



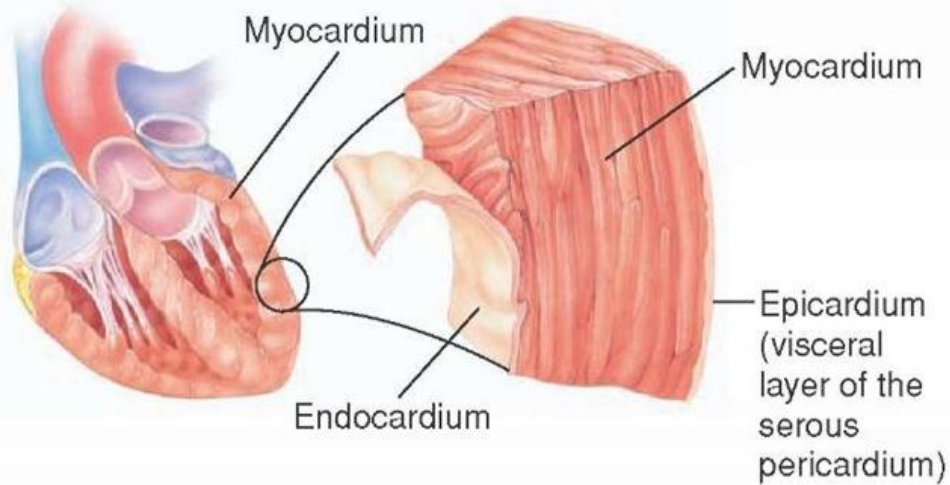
# Cardiovascular System

## Introduction to Anatomy and Embryology

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# Heart

- ✓ Roughly the same size (but not the same shape) as your closed fist.
- ✓ An average mass of 250 g in adult females and 300 g in adult males.
- ✓ The heart rests on the diaphragm, near the midline of the thoracic cavity.
- ✓ The heart lies in the mediastinum
- ✓ About two-thirds of the heart lies to the left of the body's midline
- ✓ Four chambers
  - Two atria, two ventricles



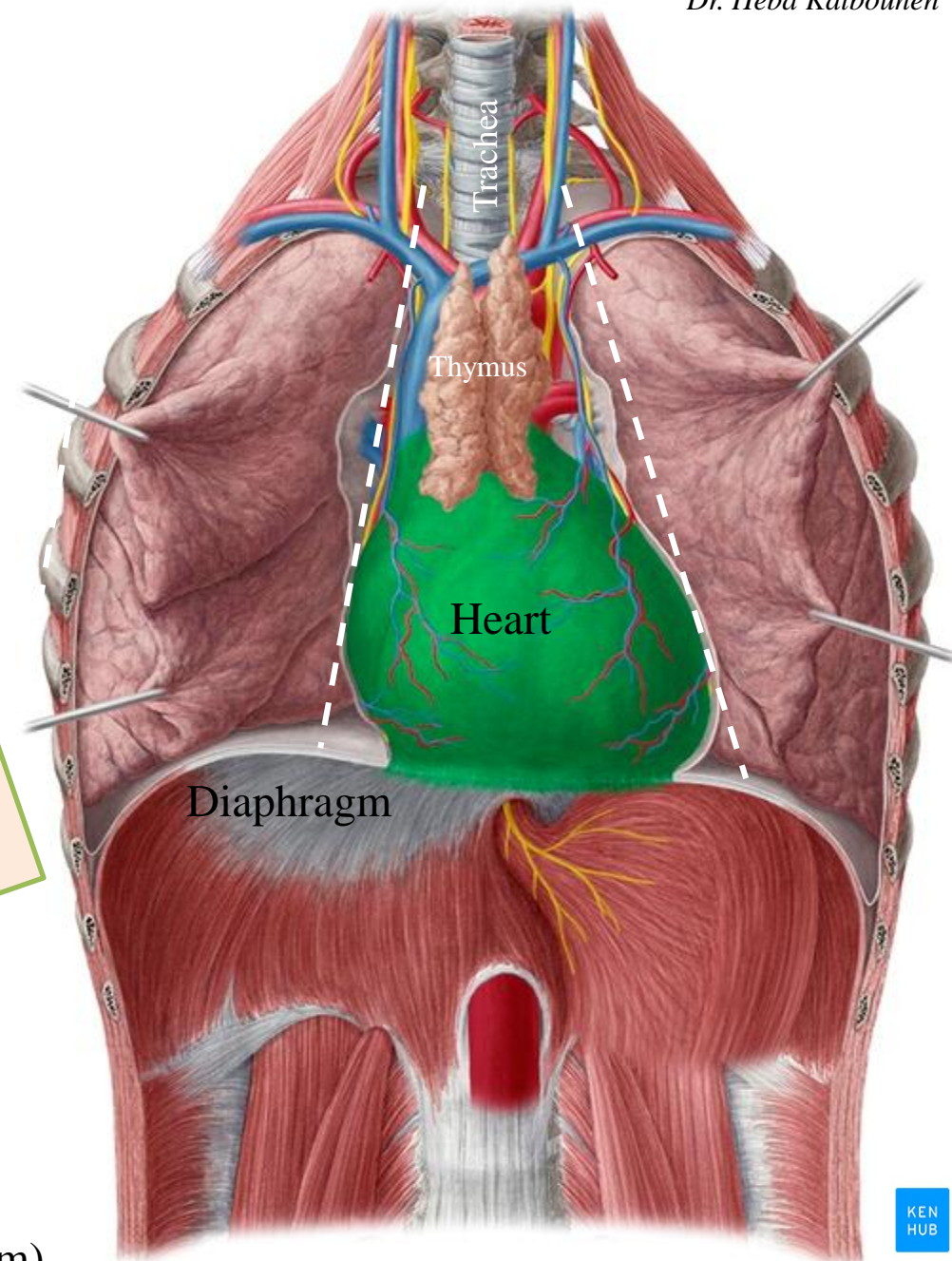
**Mediastinum**  
Is an anatomical region that extends from the sternum to the vertebral column, from the first rib to the diaphragm, and between the lungs.

The wall of the heart consists of three layers:

**Epicardium** (external layer): visceral layer of serous pericardium

**Myocardium** (middle layer): the cardiac muscle

**Endocardium** (inner layer): lining the chambers (simple squamous epithelium)





**The apex** is formed by the tip of the left ventricle and rests on the diaphragm. It is directed **anteriorly, inferiorly, and to the left**.

(approximately at the level of the fifth intercostal space)

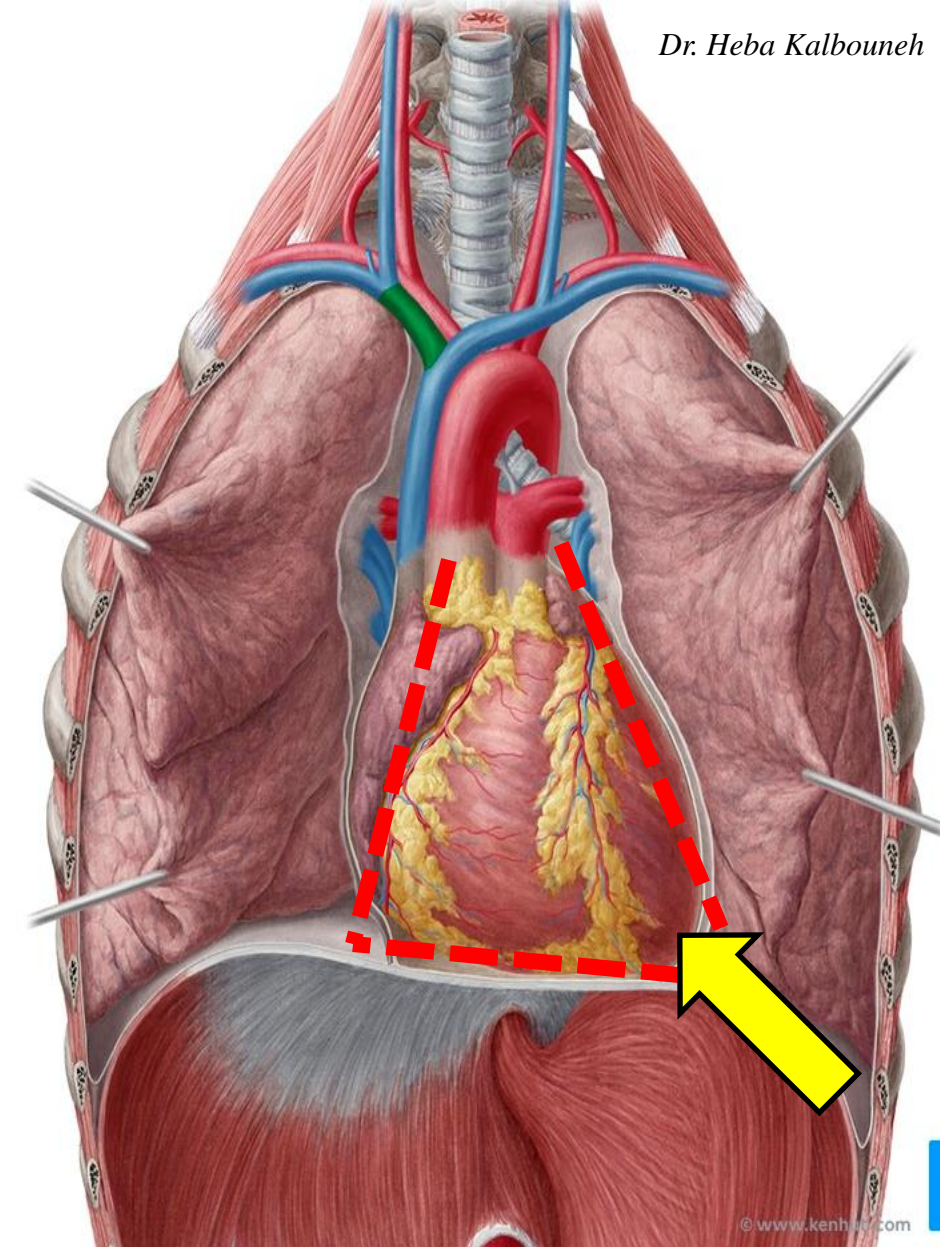
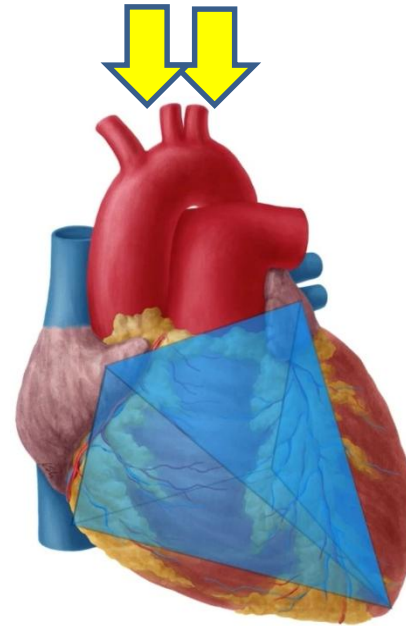
**The base** of the heart is its posterior surface.



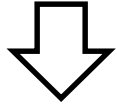
The base is formed mostly by the **left atrium**.

Rt atrium	Lt atrium
Rt ventricle	Lt ventricle

You can visualize the heart as a cone lying on its side.



Because the heart lies between two rigid structures (the vertebral column and the sternum)



External pressure on the chest (compression) can be used to force blood out of the heart and into the circulation.

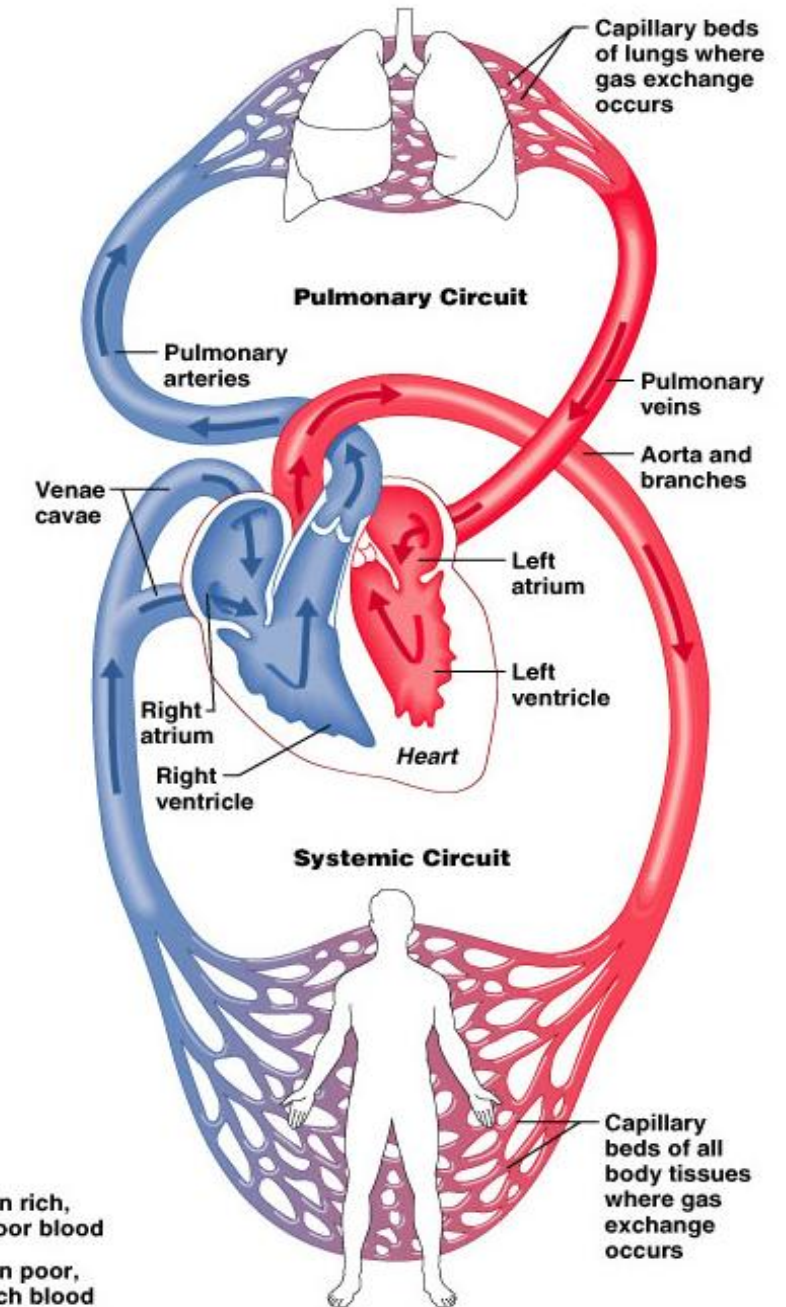
In cases in which the heart suddenly stops beating, cardiopulmonary resuscitation (CPR)—properly applied cardiac compressions, performed with artificial ventilation of the lungs via mouth-to-mouth respiration—saves lives.



CPR keeps oxygenated blood circulating until the heart can be restarted.

## Function:

- The right side receives deoxygenated blood from the body and tissues and then pumps it to the lungs.
- Left side receives oxygenated blood returning from the lungs and pumps this blood throughout the body to supply oxygen
- Two circulations
  - **Systemic** blood vessels that transport blood to and from all the body tissues
  - **Pulmonary**: blood vessels that carry blood to and from the lungs

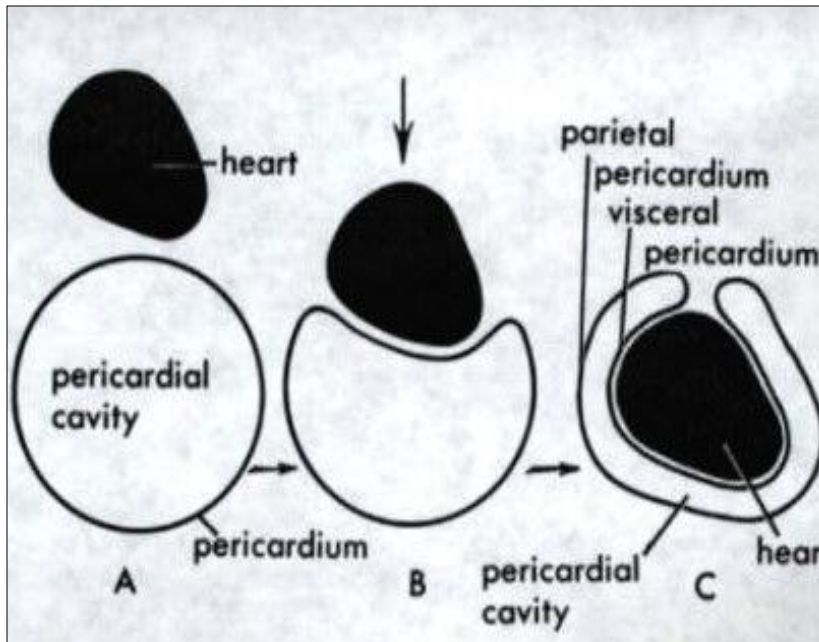




## Pericardium *The sac where the heart sits in*

Is the membrane that surrounds and protects the heart:

- (1) The fibrous pericardium: is composed of tough, inelastic, dense irregular connective tissue. It resembles a bag, prevents overstretching of the heart and provides protection.
- (2) The serous pericardium: forms a slippery double layer around the heart. The outer **parietal layer** (fused to the fibrous pericardium) The inner **visceral layer** (adheres tightly to the surface of the heart, also called **epicardium**, and is part of its wall)

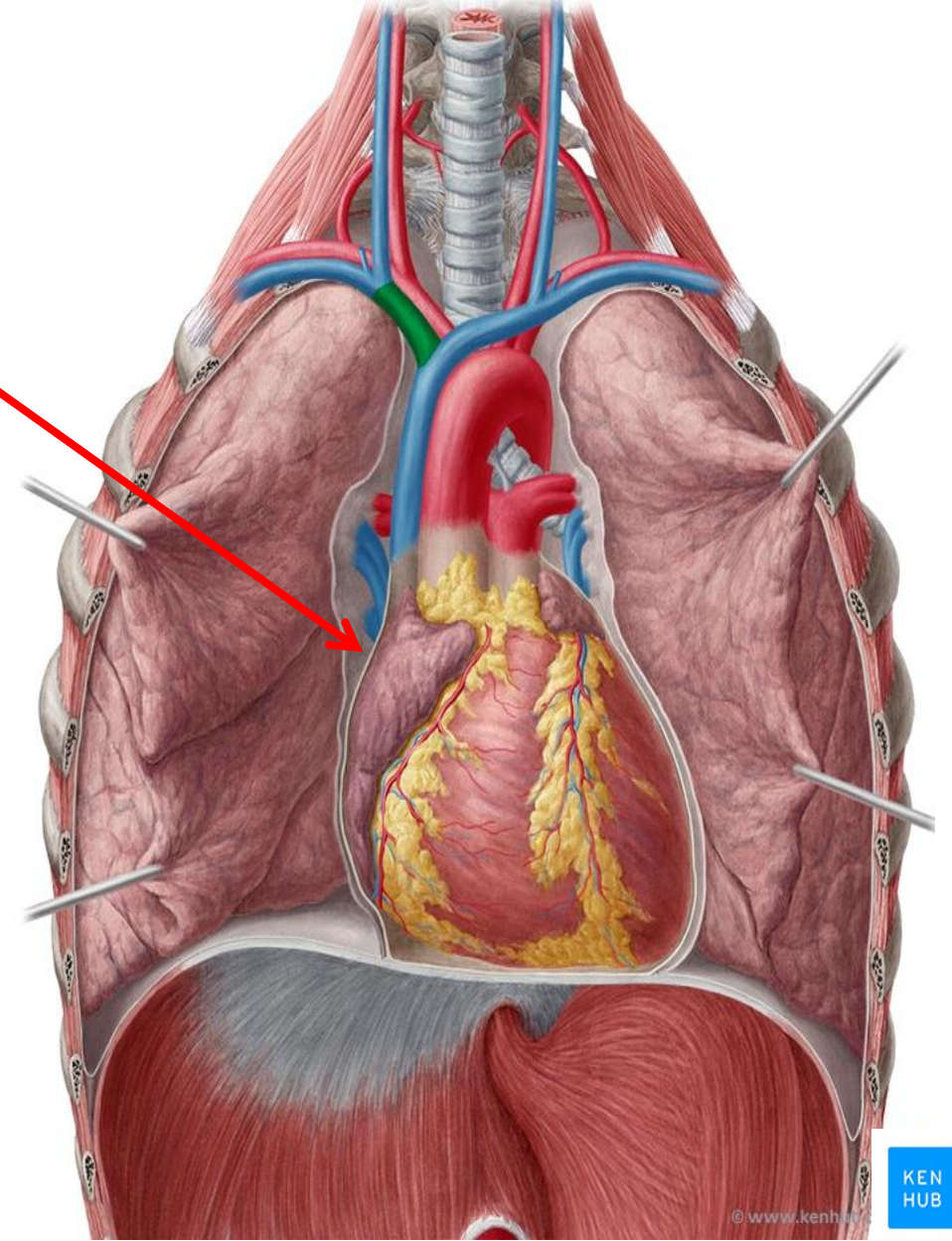


Between the parietal and visceral layers of the serous pericardium is a thin film of lubricating serous fluid.

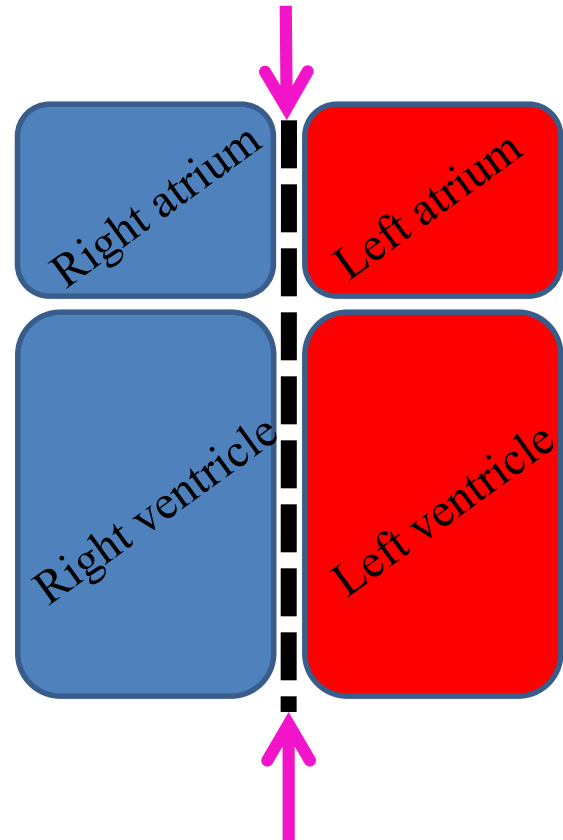
### Pericardial fluid

It reduces friction between the layers of the serous pericardium as the heart moves.

The space that contains the few milliliters of pericardial fluid is called the **pericardial cavity**



Interatrial septum



Interventricular septum

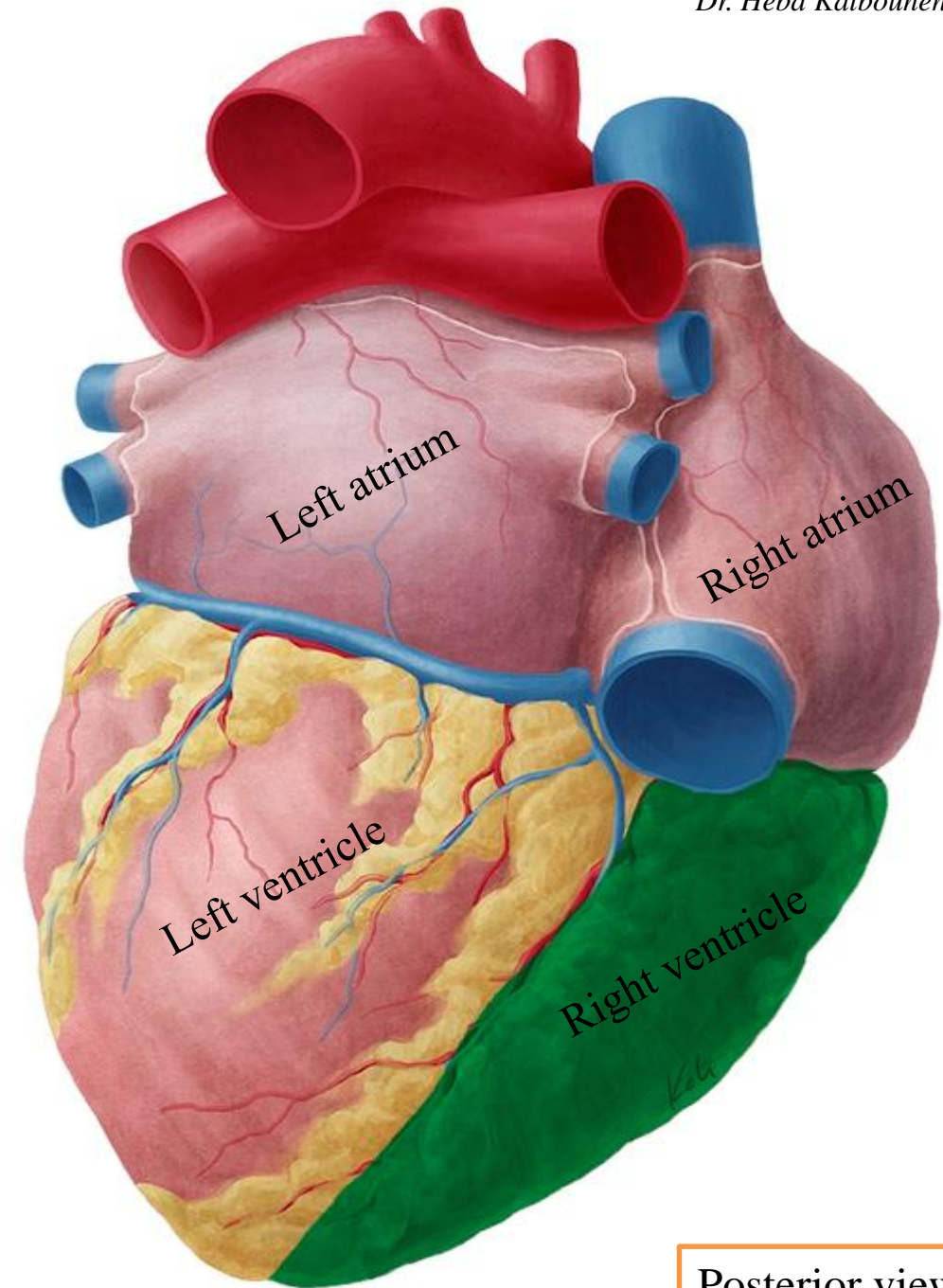
The heart has four hollow chambers: two atria and two ventricles.

**Receiving chambers.** The two superior **atria** are primarily the receiving chambers, they play a lighter role in the pumping activity of the heart.

**Discharging chambers.** The two inferior, thick-walled **ventricles** are the discharging chambers, or actual pumps of the heart wherein when they contract, blood is propelled out of the heart and into the circulation.

**Septum.** The septum that divides the heart longitudinally is:

- 1- The **interventricular** septum
- 2- The **interatrial** septum



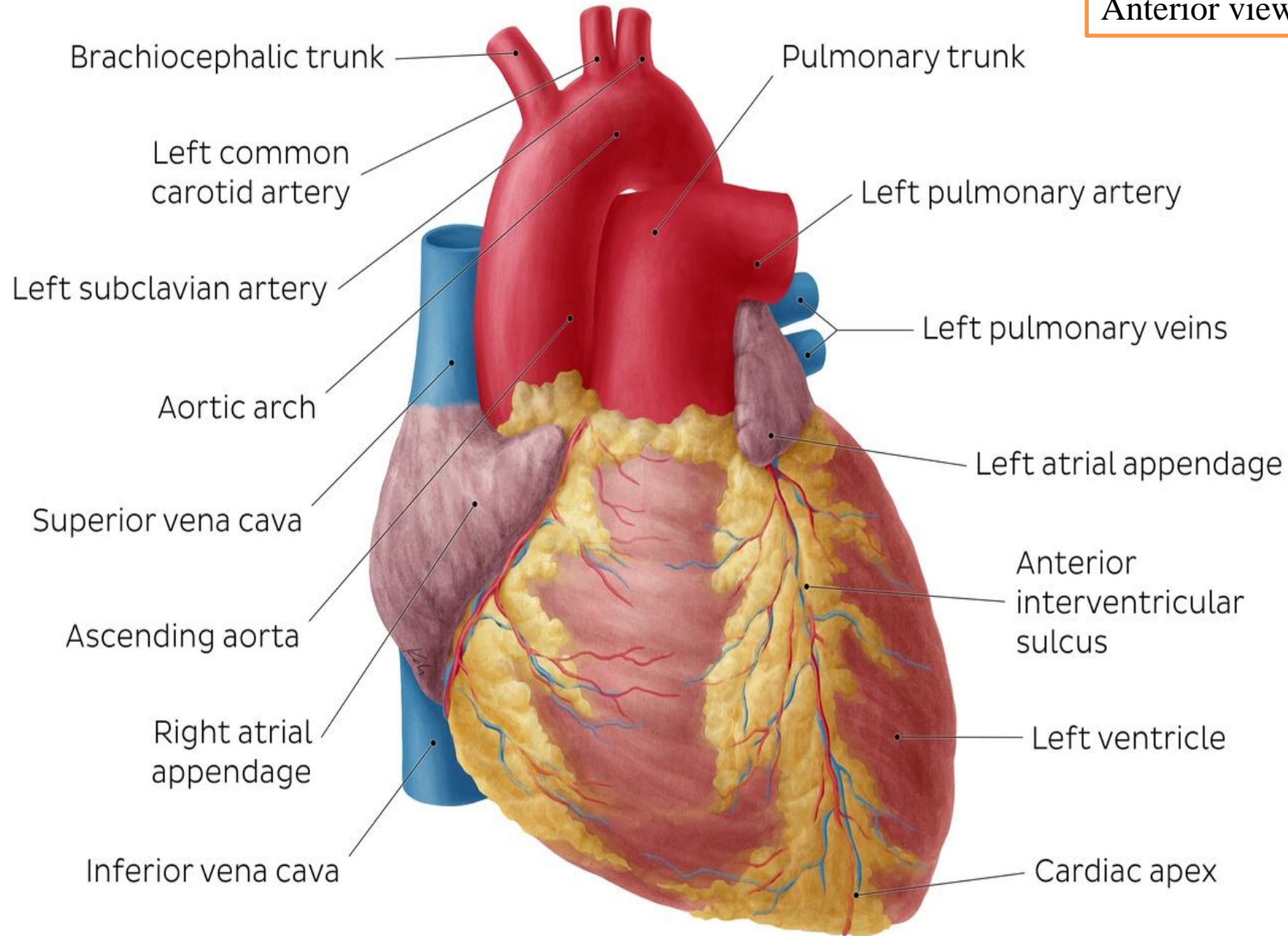
Posterior view

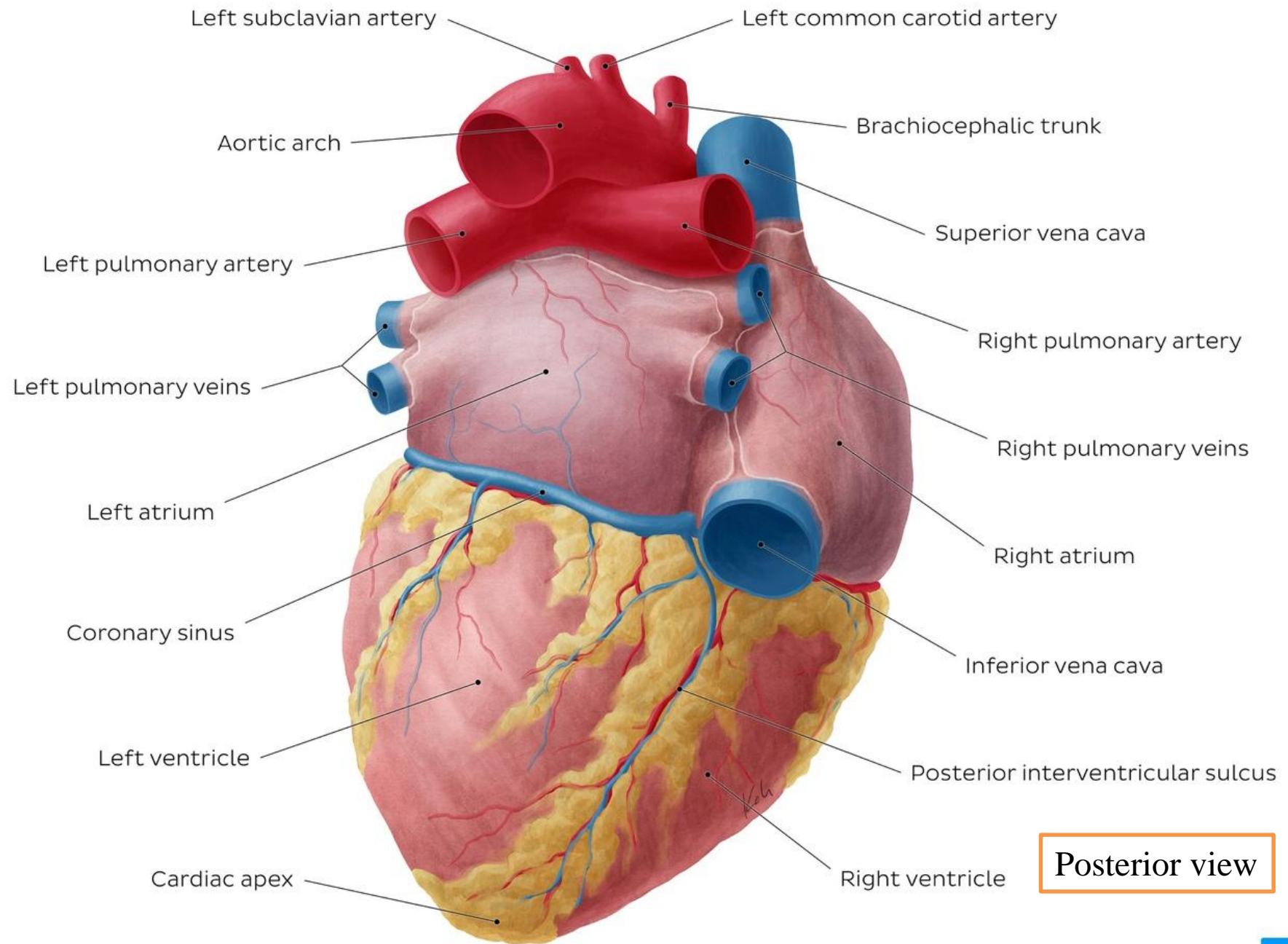
Veins always carry  
blood toward the heart

Arteries always carry  
blood away the heart



## Anterior view







### Aorta:

Blood returned to the left side of the heart is pumped out of the heart into the aorta from which the systemic arteries branch to supply essentially all body tissues.

### Pulmonary arteries

### Superior and inferior vena cava:

The heart receives relatively **oxygen-poor blood** from the veins of the body through the large superior and inferior vena cava and pumps it through the pulmonary trunk

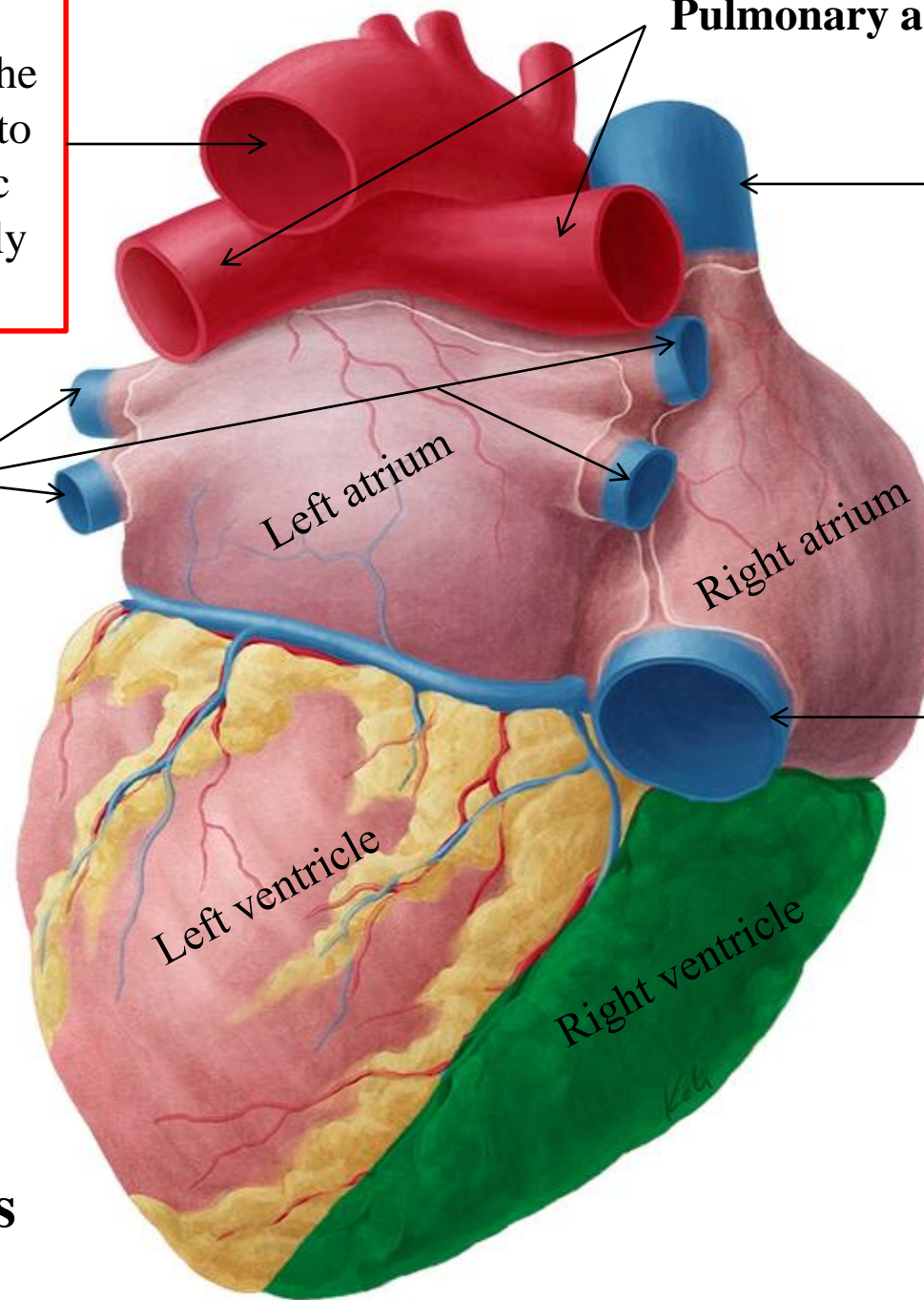
### Pulmonary veins

**Pulmonary veins:**  
**Oxygen-rich blood** drains from the lungs and is returned to the left side of the heart through the four pulmonary veins.

### Pulmonary arteries:

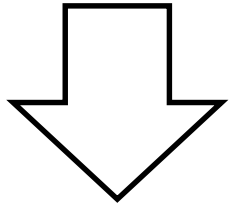
The pulmonary trunk splits into the right and left pulmonary arteries, which carry blood to the lungs, where oxygen is picked up and carbon dioxide is unloaded

## Associated Great Vessels



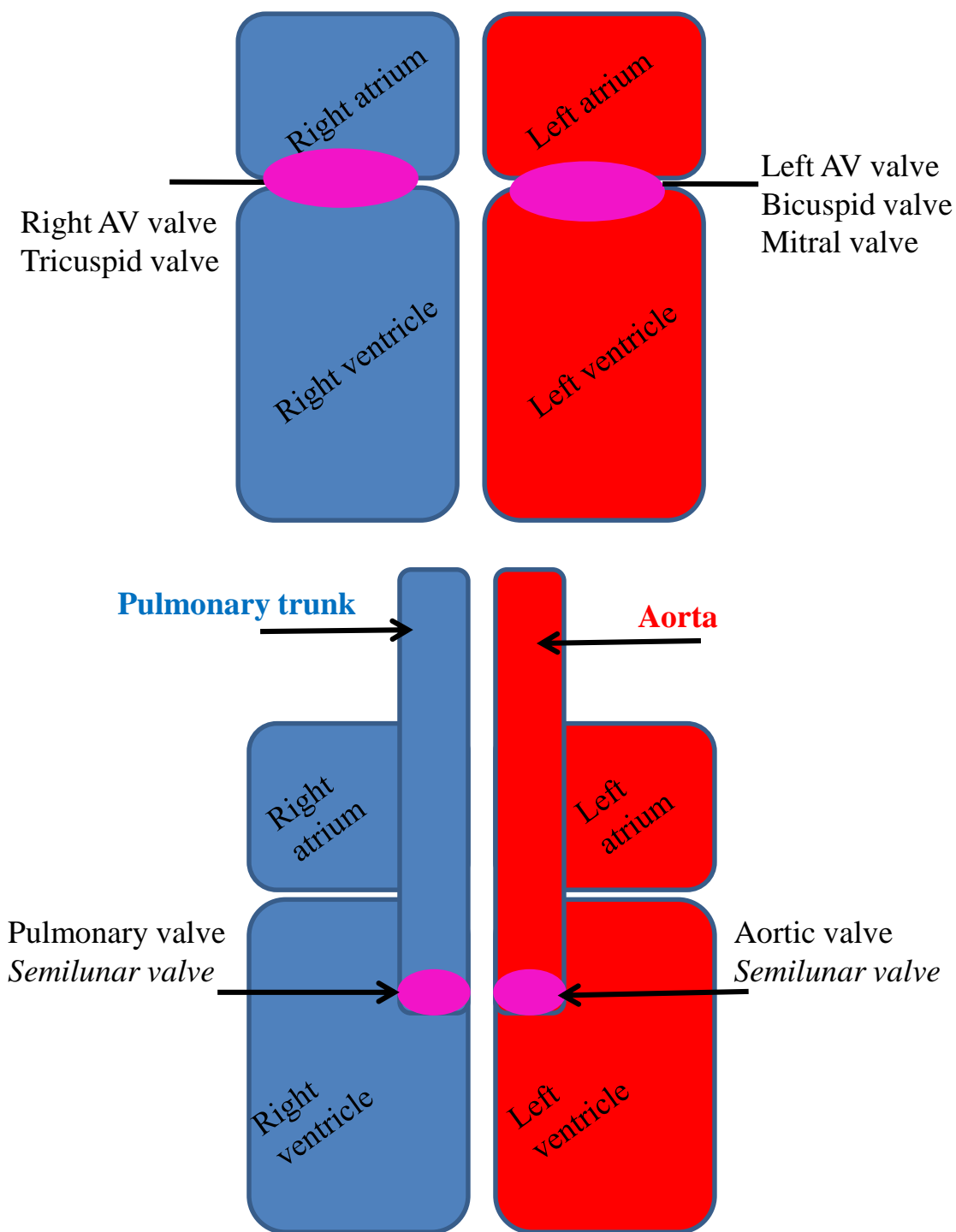
**Heart Valves:** The heart is equipped with four valves, which allow blood to flow in only one direction through the heart chambers

**Atrioventricular valves (AV valves)** are located between the atria and ventricles on each side, and they prevent backflow into the atria when the ventricles contract.

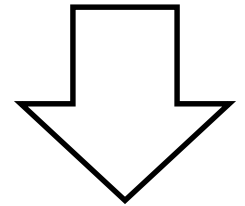


**Tricuspid valve (right AV valve):** has three flaps or cusps, of endocardium.

**Bicuspid valve (left AV valve or mitral valve):** has two flaps



**Semilunar valves** guard the bases of the two large arteries leaving the ventricles

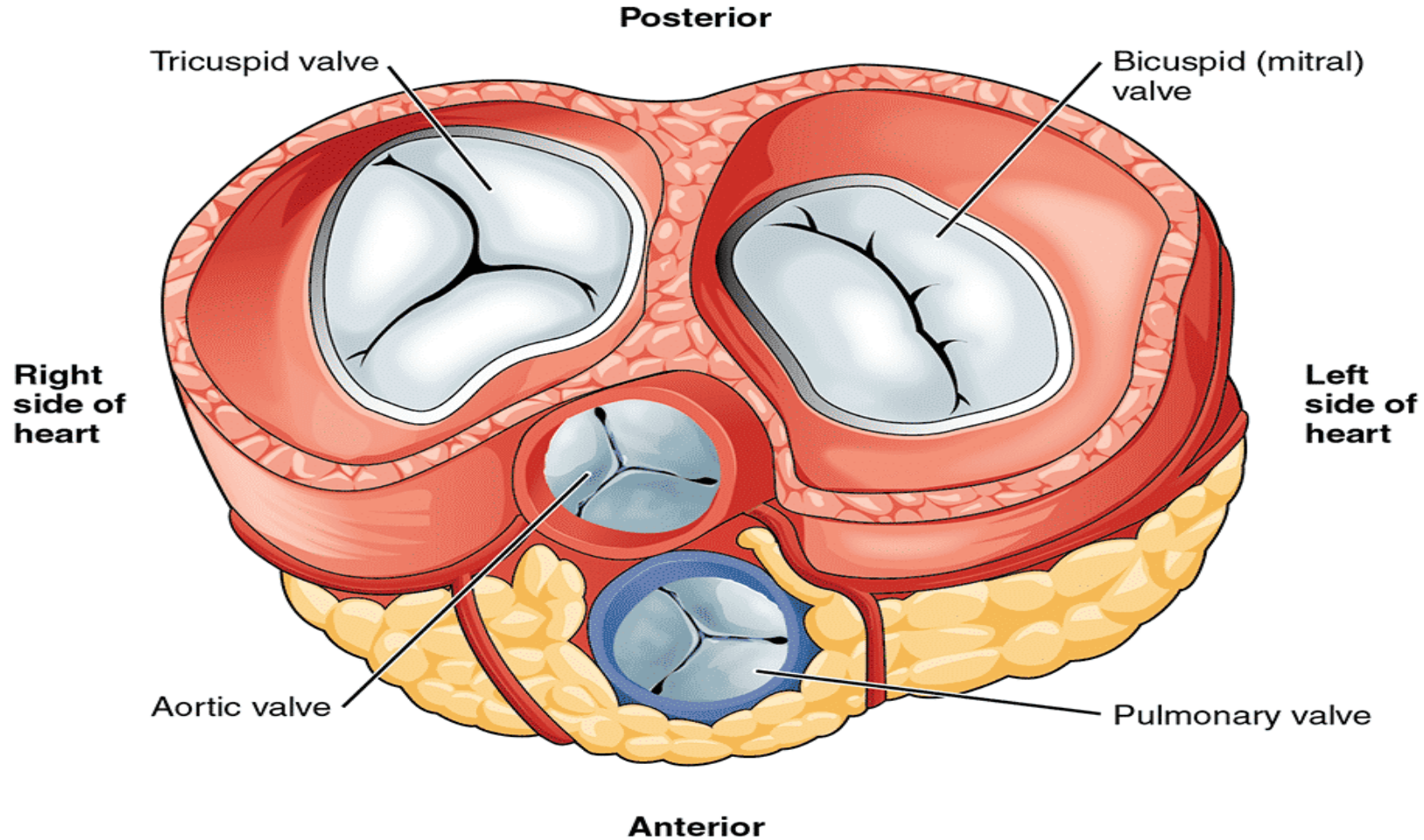


**Pulmonary semilunar valve:** between right ventricle and the pulmonary trunk

**Aortic semilunar valve:** between left ventricle and aorta

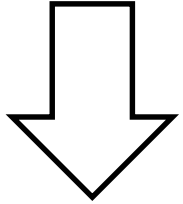


# Heart Valves



# External features of the heart

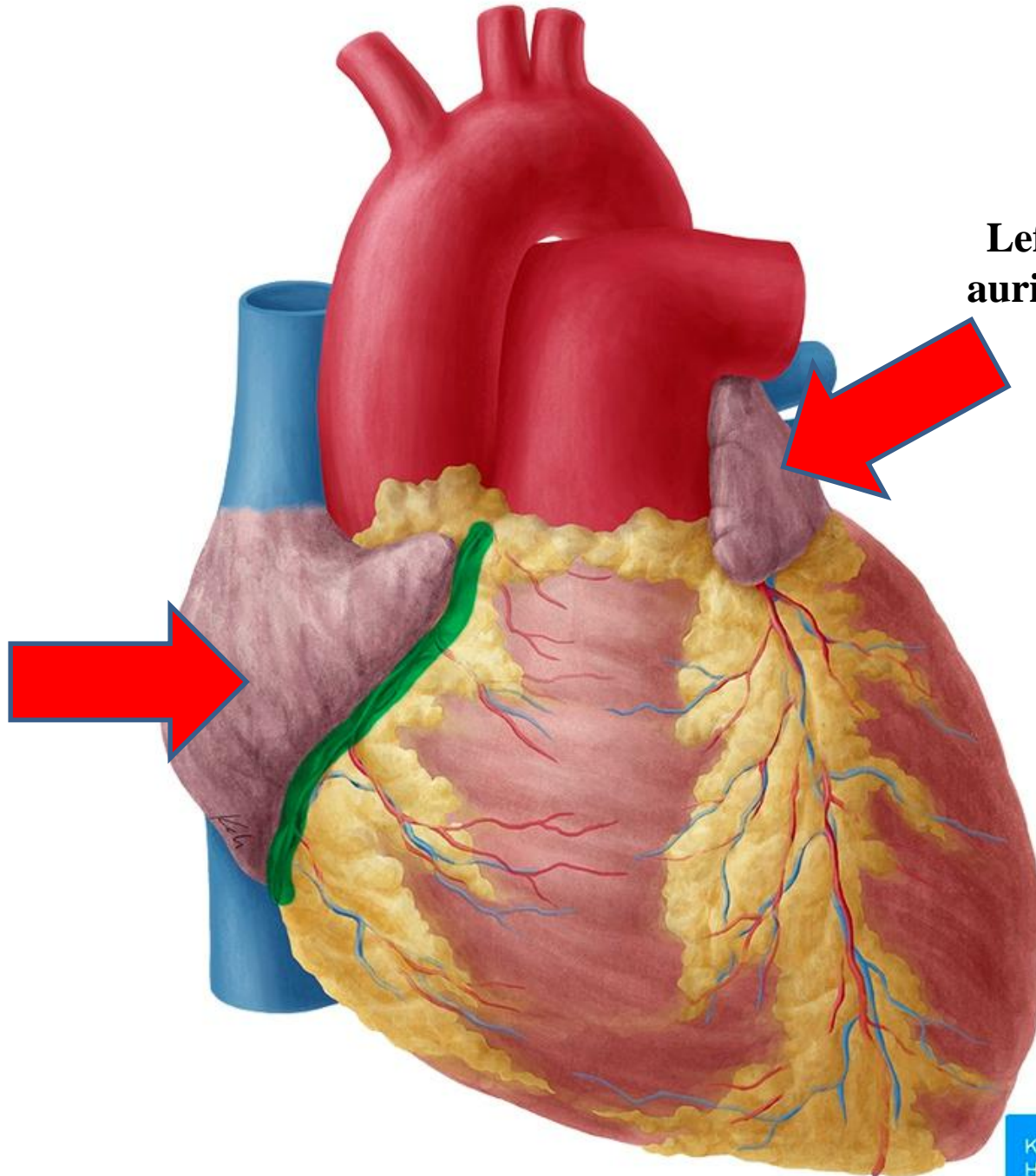
On the anterior surface of each atrium is a wrinkled pouch like structure called an **auricle** (atrial appendage)



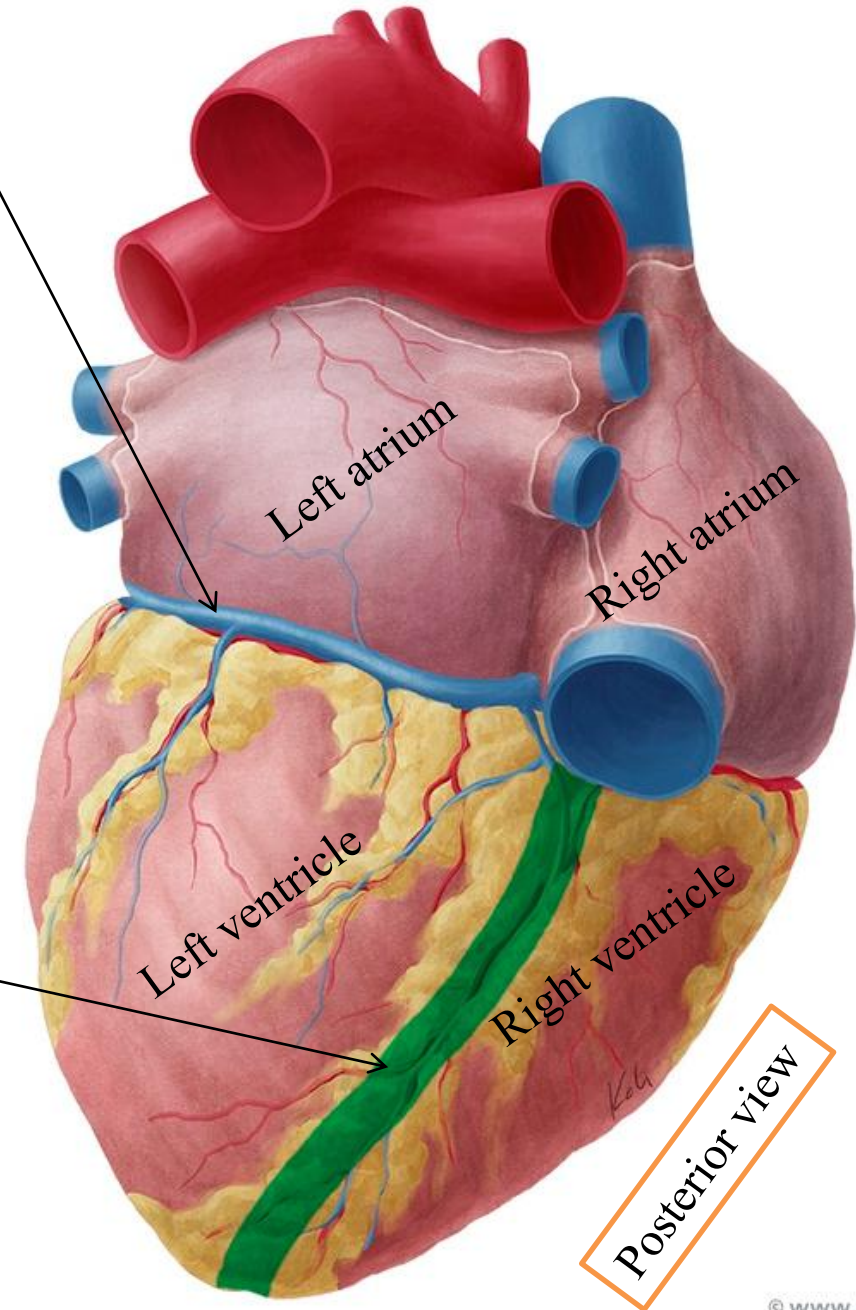
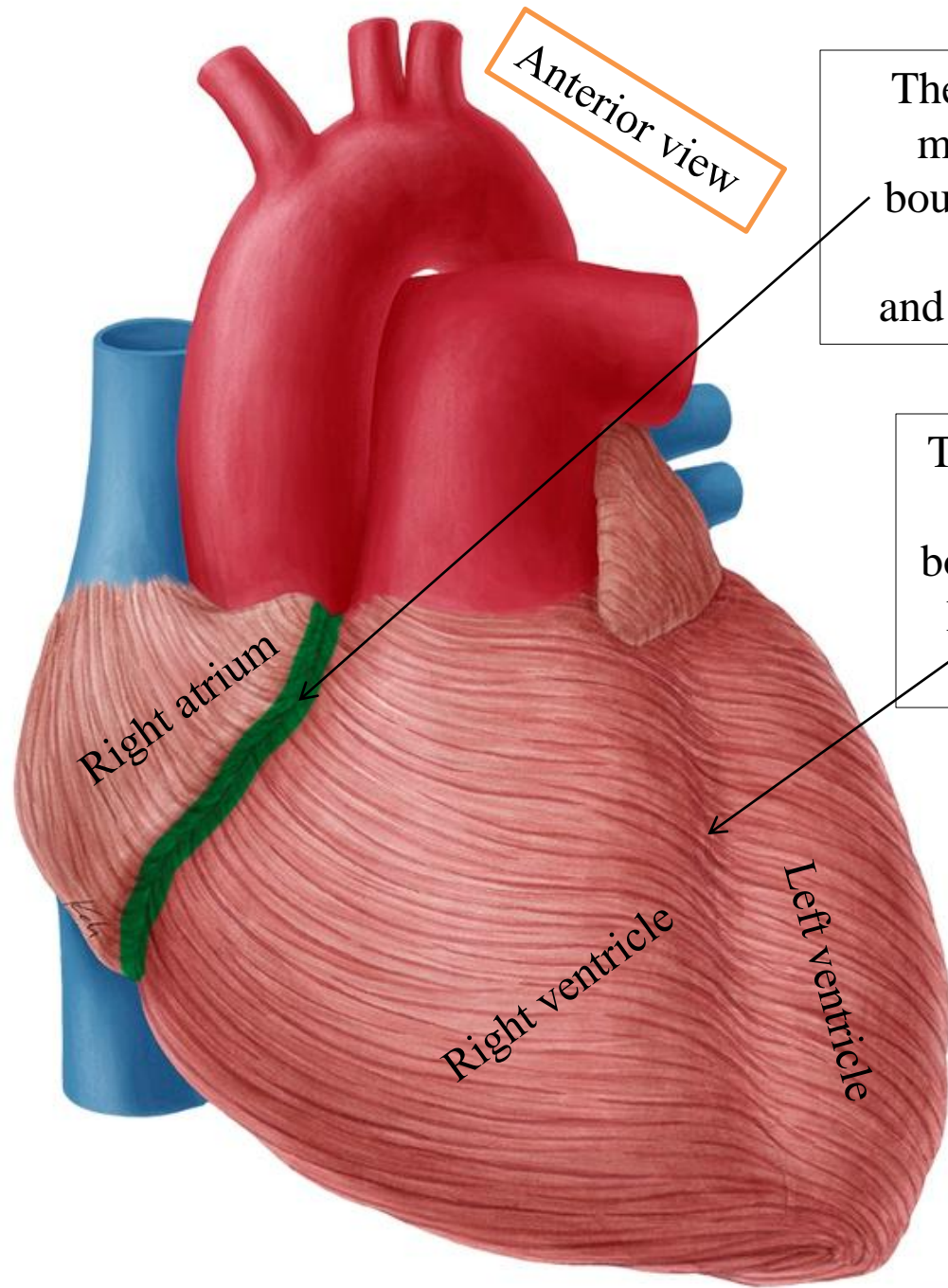
increases the capacity of an atrium

**Right auricle**

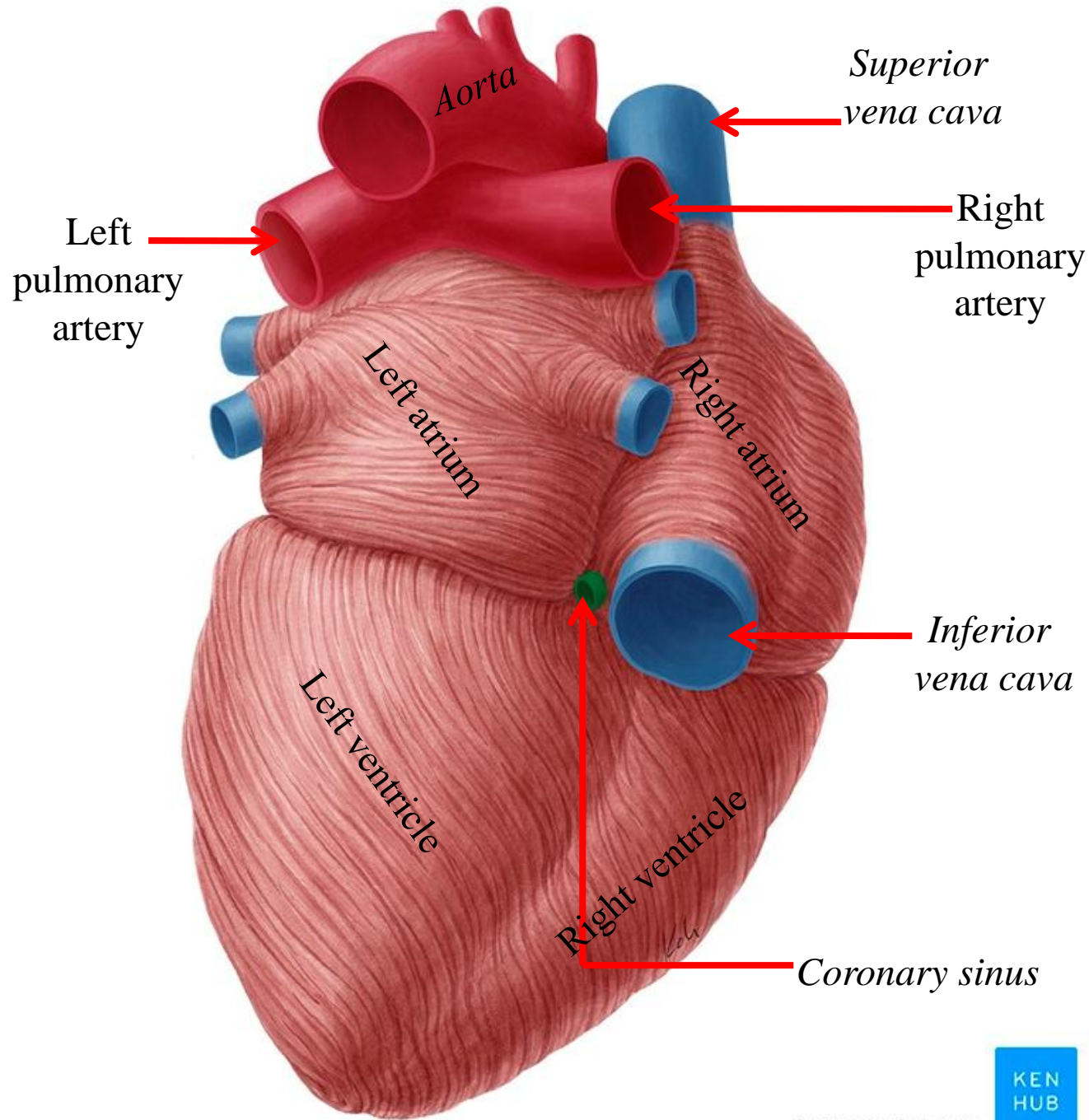
**Left auricle**







Posterior view

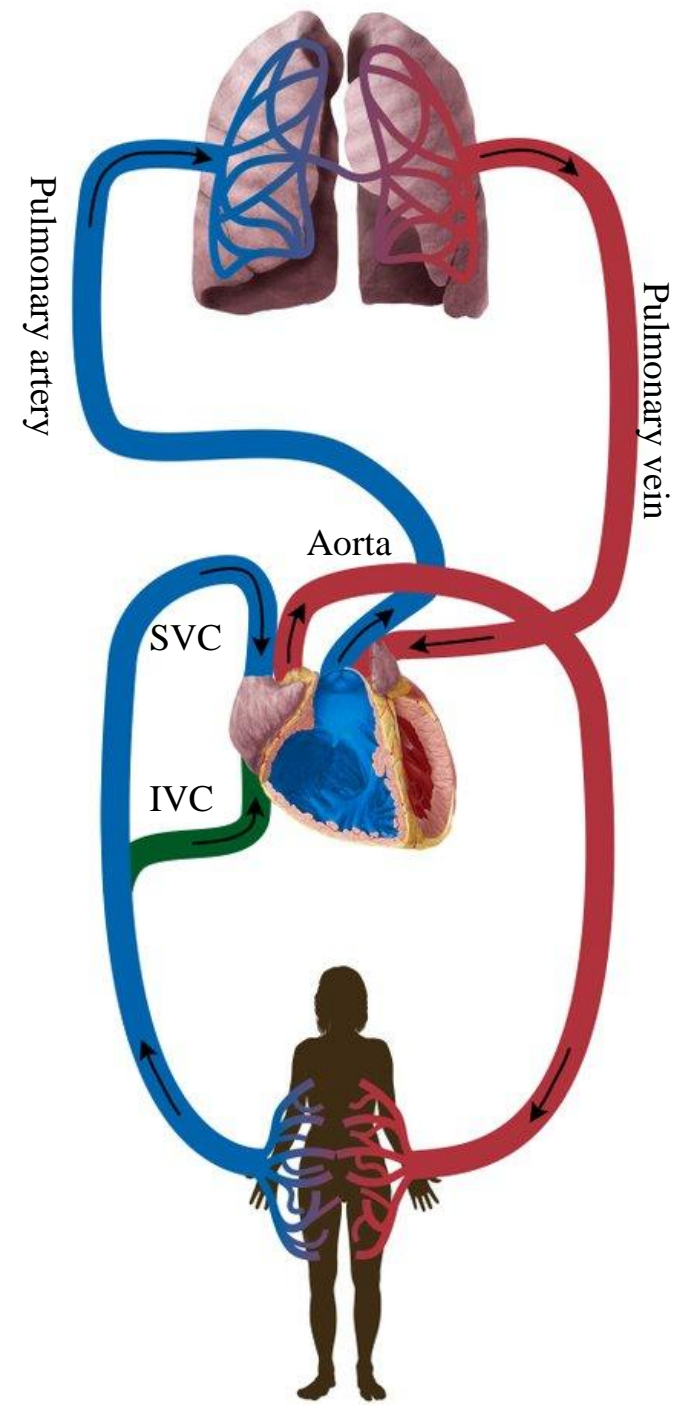
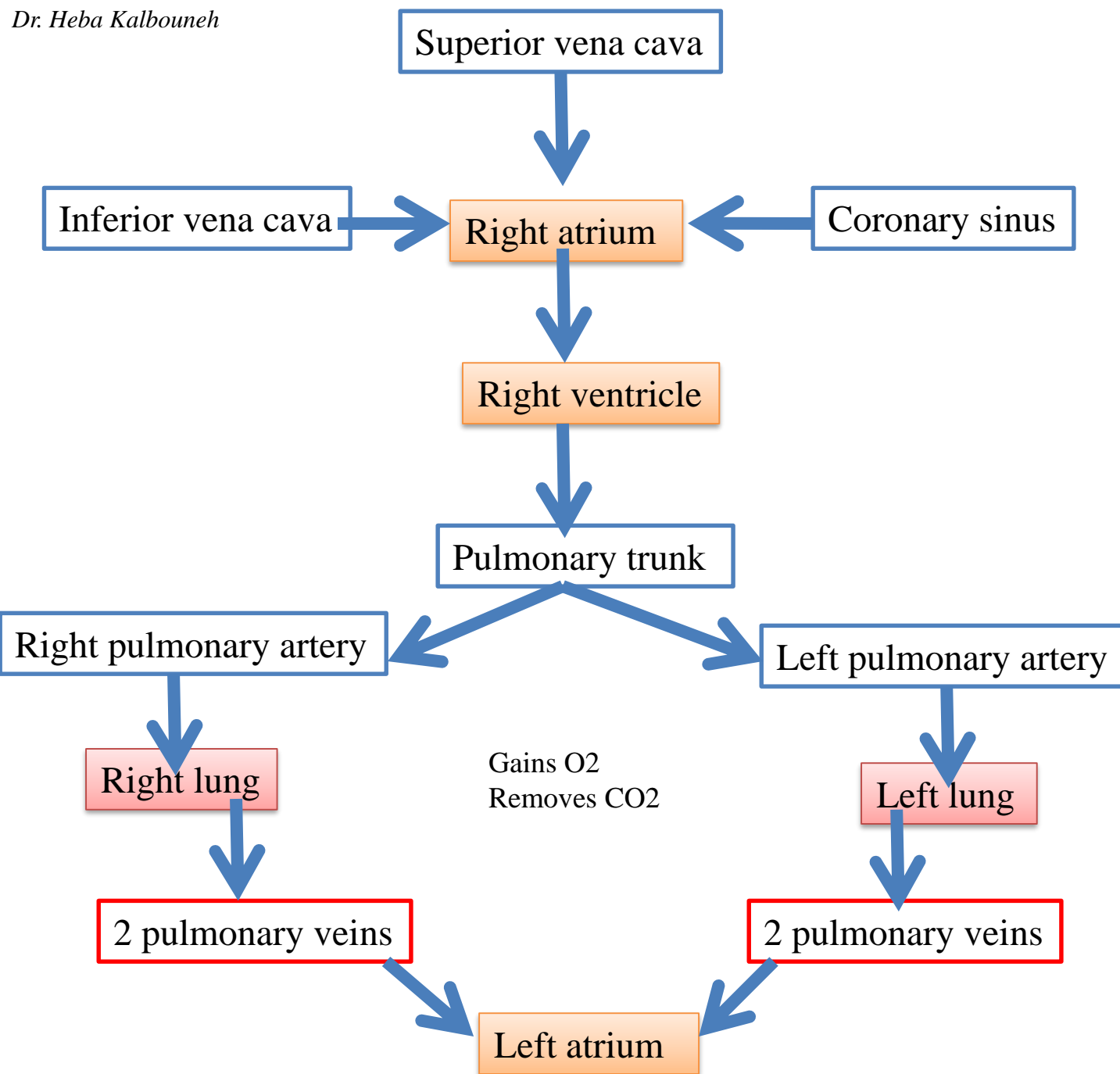


The **pulmonary trunk** divides into **right and left pulmonary arteries** and carries blood to the lungs

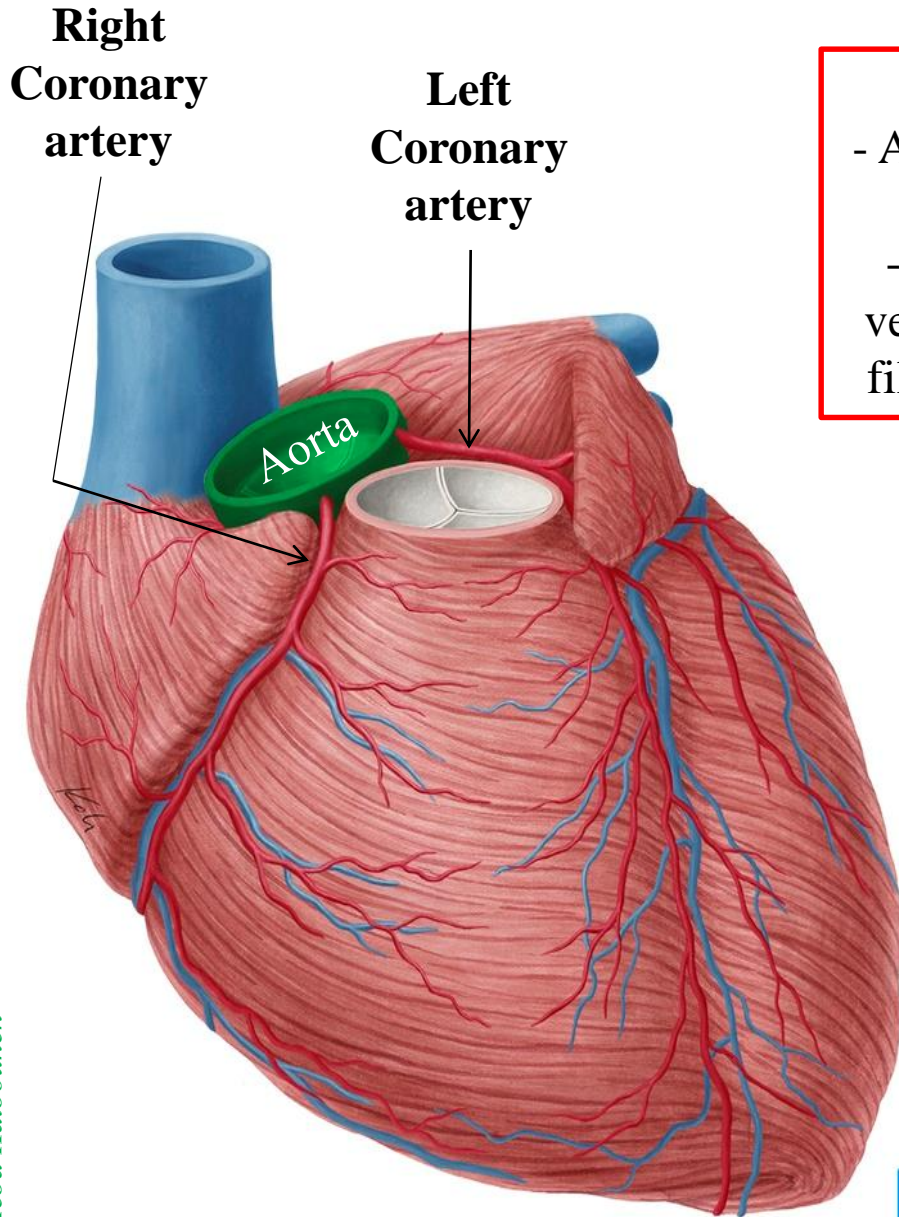
**Inferior vena cava** carries blood from the lower half of the body whilst the **superior vena cava** carries blood from the upper half of the body.

The **coronary sinus** collects the majority of the cardiac venous blood





# Cardiac Circulation Vessels



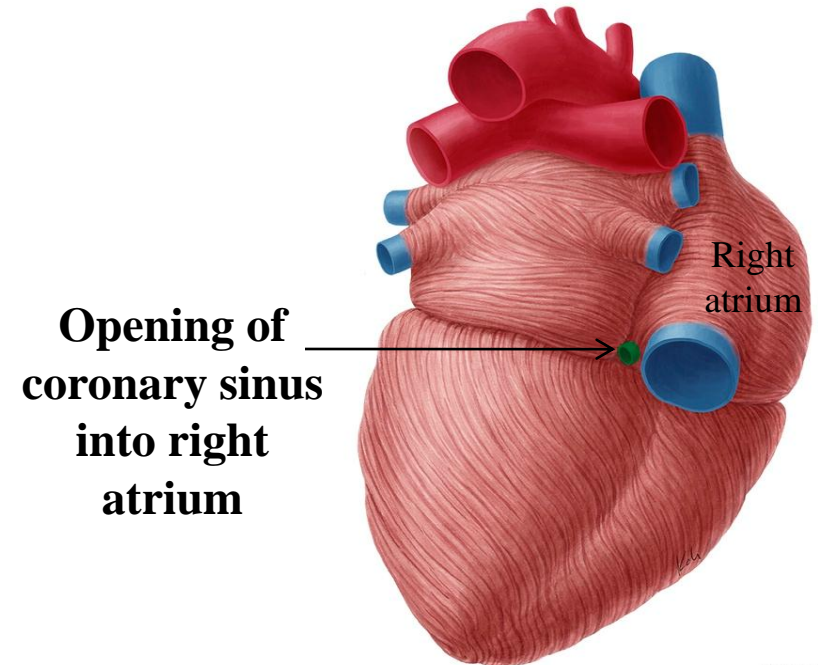
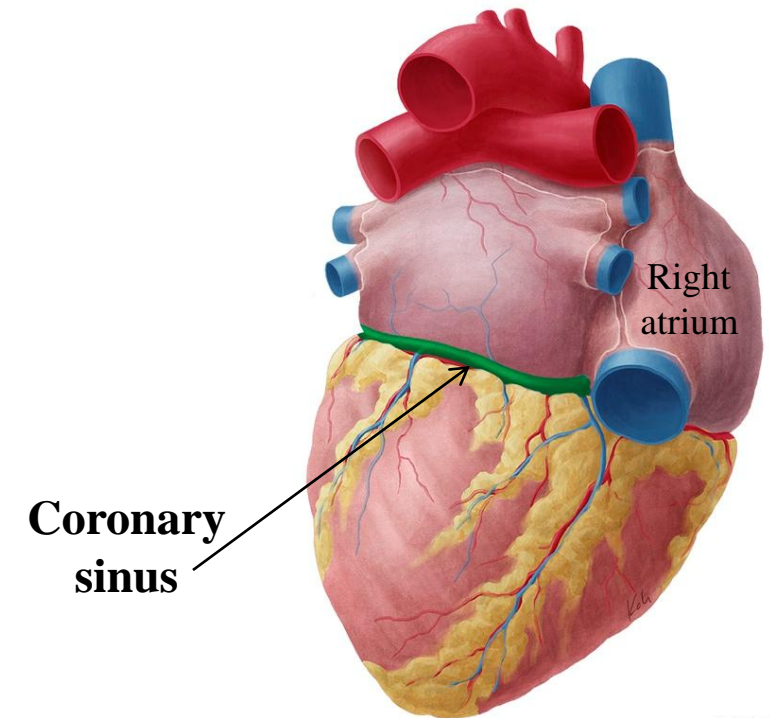
## Coronary arteries

- Are branches from ascending aorta
- Are compressed when the ventricles are contracting and fill when the heart is relaxed.

Note the blood contained in the heart does not nourish the myocardium.

## Cardiac veins

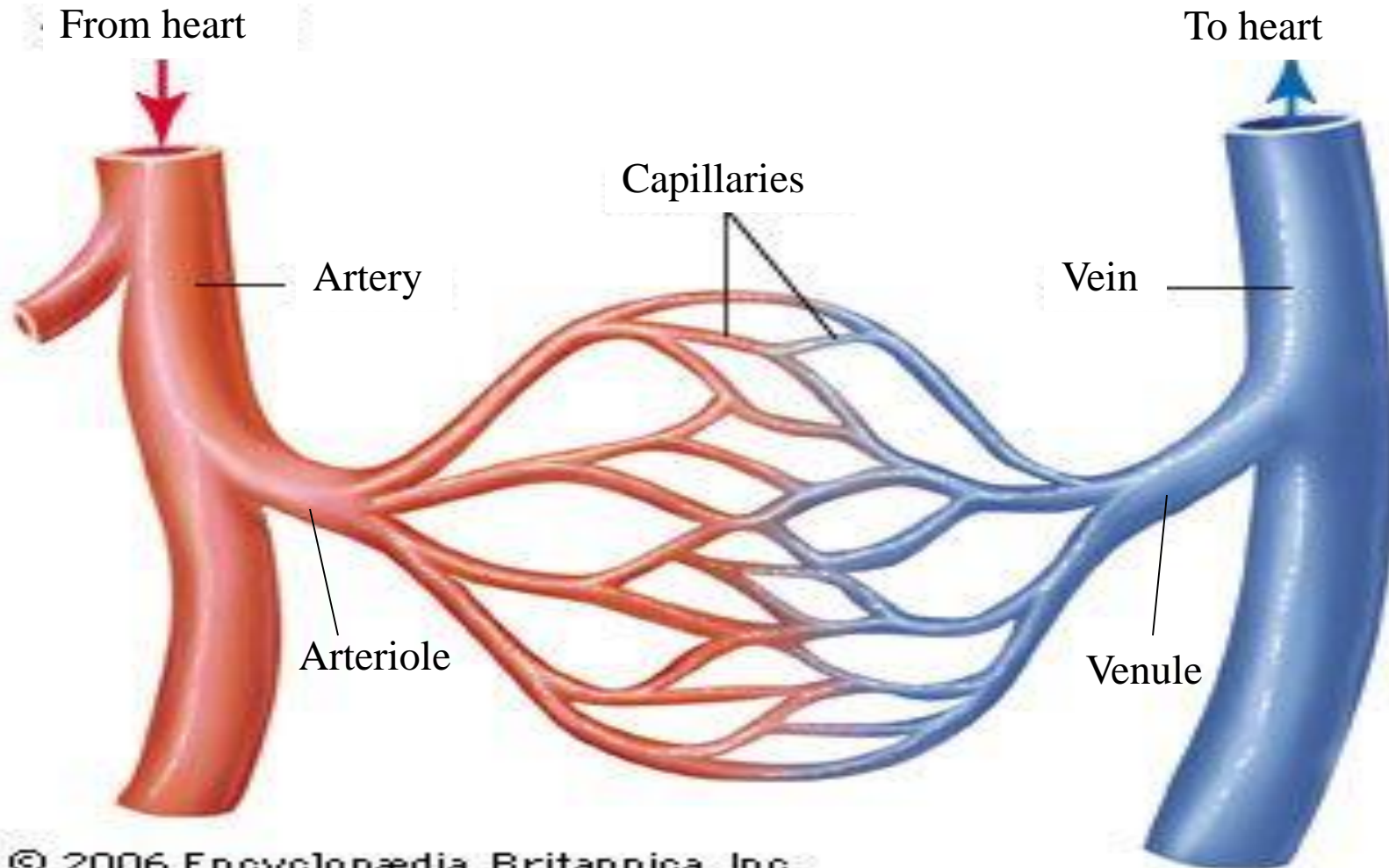
The myocardium is drained by several cardiac veins, which empty into an enlarged vessel on the posterior surface of the heart called the **coronary sinus**.





# Blood Vessels

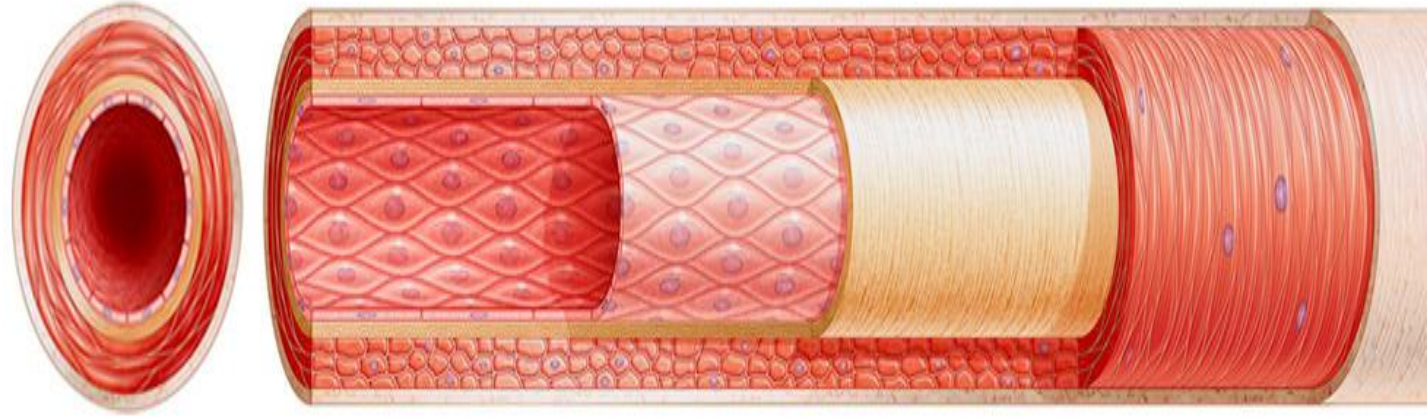
As the heart beats, blood is propelled into large **arteries** leaving the heart. It then moves into successively smaller and smaller arteries and then into **arterioles**, which feed the **capillary beds** in the tissues. Capillary beds are drained by **venules**, which in turn empty into **veins** that finally empty into the great veins entering the heart.



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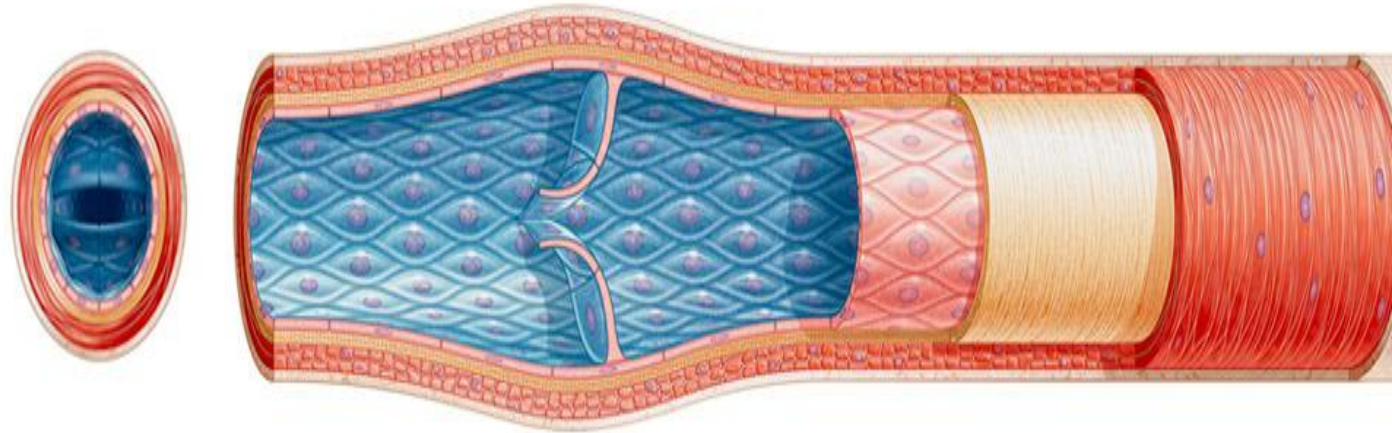
## Artery

- ✓ Thick wall
- ✓ Elastic
- ✓ Relatively Small lumen



## Vein

- ✓ Thin wall
- ✓ Relatively Large lumen
- ✓ Valve



## Capillary

- ✓ Single cell wall





	Arteries	Veins
Blood	Carry oxygenated blood (exception: pulmonary arteries)	Carry deoxygenated blood (exception: pulmonary veins)
Wall thickness	Thicker wall	Thin wall
Body location	Deeply located	Superficial and deep veins
Flow direction	From heart to tissues	From tissues to heart
Color	Bright red	Dark red
Valves	No valves	Valve allowing blood to flow in upward direction and preventing back flow
Pressure	High <b>120/80 mmHg</b>	Low <b>25/12 mmHg</b>
Vessel cut	Blood spurts out	Blood oozes out
Pulse	Yes	No
Lumen	Small	Large

*Note: The lower blood pressure in veins means that valves are needed to stop blood flowing backwards*

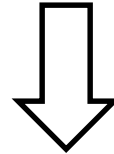
*For example*

*In veins in the legs, blood needs to flow upwards against the pull of gravity*

## Anastomoses

Most tissues of the body receive blood from more than one artery. The union of the branches of two or more arteries supplying the same body region is called an **anastomosis**

Anastomoses between arteries provide alternative routes for blood to reach a tissue or organ.



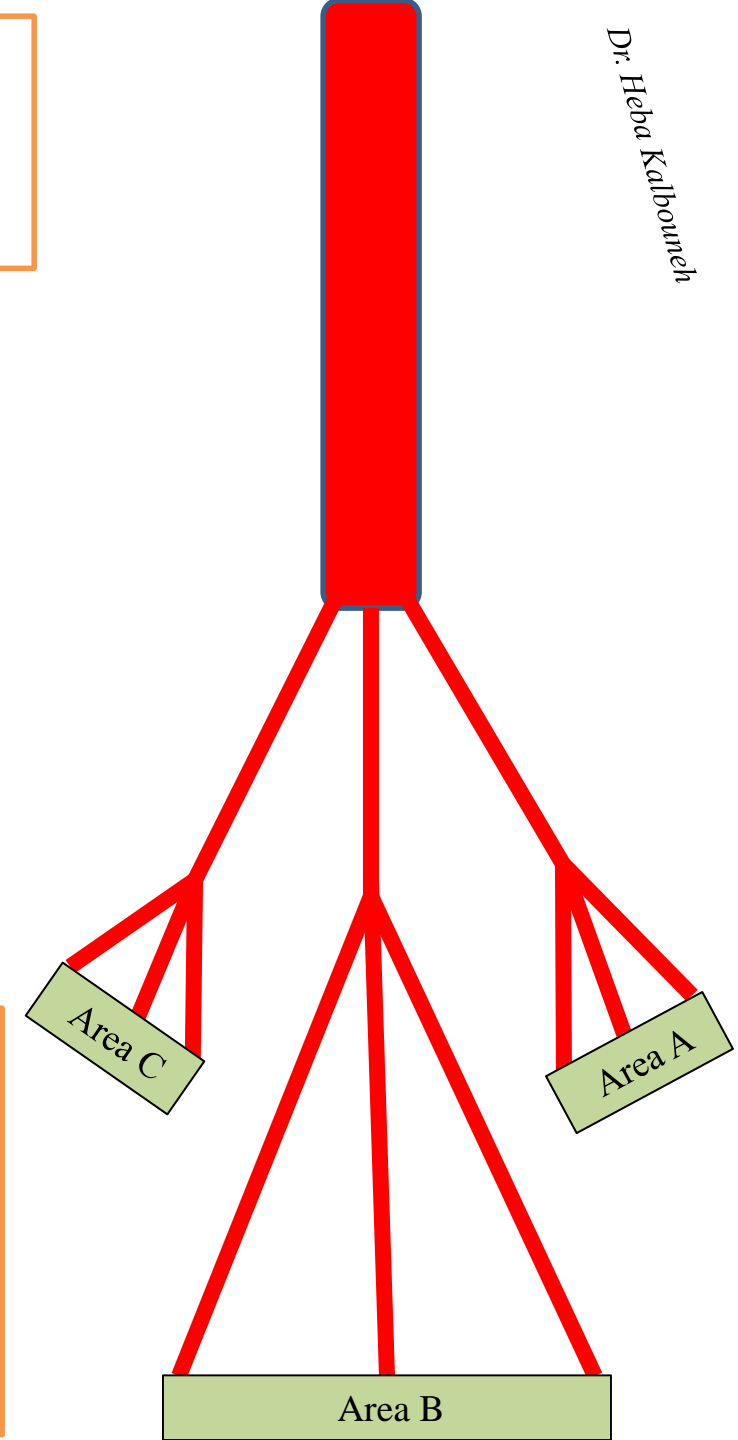
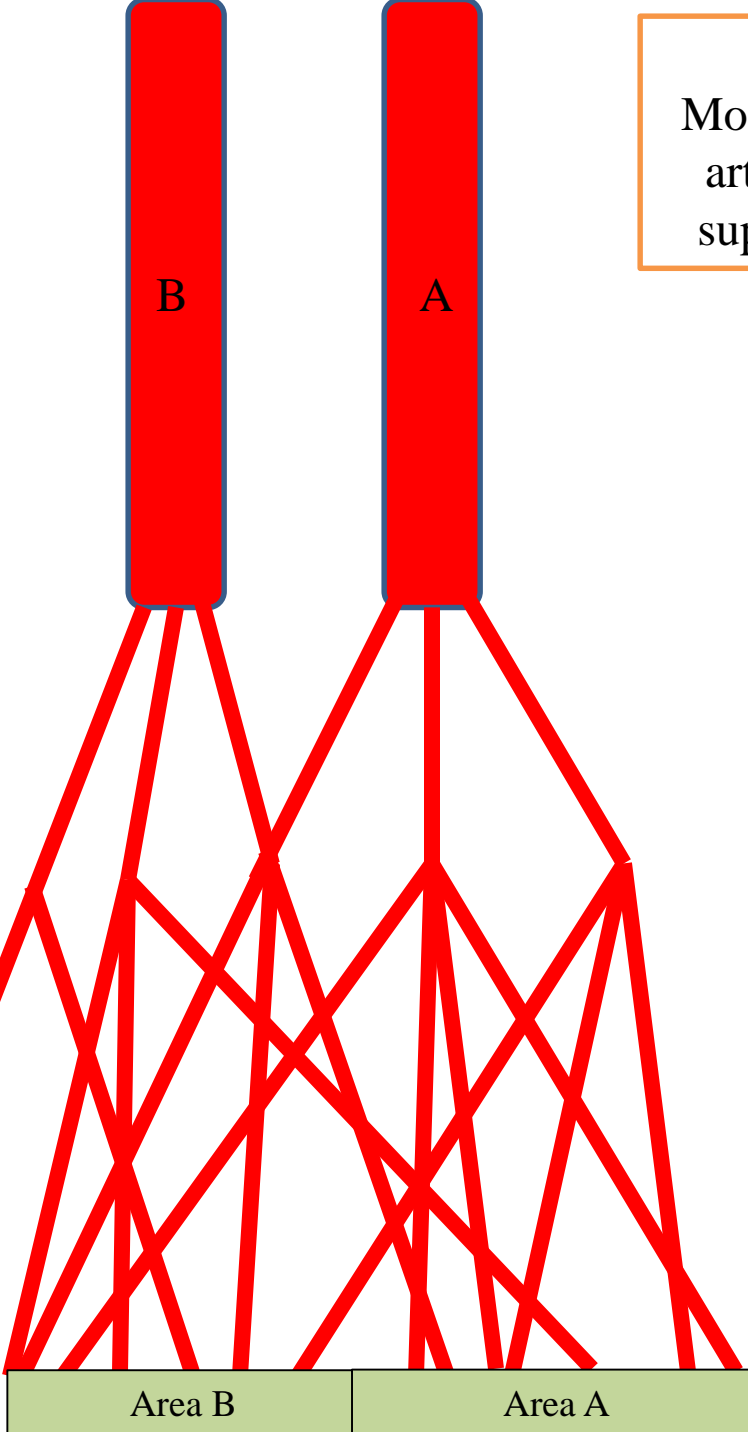
If blood flow stops for a short time when normal movements compress a vessel, or if a vessel is blocked by disease, injury, or surgery, then circulation to a part of the body is not necessarily stopped. The alternative route of blood flow to a body part through an anastomosis is known as **collateral circulation**

Arteries that do not anastomose are known as **end arteries**

Obstruction of an end artery cuts off the blood supply to a whole segment of an organ, producing necrosis (death) of that segment.

Example: central artery of retina

*Occlusion: blindness*





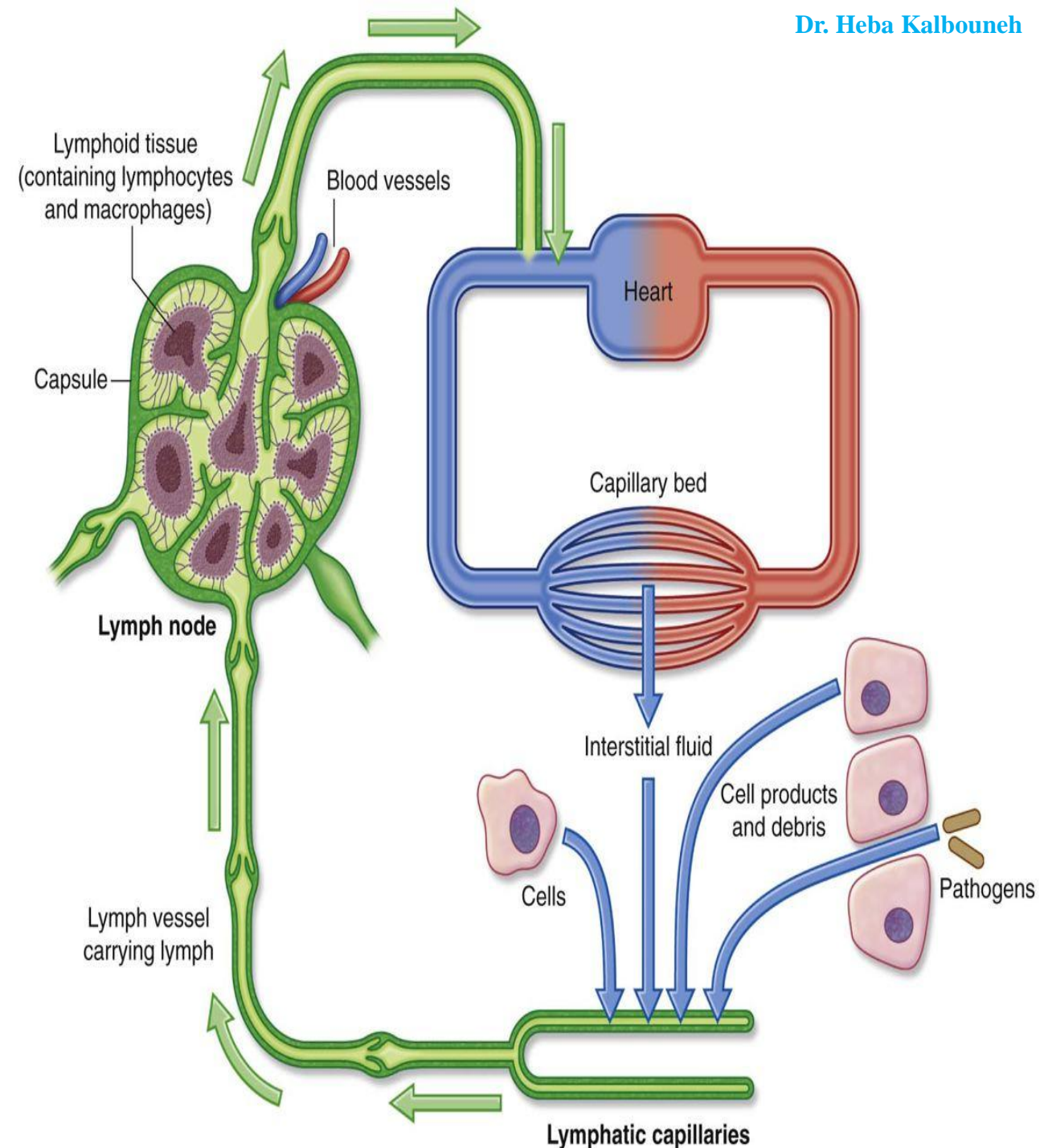
# The lymphatic vascular system

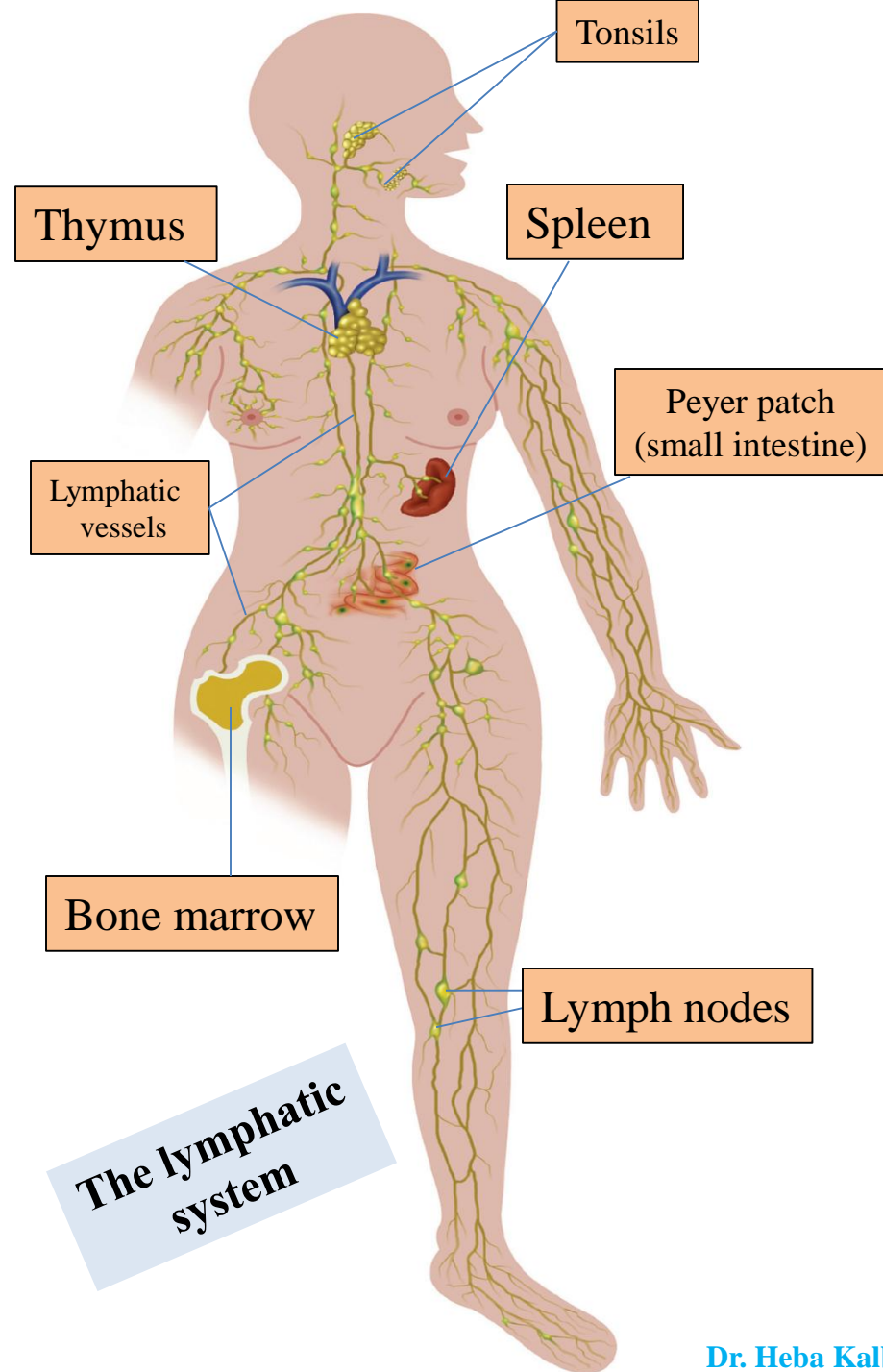
- ✓ It is composed of vascular channels that drain extracellular fluid called lymph from the tissues.
- ✓ It consists of lymph capillaries and lymph vessels that originate as blind-ending tubules in the connective tissue of different organs.
- ✓ The lymph capillaries lie close to the blood capillaries and collect the excess interstitial fluid (lymph) from the tissues.

The lymphatic system consists of lymphatic fluid, lymphatic vessels, lymphatic tissue, and lymphatic organs located

throughout the tissues of the body. It functions to:

- 1- Drain excess interstitial fluid from the tissues and return to blood stream**
- 2- Initiate an immune response against disease by producing and transporting lymphocytes**
- 3- Transport dietary lipids absorbed by the gastrointestinal tract into the blood.**





**Lymph** is a colorless fluid that floats in the lymphatic vessels (lymphatics). It is similar in composition to blood plasma

**Lymphatic vessels** are thin vessels that accompany arteries and veins throughout the body and transport lymph.

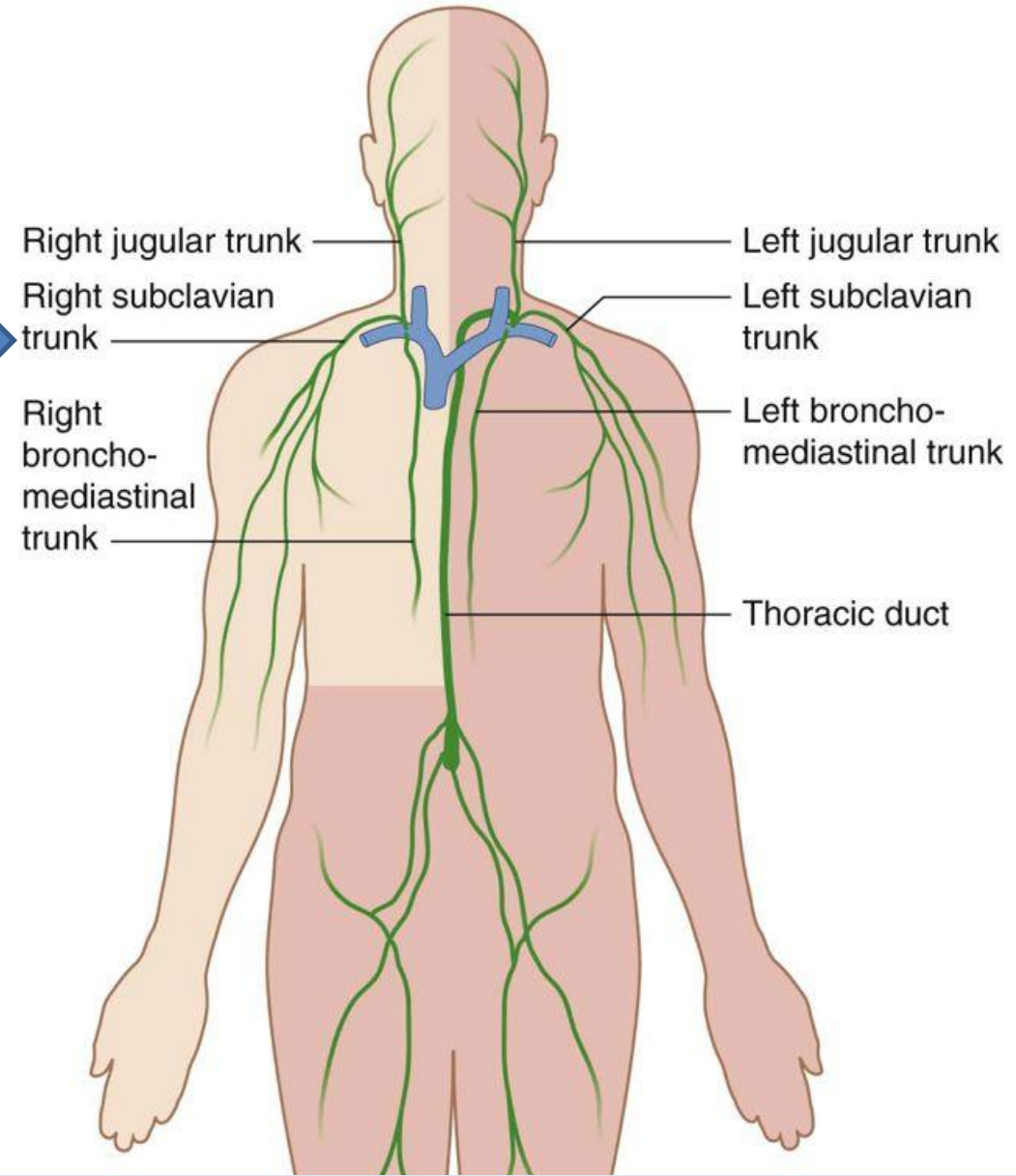
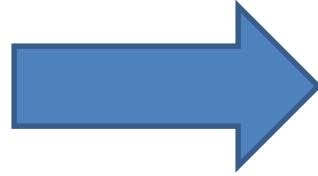
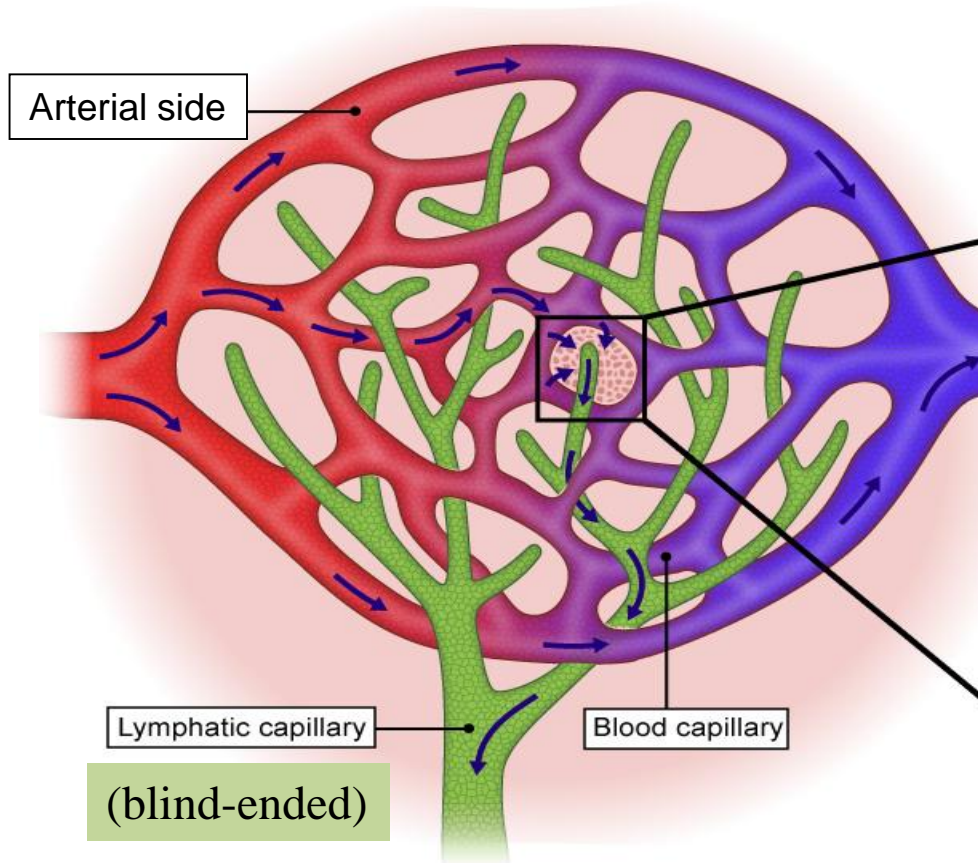
**Lymphatic organs** include the lymph nodes (masses of lymphocytes), spleen, thymus, and red bone marrow

✓ The collected lymph is returned to the venous blood via the large lymph vessels after it is filtered through numerous lymph nodes that are located throughout the body

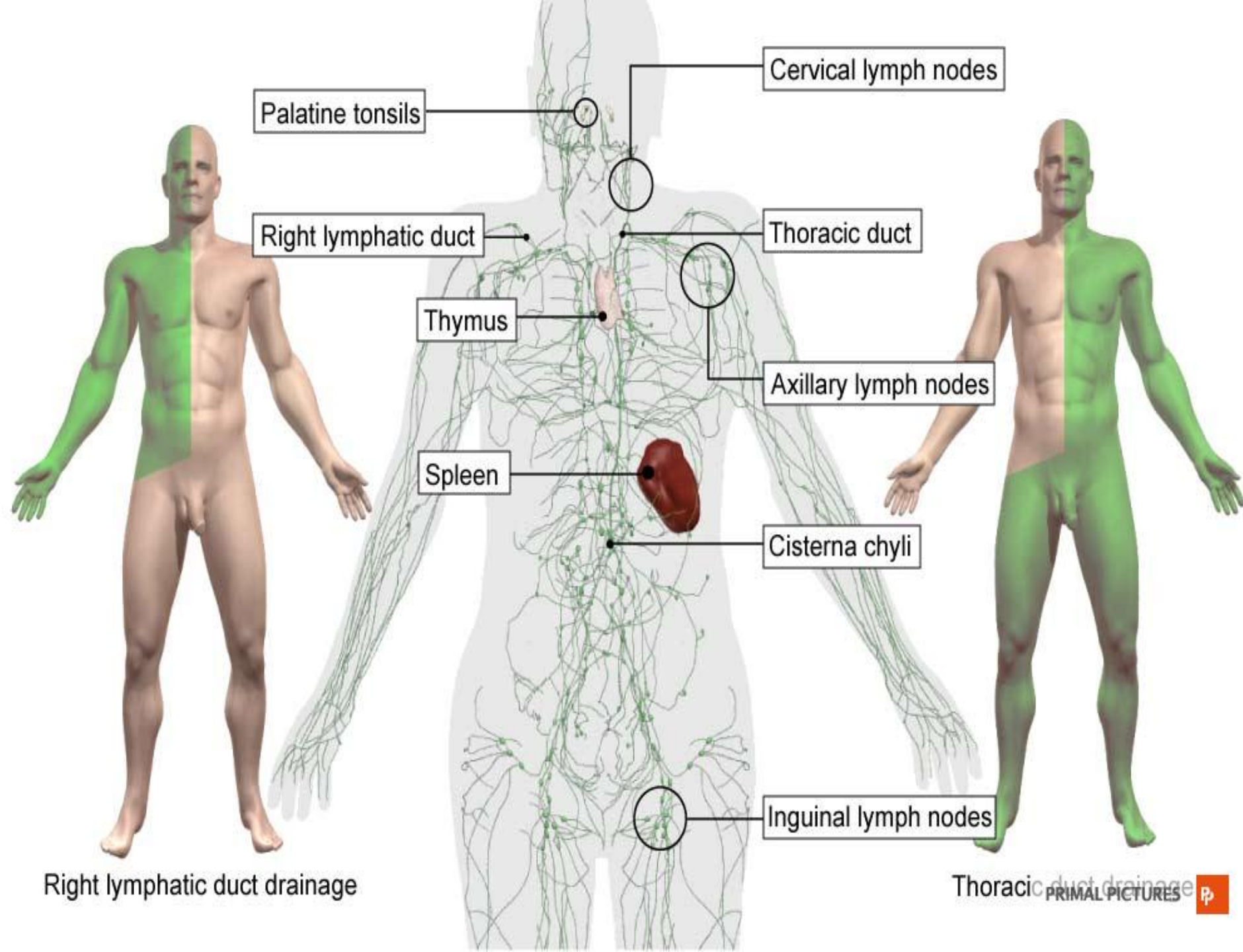
✓ Lymph movement in the lymphatic vessels is due to the contractions of surrounding skeletal muscles which force the lymph to move forward (**similar to venous blood movement**)



**Lymphatic vessels** begin as “porous” blind-ended lymphatic capillaries in tissues of the body and converge to form a number of larger vessels, which ultimately connect with large veins in the root of the neck.



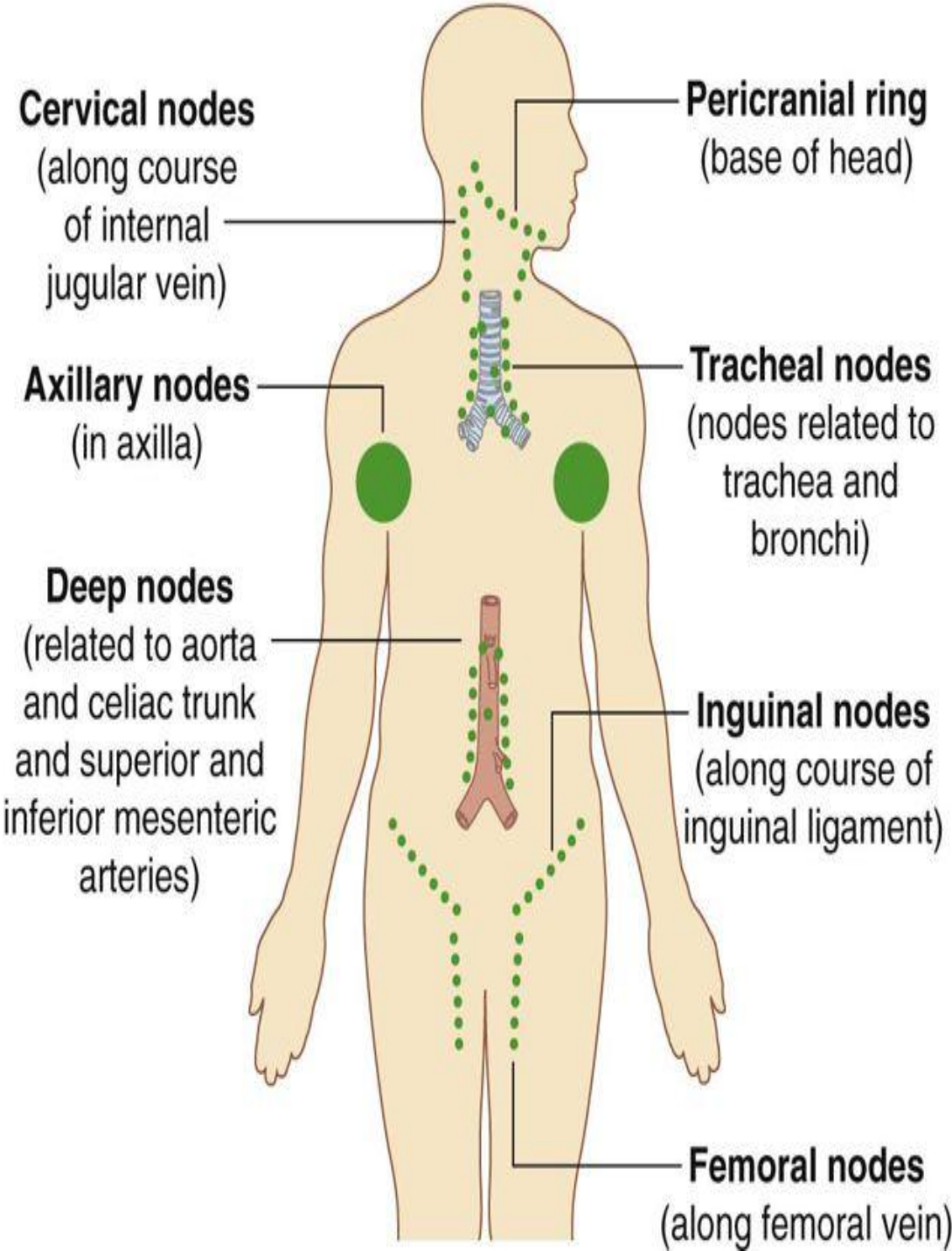
Lymph returns back to the big veins (venous angle: the junction between subclavian and internal jugular veins) through the Thoracic duct and Right lymphatic duct.





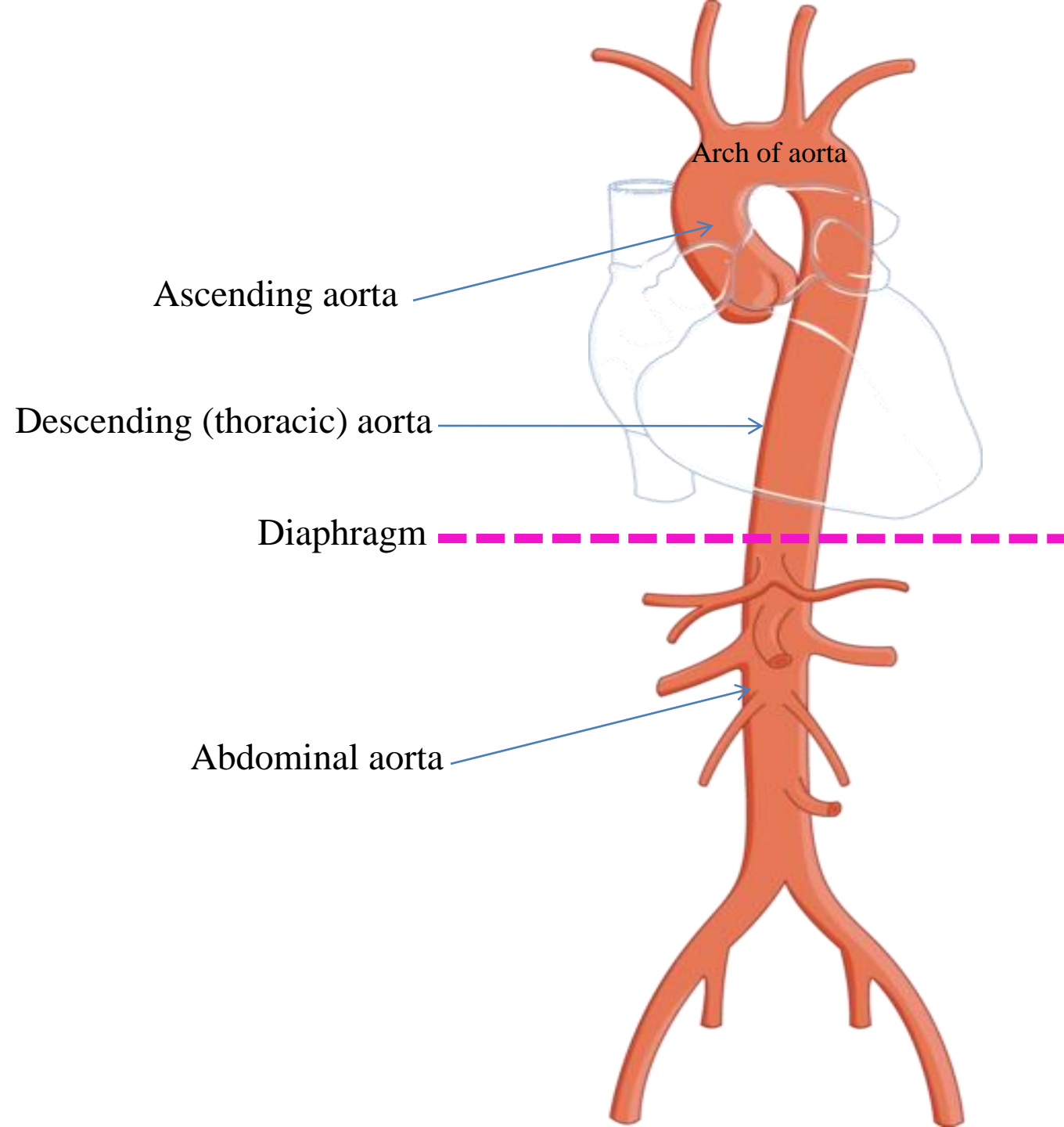
The main groups of lymph nodes include:

Name	Location	Associated vessel
Axillary nodes	Armpit	Axillary vein
Cubital nodes	Elbow	Basilic vein
Popliteal nodes	Posterior knee	Popliteal vein
Inguinal nodes	Groin	Great saphenous vein Femoral vein
Cervical lymph nodes	Neck	Internal jugular vein



Read only 😊

# **Major Arteries of the Systemic Circulation**



The aorta is divided into:

- 1- Ascending aorta
- 2- Arch of aorta
- 3- Descending thoracic aorta
- 4- Abdominal aorta

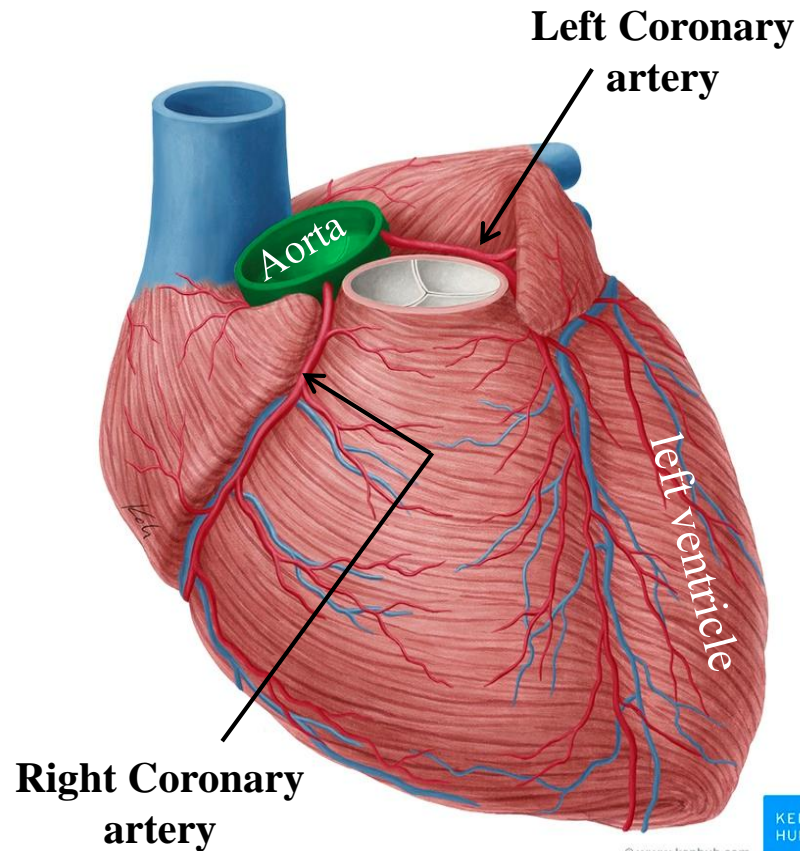


## Ascending aorta

**Begins:** base of the left ventricle

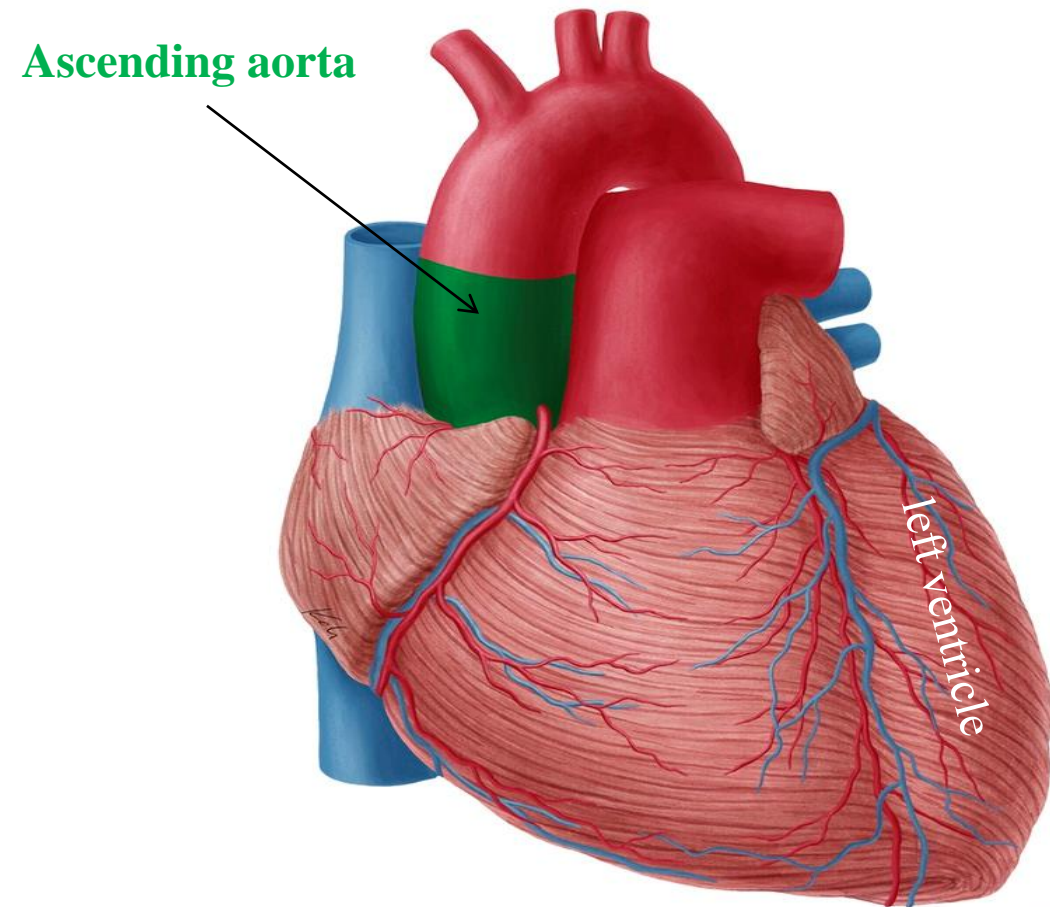
**Ends:** right half of the sternum at the level of the sternal angle

✓ Enclosed by fibrous pericardium



## Branches of the Ascending aorta:

Coronary arteries

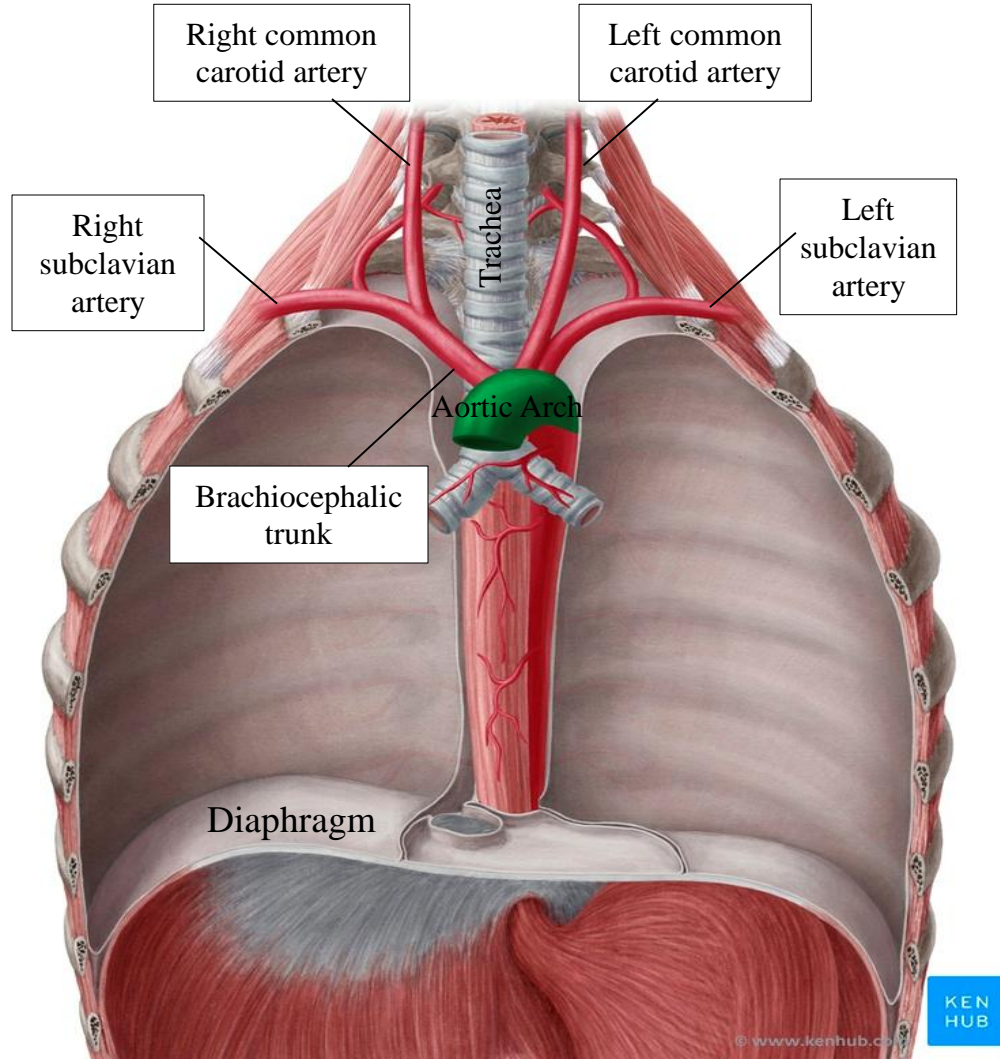


## Arch of aorta

**Begins:** Sternal angle

- Arches upward, backward, to the left
- Anterior then left to the trachea

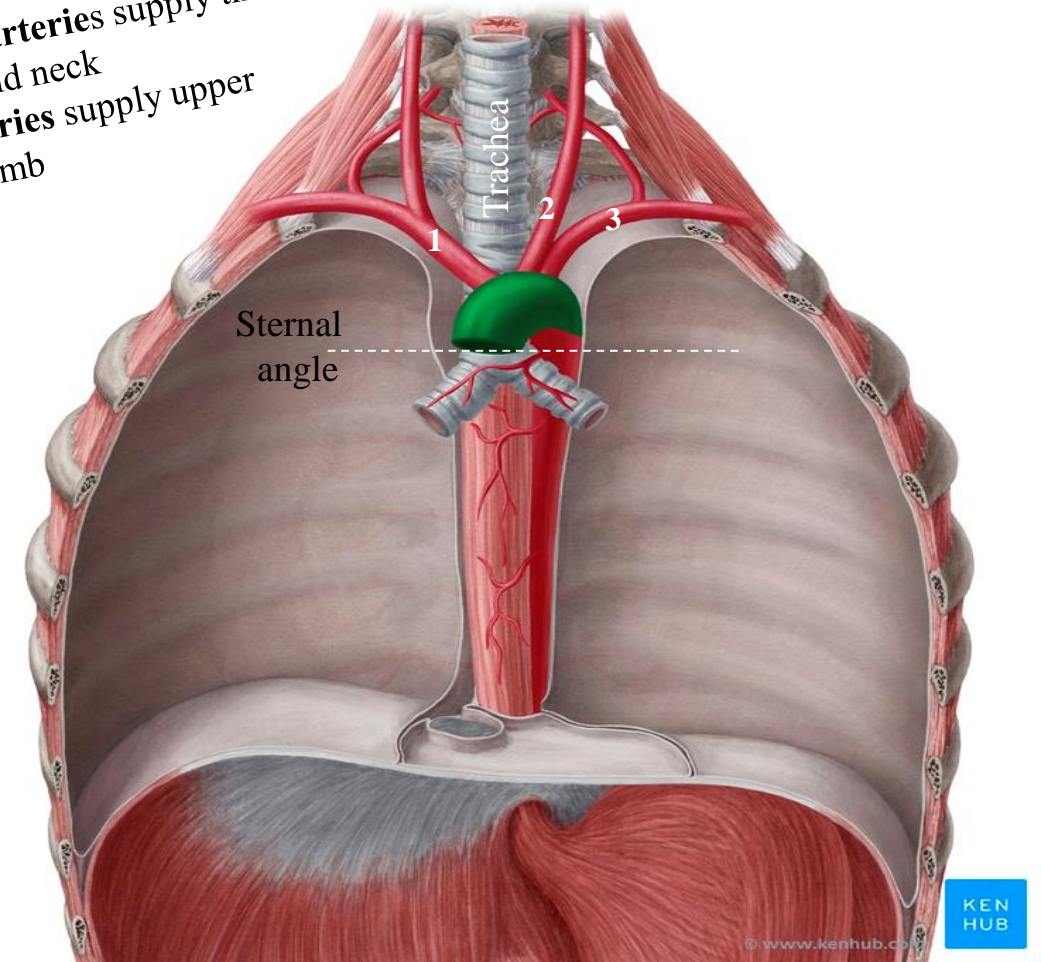
**Ends:** Sternal angle



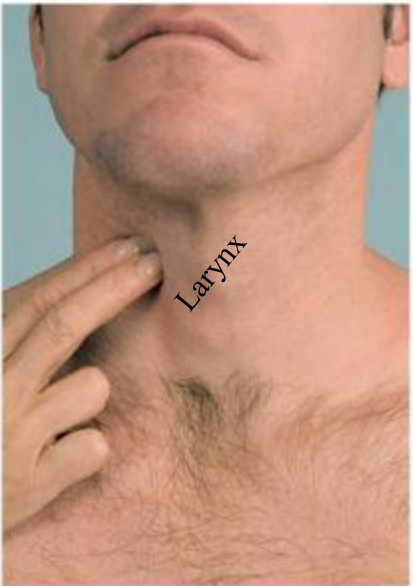
## Branches of the Aortic Arch:

- 1- **Brachiocephalic trunk:** splits into the right common carotid artery and right subclavian artery
- 2- **Left common carotid artery**
- 3- **Left subclavian artery**

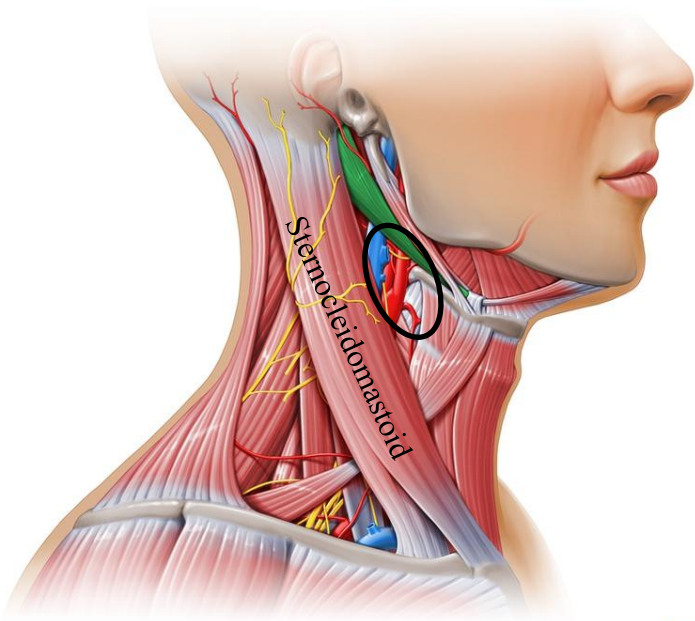
*Common carotid arteries supply the head and neck  
Subclavian arteries supply upper limb*





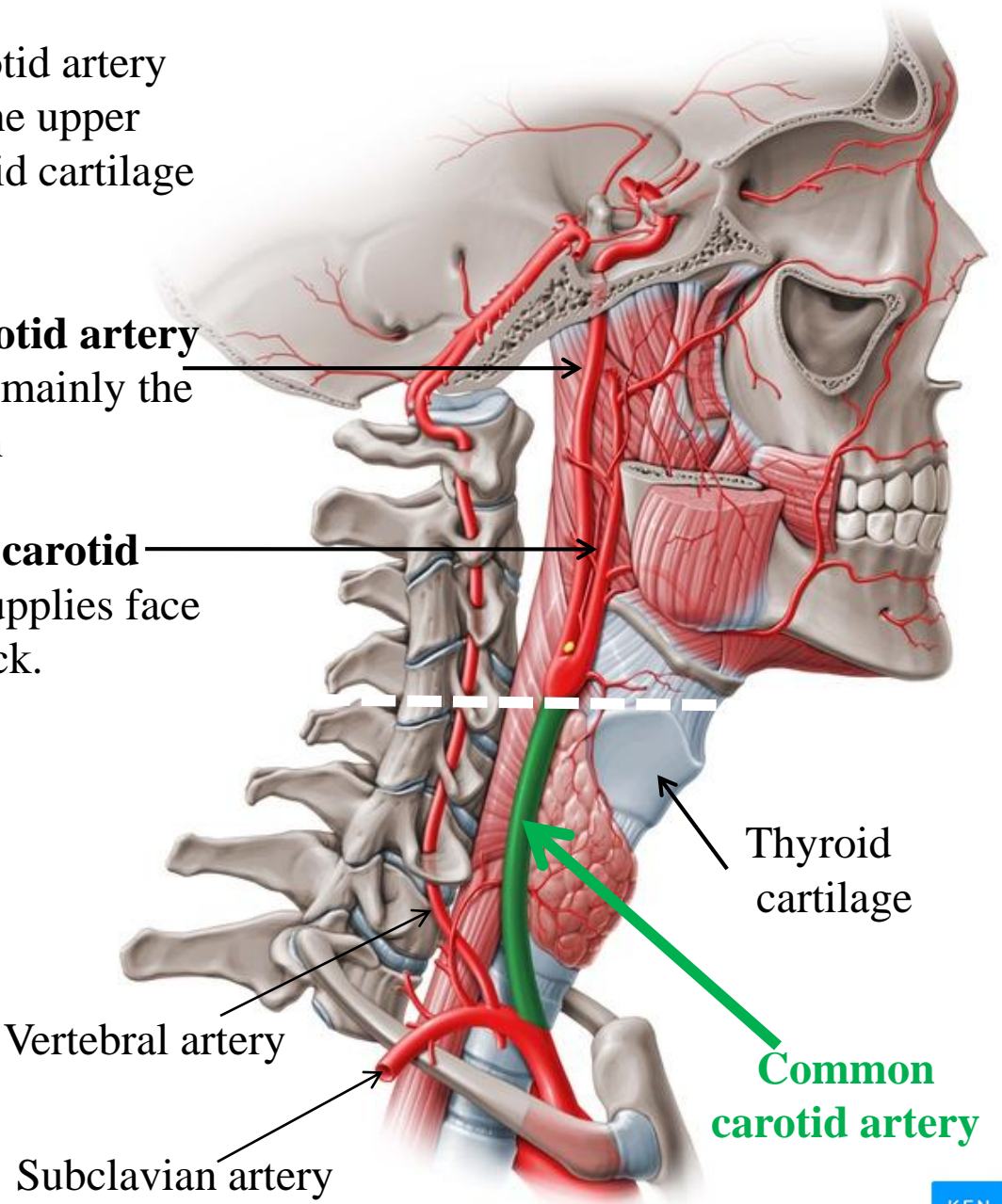


**Carotid pulse** is felt between the larynx and the anterior border of the sternocleidomastoid



Common carotid artery divides at the upper border of thyroid cartilage into:

- 1- **Internal carotid artery** which supplies mainly the brain
- 2- **External carotid artery** which supplies face and neck.



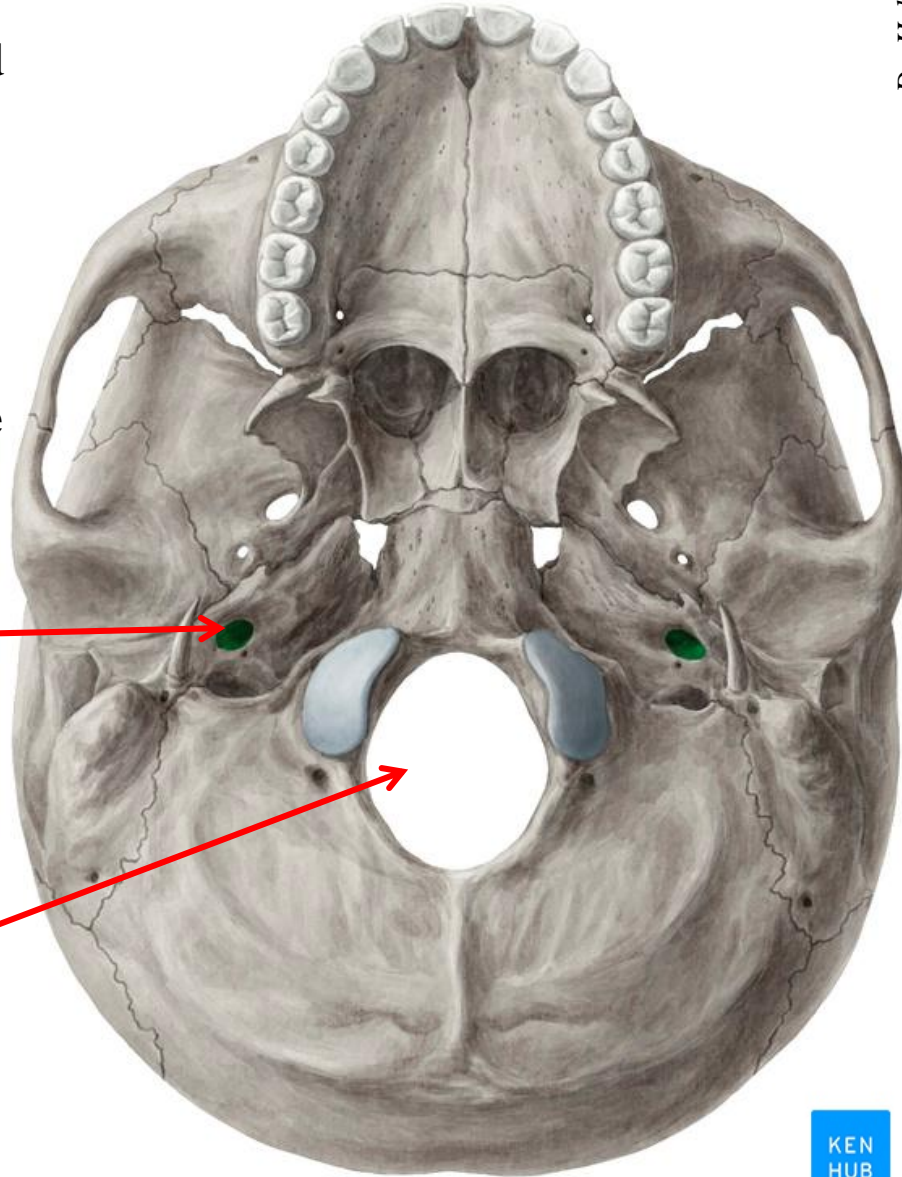


# Arterial Blood Supply of brain

- Brain is supplied by pairs of internal carotid artery and vertebral artery.
- Their branches anastomose on the inferior surface of the brain to form the **circle of Willis**

**Internal carotid artery** enters the skull via carotid canal

**Vertebral artery** (branch of subclavian artery) enters the skull via foramen magnum

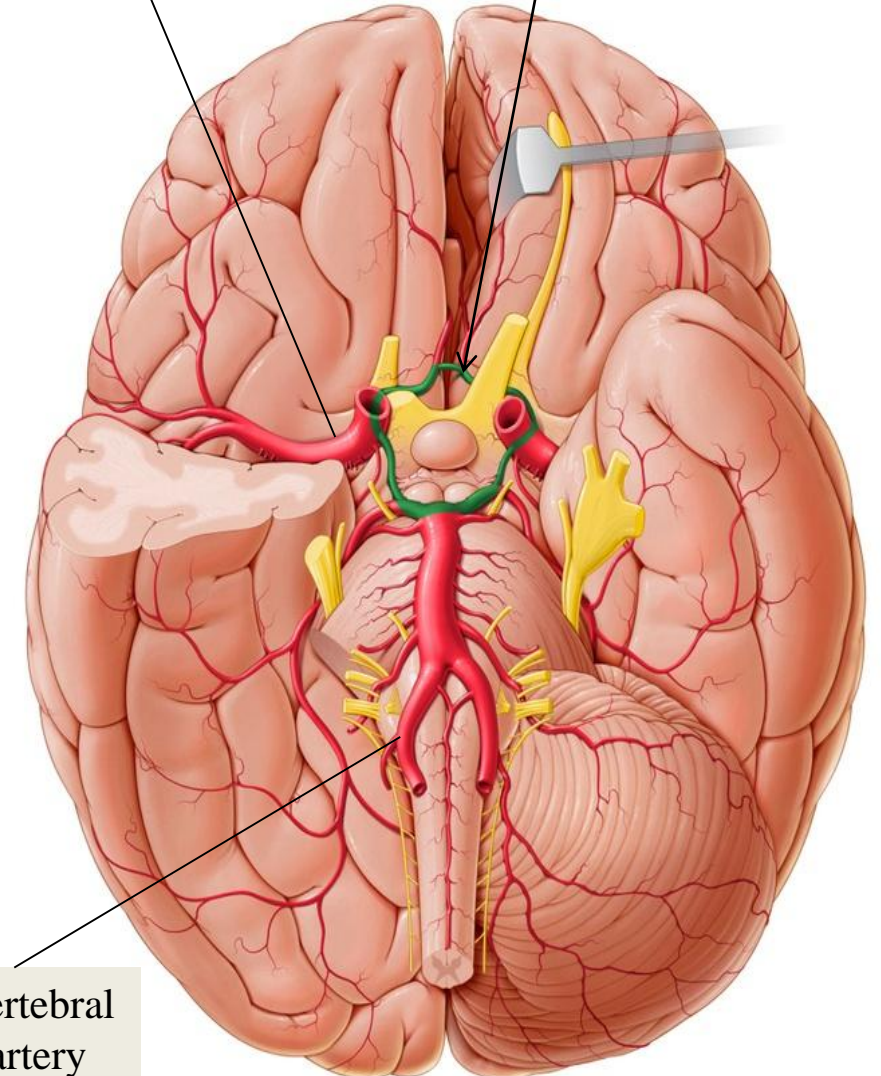


Dr. Heba Kalbouneh

Internal carotid artery

The branches of internal carotid arteries and vertebral arteries anastomose to form the **circle of Willis** at the inferior surface of the brain

Vertebral artery



Inferior surface of the brain

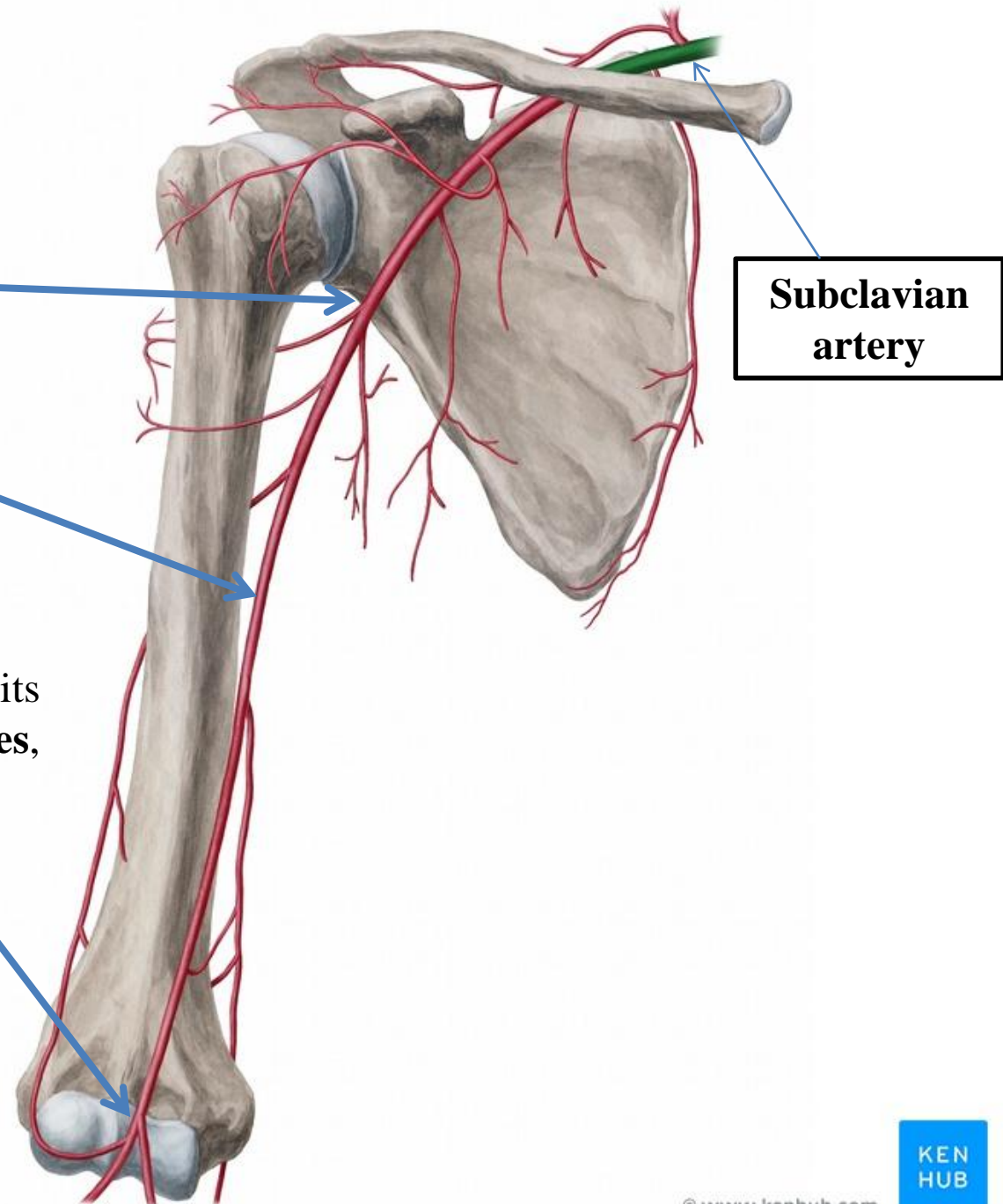
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# Subclavian artery

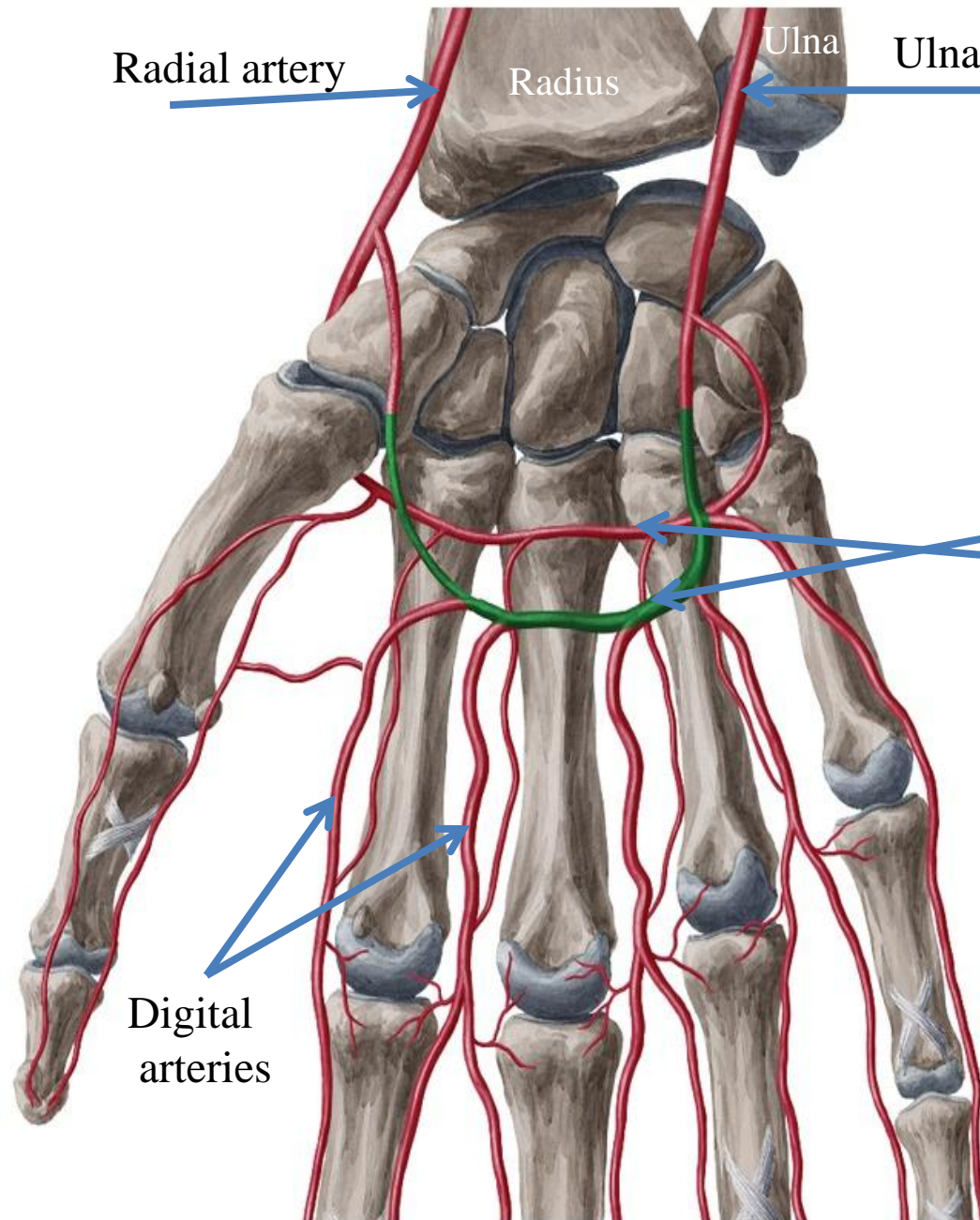
**In the axilla,** the subclavian artery becomes the **axillary artery**.

**In the arm,** the subclavian artery continues as the **brachial artery**, which supplies the arm.

**At the elbow,** the brachial artery splits to form the **radial and ulnar arteries**, which supply the forearm







Radial artery

Radius

Ulna

Ulnar artery

The radial and ulnar arteries terminate in anastomosing (interconnecting) branches to form two arches: **the superficial palmar arch and deep palmar arch**

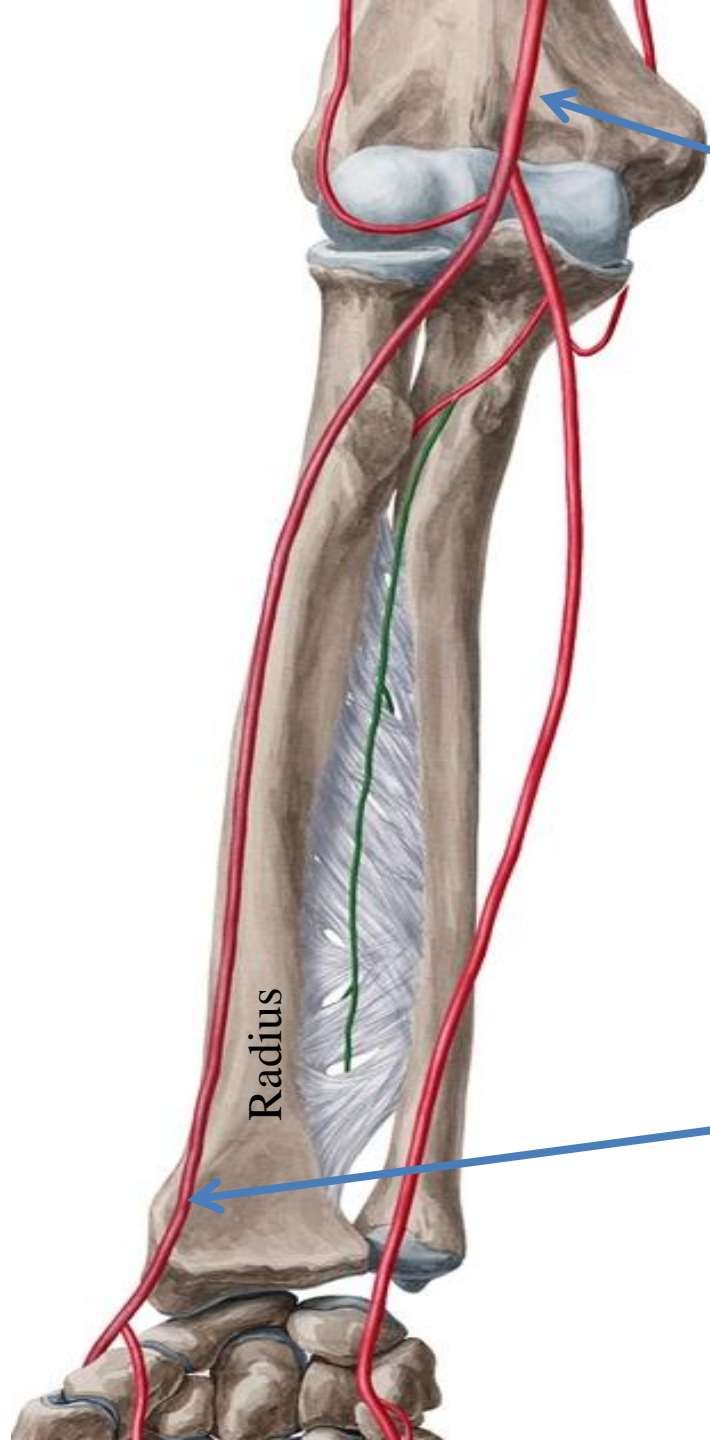
From which arise tiny digital arteries down each side of the finger

Digital arteries

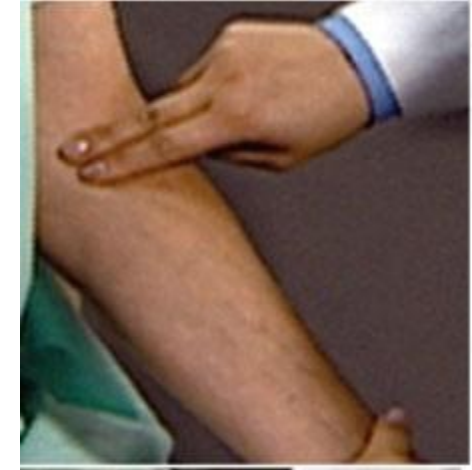
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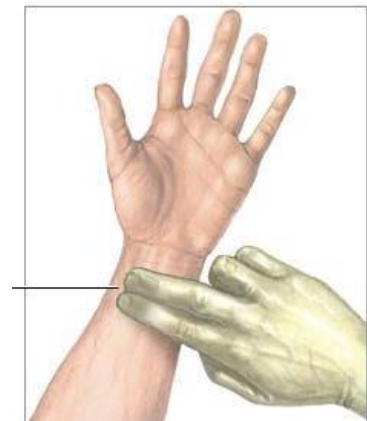




You can feel **the pulse of brachial artery** on the anterior aspect of elbow (medial to the tendon of the biceps)



You can feel **the pulse of radial artery** at wrist (anterior to the distal end of radius)



## Descending (thoracic) aorta:

**Begins:** Sternal angle

Runs downward in the posterior mediastinum

**Ends:** 12th thoracic vertebra (T12) through the aortic opening of diaphragm

### Branches of the descending (thoracic) aorta:

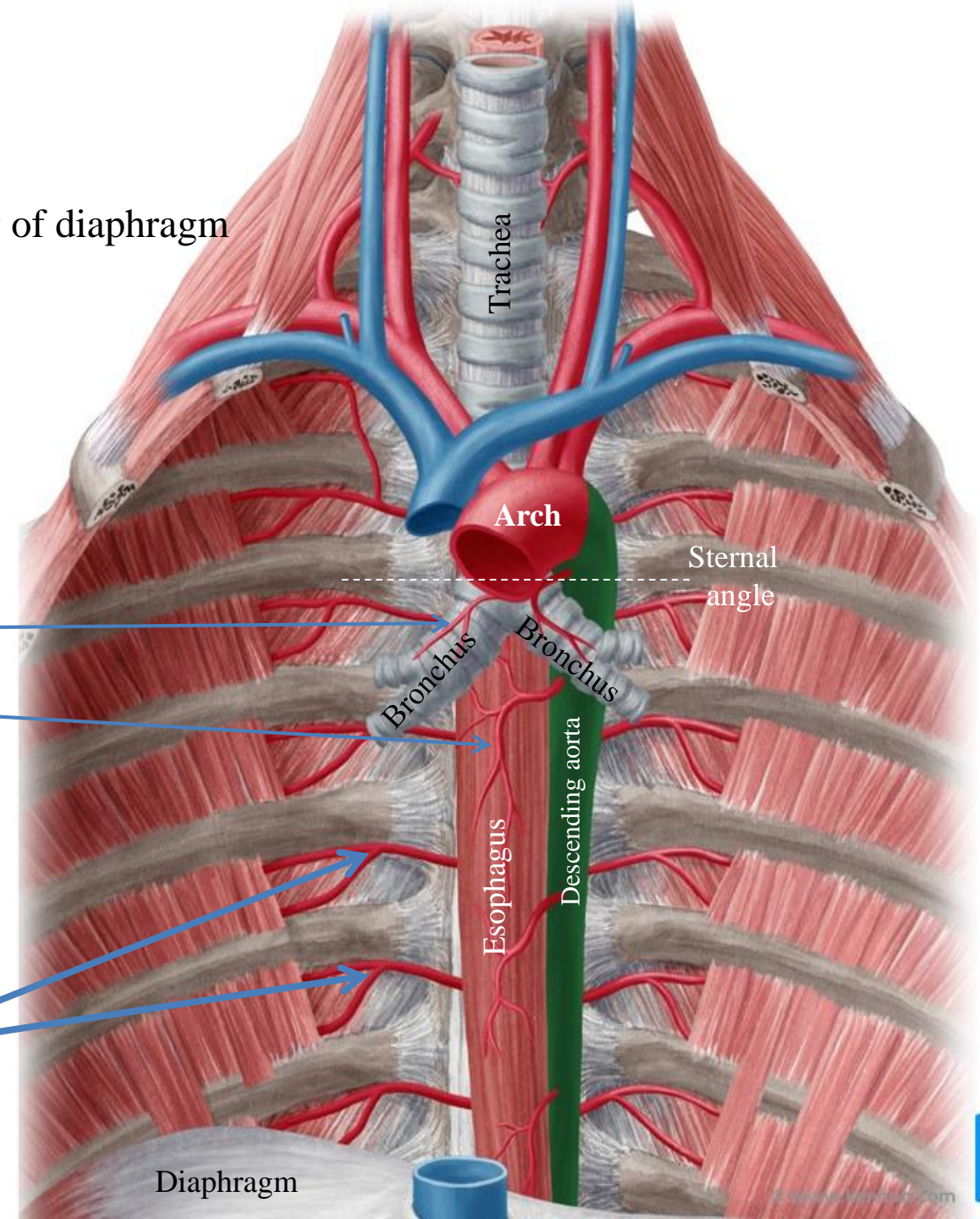
**Intercostal arteries:** supply the muscles of the thorax wall.

**Pericardial arteries**

**Bronchial arteries**

**Esophageal arteries**

**Intercostal arteries**





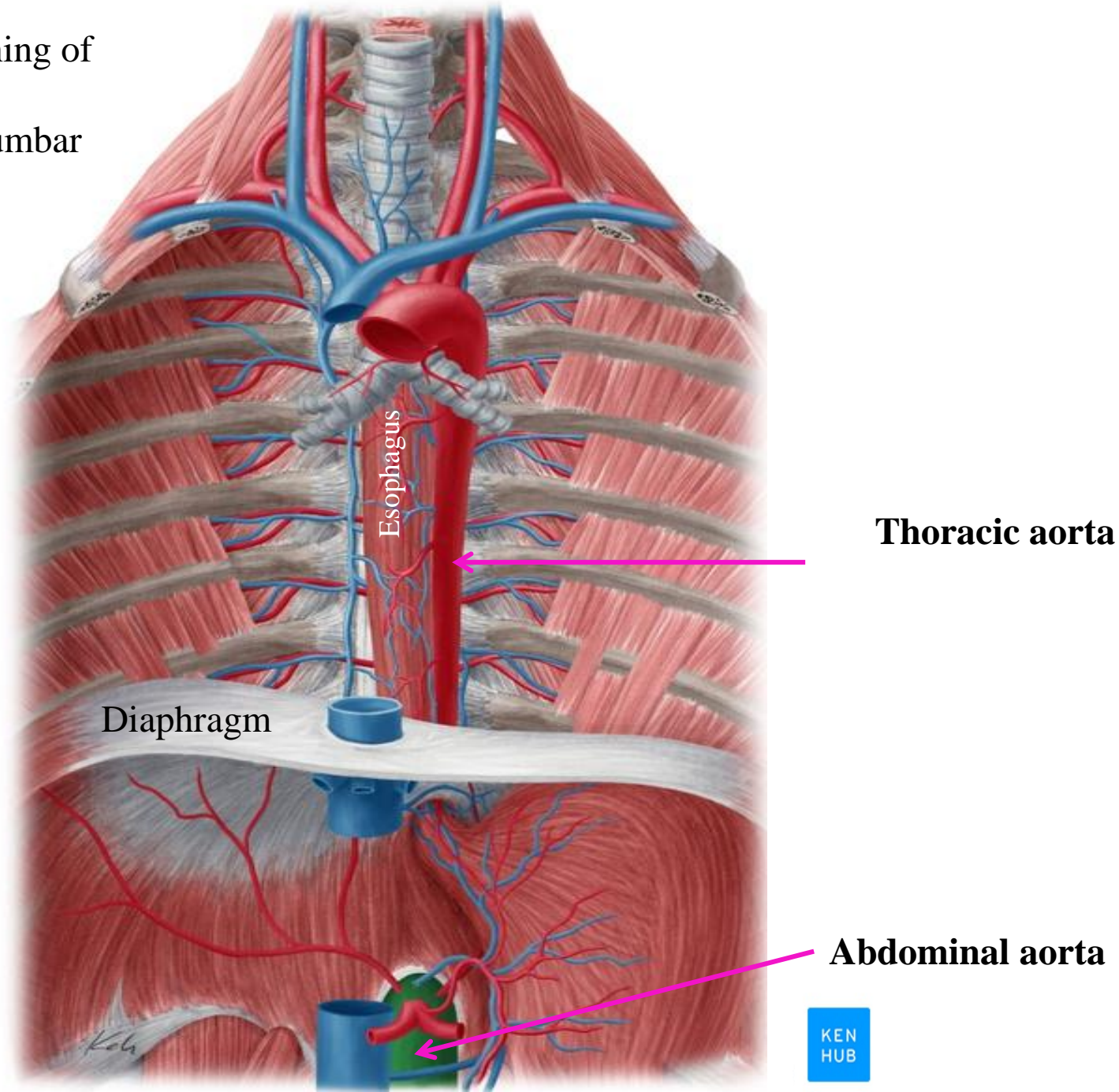
## Abdominal aorta:

**Begins:** 12th thoracic vertebra through the aortic opening of diaphragm

**Ends:** Aortic bifurcation is at the level of the fourth lumbar vertebra L4

- ✓ The aorta passes through the diaphragm into the abdominopelvic cavity, where it becomes the abdominal aorta
- ✓ It has single and paired branches

The aorta passes through the diaphragm *at the level of the twelfth thoracic vertebra*





## Single branches

### Celiac trunk

✓ Has three branches:

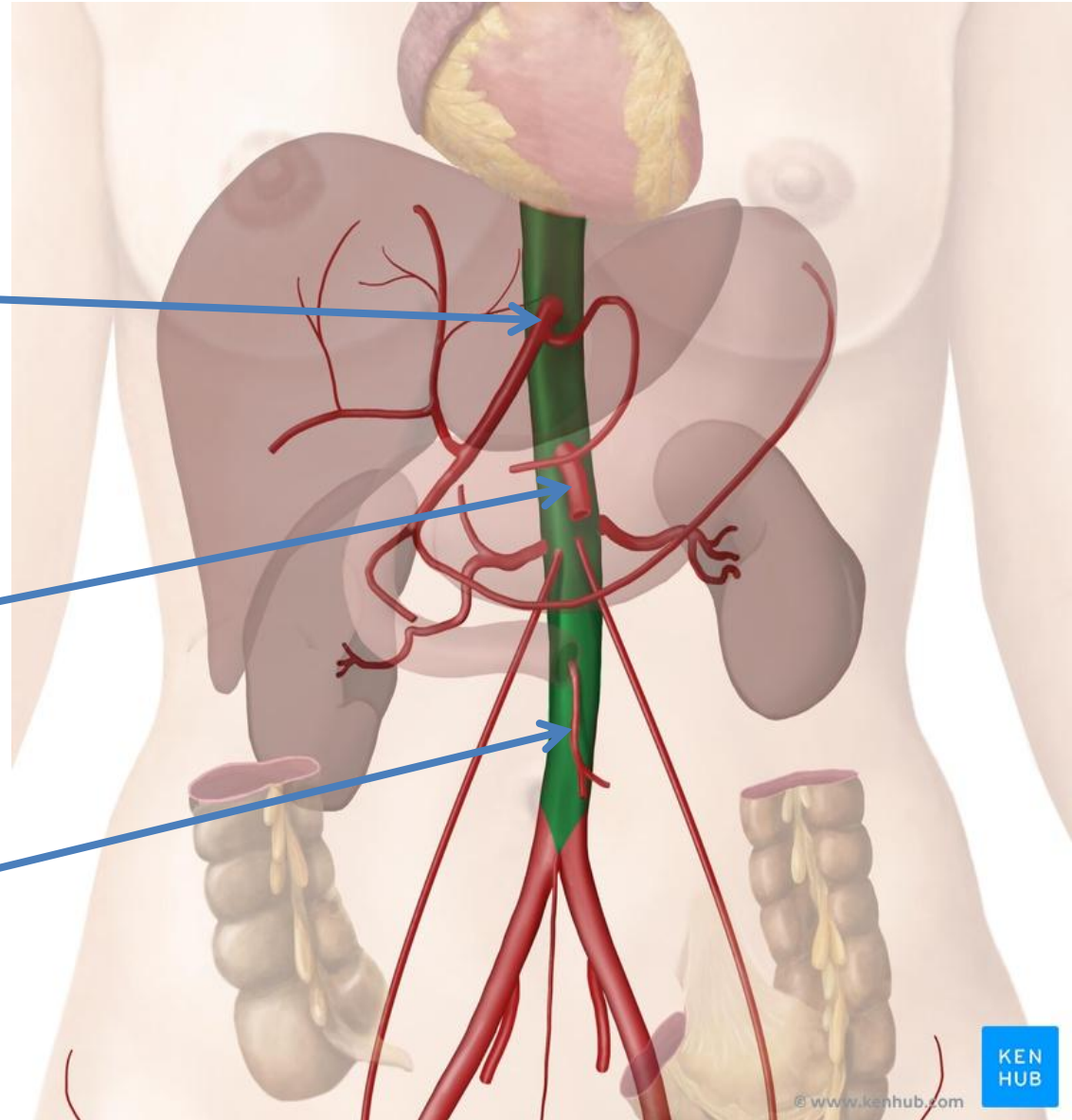
- 1- **Left gastric artery** supplies the stomach
- 2- **Splenic artery** supplies the spleen
- 3- **Common hepatic artery** supplies the liver

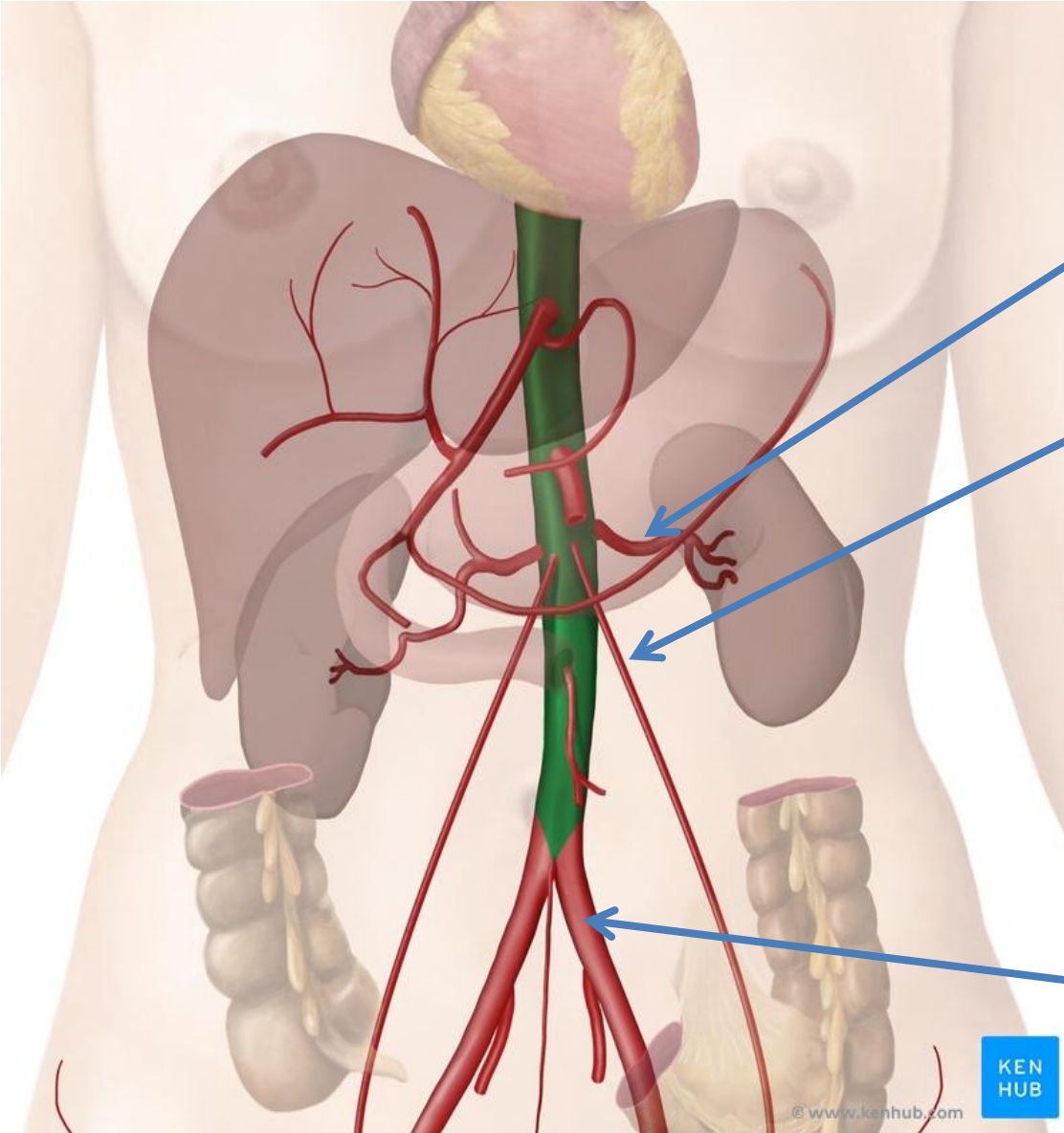
### Superior mesenteric artery

Supplies most of the small intestine and the first half of the large intestine

### Inferior mesenteric artery

Supplies the second half of the large intestine





## Paired branches

### **Renal arteries**

Supply the kidneys

### **Gonadal arteries**

Supply the gonads

They are called **ovarian arteries** in females while in males they are **testicular arteries**.

### **Lumbar arteries**

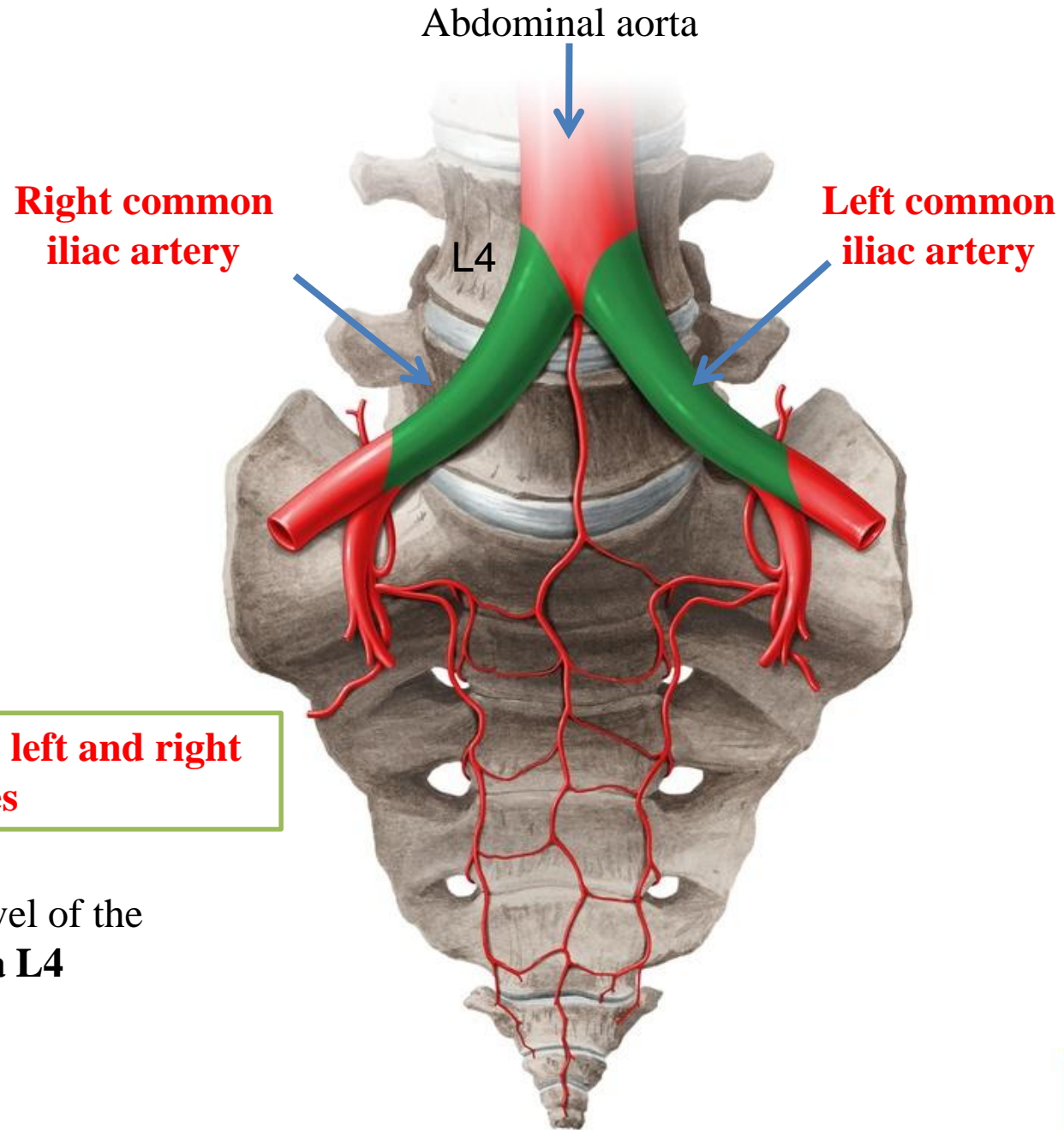
Supply muscles of the abdomen and trunk walls

### **Common iliac arteries**

Are the final branches of the abdominal aorta.



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Abdominal aorta bifurcates into the **left and right common iliac arteries**

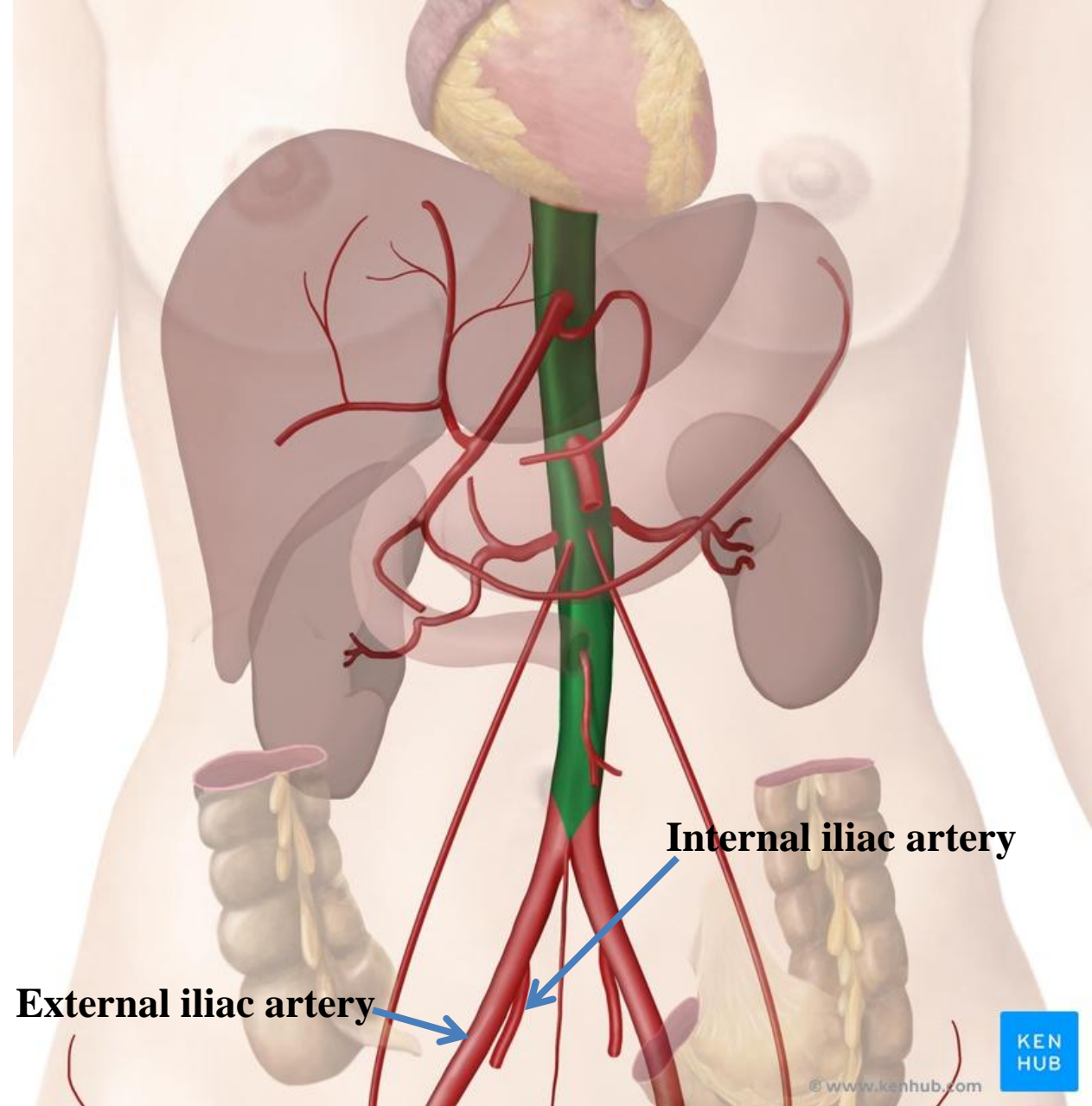
Aortic bifurcation is at the level of the **fourth lumbar vertebra L4**

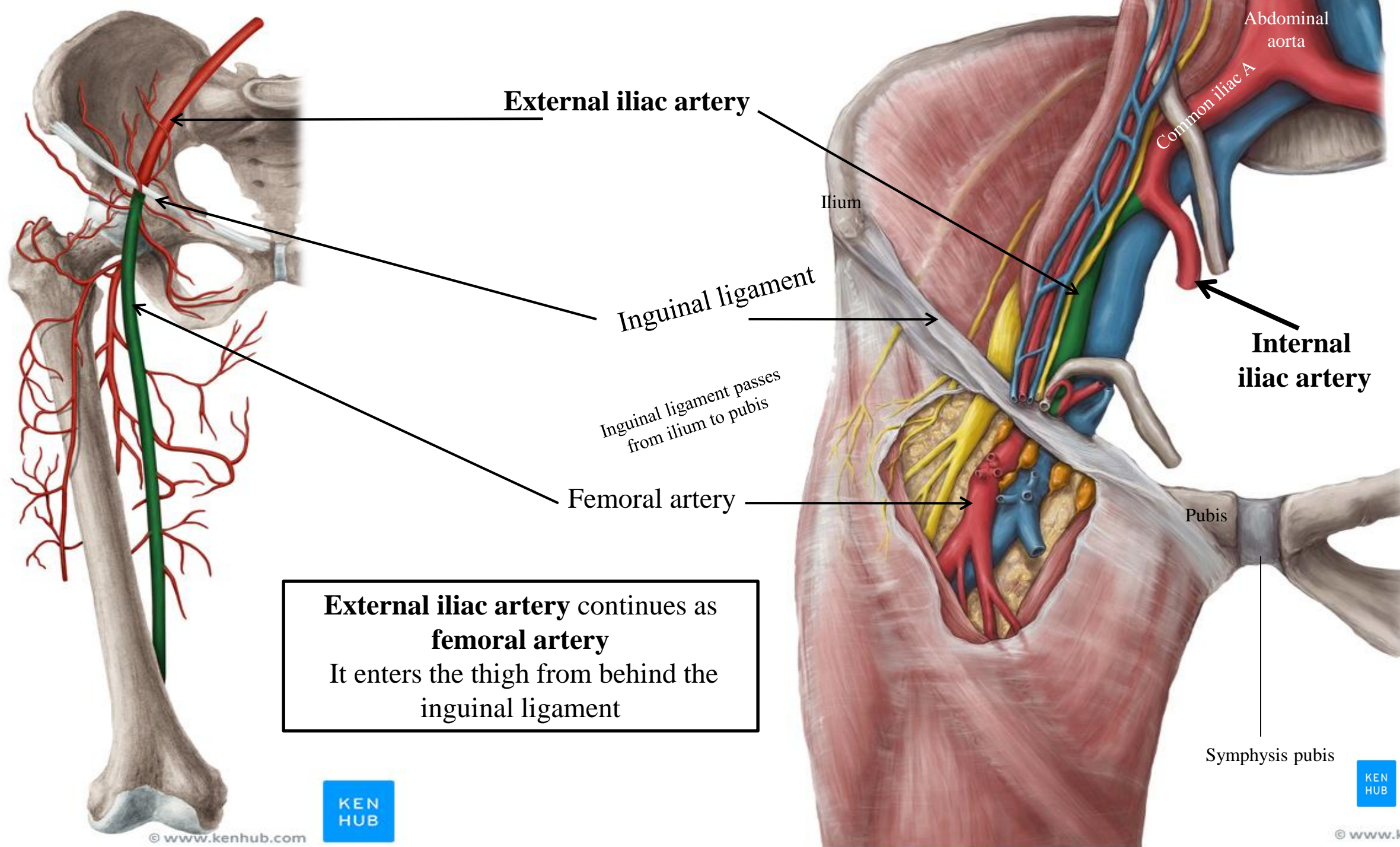


**Common iliac artery** bifurcates into the external and internal iliac arteries anterior to the sacroiliac joint

**External iliac artery** continues as femoral artery and supplies the lower limb

**Internal iliac artery** supplies the pelvis





# **Major Veins of the Systemic Circulation**



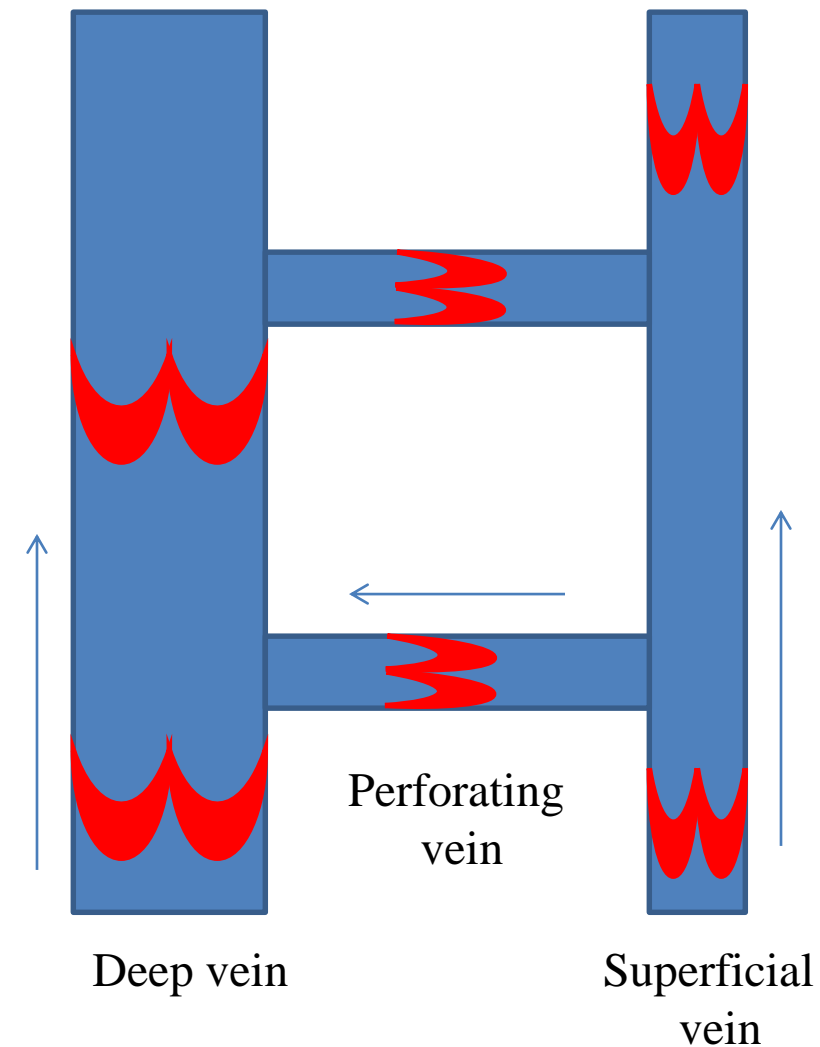
**Superficial veins** are those closer to the surface of the body, and have no corresponding arteries. They return blood from skin and subcutaneous structures by anastomosing (inter-connecting) with deep veins

**Deep veins** are deeper in the body and accompany the principle arteries and usually have the same name

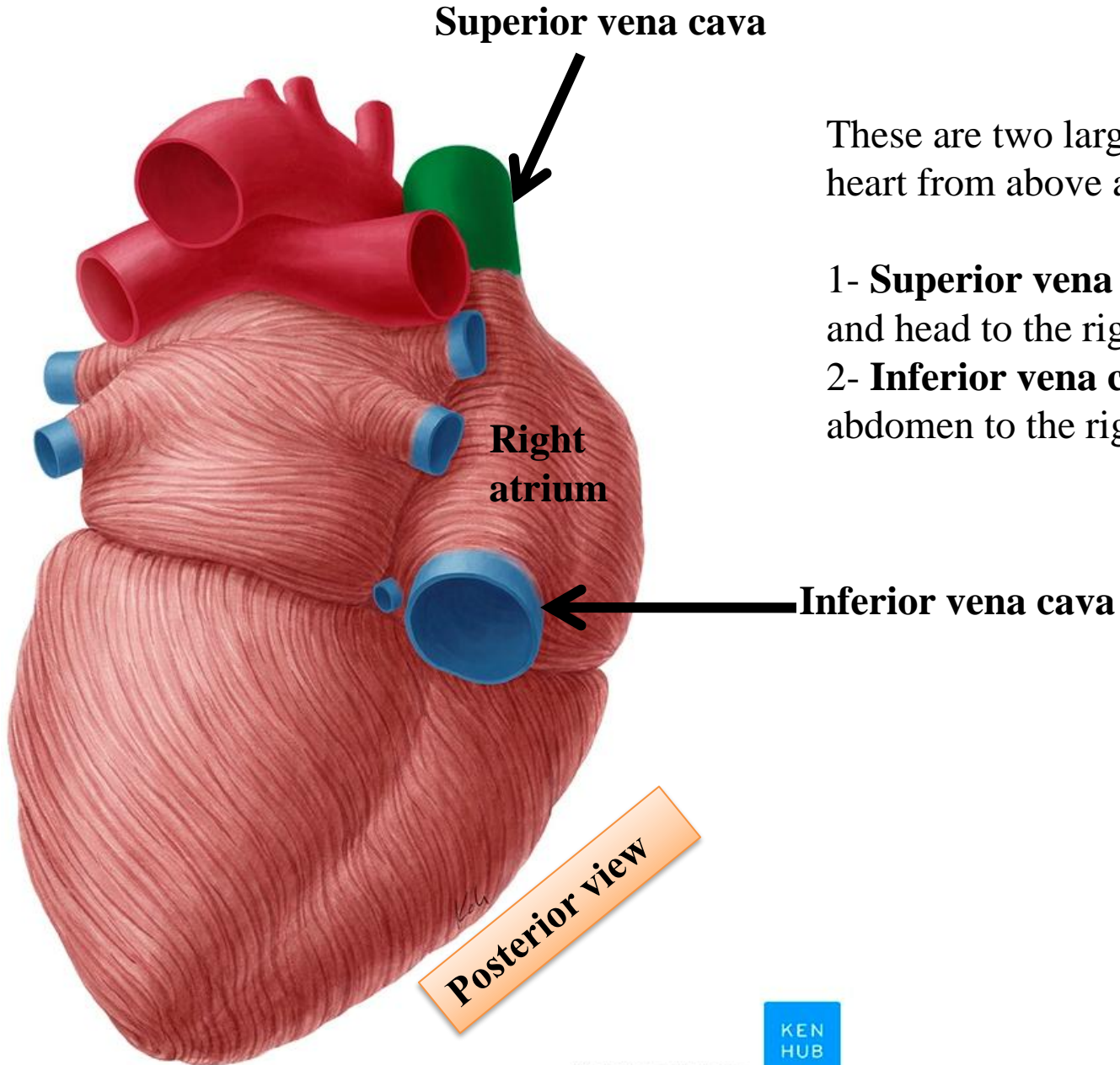
Ex. Radial vein, brachial vein, femoral vein.....

Superficial veins are important physiologically for cooling the body. When the body is too hot, the body shunts blood from the deep veins to the superficial veins, to facilitate heat transfer to the surroundings.

Superficial veins can be seen under the skin



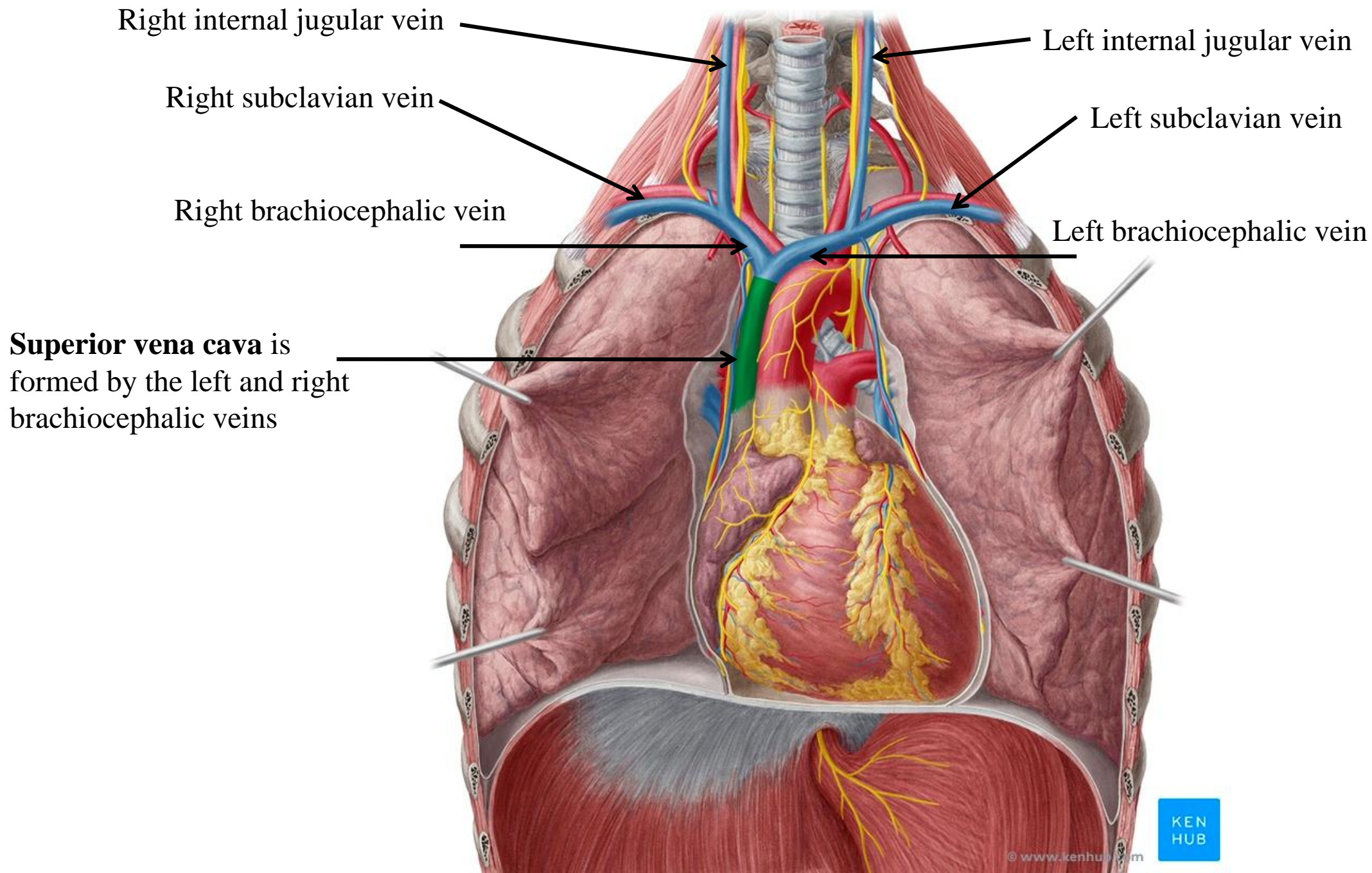
The normal flow of blood in the lower limbs is from skin and subcutaneous tissues to the superficial veins, which drain by perforating veins to the deep veins, which in turn drain into the iliac veins and inferior vena cava



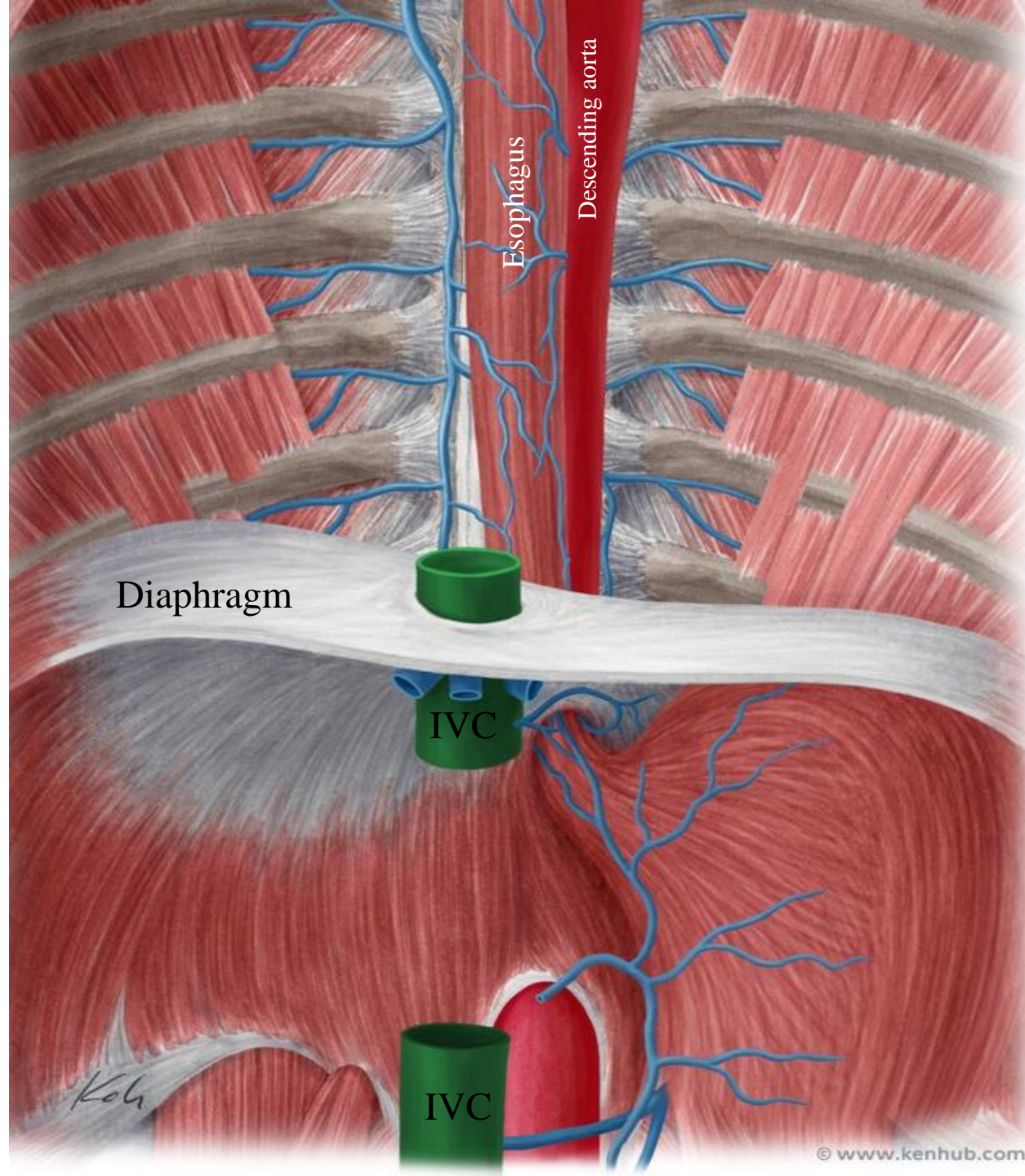
These are two large **veins** which enter the right atrium of the heart from above and below.

1- **Superior vena cava** carries blood from the upper limbs and head to the right atrium of the heart

2- **Inferior vena cava** carries blood from the lower limbs and abdomen to the right atrium of the heart







The **inferior vena cava** begins as the left and right common iliac veins unite at about the level of L5.

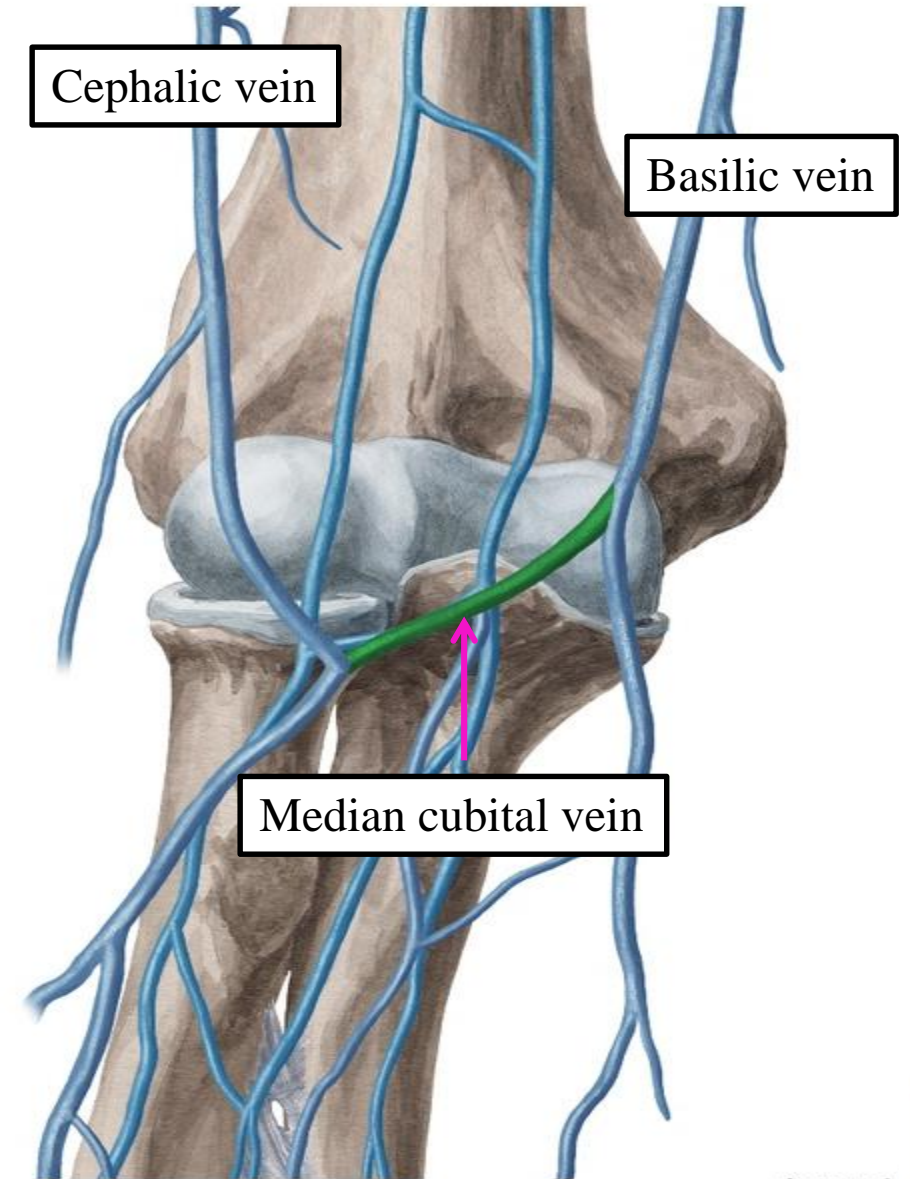
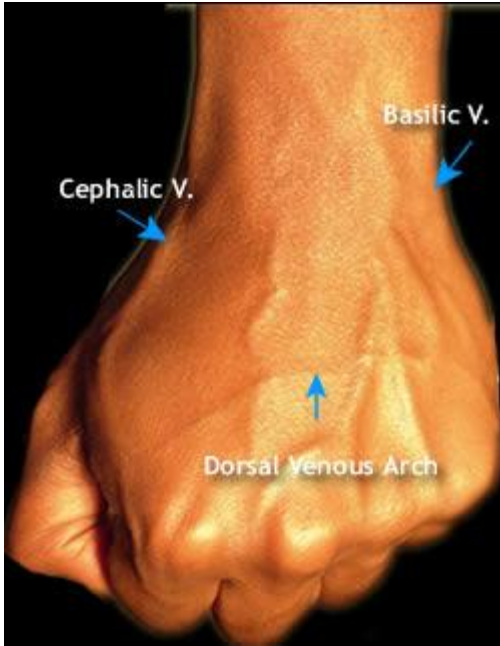
It passes through the diaphragm at the caval opening at the level of T8

# Major superficial veins- upper limb

- 1- **Cephalic vein** (lateral)
- 2- **Median cubital vein:** often used to draw blood (venipuncture)
- 3- **Basilic vein** (medial)

**Venipuncture** is the process of obtaining intravenous access for blood sampling

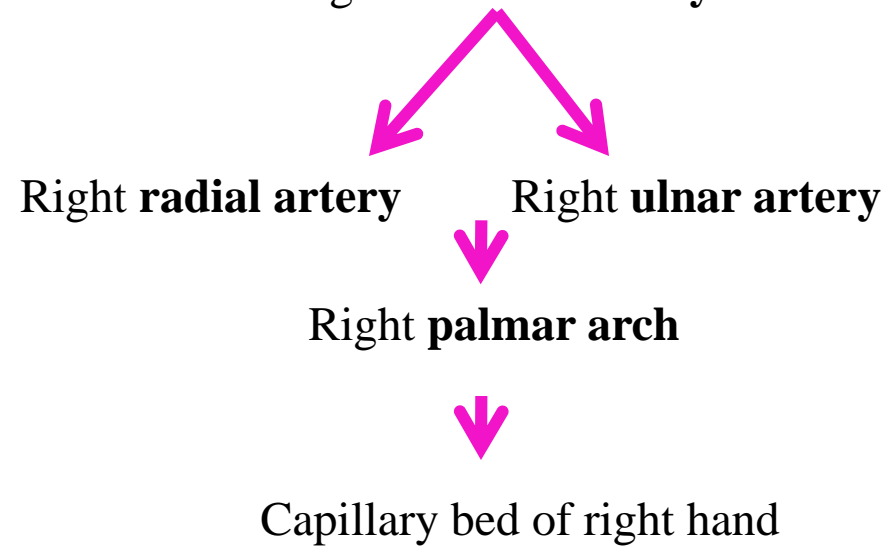
The **cubital fossa** or **elbow pit** is the triangular area on the anterior view of the elbow



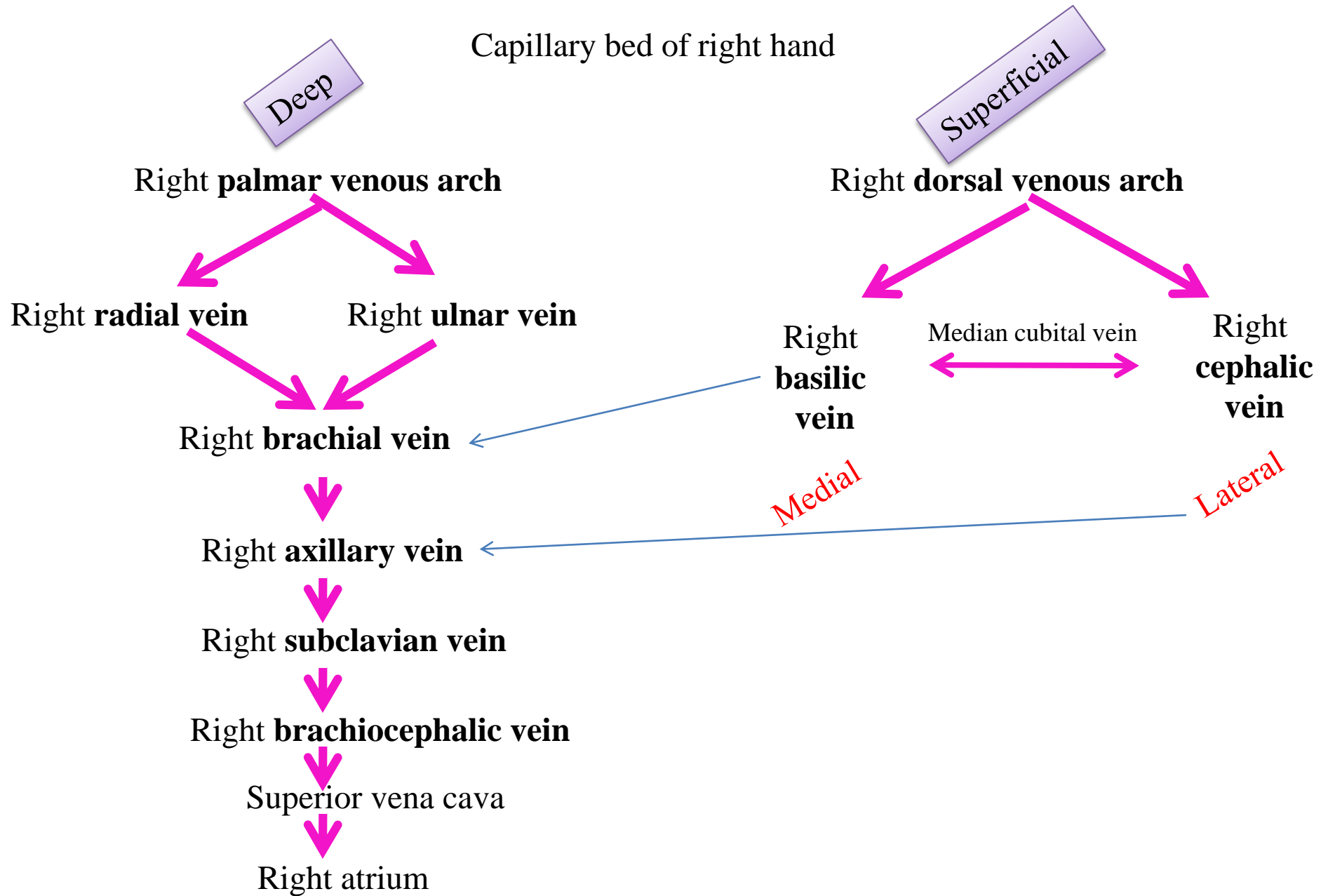
## Trace the path of blood

Left ventricle-----right hand----right atrium

1. Left ventricle
2. Ascending aorta
3. Aortic arch
4. Brachiocephalic artery
5. Right **subclavian artery**
6. Right **axillary artery**
7. Right **brachial artery**



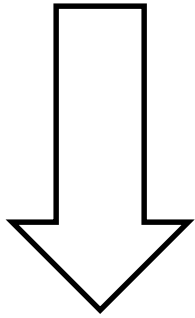




# Major superficial veins-lower limb

## The great saphenous vein

- ✓ Is a large, subcutaneous, superficial vein of the lower limb
- ✓ It is the longest vein in the body
- ✓ Passes anterior to medial malleolus
- ✓ Ascends medially up the lower limb
- ✓ Drains blood from the foot, leg and thigh
- ✓ Drains into femoral vein



Incompetence of this vein is an important cause of varicose veins of lower limbs

