ventricles:

Ventricle	Pumps To	Valve
Right	Lungs	Pulmonary semilunar
Left	Systemic circulation	Aortic semilunar

GROSS ANATOMY OF THE HEART: INTERIOR VIEW

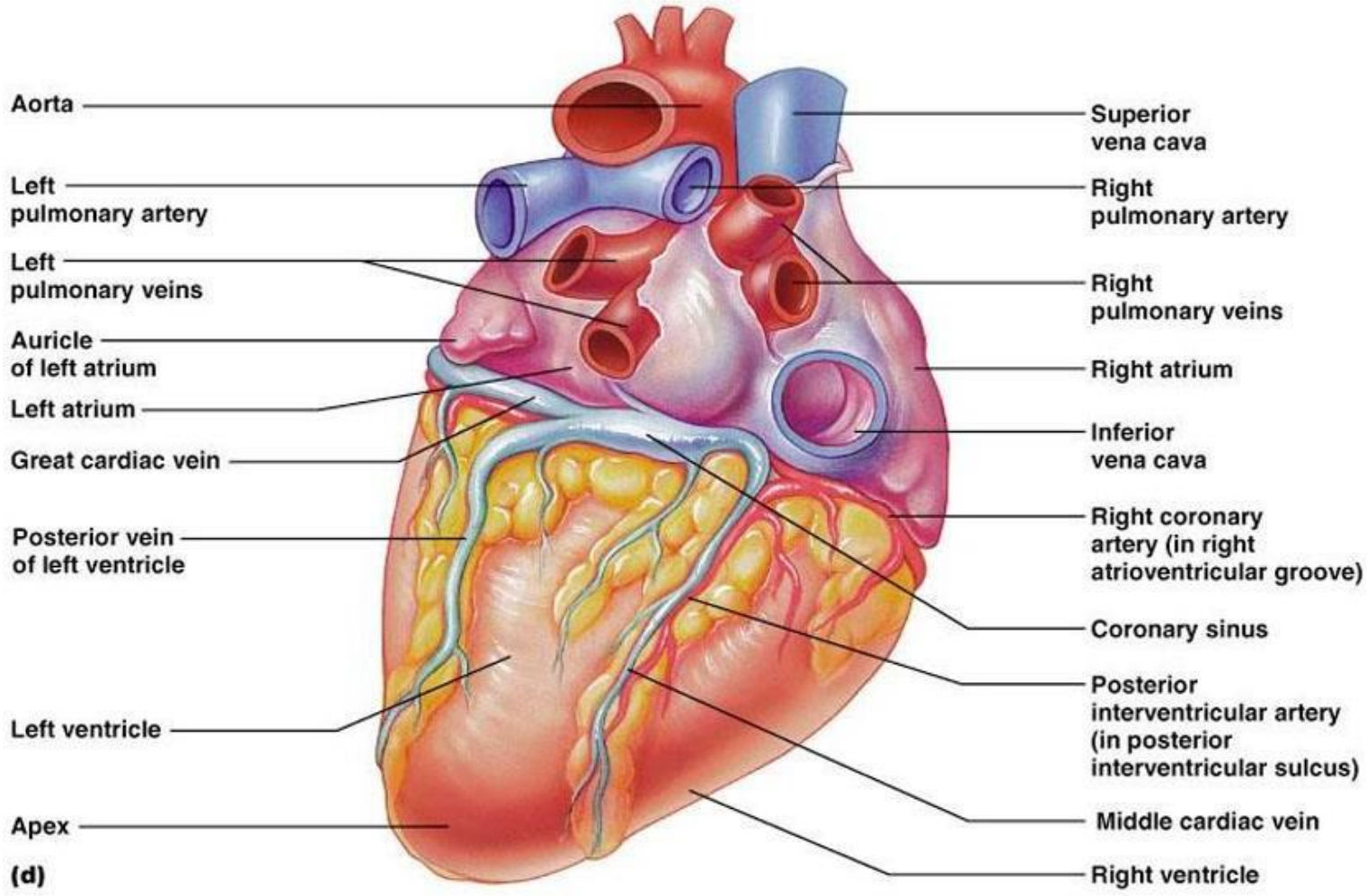


EXTERNAL FEATURES OF THE HEART: ANTERIOR VIEW



Auricles: Wrinkled pouches for blood reservoir.

EXTERNAL FEATURES OF THE HEART: POSTERIOR VIEW



RIGHT ATRIUM

- **Location:** Forms right border of heart.
- **Blood supply:**
  - Superior vena cava (deoxygenated blood from upper body).
  - Inferior vena cava (deoxygenated blood from lower body).
  - Coronary sinus (deoxygenated blood from heart muscle).
- **Structure:**
  - Thin-walled.
  - Contains *pectinate muscles*.
  - Has right *auricle* (pouch).
- **Valve:** Tricuspid valve.
- **Function:** Receives and temporarily stores deoxygenated blood.

RIGHT VENTRICLE

- **Shape:** Crescent-shaped in cross-section.
- **Location:** Anterior to LV.
- **Structure:**
  - Moderately thick walls.
  - *Trabeculae carneae* (muscular ridges).
  - Papillary muscles with *chordae tendineae*.
- **Valve:** Pulmonary semilunar valve.
- **Function:** Pumps deoxygenated blood to lungs (low-pressure system).
- The **pulmonary trunk** divides into the **left and right pulmonary arteries**.

LEFT ATRIUM

- **Location:** Posterior base of heart.
- **Blood supply:** 4 pulmonary veins (oxygenated blood from lungs).
- **Structure:**
  - Smooth-walled (no pectinate muscles).
  - Has left auricle.
- **Valve:** Bicuspid (mitral) valve.
- **Function:** Receives oxygenated blood from lungs.

LEFT VENTRICLE

- **Shape:** Oval/conical shape.
- **Structure:**
  - Thickest walls.
  - Robust trabeculae carneae.
  - Strong papillary muscles.
- **Valve:** Aortic semilunar valve.
- **Special features:**
  - Forms cardiac apex.
  - Gives rise to coronary arteries (blood vessels that lie on and nourish the heart itself).
- **Function:** Pumps oxygenated blood to body (high-pressure system).

SUMMARY OF MAJOR VESSELS OF THE HEART

- The **aorta** continues as **ascending aorta** then the **arch of the aorta** and then the **descending aorta**.
- Vessels returning blood to the heart include:
  - **Superior and inferior venae cavae.**
  - **Right and left pulmonary veins.**
- Vessels conveying blood away from the heart include:
  - **Pulmonary trunk,** which splits into **right and left pulmonary arteries**.
  - Ascending aorta (three branches):
    - **Brachiocephalic.**
    - **Left common carotid.**
    - **Left subclavian arteries.**

SUMMARY OF BLOOD FLOW PATHWAY

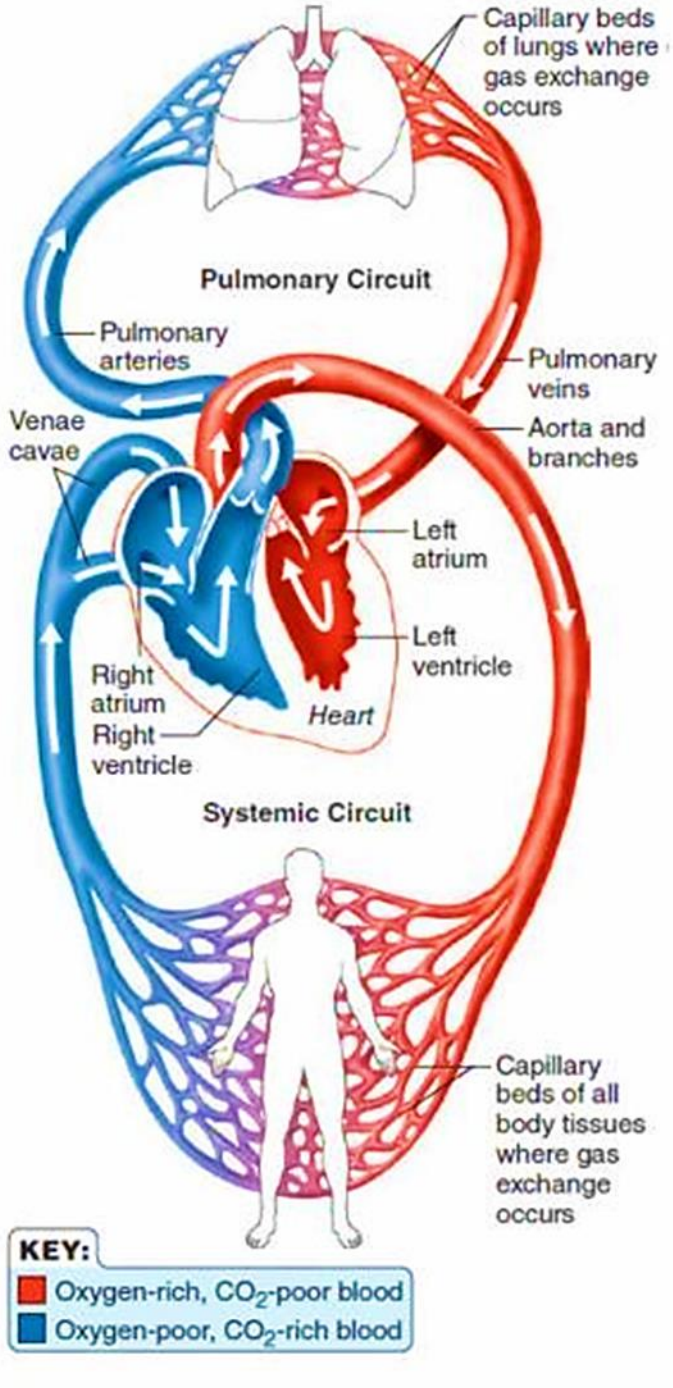
- **Blood flow pathway**

1. Deoxygenated → RA → Tricuspid → RV → Pulmonary valve → Lungs

2. Oxygenated → LA → Mitral → LV → Aortic valve → Body

- **Coronary circulation (heart supply)**

- Left Coronary Artery: Supplies LV (critical for systemic perfusion).
- Right Coronary Artery: Supplies RA/RV/SA node.



ANATOMY OF BLOOD VESSELS

- **Three main types:**

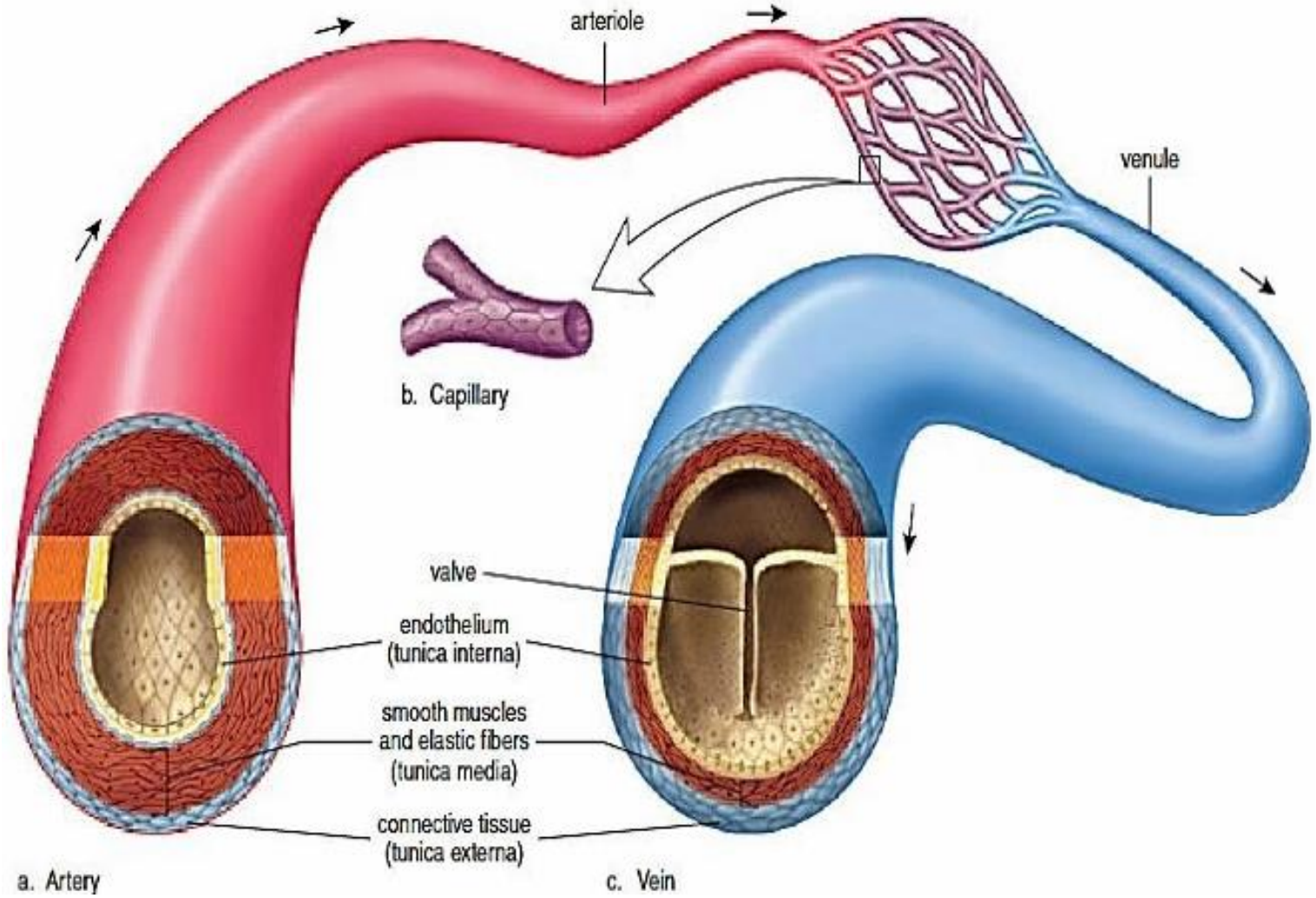
1. **Arteries:** Carry blood away from heart (oxygenated except pulmonary arteries).
2. **Veins:** Return blood to heart (deoxygenated except pulmonary veins).
3. **Capillaries:** Microscopic vessels for gas/nutrient exchange.

- **Key Functions:**
  - Transport blood and its components.
  - Gas exchange:
    - Pulmonary capillaries: CO_2/O_2 exchange.
    - Systemic capillaries: O_2/nutrient delivery and waste removal.
  - Blood pressure regulation.
  - Selective blood flow distribution.

ANATOMY OF BLOOD VESSELS

💡 Clinical Correlation:
Hypertension & Arterioles:

- Vasoconstrictors (e.g., angiotensin II)
- Vasodilators (e.g., calcium channel blockers).



Anatomy of Blood Vessels:

- **Arteries:** Thick muscular walls to withstand high pressure.
- **Capillaries:** Single endothelial cell layer for efficient diffusion.
- **Veins:** Thin walls with valves to prevent backflow.

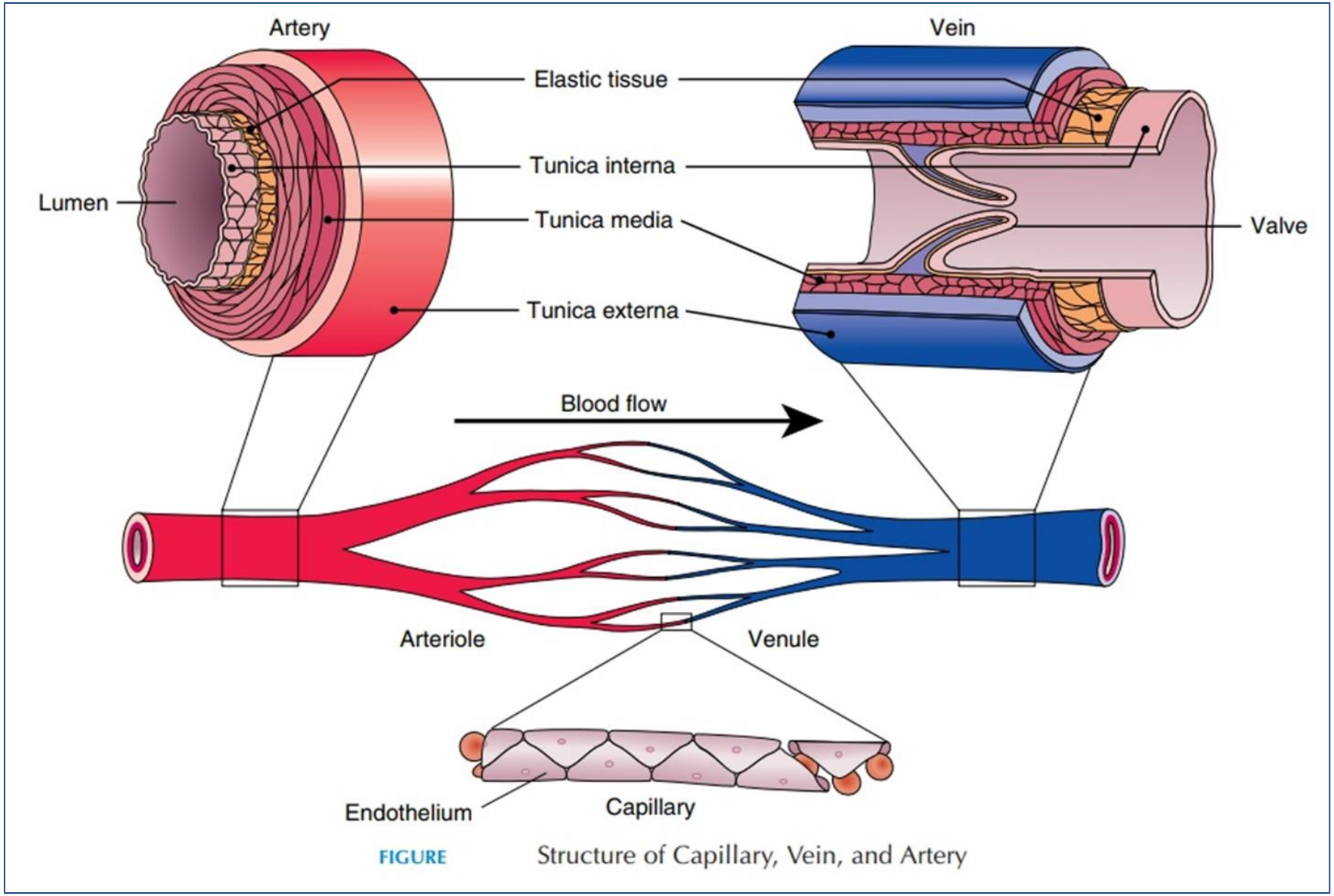
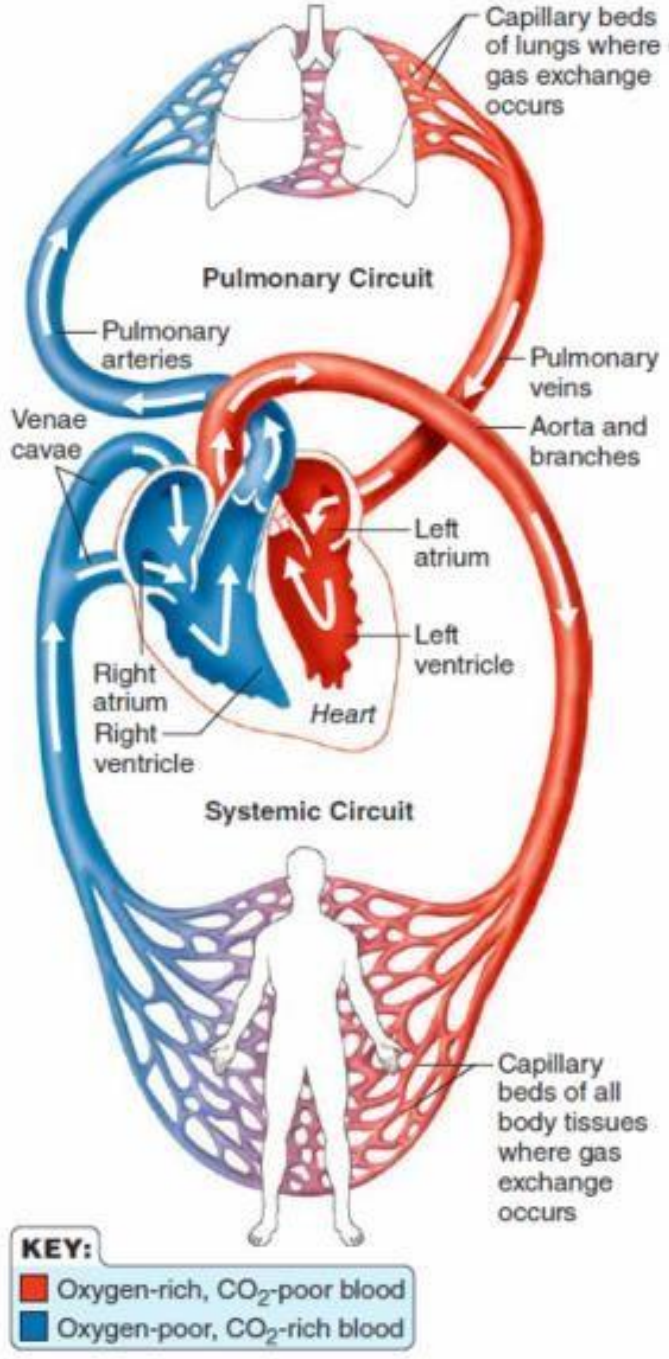


FIGURE Structure of Capillary, Vein, and Artery

CIRCULATORY PATHWAYS

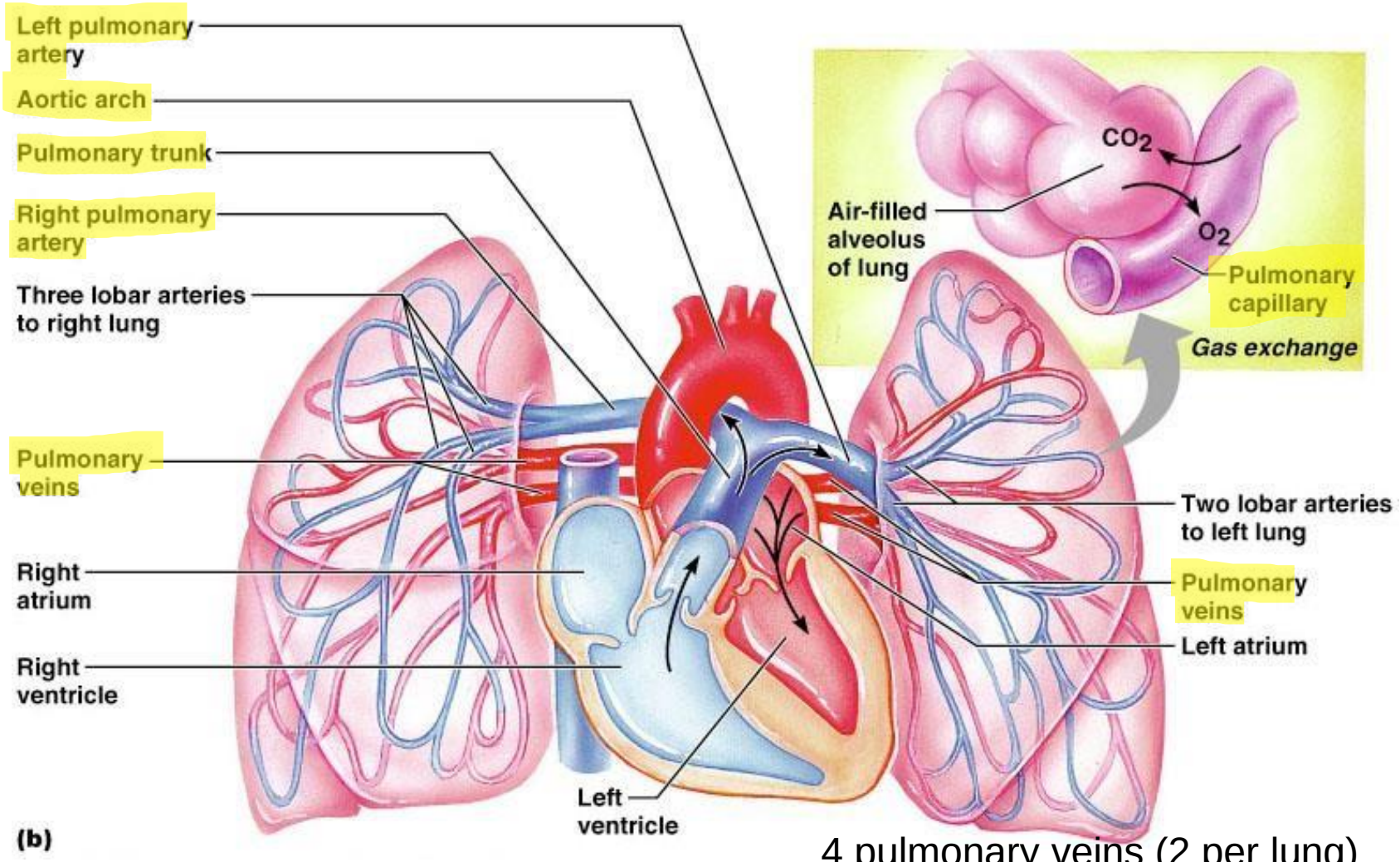
- **Pulmonary vs Systemic circulations:**
  - **Pulmonary circulation** – short loop that runs from the right heart to the lungs and back to the left heart.
  - **Systemic circulation** – routes blood through a long loop to all parts of the body and returns to the heart.



PULMONARY CIRCULATION

Blood Pathway :

1. Deoxygenated blood → Right atrium → Right ventricle
2. Pulmonary trunk → Pulmonary arteries → Lung arterioles
3. Pulmonary capillaries (gas exchange)
4. Pulmonary venules → Pulmonary veins → Left atrium

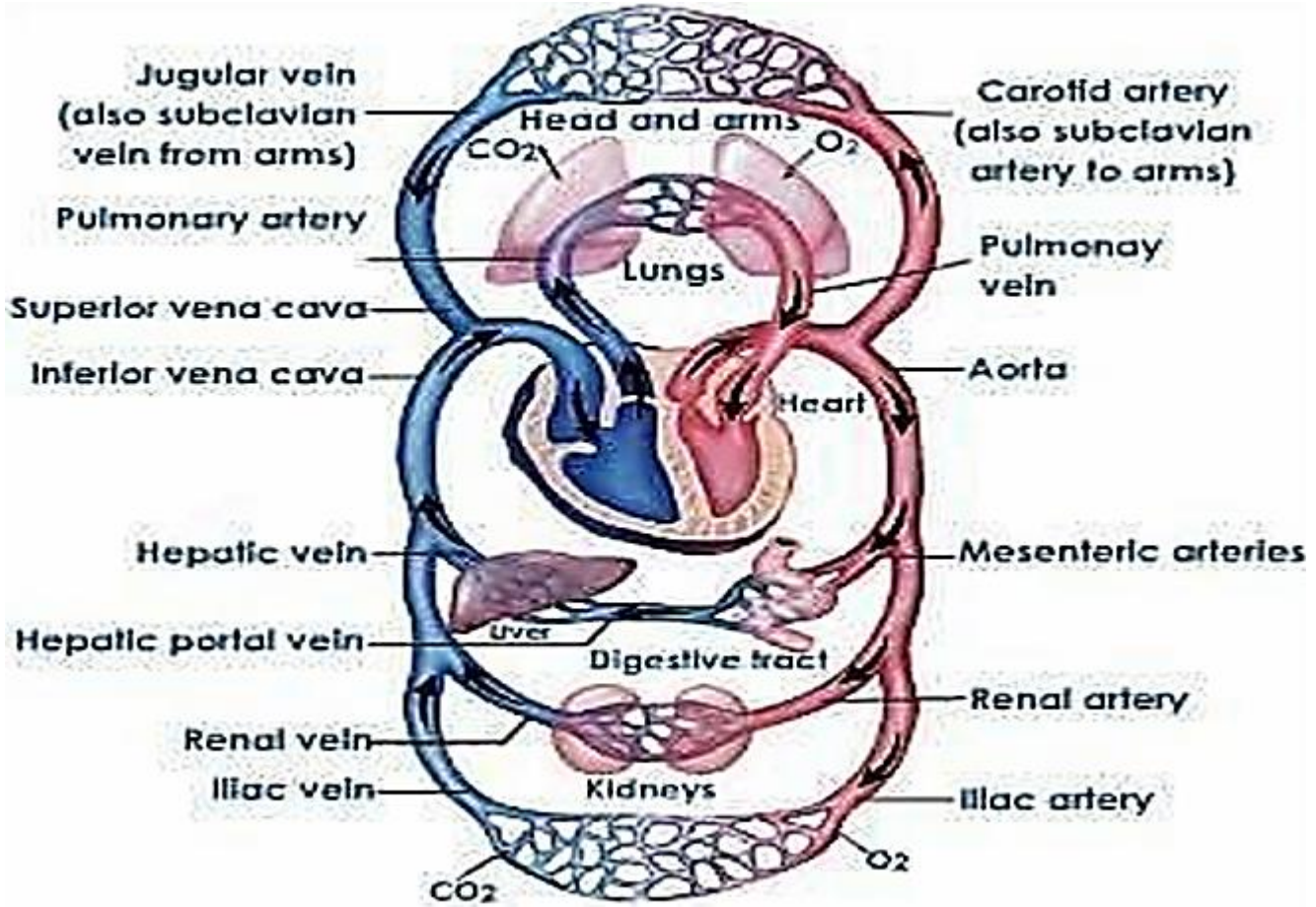


4 pulmonary veins (2 per lung)

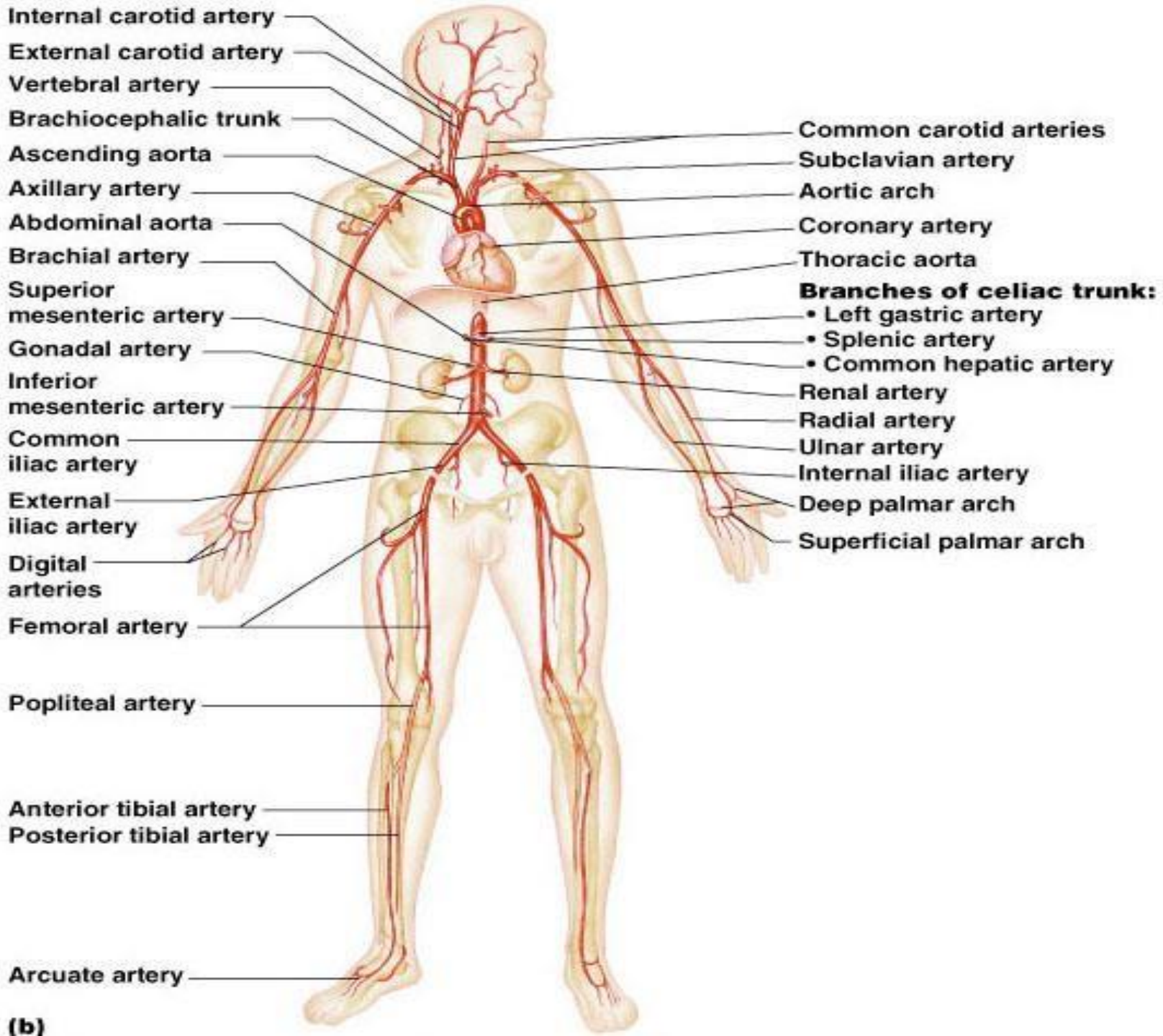
SYSTEMIC CIRCULATION

Blood Pathway:

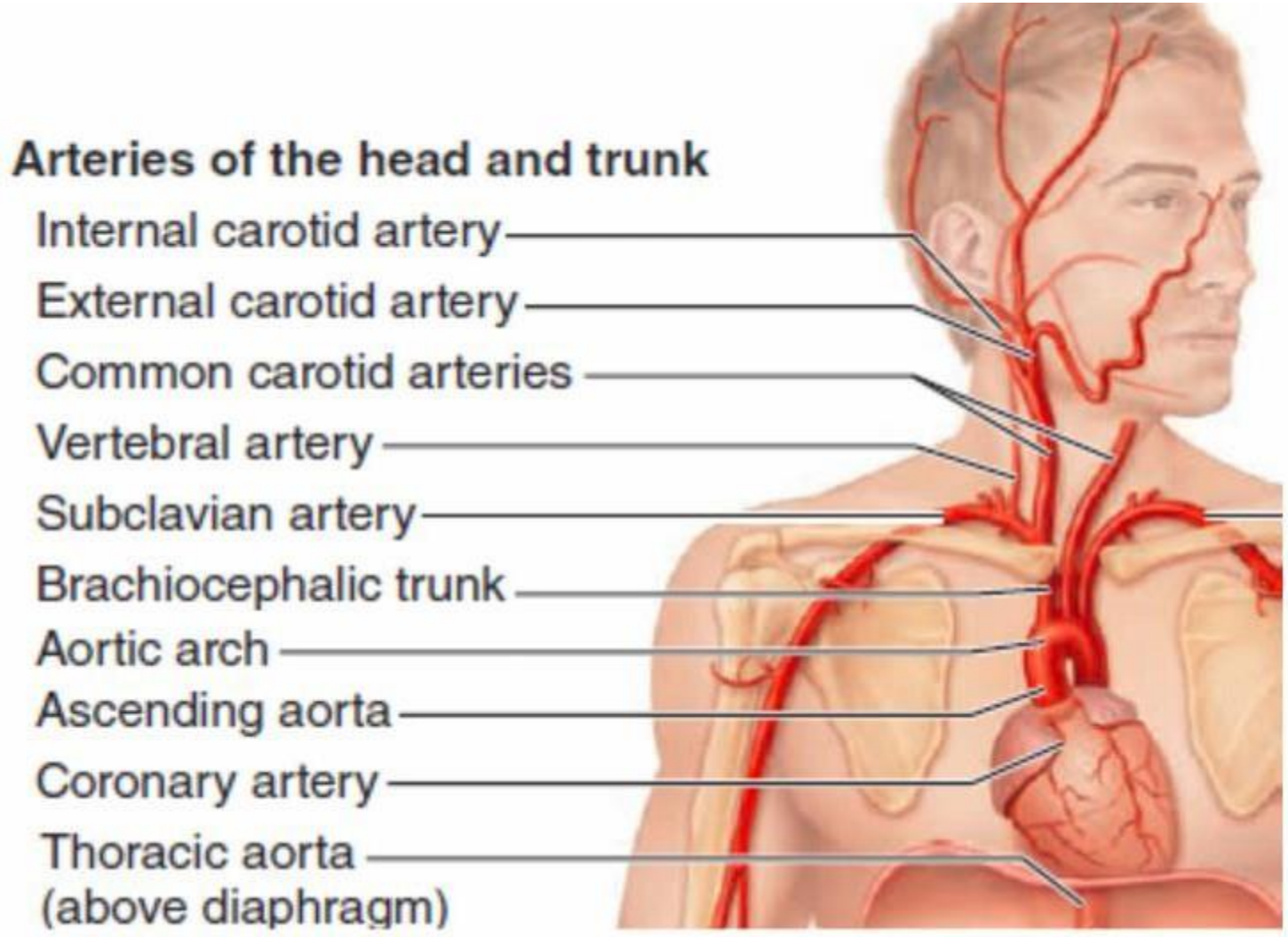
1. Oxygenated blood → Left atrium → Left ventricle → Aorta
2. Systemic arteries → Arterioles → Capillaries (tissue exchange)
3. Venules → Veins → Superior/Inferior vena cava → Right atrium



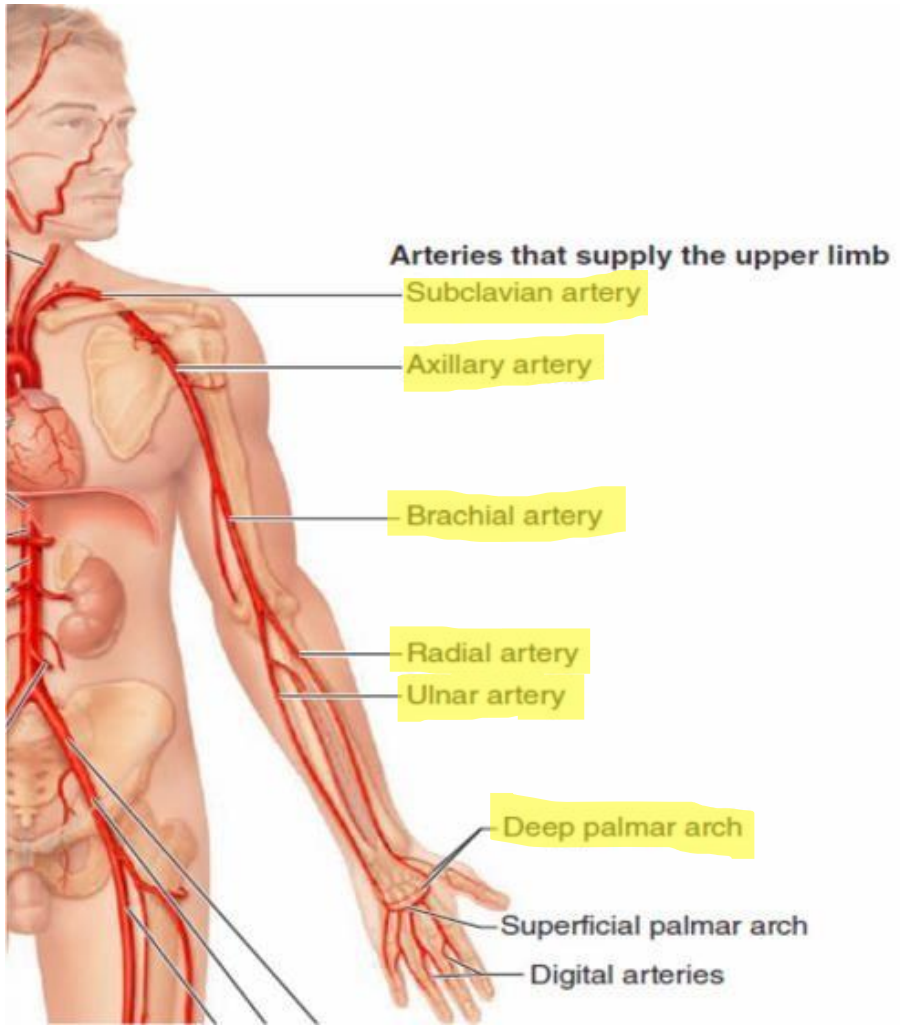
SYSTEMIC CIRCULATION: ARTERIES



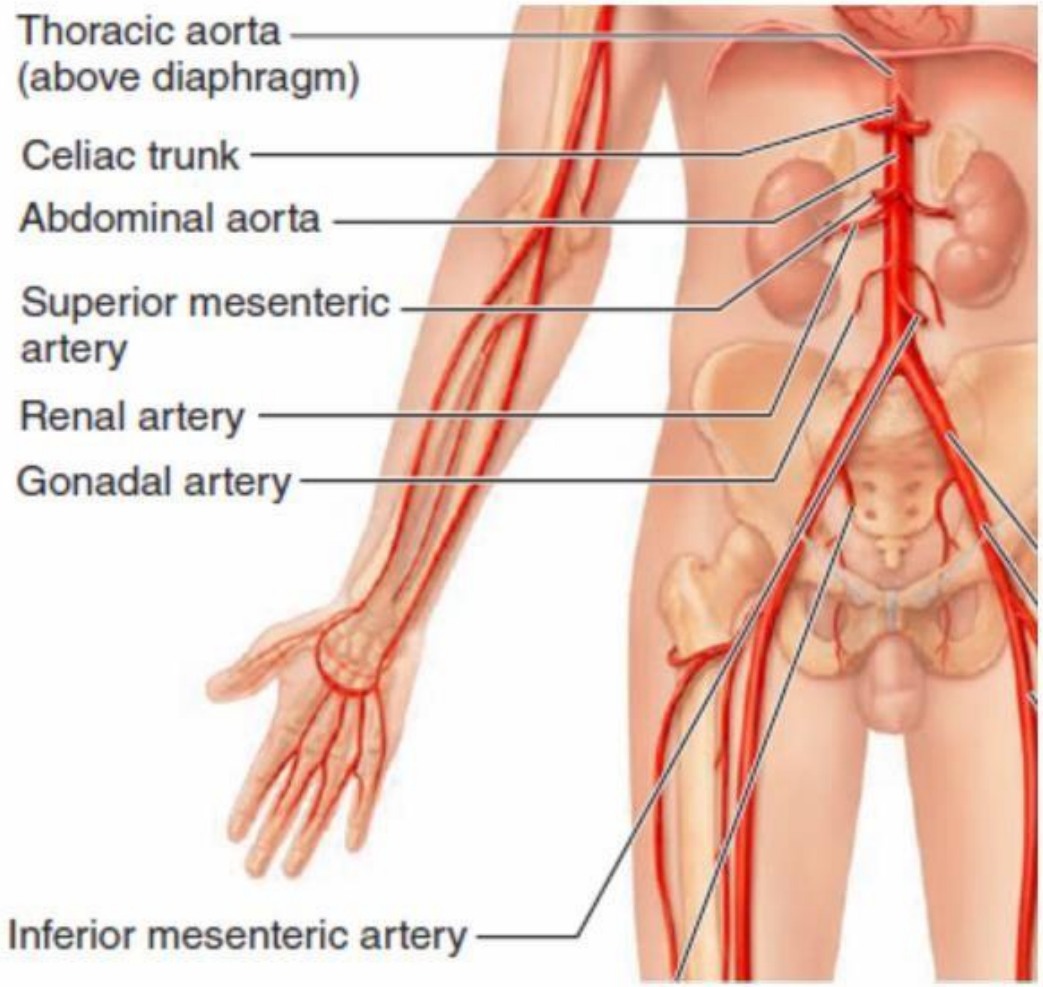
ARTERIES OF THE HEAD, NECK AND THORAX



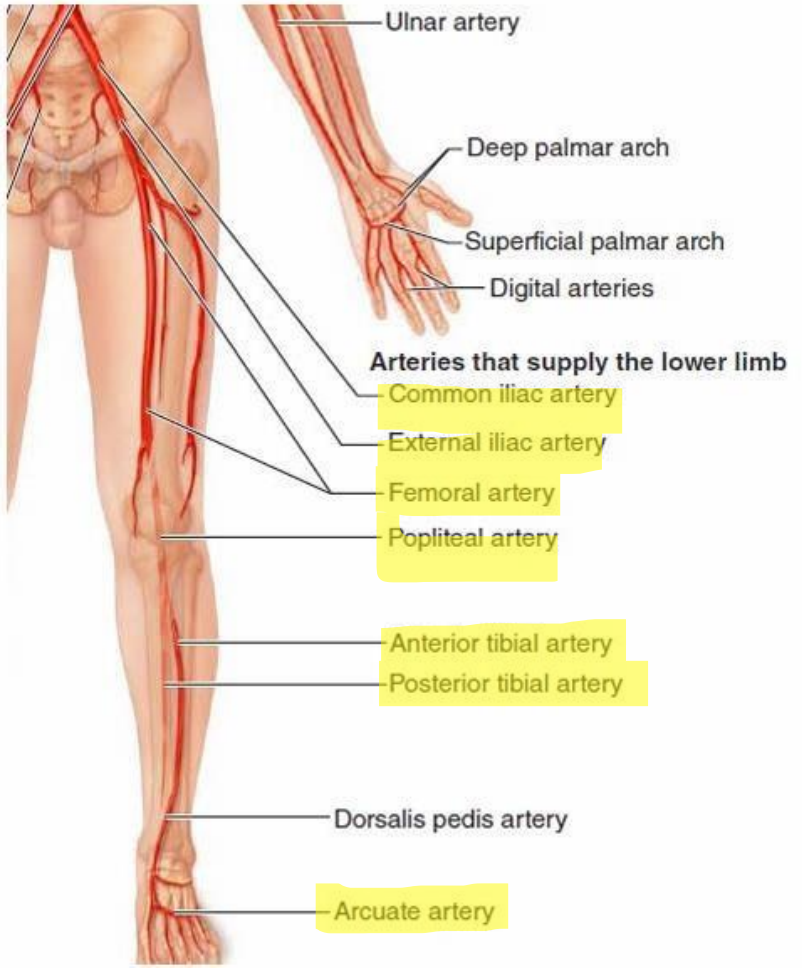
ARTERIES OF THE UPPER LIMB



ARTERIES OF THE ABDOMEN AND PELVIS



ARTERIES OF THE LOWER LIMB

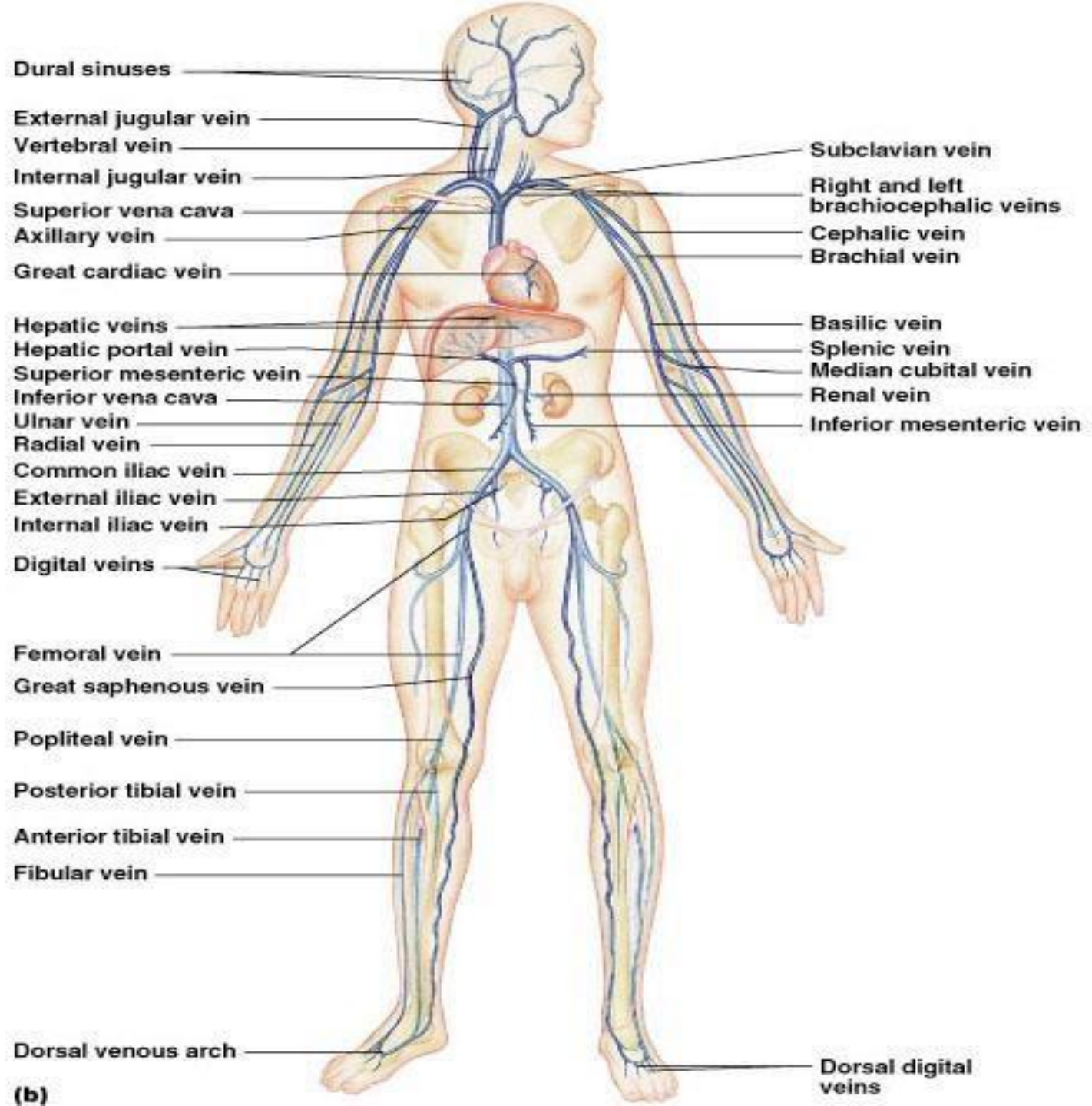


MAJOR SYSTEMIC ARTERIES: AORTA STRUCTURE

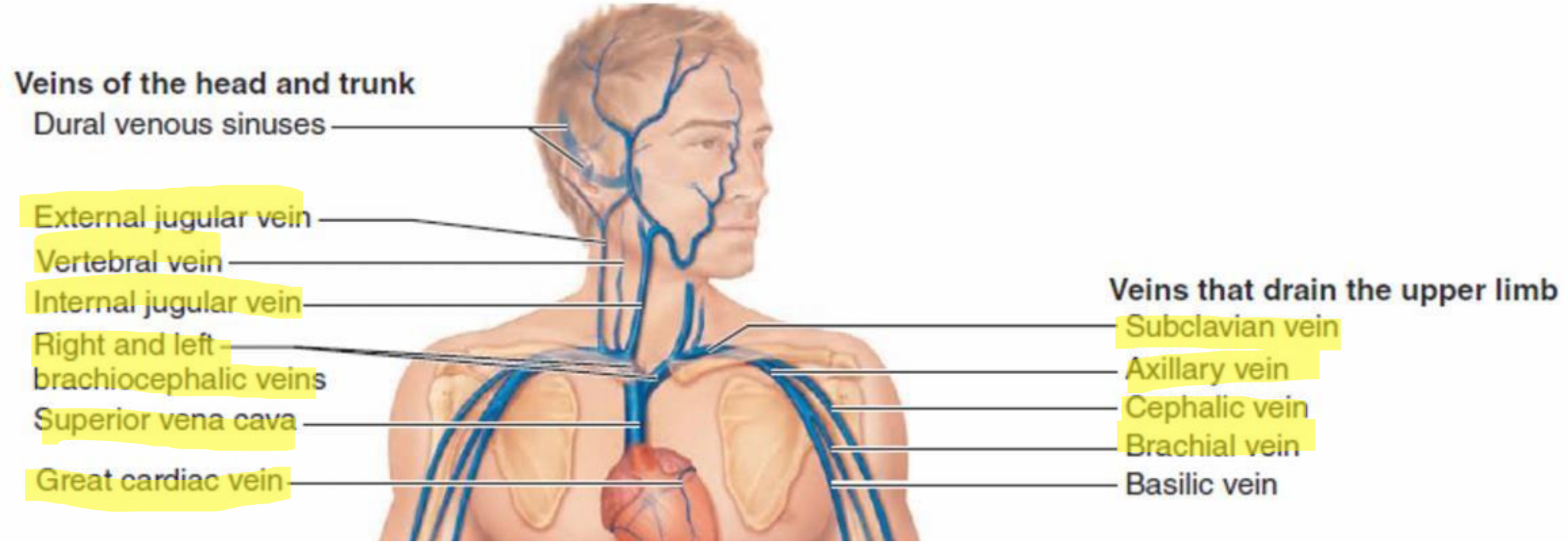
1. **Ascending aorta**
    - Branches: Left & right coronary arteries (heart supply)
2. **Aortic arch**
    - Branches:
        1. Brachiocephalic artery →
            - Right common carotid (head)
            - Right subclavian (right arm)
        2. Left common carotid (head)
        3. Left subclavian (left arm)

3. **Descending aorta**
    - Thoracic aorta (supplies chest organs)
    - Abdominal aorta (supplies abdominal organs)
        - Terminates as:
            - Left & right common iliac arteries →
                - Internal iliac (pelvic organs)
                - External iliac (legs)

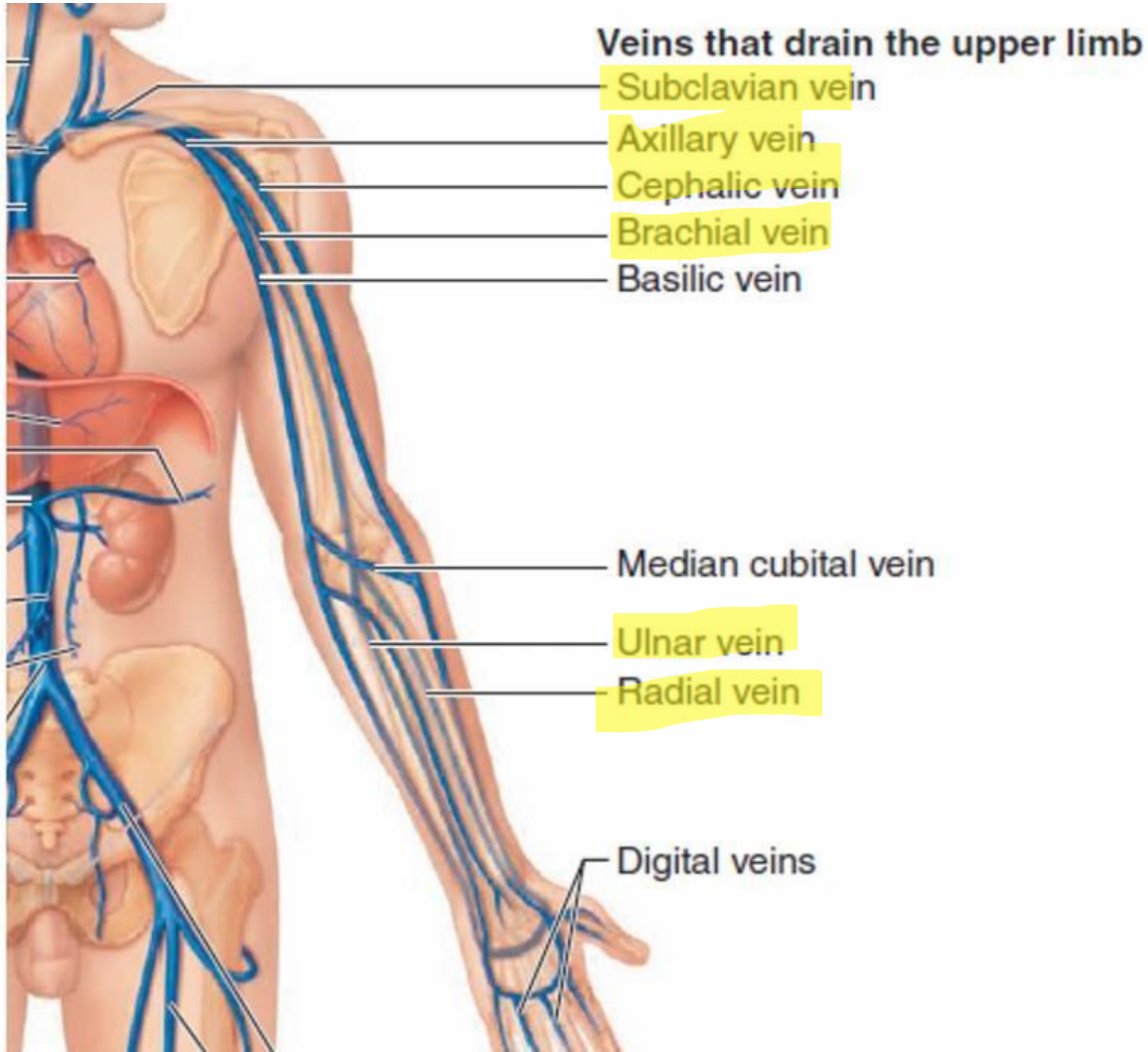
SYSTEMIC CIRCULATION: VEINS



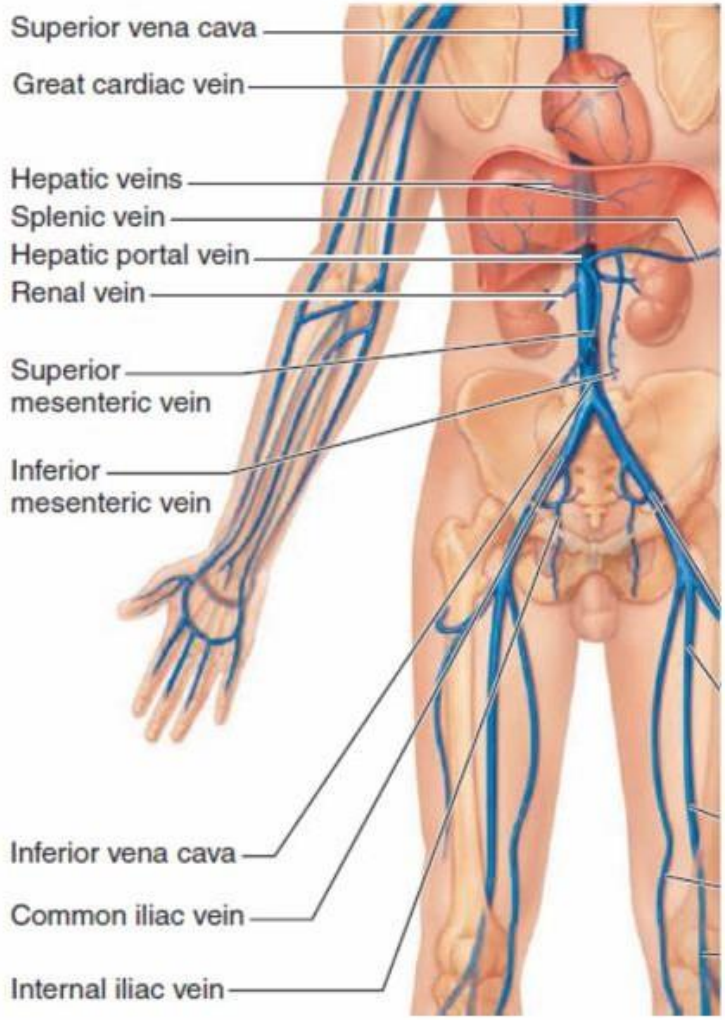
VEINS OF THE HEAD, NECK AND THORAX



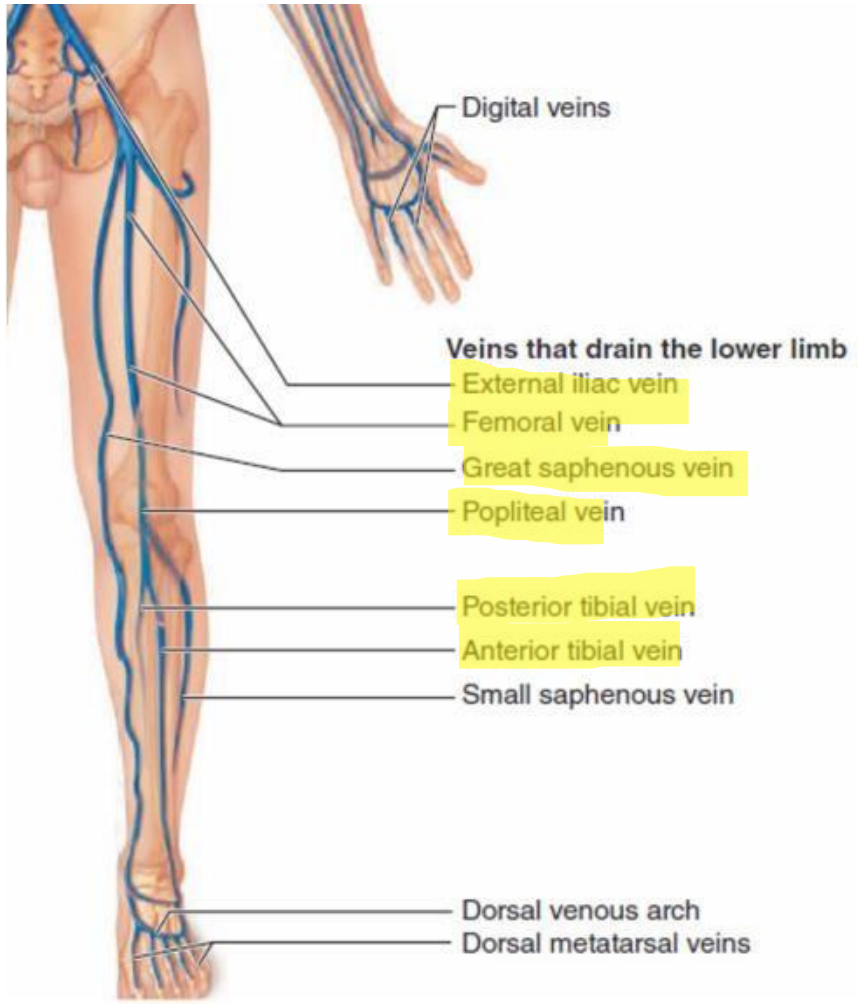
VEINS OF THE UPPER LIMB



VEINS OF THE ABDOMEN AND PELVIS

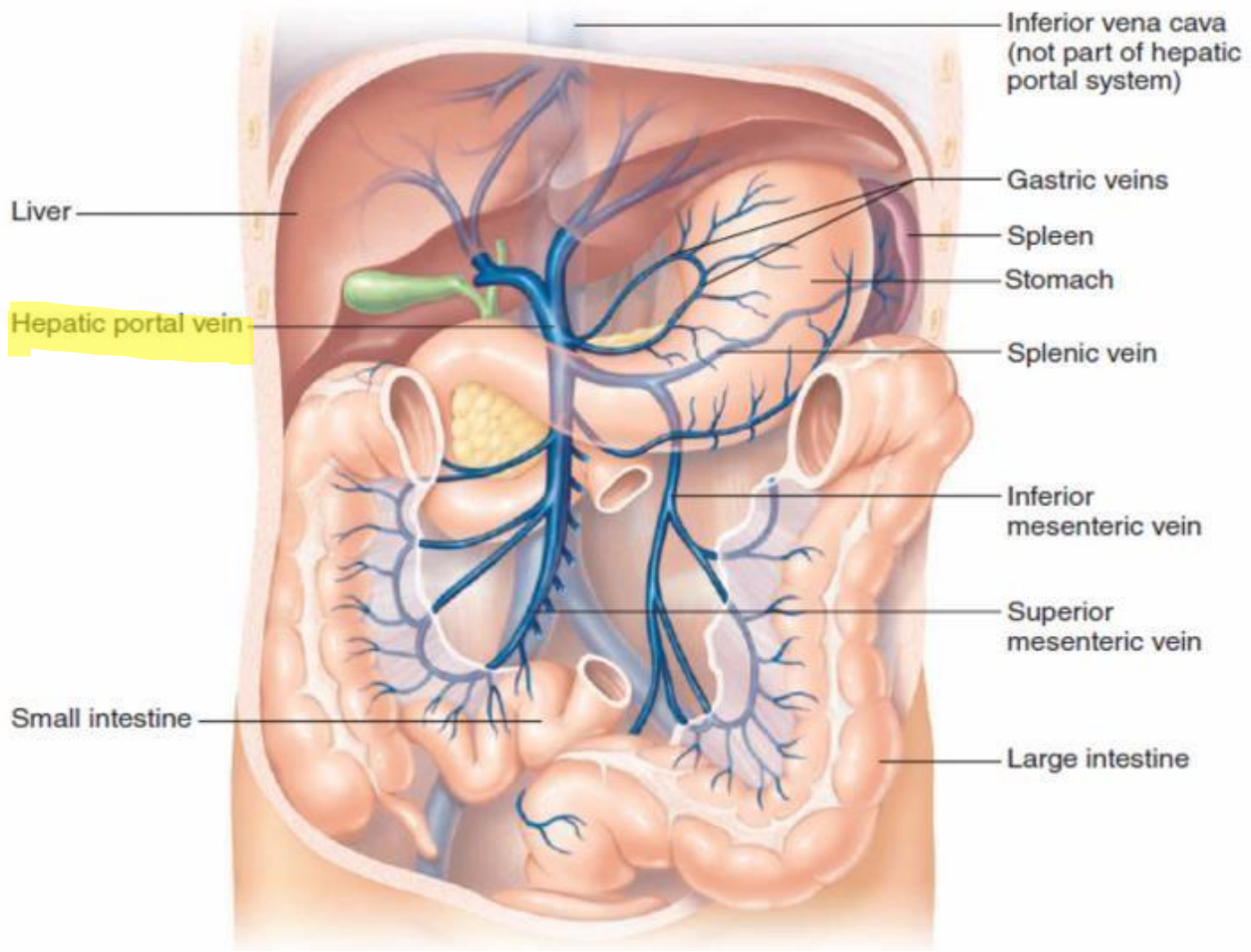


VEINS OF THE LOWER LIMB



HEPATIC PORTAL CIRCULATION

- 💡 Clinical Correlation: Which vein is critical for first-pass metabolism?
- Sublingual drugs bypass hepatic metabolism (nitroglycerin for angina).



MAJOR SYSTEMIC VEINS

Upper Body Drainage:

- External & internal jugular veins (head/neck) →
  - Subclavian veins →
    - Brachiocephalic veins →
      - Superior vena cava → Right atrium

Lower Body Drainage:

- Hepatic portal system:
  - Abdominal viscera → Hepatic portal vein → Liver
  - Liver → Hepatic veins → Inferior vena cava
- Pelvis/legs:
  - Internal iliac veins (pelvic organs)
  - External iliac veins (legs) →
    - Common iliac veins →
      - Inferior vena cava → Right atrium

BLOOD VESSELS & PHARMACOLOGY

💡 Clinical Correlation:

Aorta Branches:

•Coronary arteries → nitroglycerin for angina.

•Carotid arteries → anticoagulants for stroke prevention.

Hepatic Portal Vein:

•First-pass metabolism → sublingual nitroglycerin bypasses liver.

HOME ACTIVITY

Foetal (Fetal) Circulation | Embryology

- https://www.youtube.com/watch?v=m3p5PsB6aZ4&ab_channel=ByteSizeMed
- https://www.youtube.com/watch?v=iciwEwNXEWI&ab_channel=AJmonics

THANK YOU

Key Take Home Message: Anatomy dictates function; function dictates pharmacology.