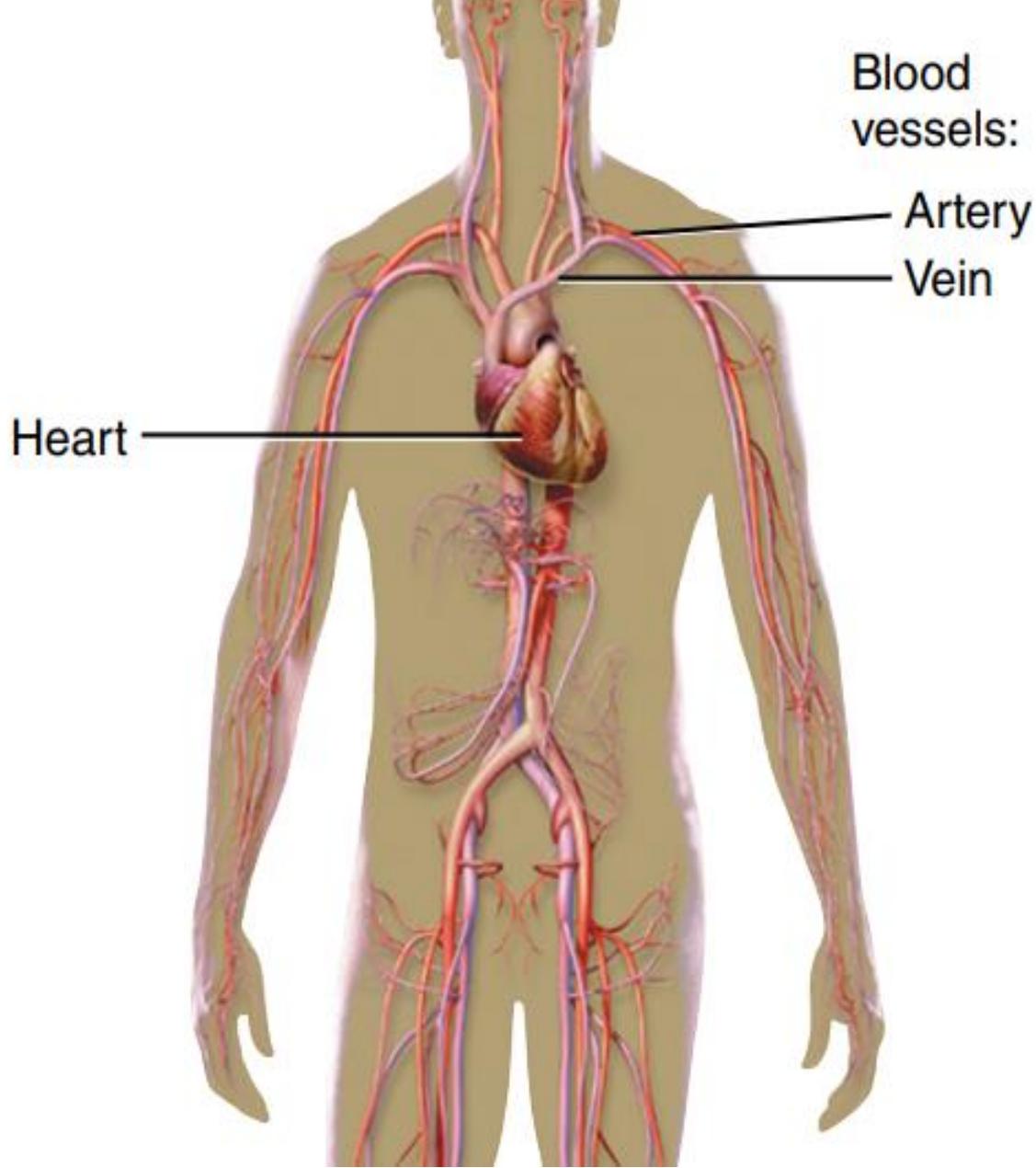


Cardiovascular System



Dr. Aman Shakya

2080.02.22

Objectives

- To explain about development of heart
- To discuss congenital anomalies

Development of Heart

- 1. Formation of Heart Tube
- 2. Primitive Heart Tube Dilation
- 3. The Aorticopulmonary Septum
- 4. The Atrial Septum
- 5. The Atrioventricular Septum
- 6. The Interventricular Septum

Formation of Heart Tube

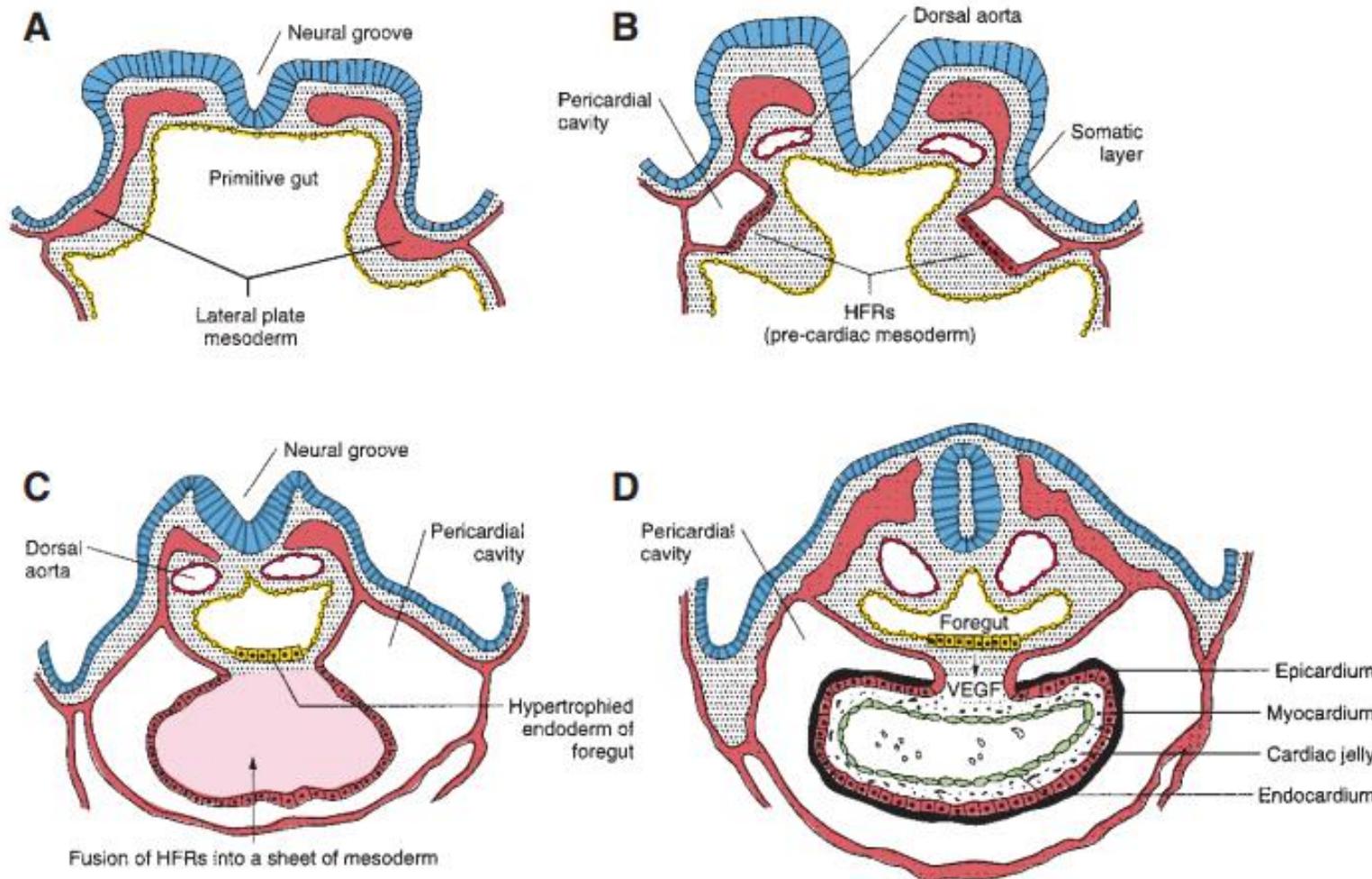
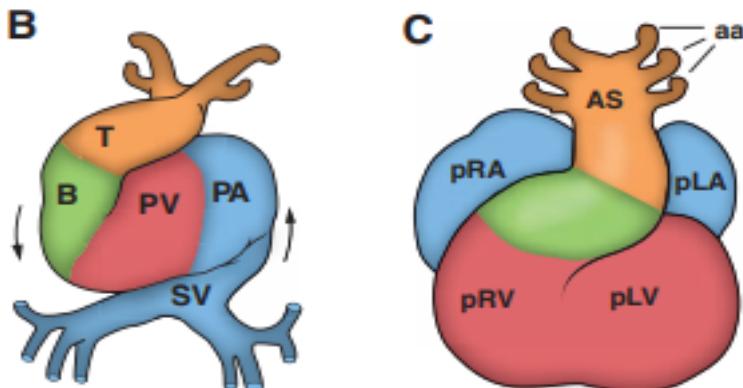
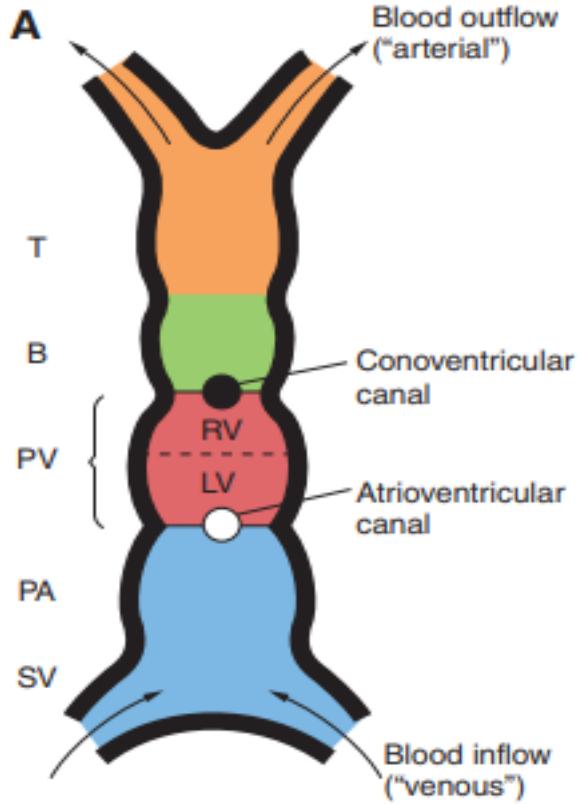


FIGURE 5.1. Schematic diagrams depict cross sections of an embryo at the level of the developing heart. **A.** Formation of lateral plate mesoderm. **B.** Splitting of lateral plate mesoderm. **C.** Fusion of heart-forming regions (HFRs) in the midline into a sheet of mesoderm. **D.** Vascular endothelial growth factor (VEGF) induction of single endocardial tube. Neuroectoderm and ectoderm, blue; mesoderm, red; endoderm, yellow; epicardium, black; and endocardium, green.

Primitive Heart Tube Dilation

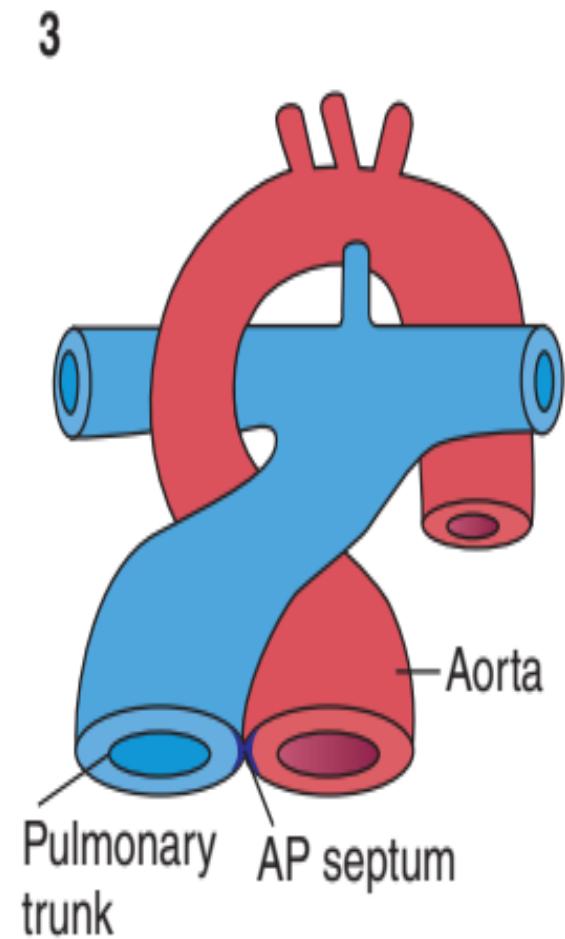
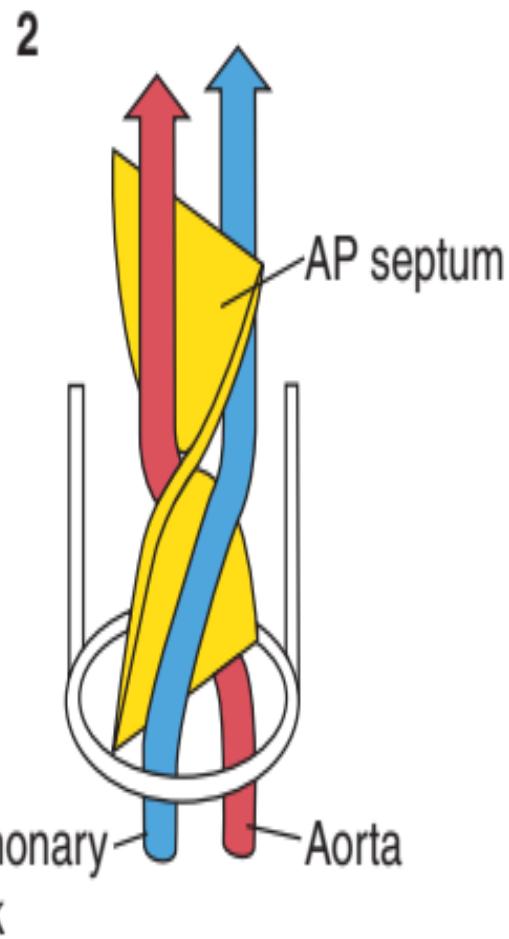
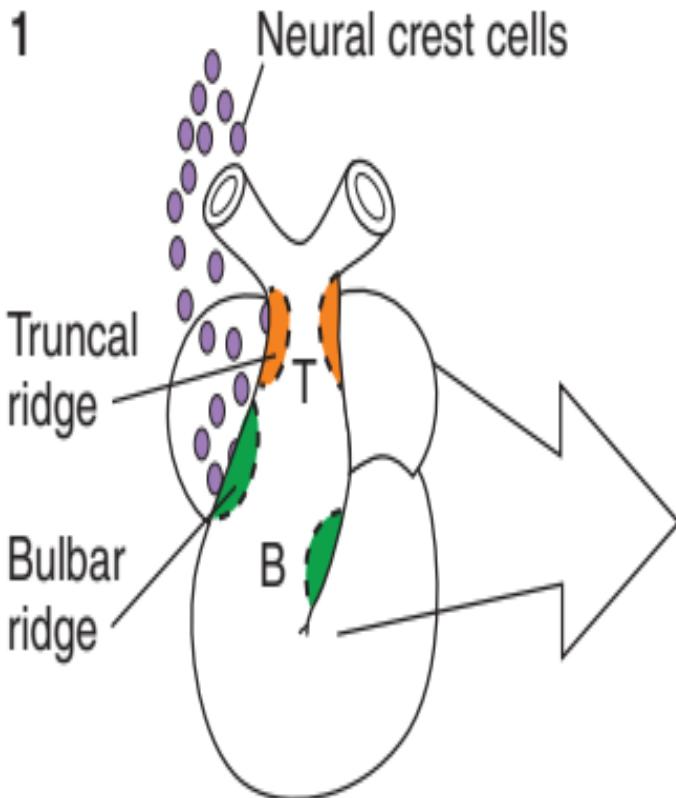


Embryonic Dilation	Adult Structure
Truncus arteriosus (T)	Aorta Pulmonary trunk
Bulbus cordis (B)	Smooth part of right ventricle (conus arteriosus) Smooth part of left ventricle (aortic vestibule)
Primitive ventricle (PV)	Trabeculated part of right ventricle (RV) Trabeculated part of left ventricle (LV)
Primitive atrium (PA)	Trabeculated part of right atrium Trabeculated part of left atrium
Sinus venosus (SV)	Smooth part of right atrium (sinus venarum)^a Coronary sinus Oblique vein of left atrium

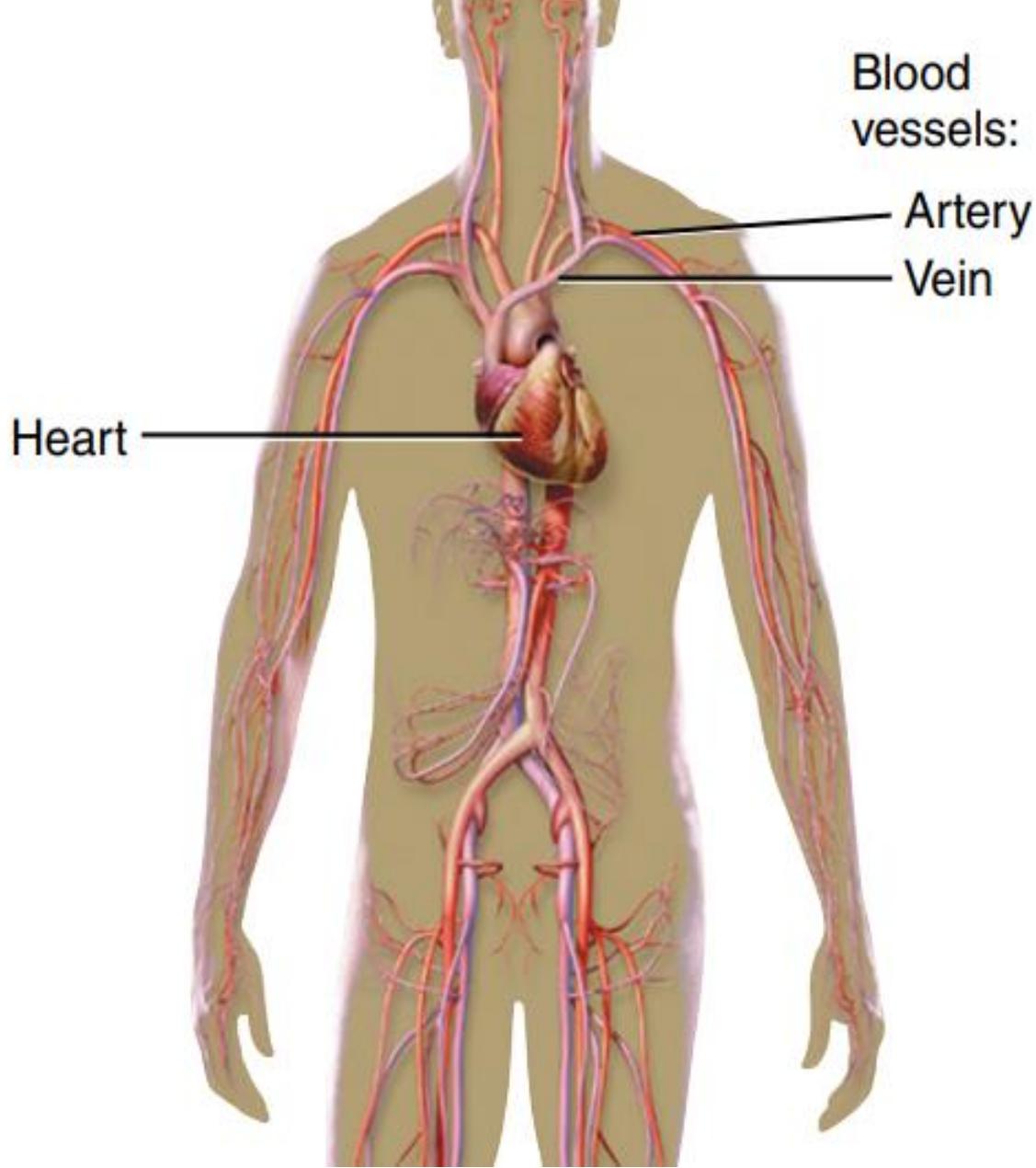
^a The smooth part of the left atrium is formed by incorporation of parts of the **pulmonary veins** into the atrial wall. The junction of the trabeculated and smooth part of the right atrium is called the **crista terminalis**.

The Aorticopulmonary Septum

Formation of the AP septum



Cardiovascular System



Dr. Aman Shakya

2080.02.23

Objectives

- To explain about development of heart
contd...
- To discuss congenital anomalies contd....

Anomalies

Persistent truncus arteriosus

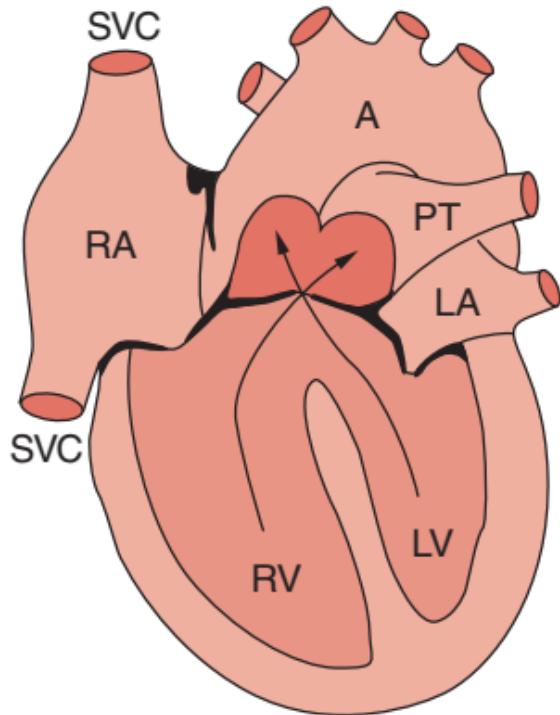


FIGURE 5.4. Persistent truncus arteriosus. SVC = superior vena cava; RA = right atrium; IVC = inferior vena cava; RV = right ventricle; LV = left ventricle; A = aorta; PT = pulmonary trunk; LA = left atrium.

- Partial development of AP septum
- One large vessel leaves the heart and receives blood from both the right and left ventricles
- Usually accompanied by a membranous ventricular septal defect (VSD)

Anomalies

D-Transposition of the great arteries

- nonspiral development of the AP septum occurs.
- aorta arises abnormally from the right ventricle and the pulmonary trunk arises abnormally from the left ventricle;
- incompatible with life unless an accompanying shunt exists, like a VSD, patent foramen ovale, or patent ductus arteriosus.

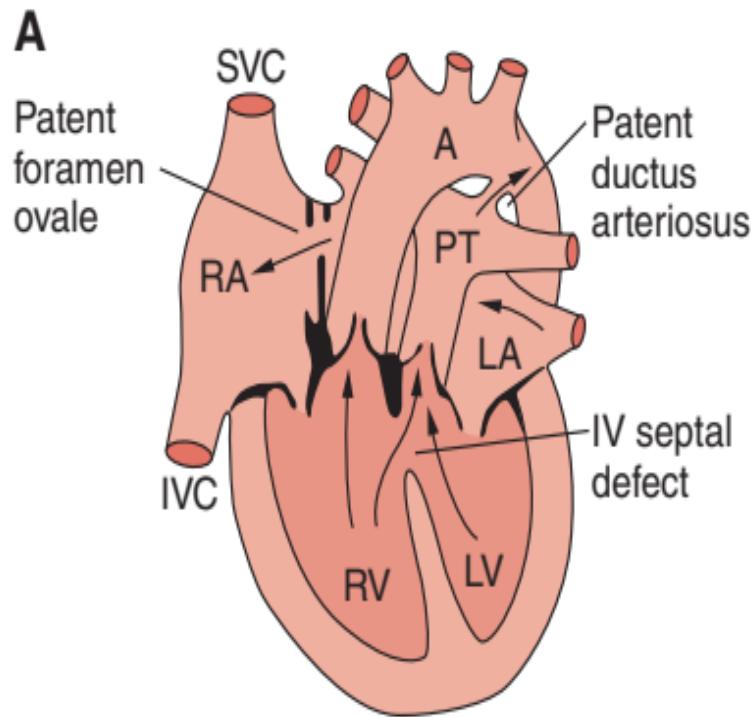


FIGURE 5.5. A. D-Transposition of the great arteries (complete). SVC = superior vena cava; RA = right atrium; IVC = inferior vena cava; RV = right ventricle; LV = left ventricle; A = aorta; PT = pulmonary trunk; LA = left atrium; IV = interventricular; P = pulmonary artery.

Anomalies

Tetralogy of Fallot

A

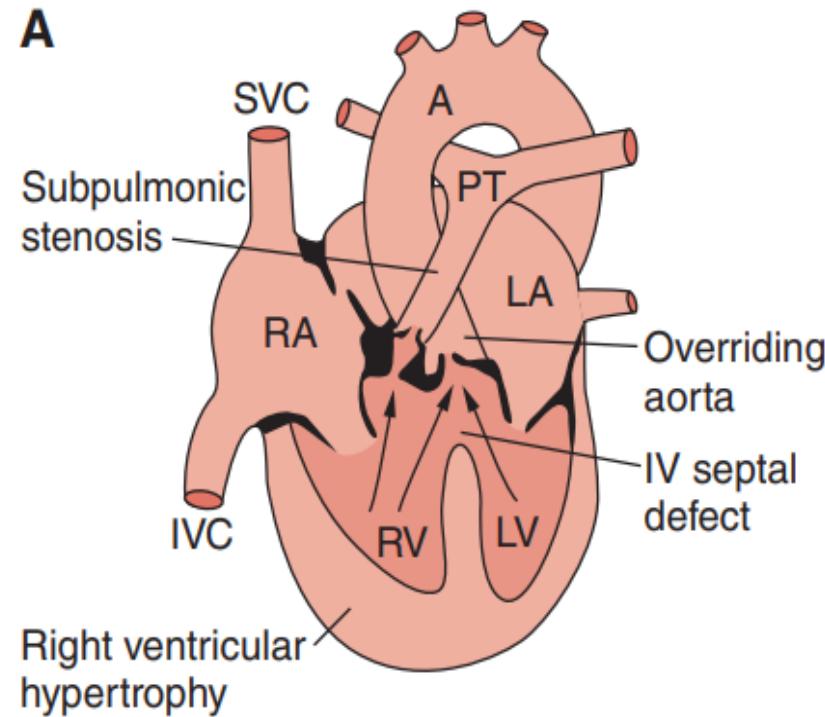
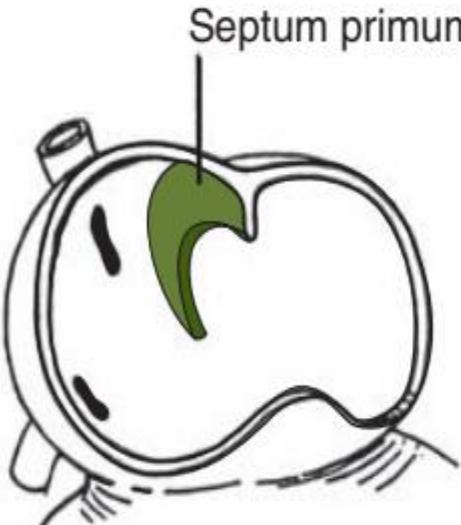


FIGURE 5.7. Tetralogy of Fallot. **A.** Arrows indicate the direction of blood flow. SVC = superior vena cava; RA = right atrium; IVC = inferior vena cava; RV = right ventricle; LV = left ventricle; A = aorta; PT = pulmonary trunk; LA = left atrium; IV = interventricular.

- skewed development of the AP septum occurs.
- pulmonary trunk exhibits a small diameter and the aorta exhibits a large diameter.
- pulmonary stenosis, right ventricular hypertrophy, overriding aorta, and ventricular septal defect,

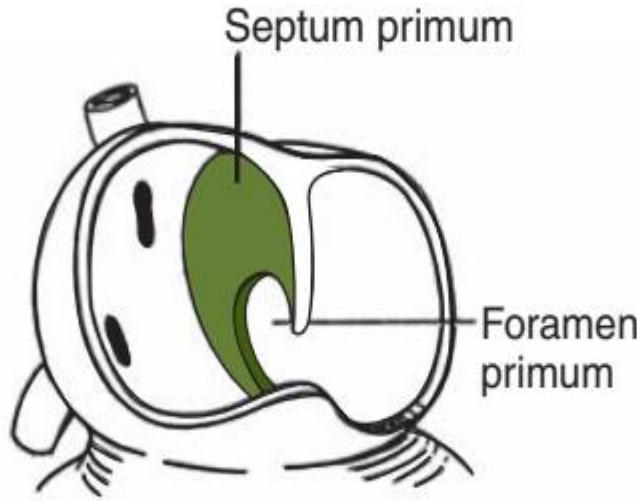
The Atrial Septum

Septum primum



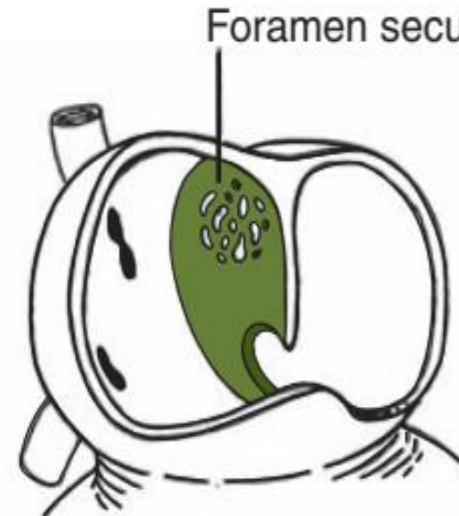
1

Septum primum



2

Foramen secundum



3

Foramen secundum

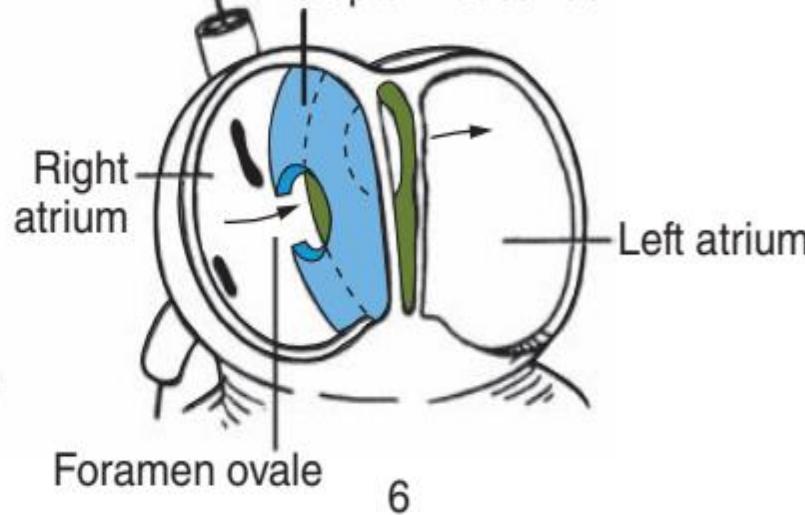


4

Septum secundum



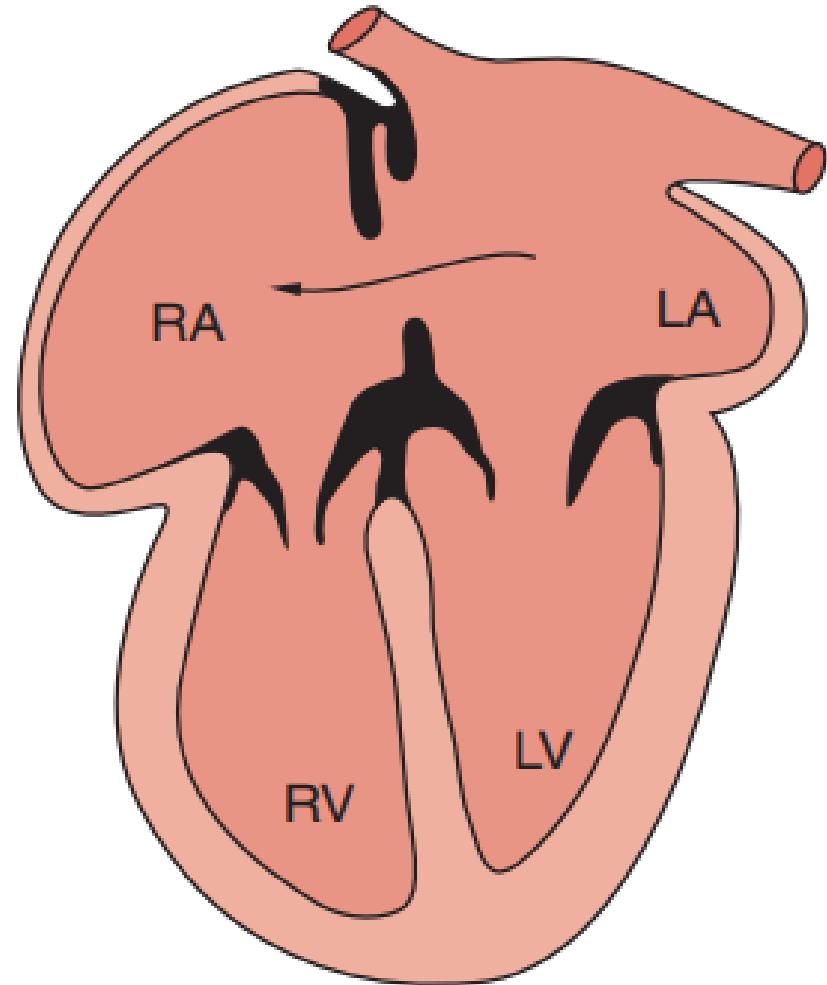
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6

Anomalies

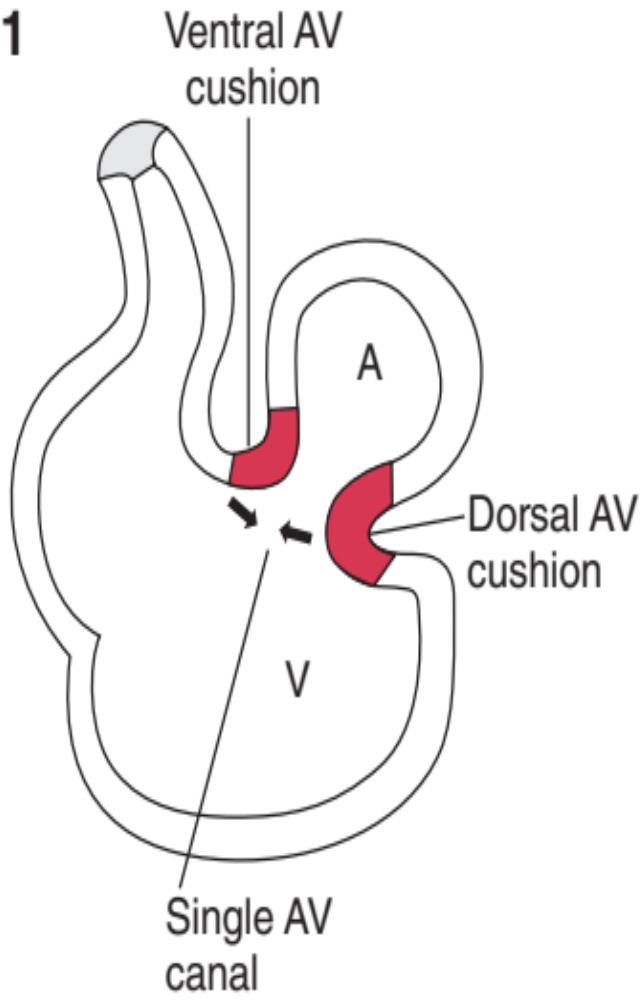
- Probe patency of the foramen oval
- Premature closure of the foramen ovale
- Foramen secundum defect



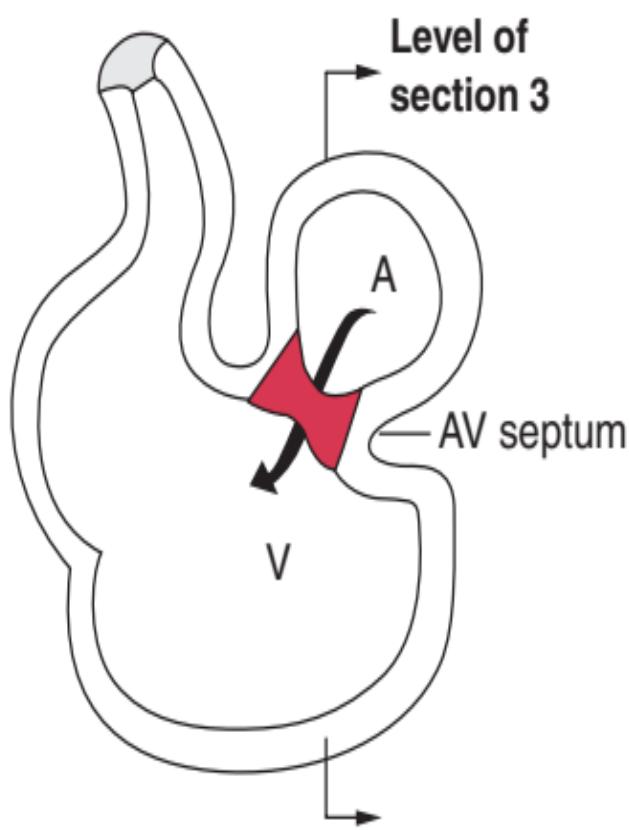
The Atrioventricular Septum

Formation of the AV Septum

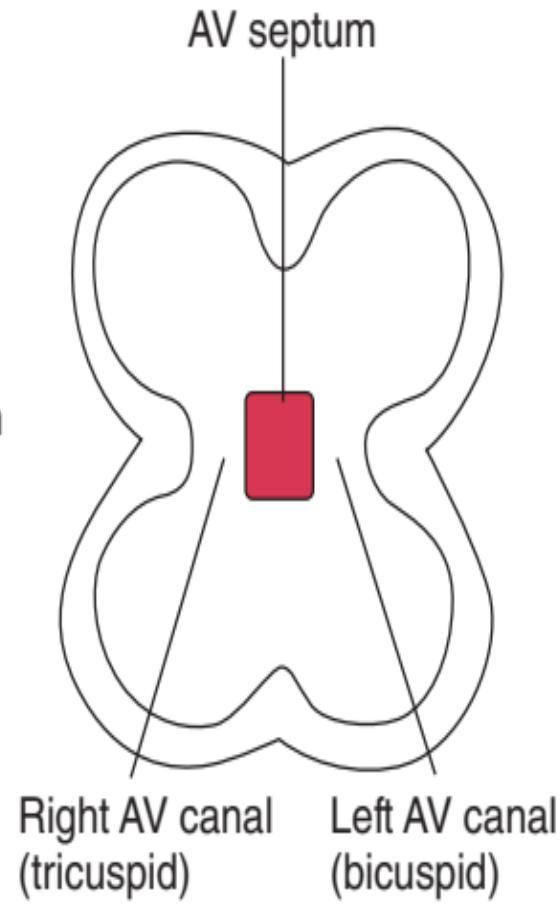
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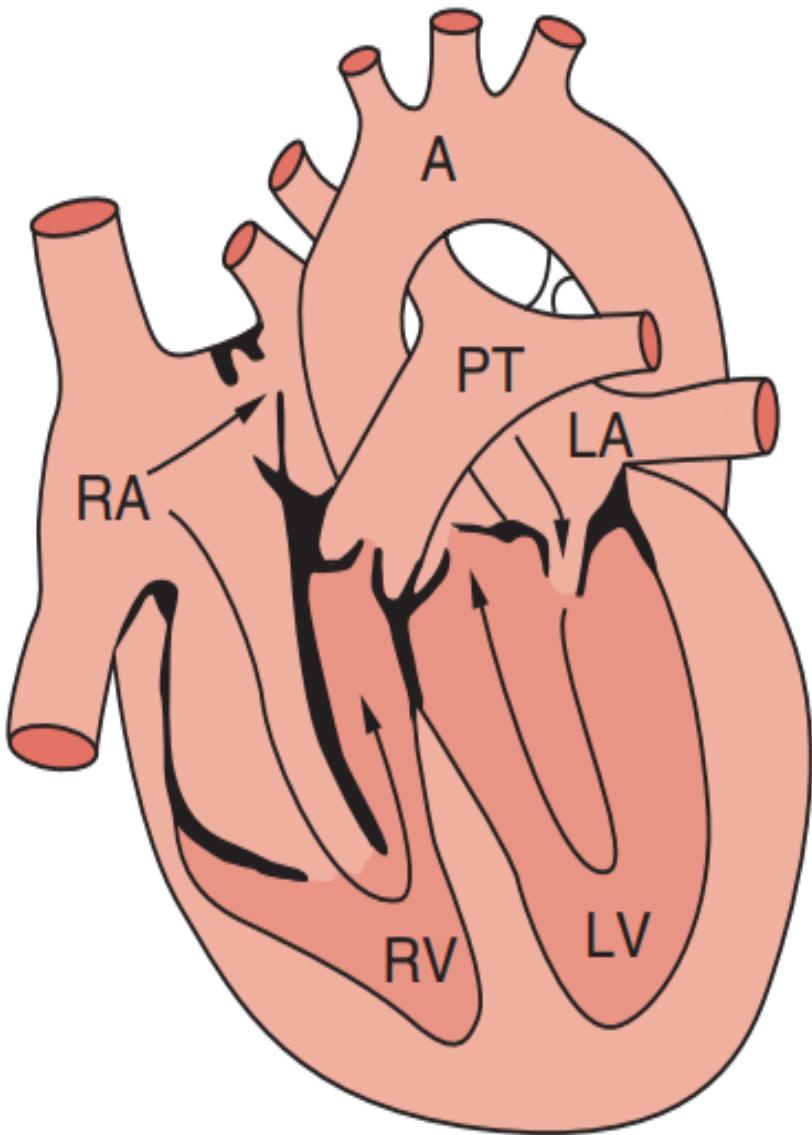
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3



Anomalies



Ebstein anomaly

- failure of the posterior and septal leaflets of the tricuspid valve to attach normally to the annulus fibrosus; instead they are displaced inferiorly into the right ventricle.
- usually associated with an ASD and maternal lithium exposure.

The Interventricular Septum

Formation of the IV Septum

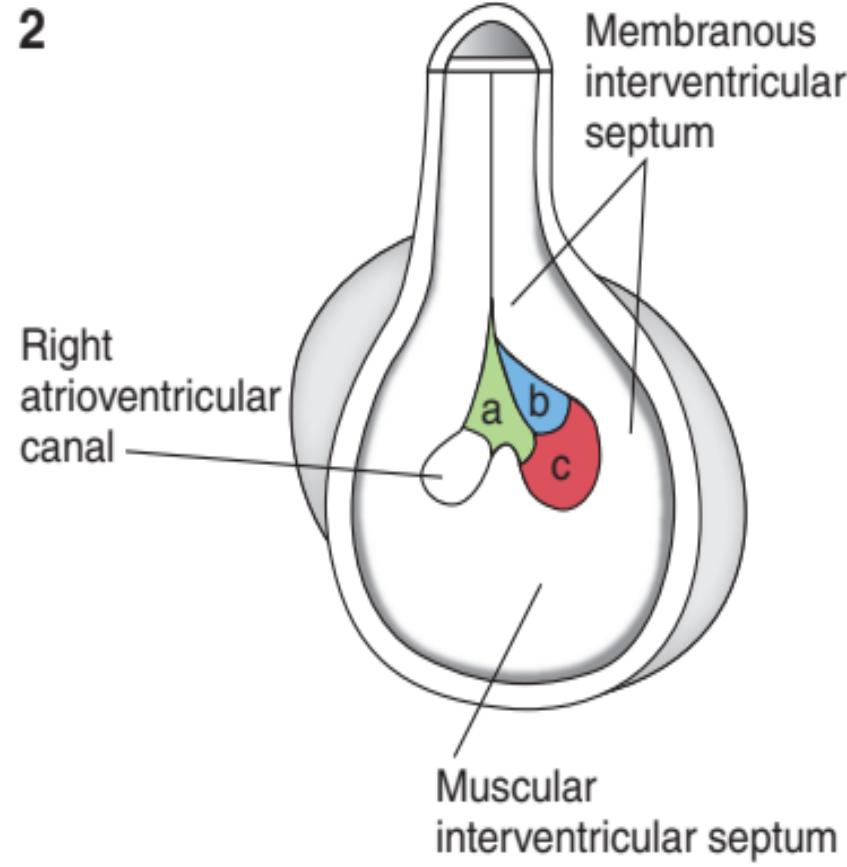
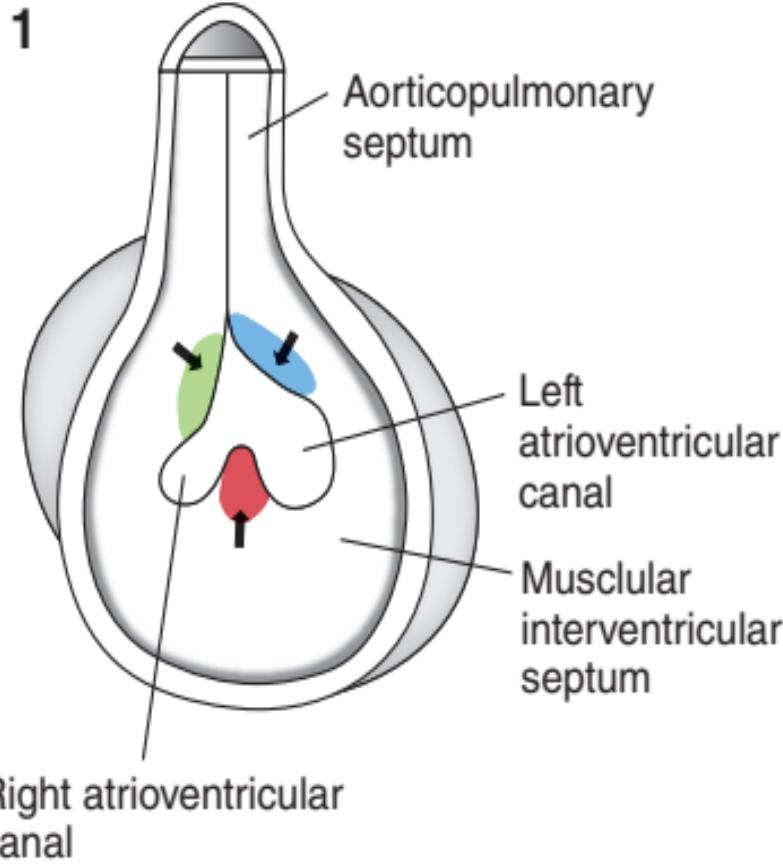
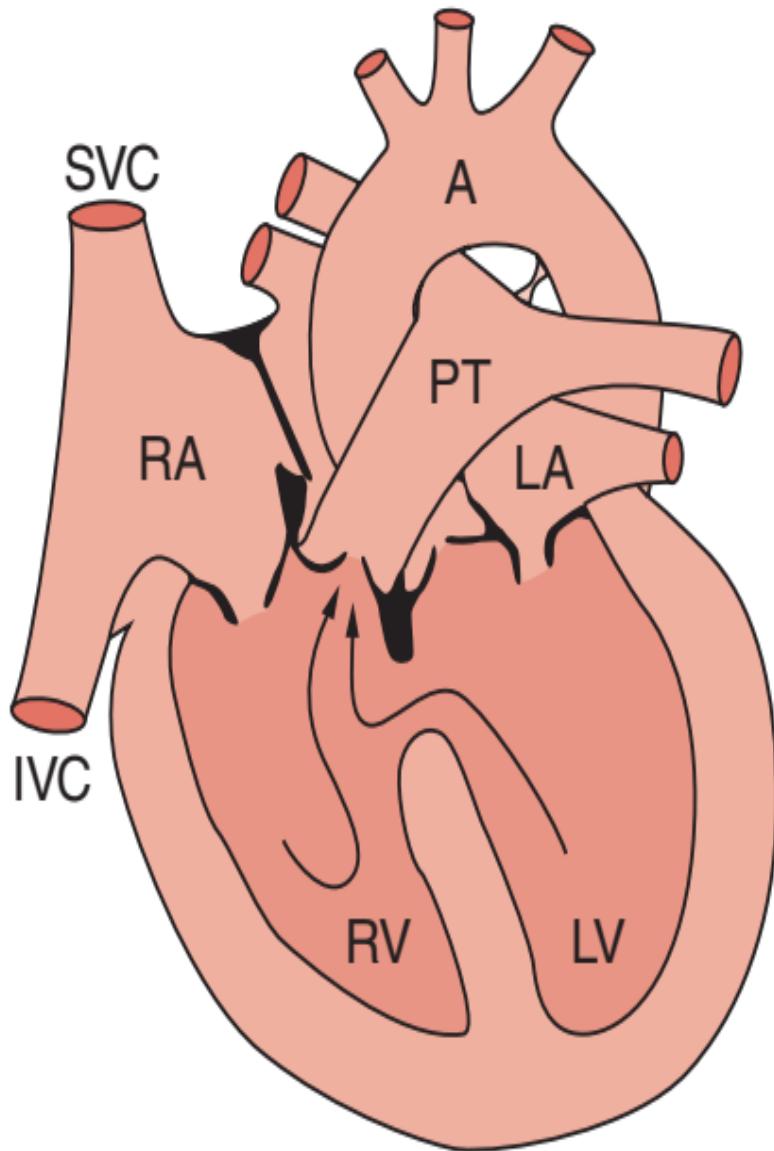


FIGURE 5.16. Formation of the interventricular (IV) septum. The IV septum partitions the primitive ventricle. The three sources of the membranous interventricular septum are indicated: a = right bulbar ridge (green); b = left bulbar ridge (blue); c = atrioventricular (AV) cushions (red).

Anomalies

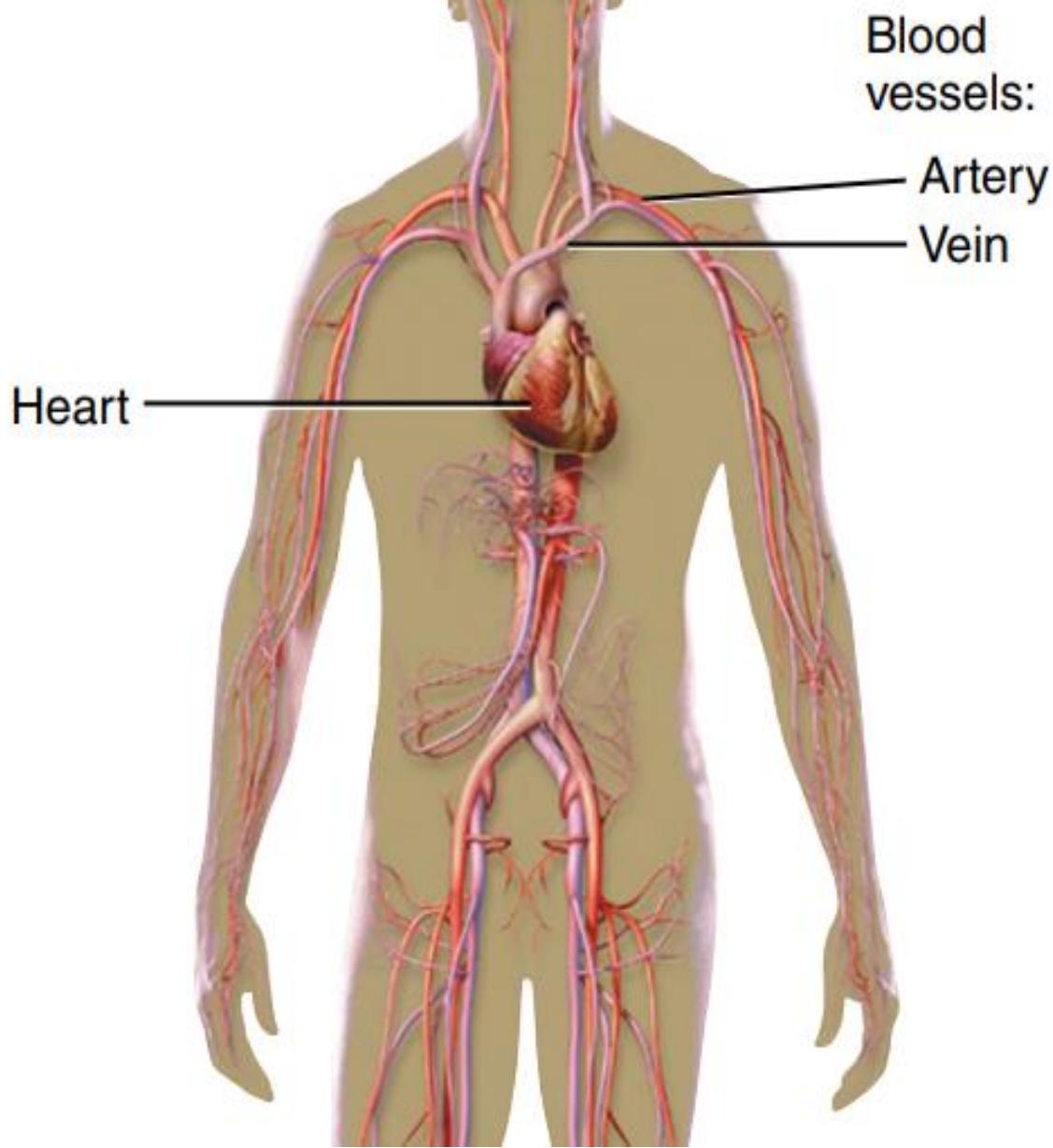


Membranous VSD

- faulty fusion of the right bulbar ridge, left bulbar ridge, and AV cushions. It results in an opening between the right and left ventricles, which allows free flow of blood.
- “Eisenmenger complex.”
- most common type of VSD.

Thank you

Cardiovascular System



Dr. Aman Shakya

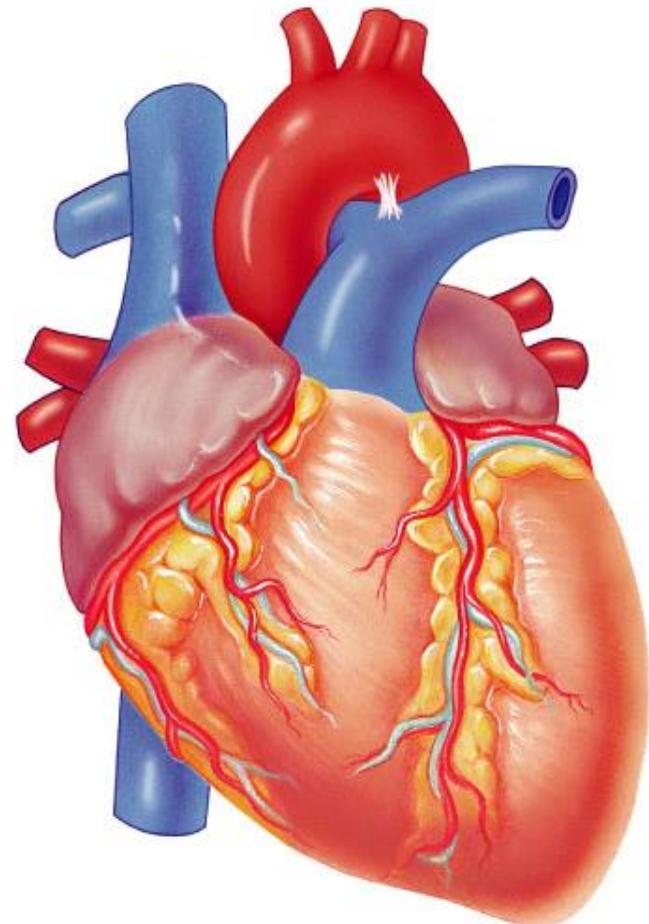
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Objectives

- To discuss about position of heart
- To describe gross and microscopic structure of heart
- To know about vessels entering and going out of the heart
- To describe blood supply of the heart

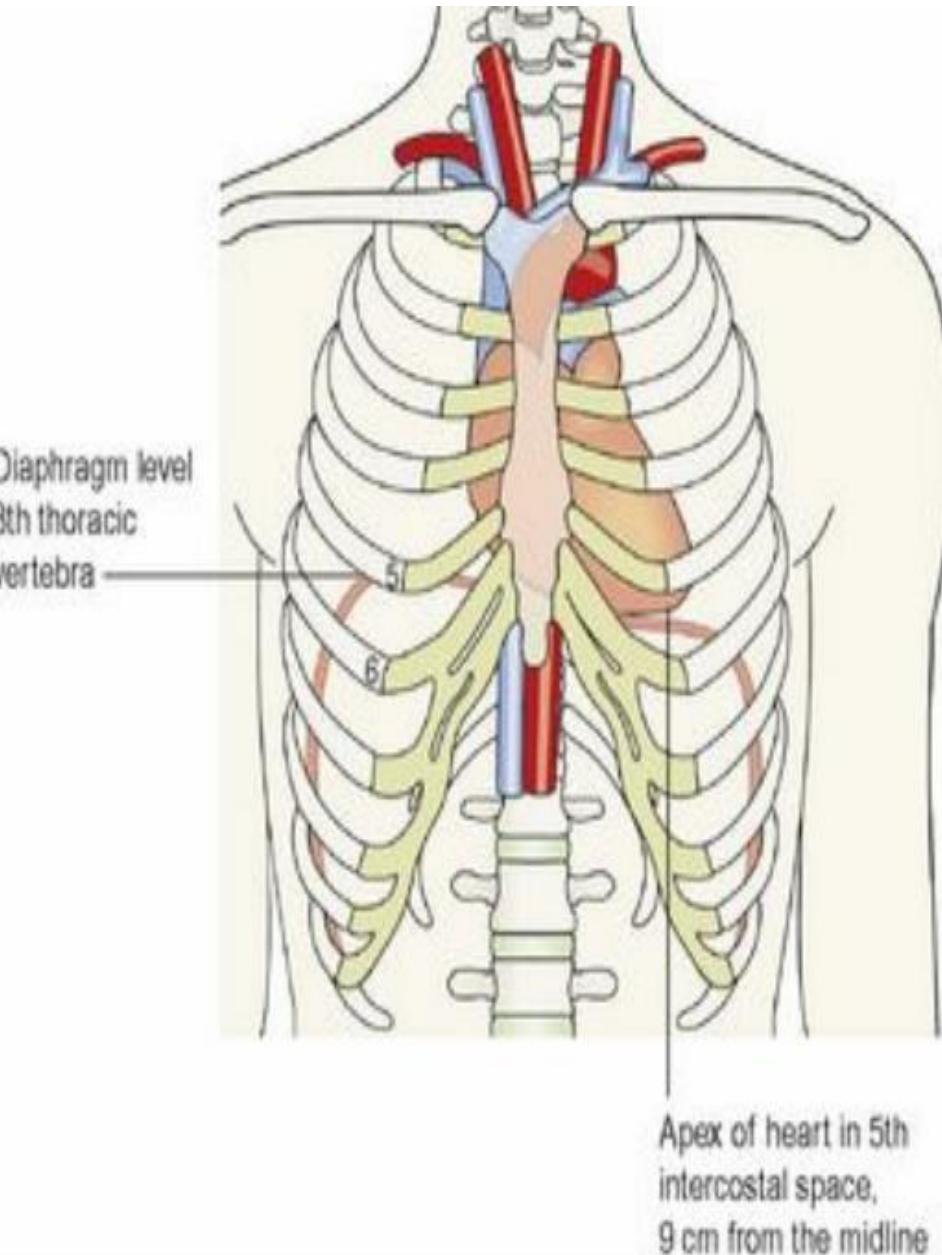
Heart

- Roughly cone-shaped hollow muscular organ
- About the size of owner's fist
- Weighs heavier in men



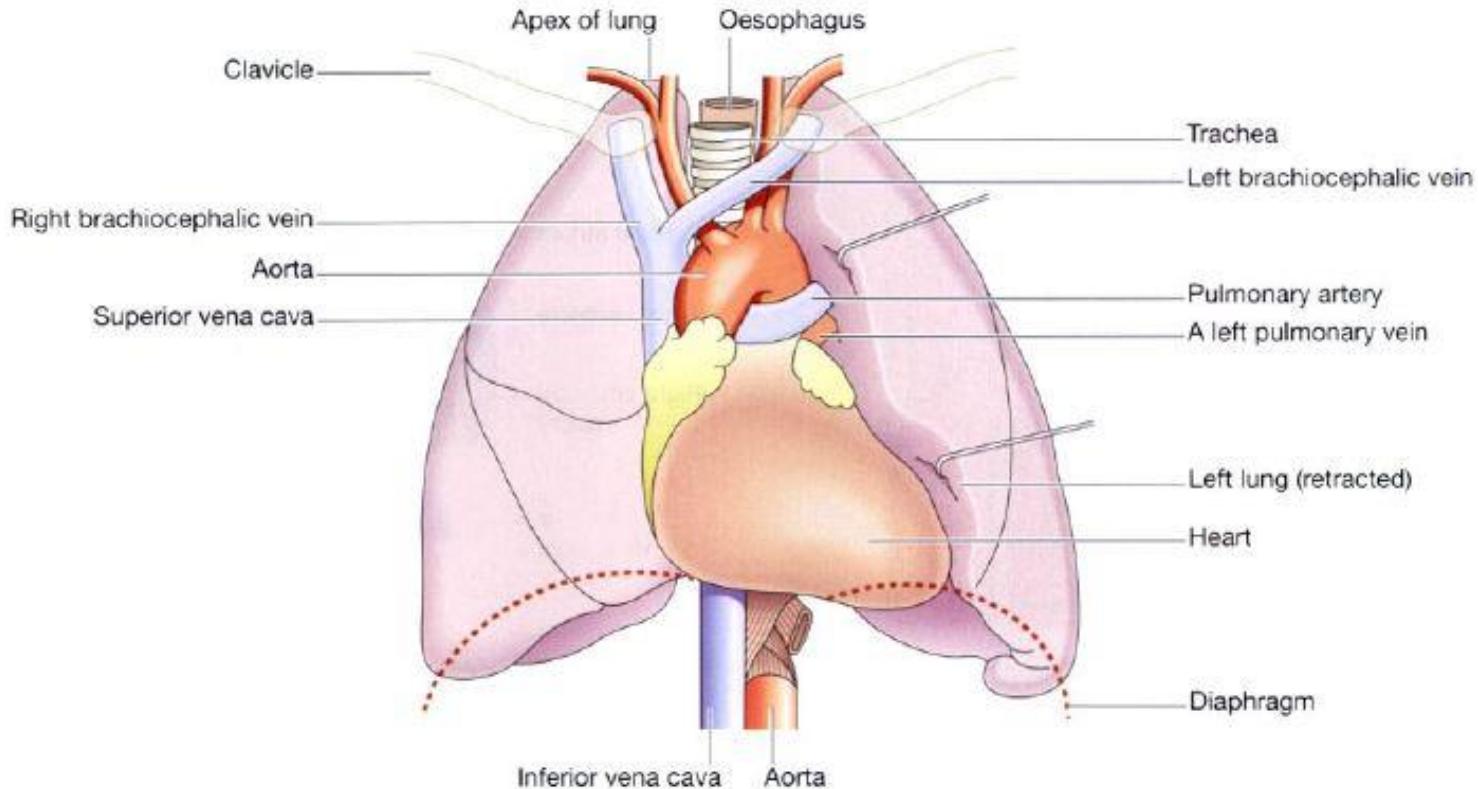
Heart Position

- Situated in the thoracic cavity in mediastinum
- Lies obliquely, a little more to left than right
- A *base* above, and an *apex* below
 - Apex is about 9 cm to the left of midline at level of 5th ICS, a little below the nipple (**apex beat**)
 - Base extends to the level of the 2nd rib



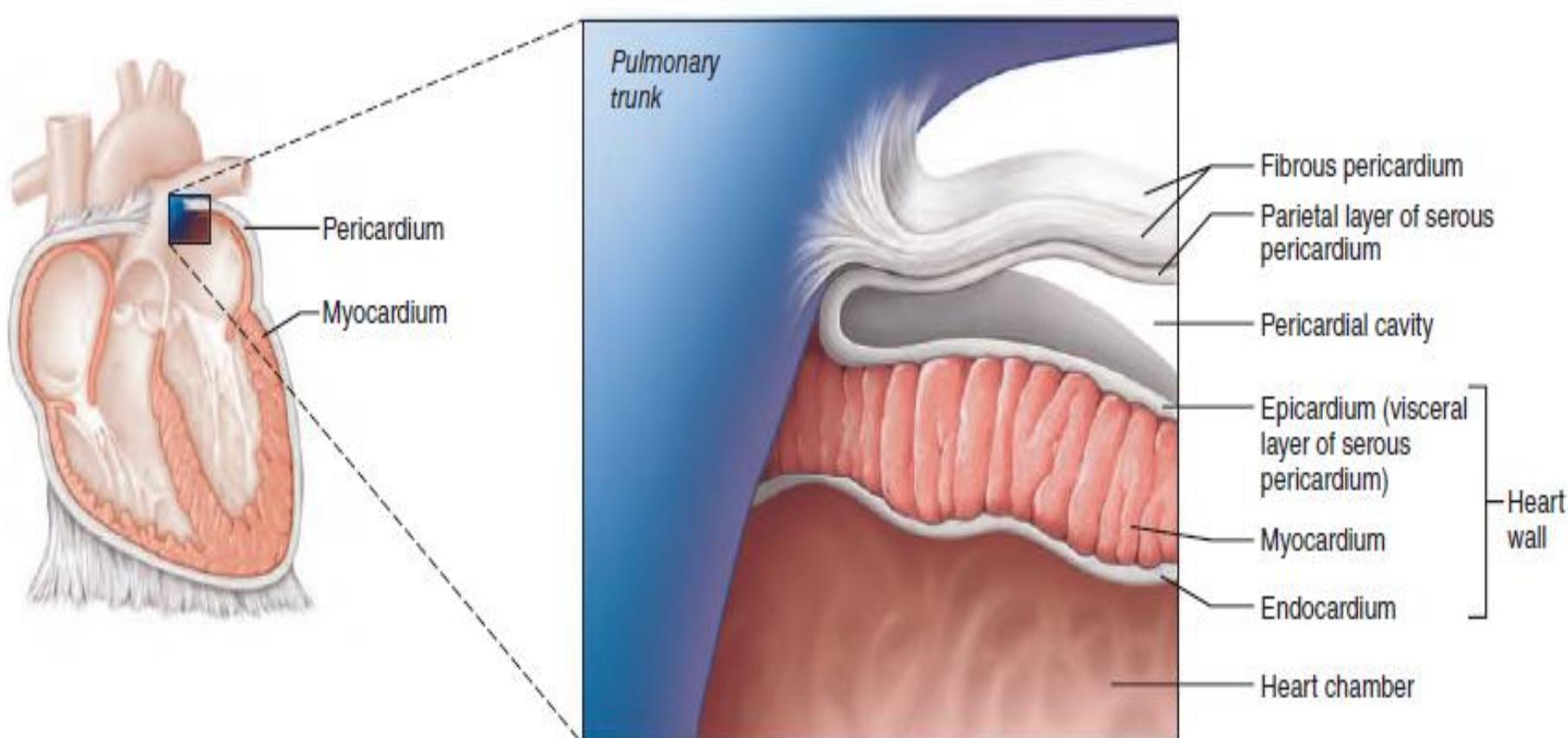
Heart- Relations

- **Inferiorly:** Diaphragm
- **Superiorly:** Great blood vessels
- **Laterally:** Lungs
- **Posteriorly:** Esophagus, Trachea, Descending aorta, IVC, Thoracic vertebrae
- **Anteriorly:** Sternum, Ribs, Intercostal muscles



Heart Structure

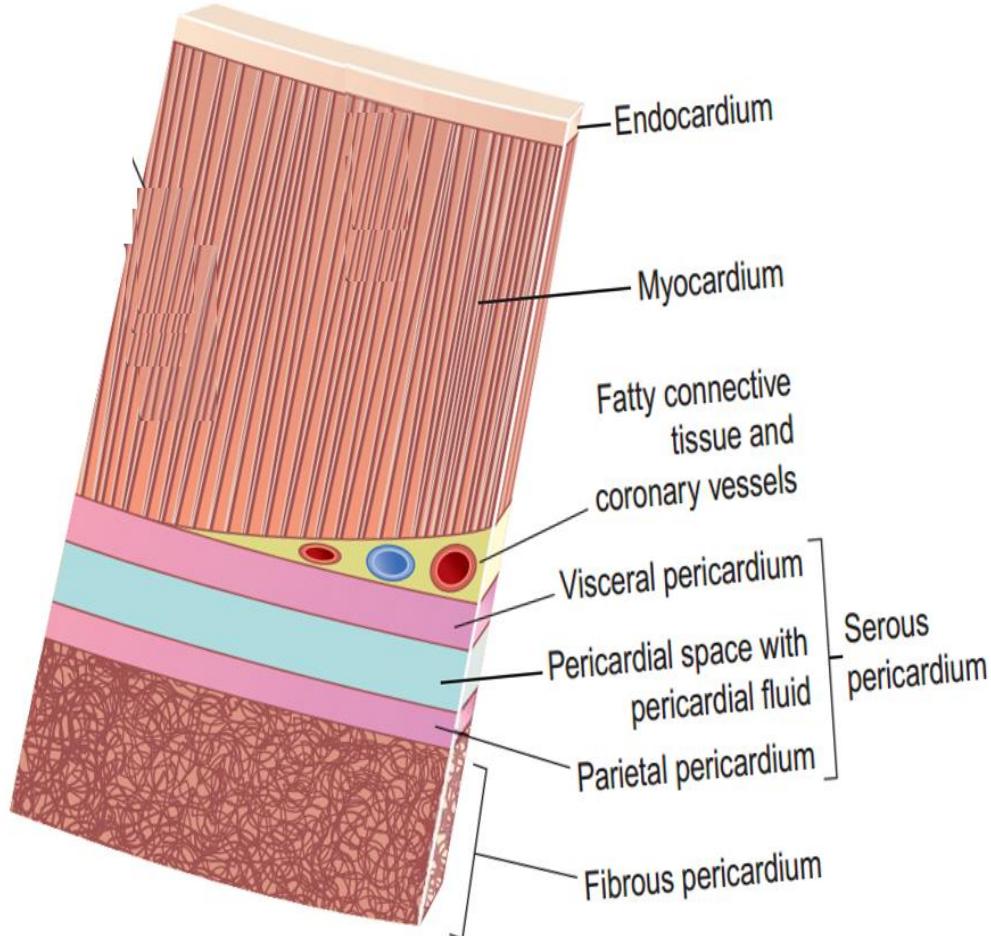
- Composed of 3 layers of tissue:
 - Pericardium
 - Myocardium
 - Endocardium



Heart- structure

Pericardium

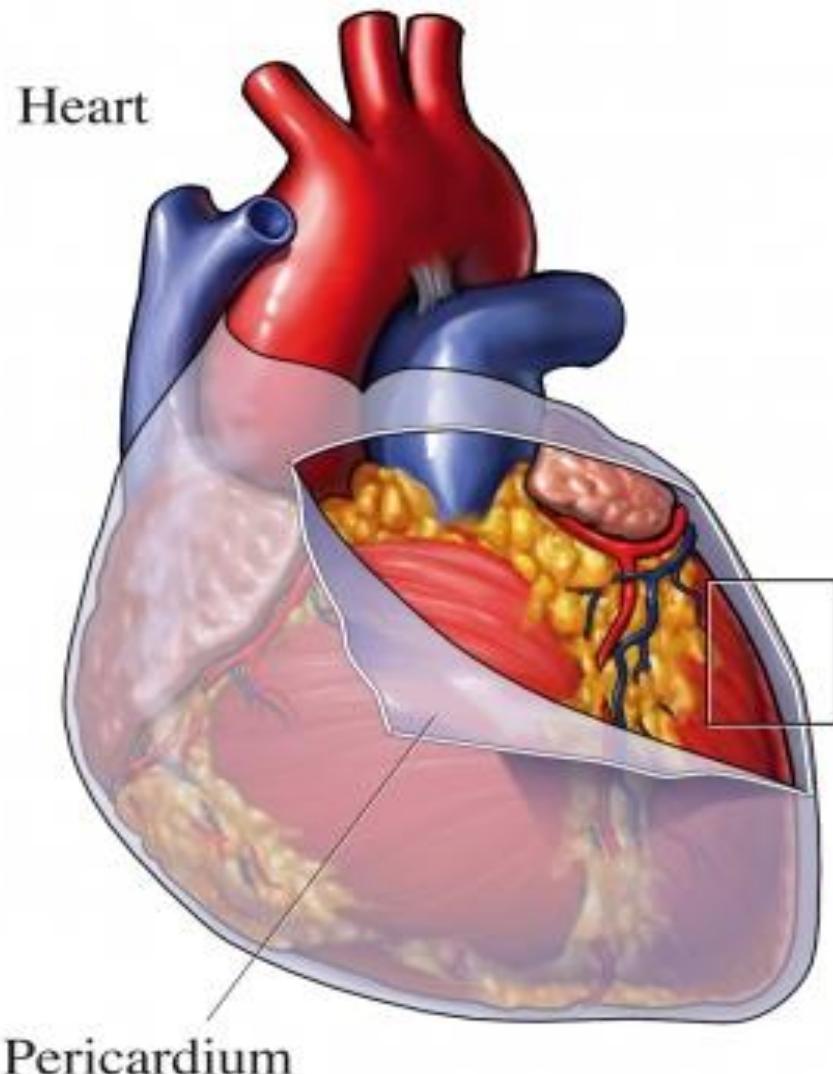
- Consists of:
 - Outer fibrous part
 - Inner double layered serous membrane
- Outer part prevents over distension
- Outer layer of serous membrane = Parietal pericardium



Heart- Structure

Pericardium

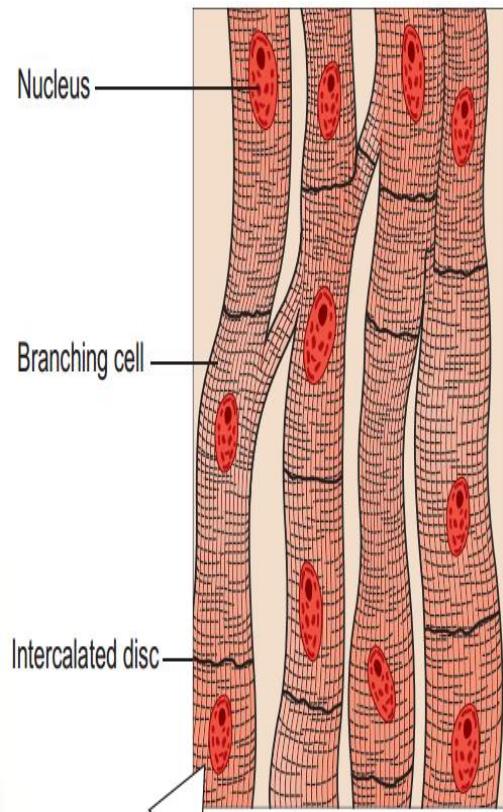
- Inner layer of serous membrane = Visceral Pericardium or Epicardium; adherent to myocardial layer
- Pericardial fluid present in between double layered serous membranes
- Allows smooth movement of heart during heart beat



Heart- structure

Myocardium

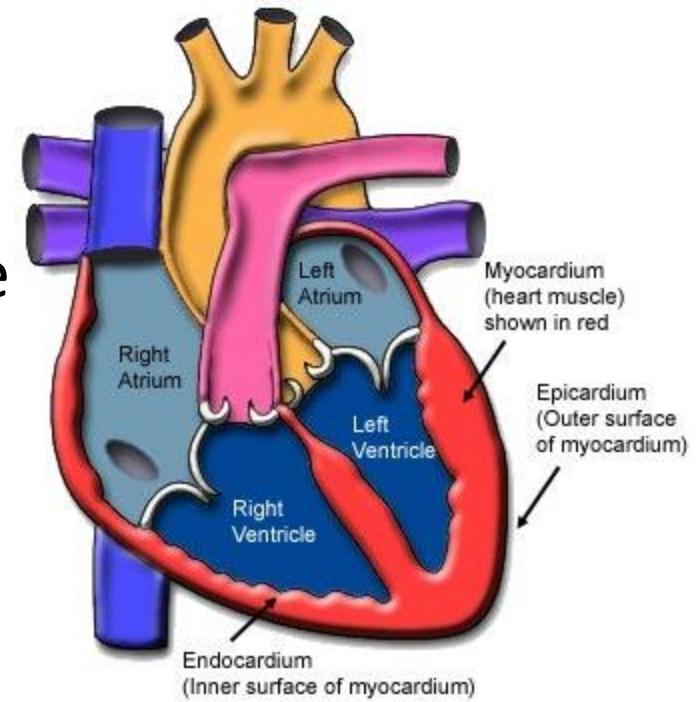
- Composed of specialized cardiac muscle
- Involuntary muscle; but striations are present
- Branching of muscle fibres
- Adjacent cells (fibres) –
- connected by intercalated discs which mediate
- immediate transfer of impulse
- Thickest in the LV



Heart- structure

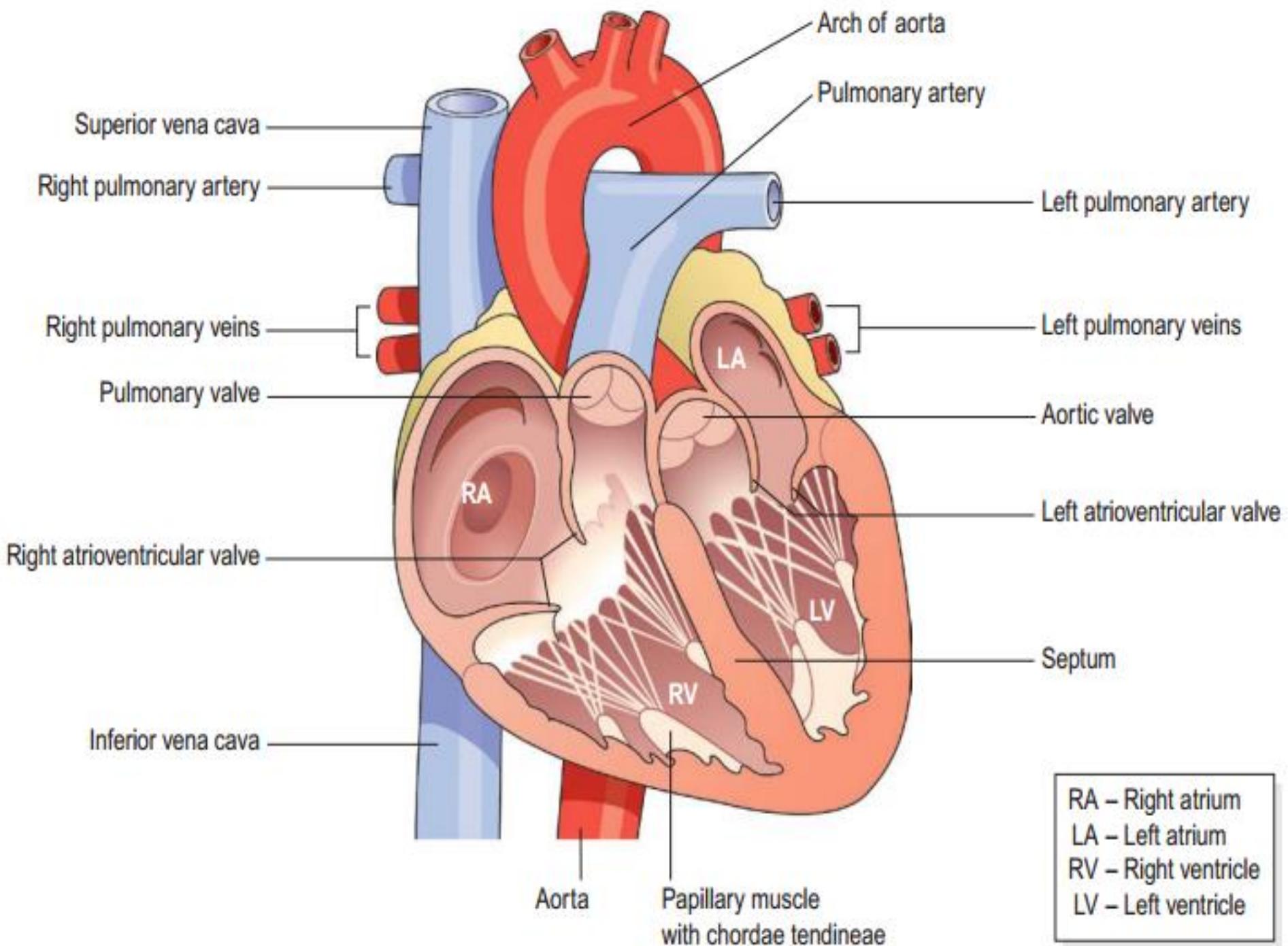
Endocardium

- Forms lining of myocardium and heart valves
- Thin, smooth, glistening membrane
- Permits smooth flow of blood inside the heart
- Continuous with endothelium lining blood vessels



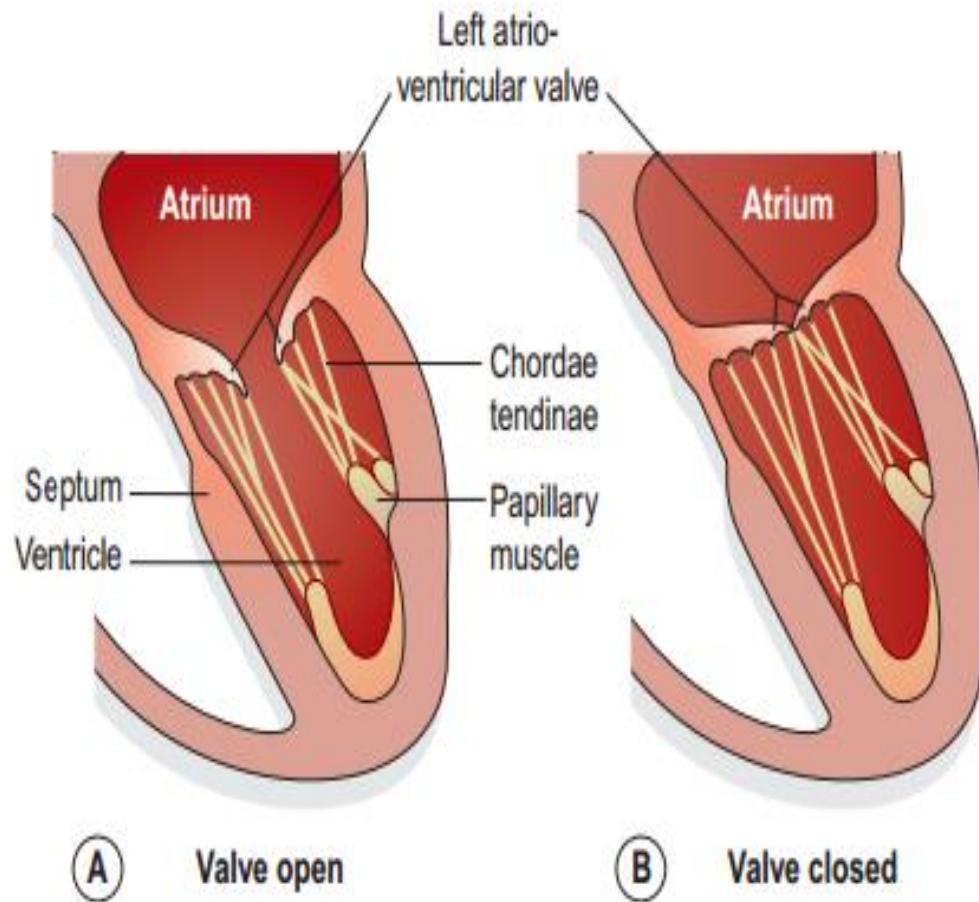
Heart- interior

- Divided into right and left by atrial septum and interventricular septum
- Each side is divided by an AV valve into an atrium and ventricle
- 4 chambers
- Right AV valves has 3 flaps or cusps (tricuspid) while Left has 2 flaps or cusps (bicuspid/mitral valve)
- Pulmonary valve and Aortic valve (3 semilunar cusps)



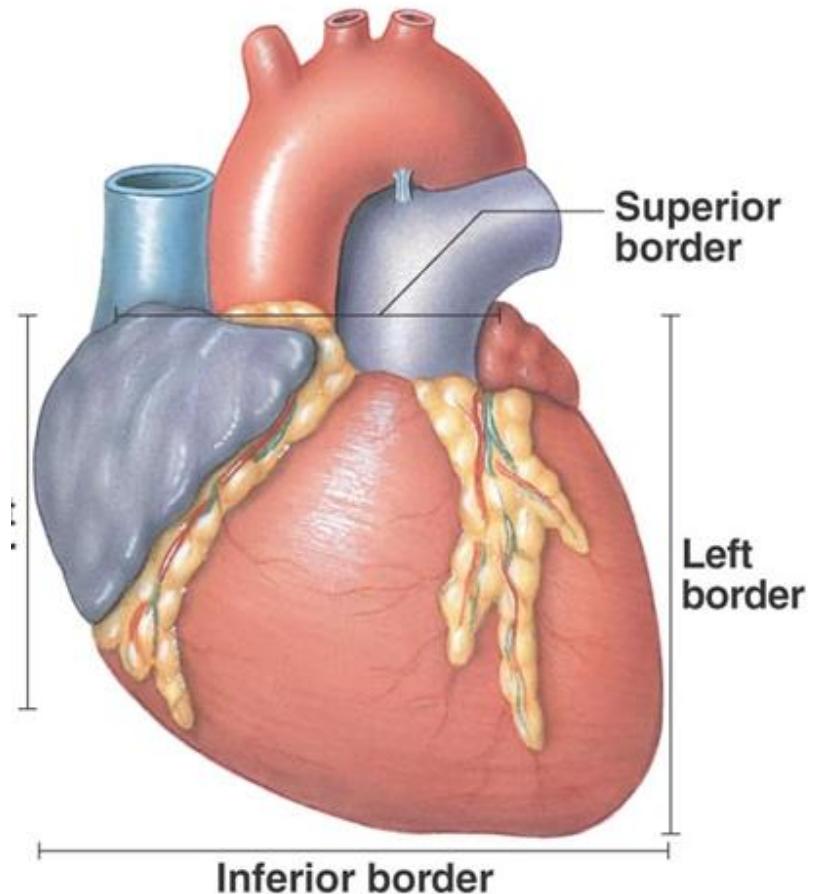
Heart-interior

- AV valves open and close passively
- Valves are prevented from opening upwards by chordae tendinae
- These cords extend from inferior surface of valves to projections of myocardium in ventricles, known as papillary muscles



Heart- external

- Coronary or AV sulcus
- Interatrial and interventricular groove
- 4 borders
 - Right
 - Superior
 - Left
 - Inferior



Superior vena cava (SVC)
Inferior vena cava (IVC)
Coronary sinus

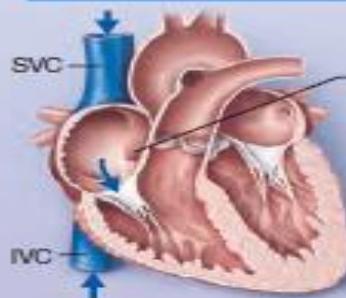
Right atrium

Tricuspid valve

Right ventricle

Pulmonary semilunar valve

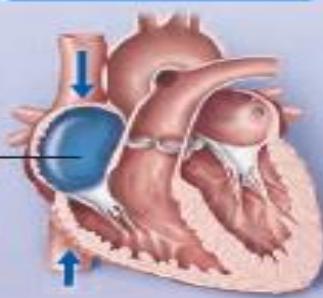
Pulmonary trunk



Coronary
sinus

Right
atrium

To heart
Oxygen-poor blood
returns from the body
tissues back to the heart.



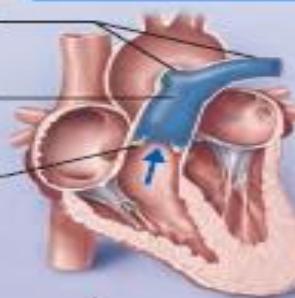
Tricuspid
valve

Right
ventricle

Pulmonary
arteries

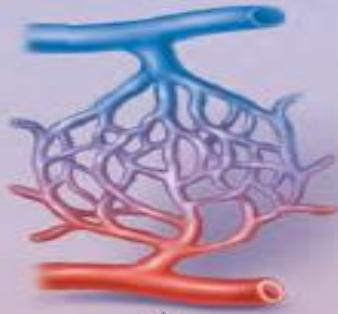
Pulmonary
trunk

Pulmonary
semilunar
valve



Oxygen-poor blood is carried
in two pulmonary arteries to
the lungs (pulmonary circuit)
to be oxygenated.

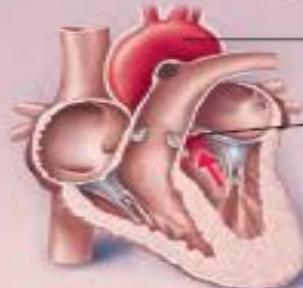
To lungs



Systemic
capillaries

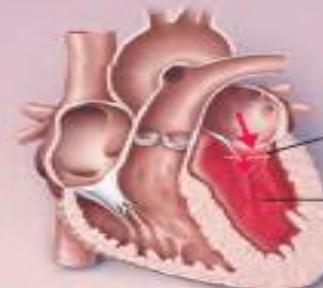
To body

Oxygen-rich blood is
delivered to the body
tissues (systemic circuit).



Aorta

Aortic
semilunar
valve



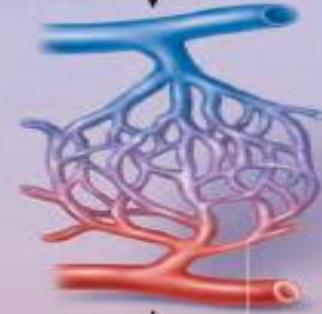
Aortic
semilunar
valve

Left
ventricle

Mitral
valve

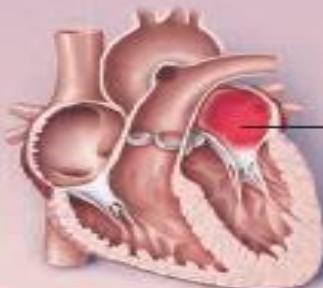
Left
atrium

Pulmonary
capillaries



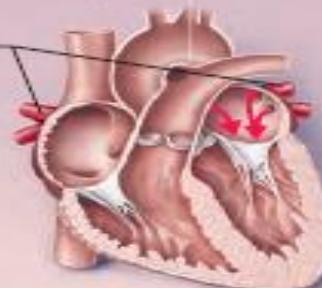
Oxygen-rich blood returns
to the heart via the four
pulmonary veins.

To heart



Pulmonary
veins

Left
atrium

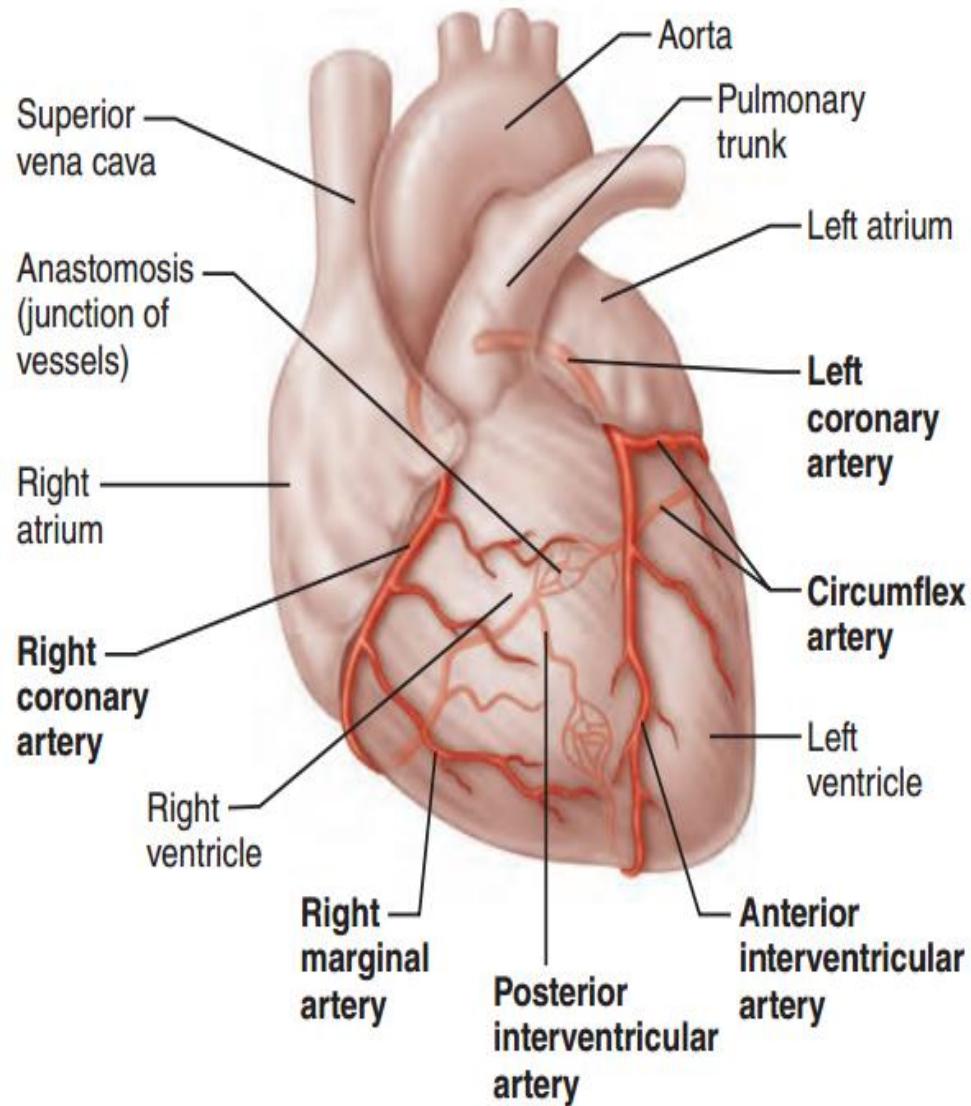


Four
pulmonary
veins

Heart- blood supply

- **Coronary arteries:**

- **RCA** (RA, RV, Posterior part of interventricular septum, SA and AV node)
- **LCA:** Anterior descending & Circumflex branch (LA, LV, Anterior part of the interventricular system)



Heart- Venous drainage

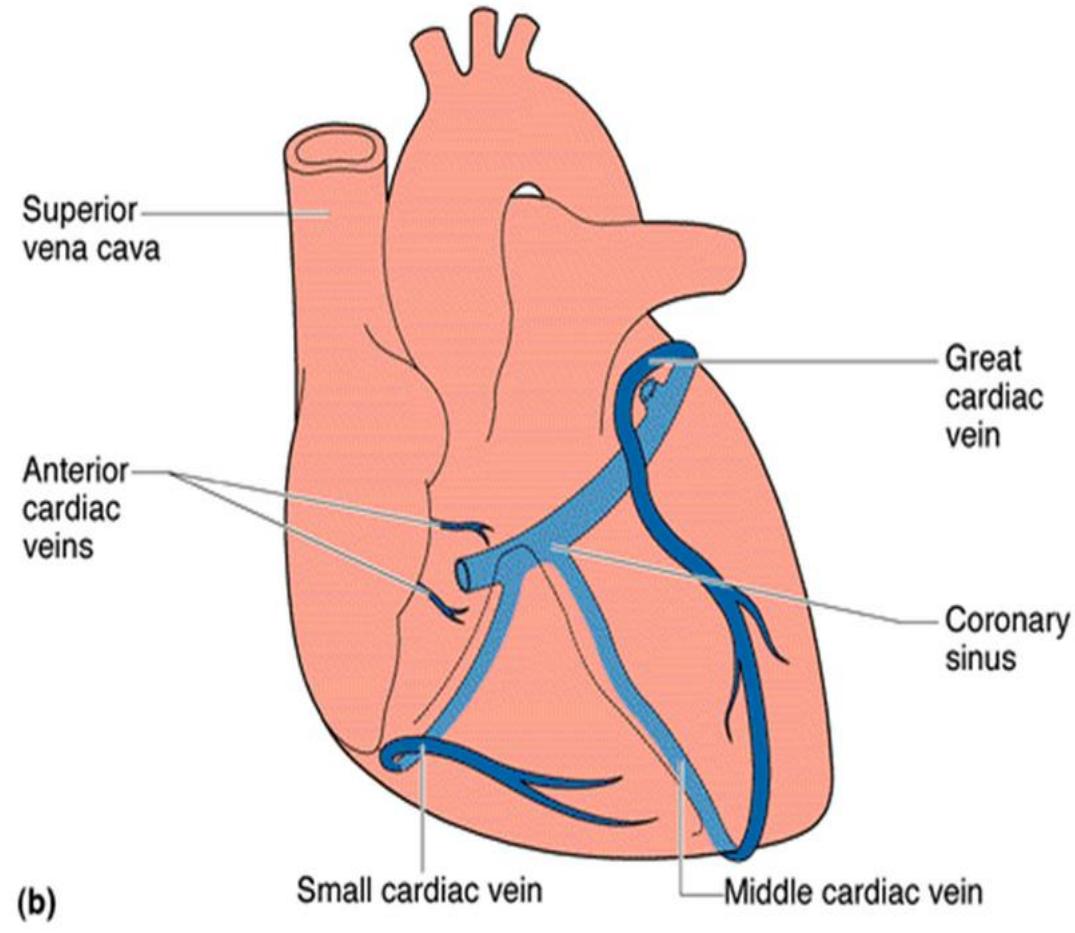
- **Coronary sinus:**

- Largest vein of the heart
- In posterior coronary sulcus
- Opens to right atrium
- Receives great, middle, small cardiac veins

- **Anterior cardiac veins**

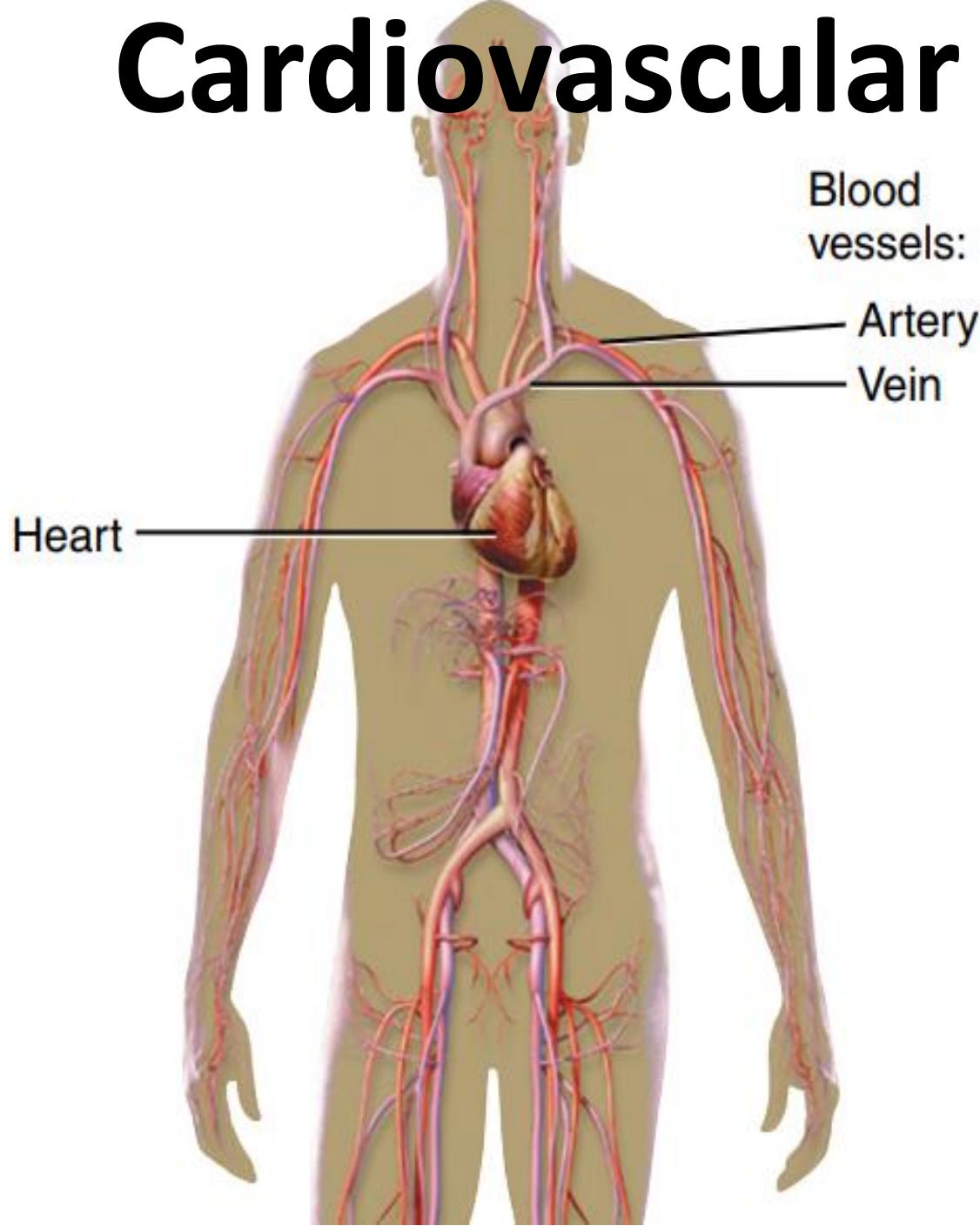
- **Venae cordis minimi:**

- Smallest cardiac veins
- In all chambers; Open directly to the same chambers



Thank you

Cardiovascular System



Dr. Aman Shakya

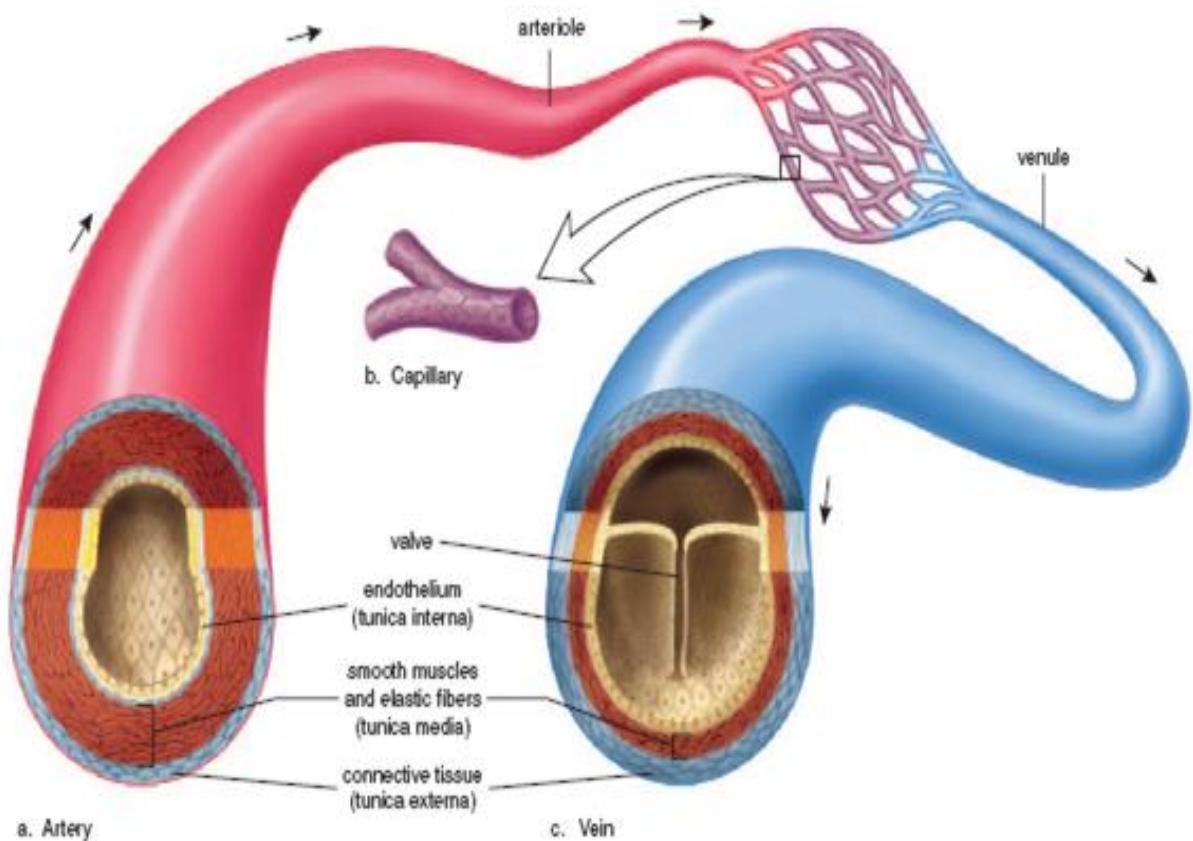
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Objectives

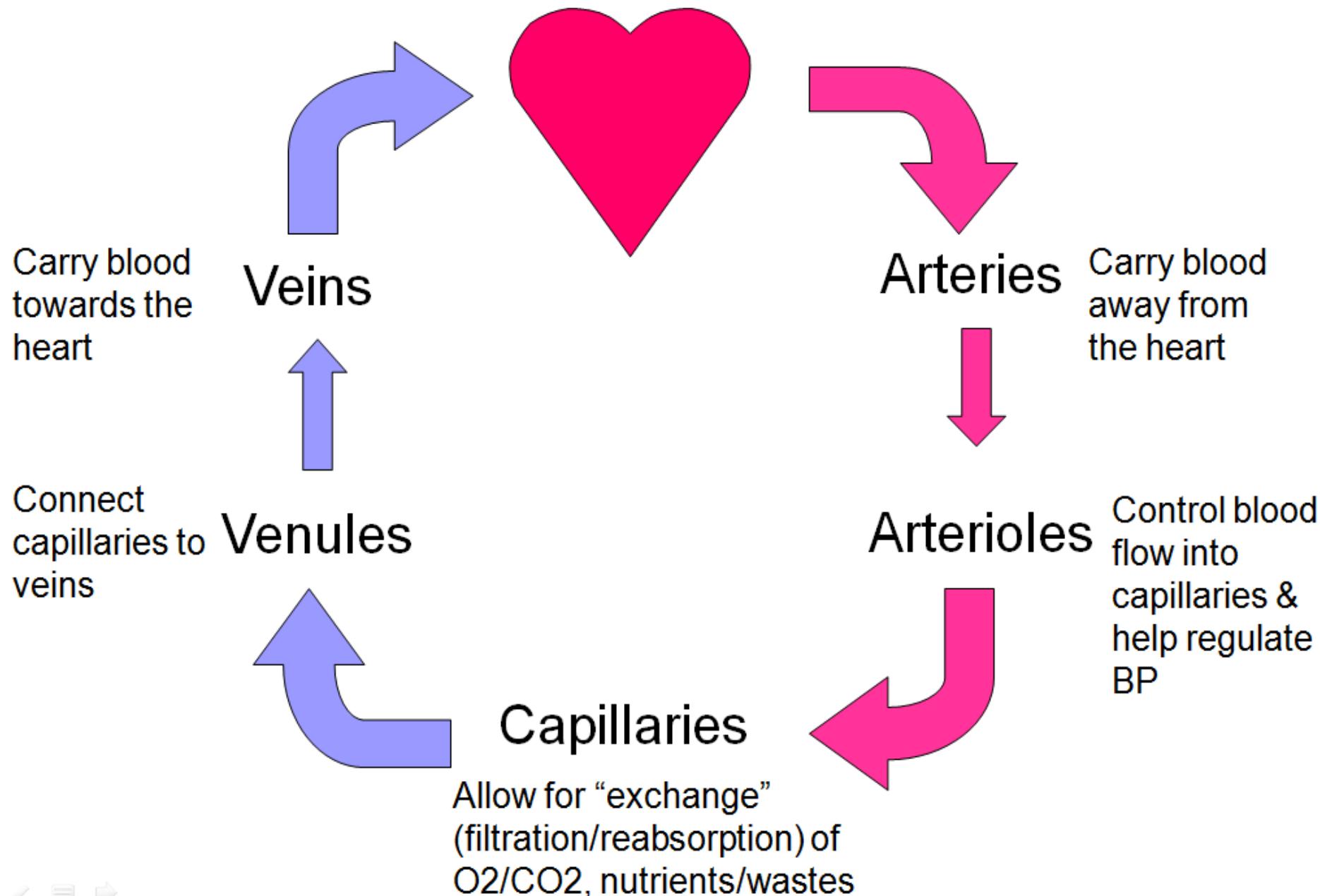
- To discuss about blood vessels (artery and vein)
- To learn about sites of checking pulse and blood pressure
- To discuss about systemic circulation

Blood Vessels

- Vary in size and function
- Several types:
 - Arteries
 - Arterioles
 - Veins
 - Venules
 - Capillaries

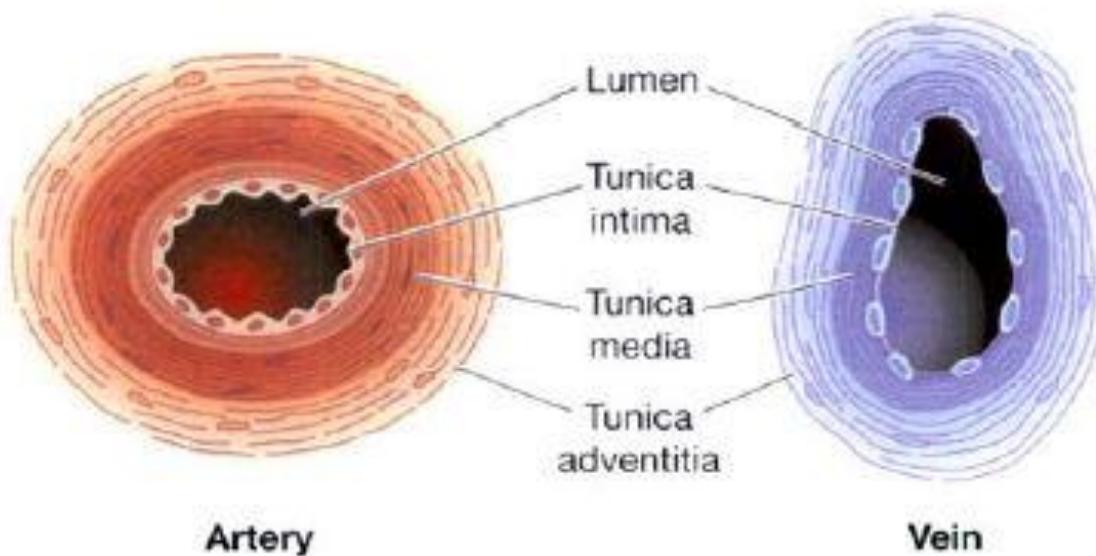


Blood Vessels



Blood vessels-Structure

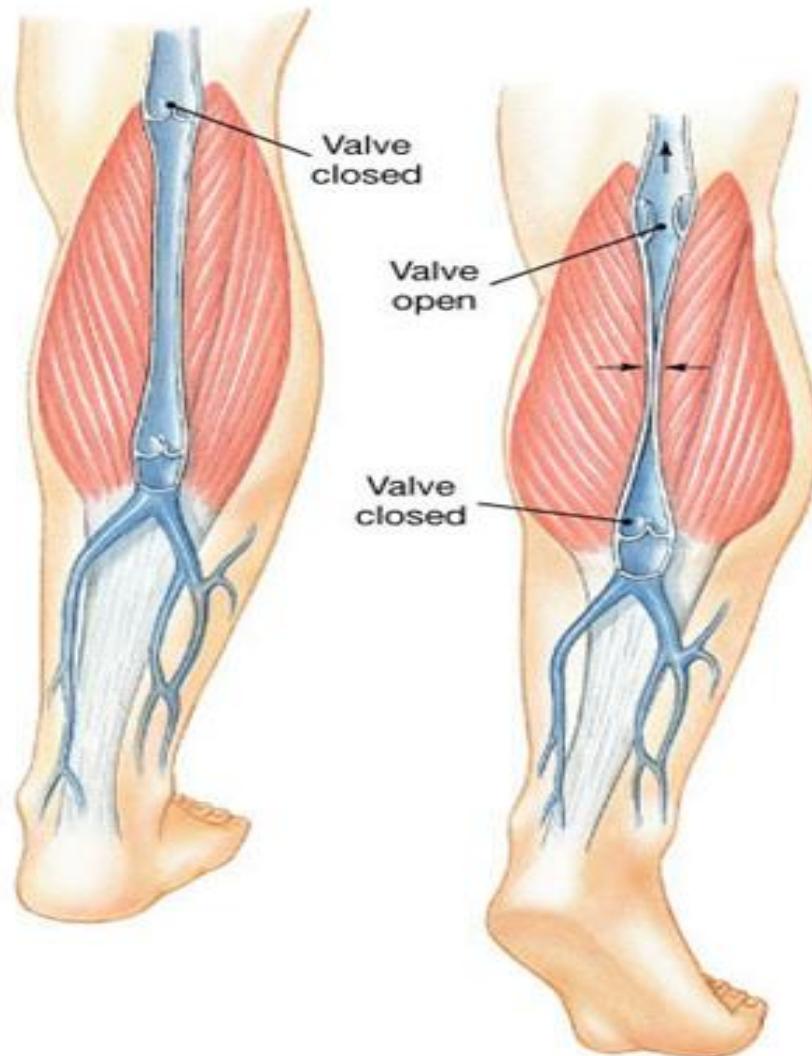
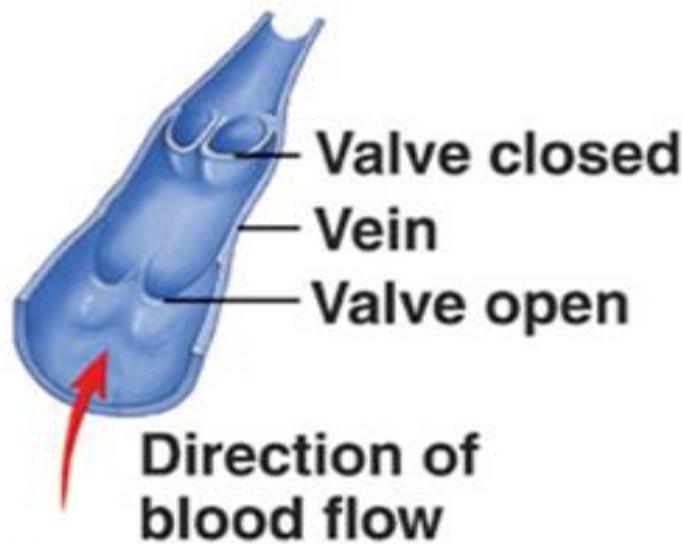
- Consist of 3 layers:
 - Tunica adventitia* - Outer layer of fibrous tissue
 - Tunica media* - Middle layer of smooth muscle and elastic tissue
 - Tunica intima* – Simple squamous epithelium called *endothelium*
- Lumen – central blood filled space



Artery and Vein-Differences

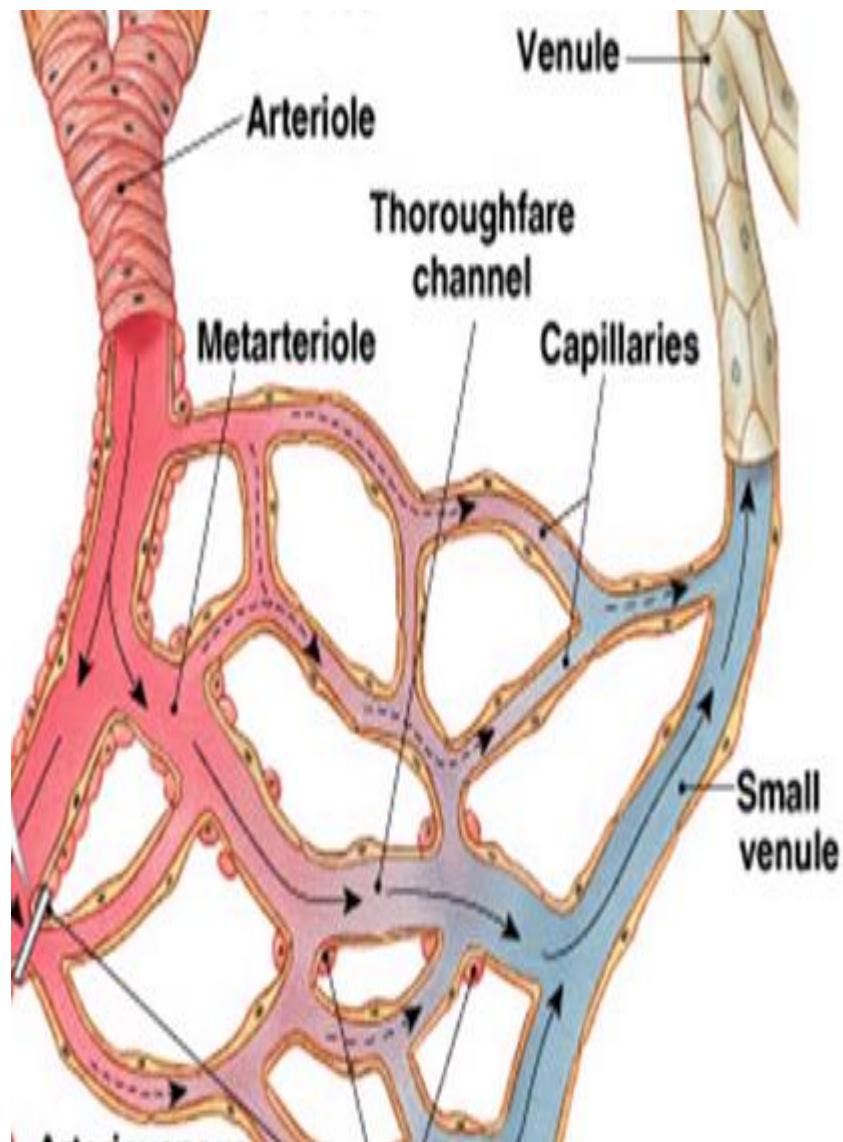
Artery	Vein
Thick tunica media	Thin tunica media
Narrow lumen	Wide lumen
No valves	Some veins have valves
Carry oxygenated blood away from heart.....	Carry deoxygenated blood to heart....
When cut- remain open	When cut-collapse
Blood flows under high pressure	Blood flows under low pressure

Valves in Vein

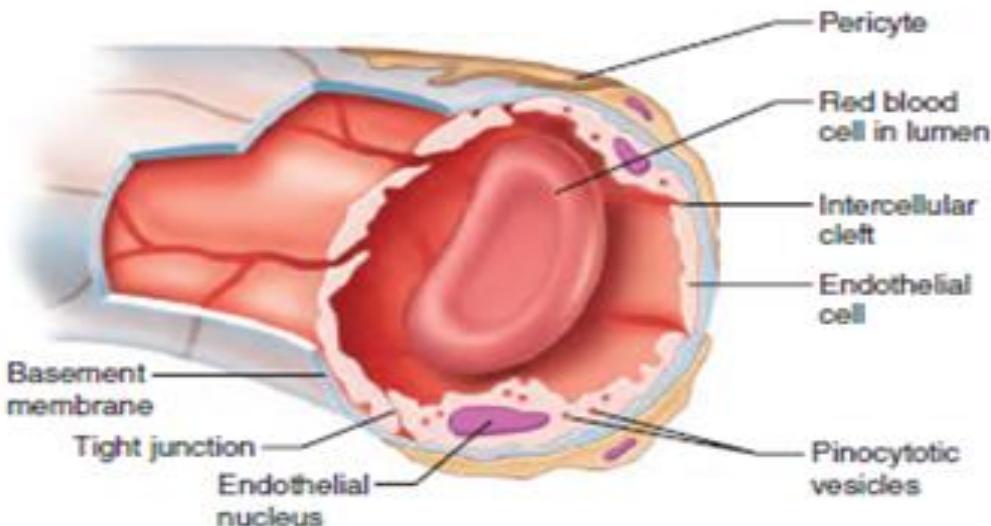


Capillaries

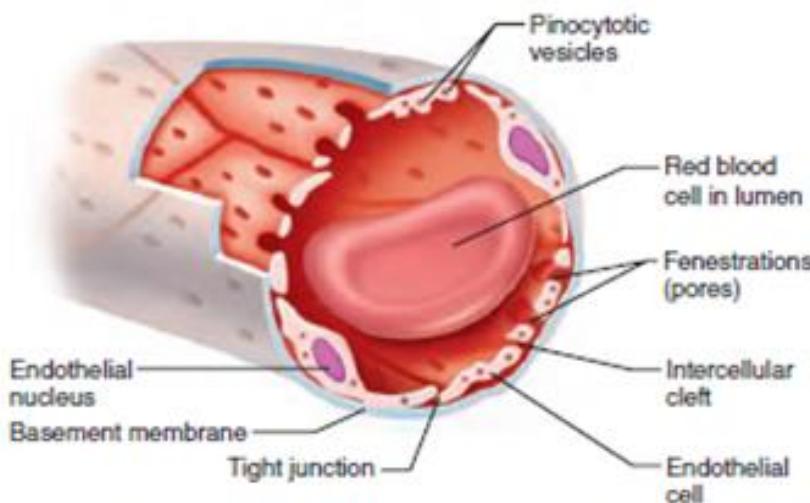
- Microscopic, very thin-walled vessels comprised of endothelium with basement membrane
- Allows for filtration and reabsorption
- Found in all tissues of the body except for those that are “avascular”
- Usually form branching networks (“capillary beds”) within tissues for increased surface area



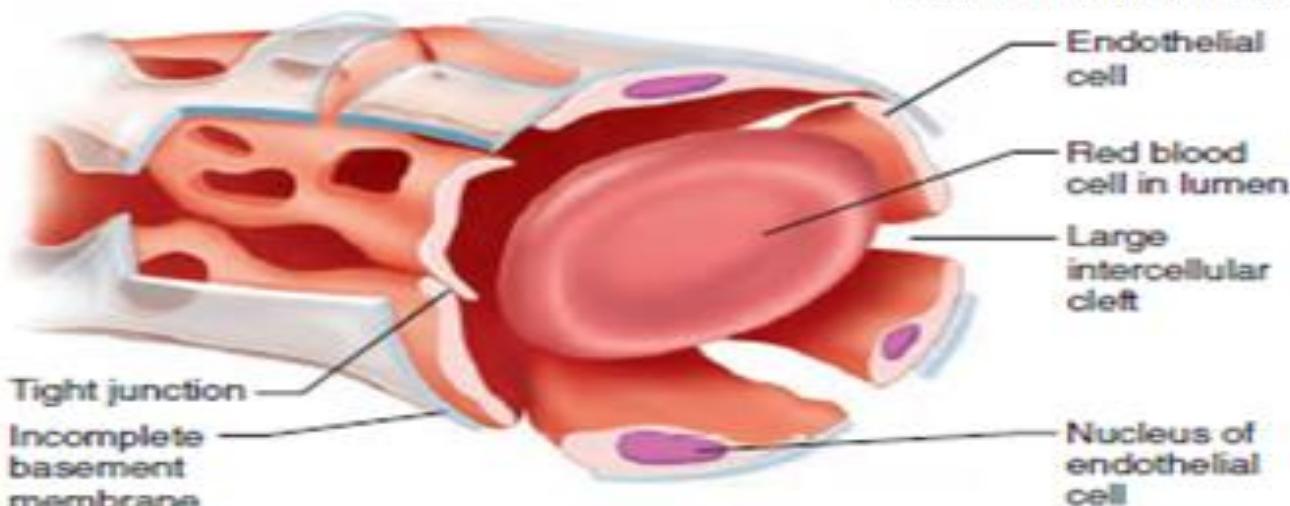
Capillaries-Types



(a) **Continuous capillary.** Least permeable, and most common (e.g., skin, muscle).



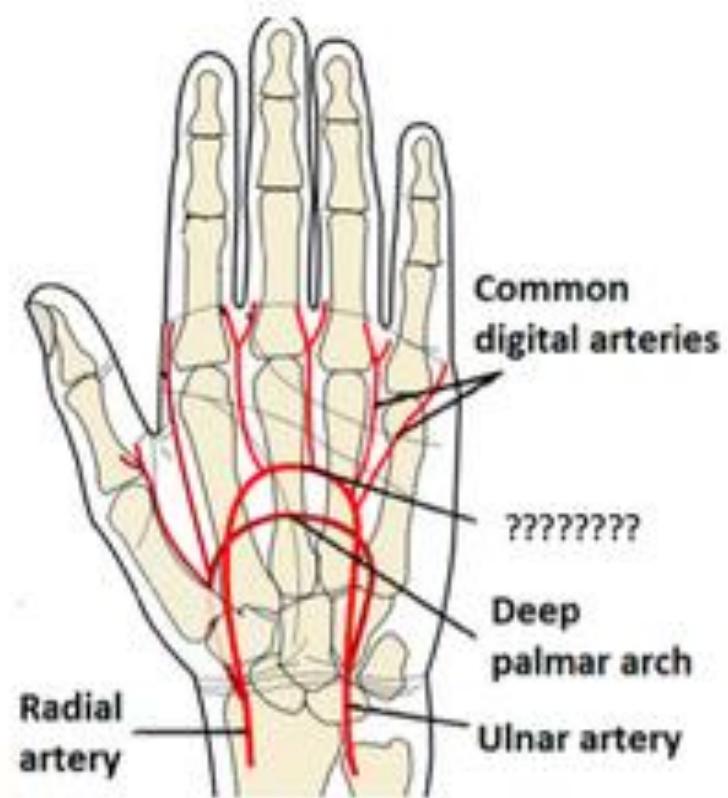
(b) **Fenestrated capillary.** Large fenestrations (pores) increase permeability. Occurs in areas of active absorption or filtration (e.g., kidney, small intestine).



(c) **Sinusoid capillary.** Most permeable. Occurs in special locations (e.g., liver, bone marrow, spleen).

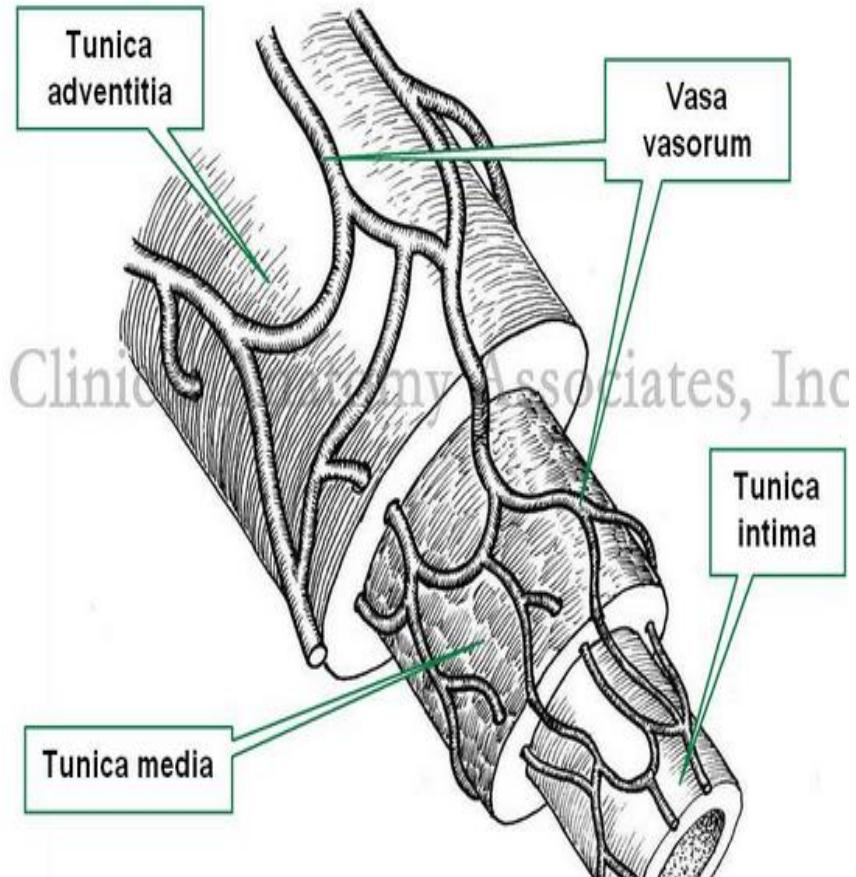
Vascular Anastomoses

- Vessels communicating with each other
- Form alternative pathways or collateral channels
- Protect organs from being supplied by just one route
 - Poor anastomoses & therefore vulnerable:
 - central artery of retina, kidneys, spleen, bone diaphyses



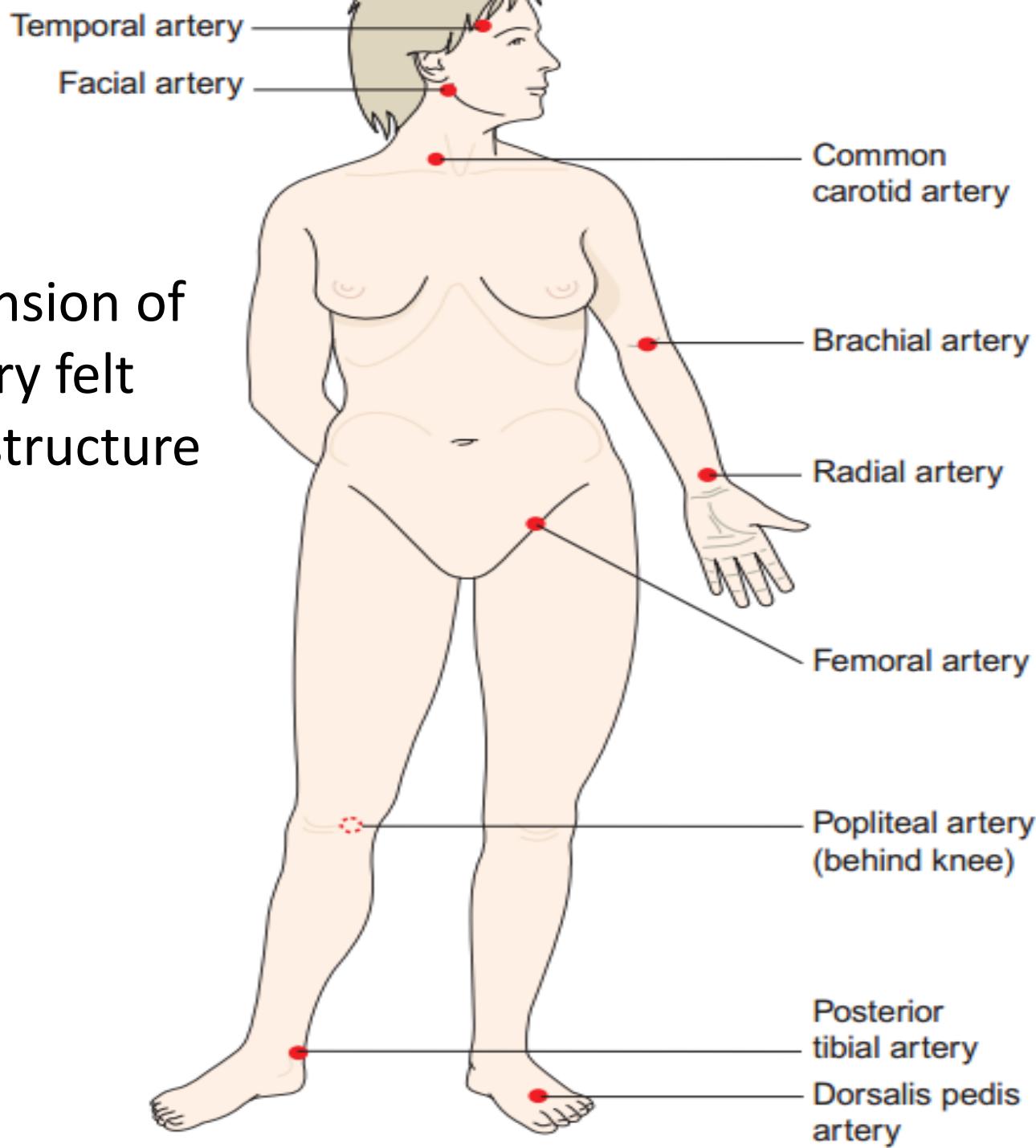
Vasa vasorum

- Means vessels of the vessels
- Blood supply to vessel itself
- Smallest vessels don't need it



Pulse

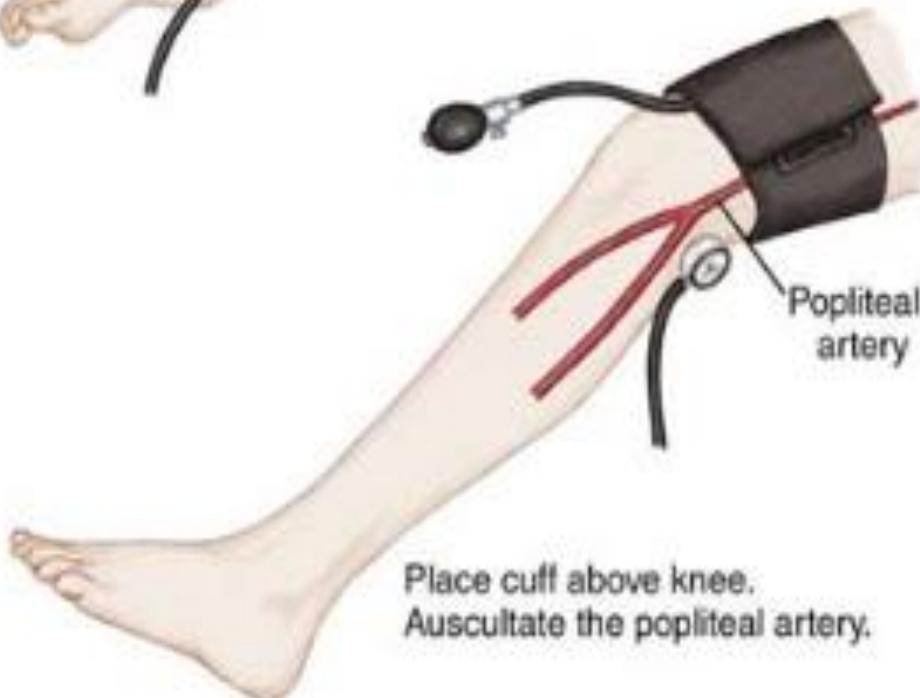
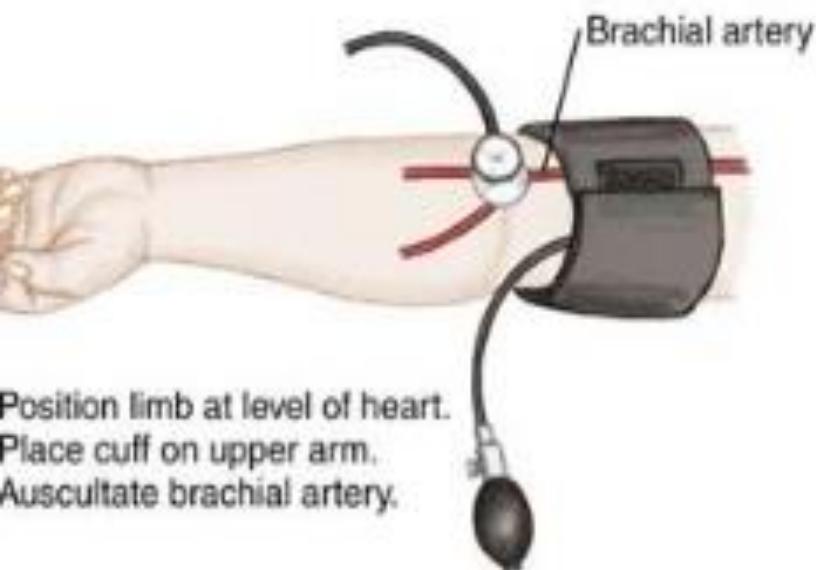
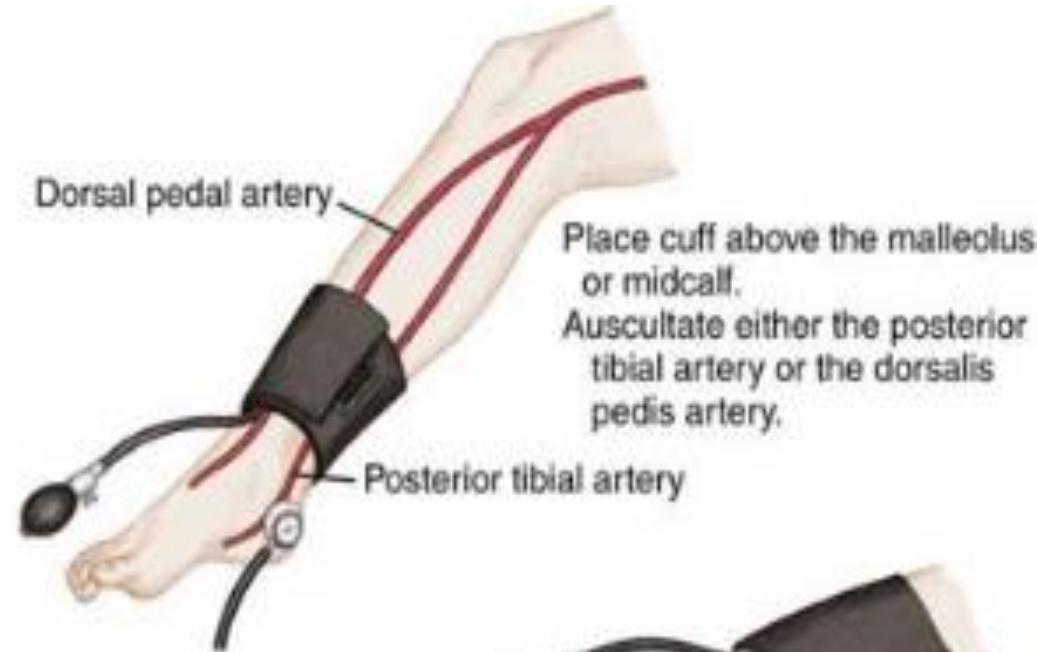
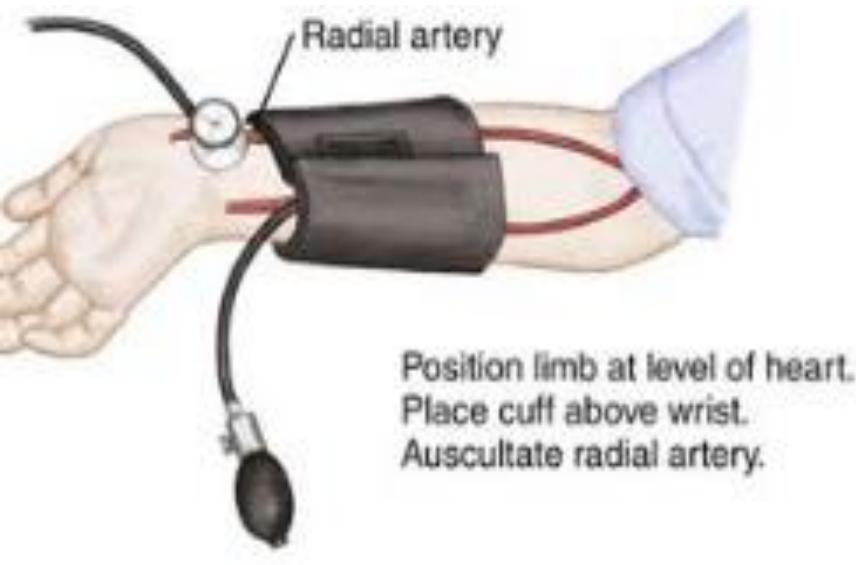
- Rhythmic distension of peripheral artery felt against a rigid structure (bone)



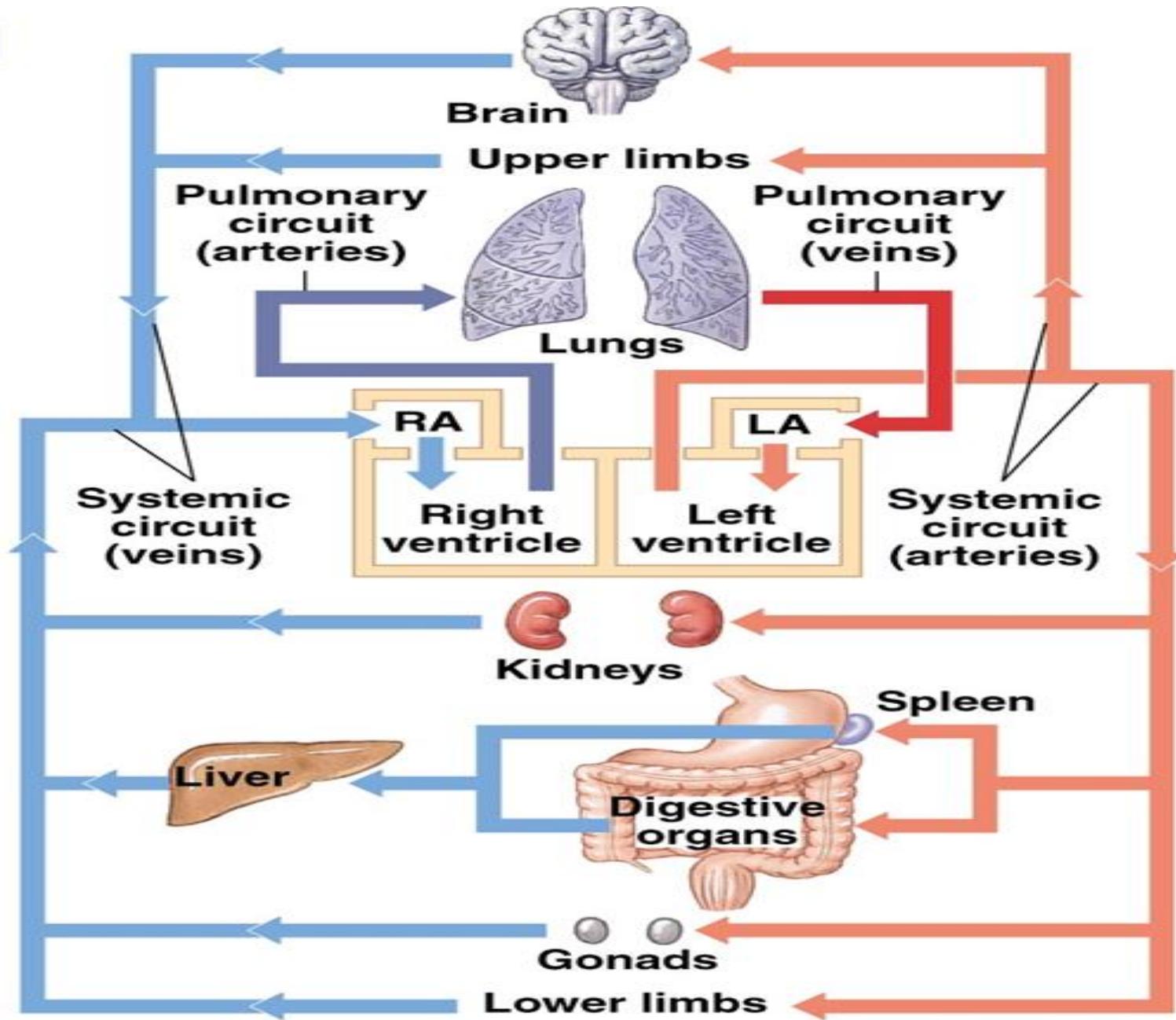
Blood Pressure

- lateral pressure exerted by the column of blood on the wall of arteries
- fluctuates during systole and diastole of the heart.
- Systolic Pressure
- Diastolic Pressure

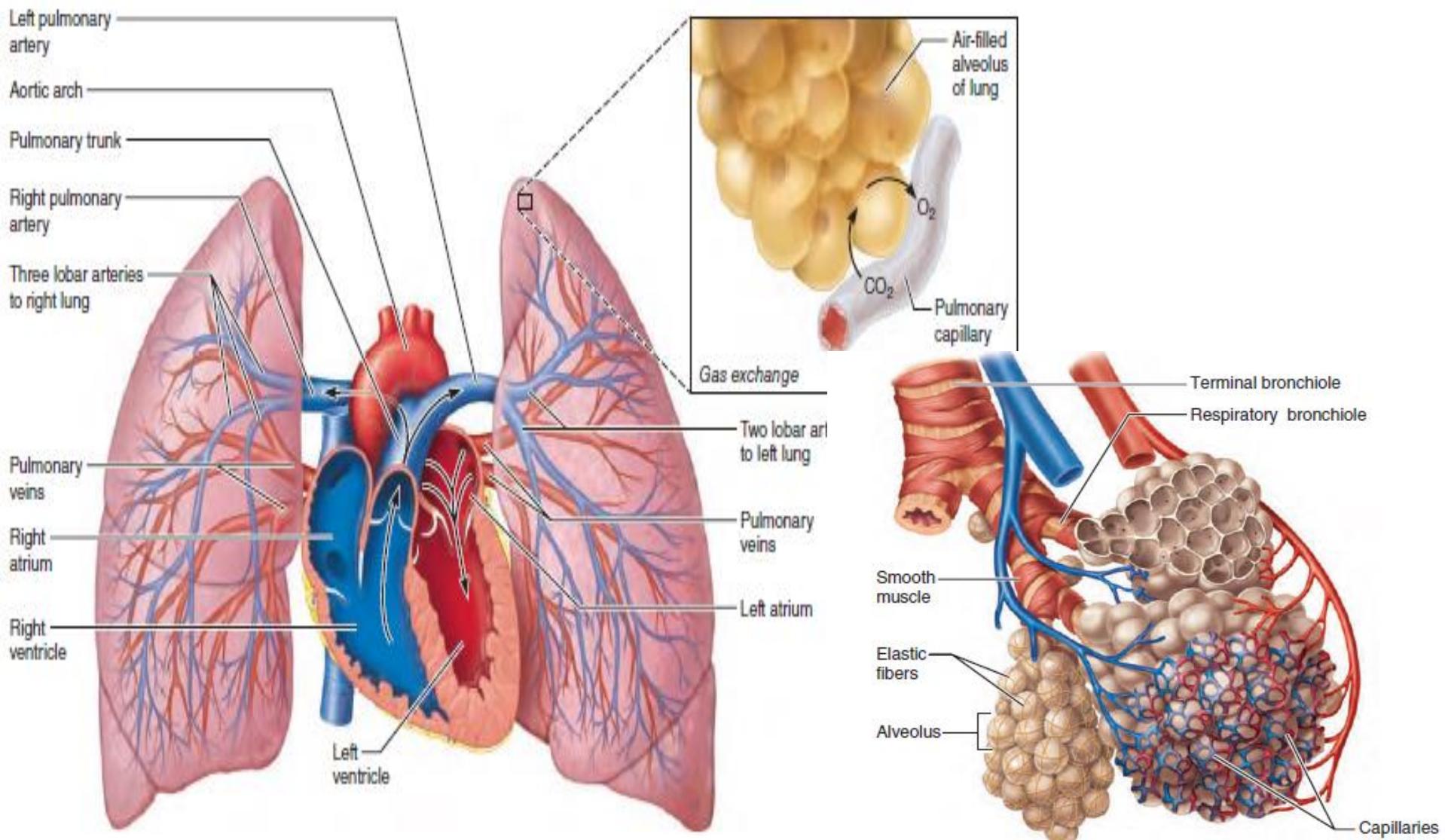
Sites for Blood Pressure Measurement



Circulation of Blood

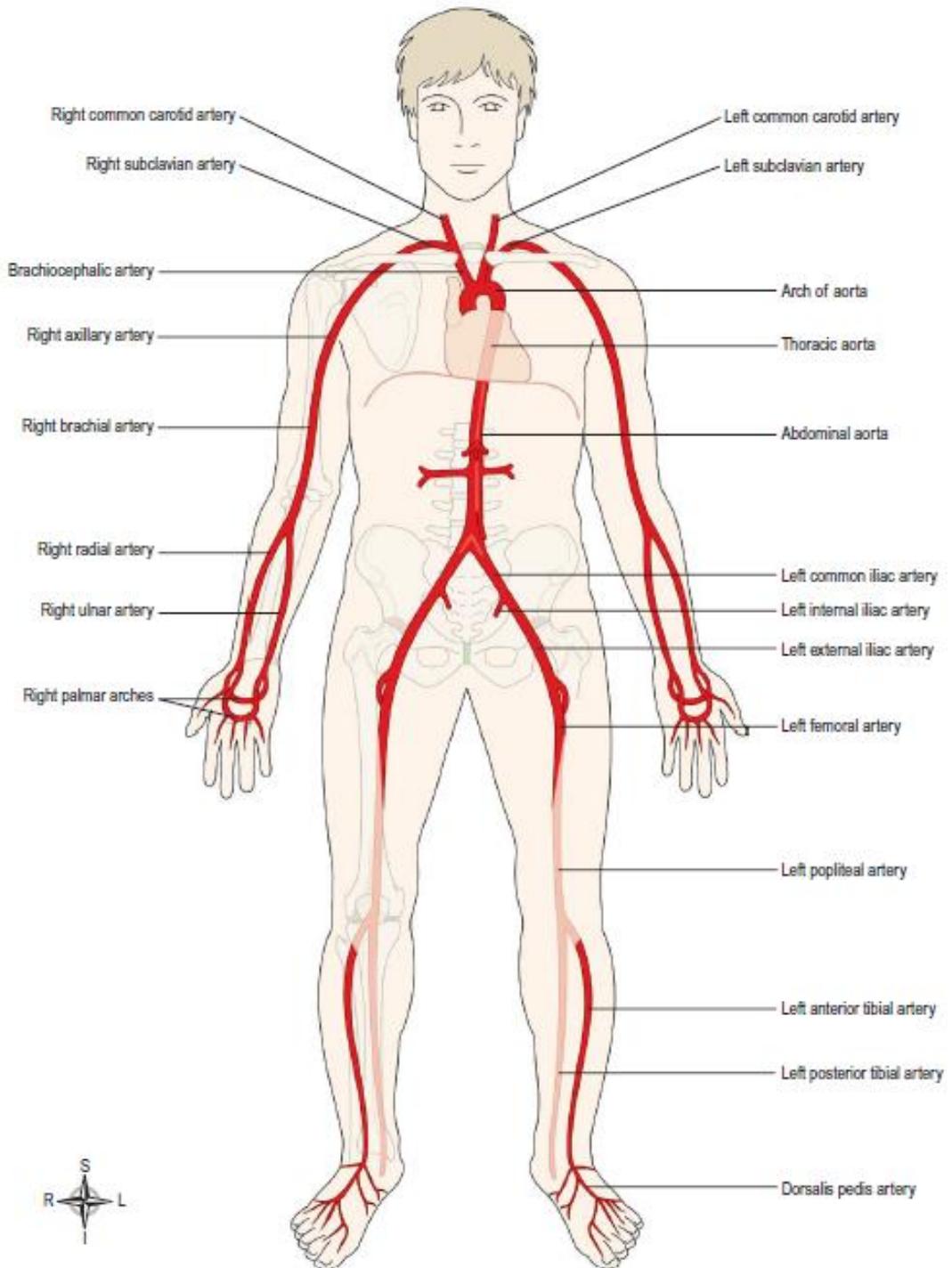


Pulmonary circulation



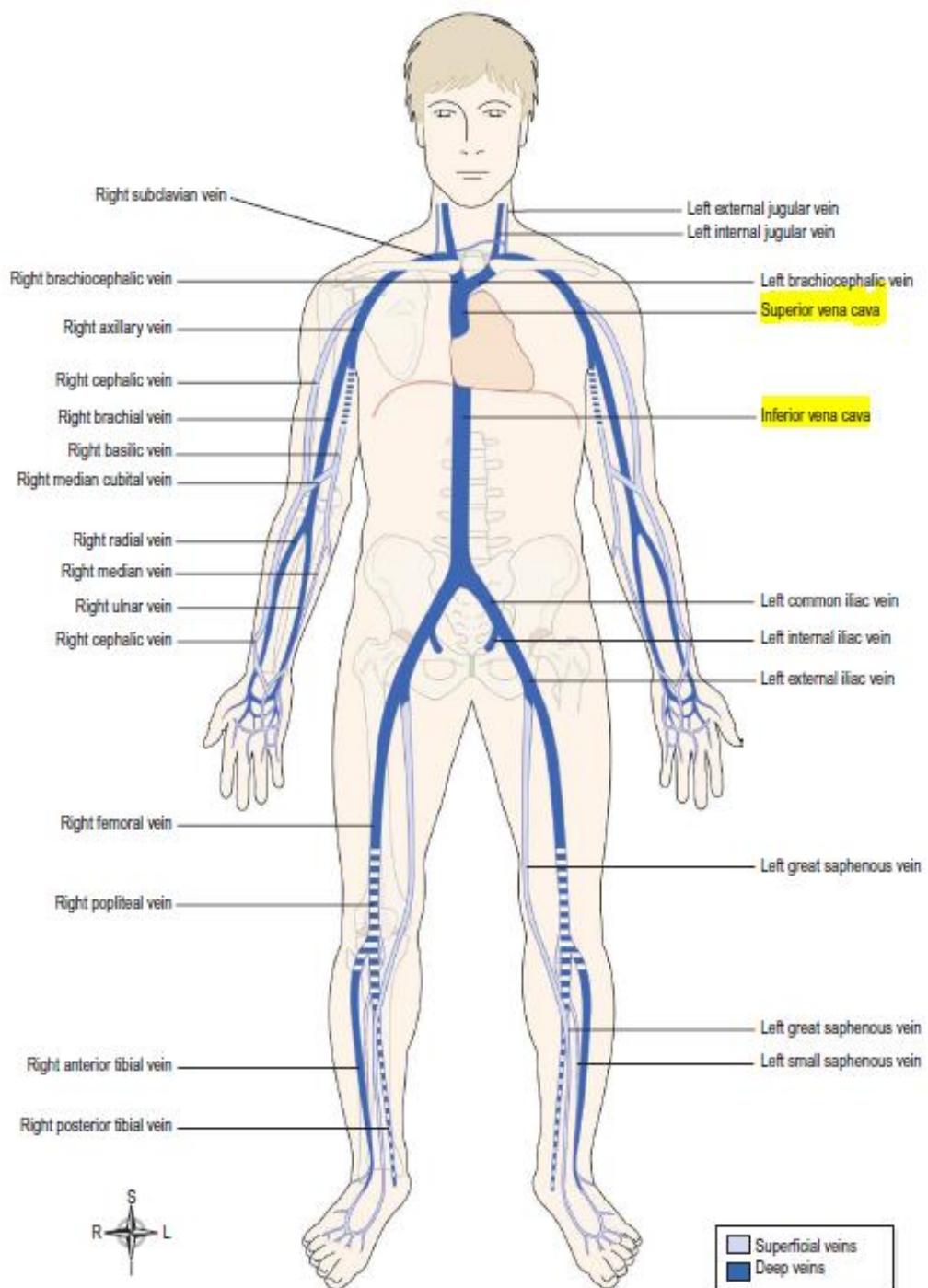
Systemic/ General circulation

- Blood pumped from LV is carried around the body by branches of aorta



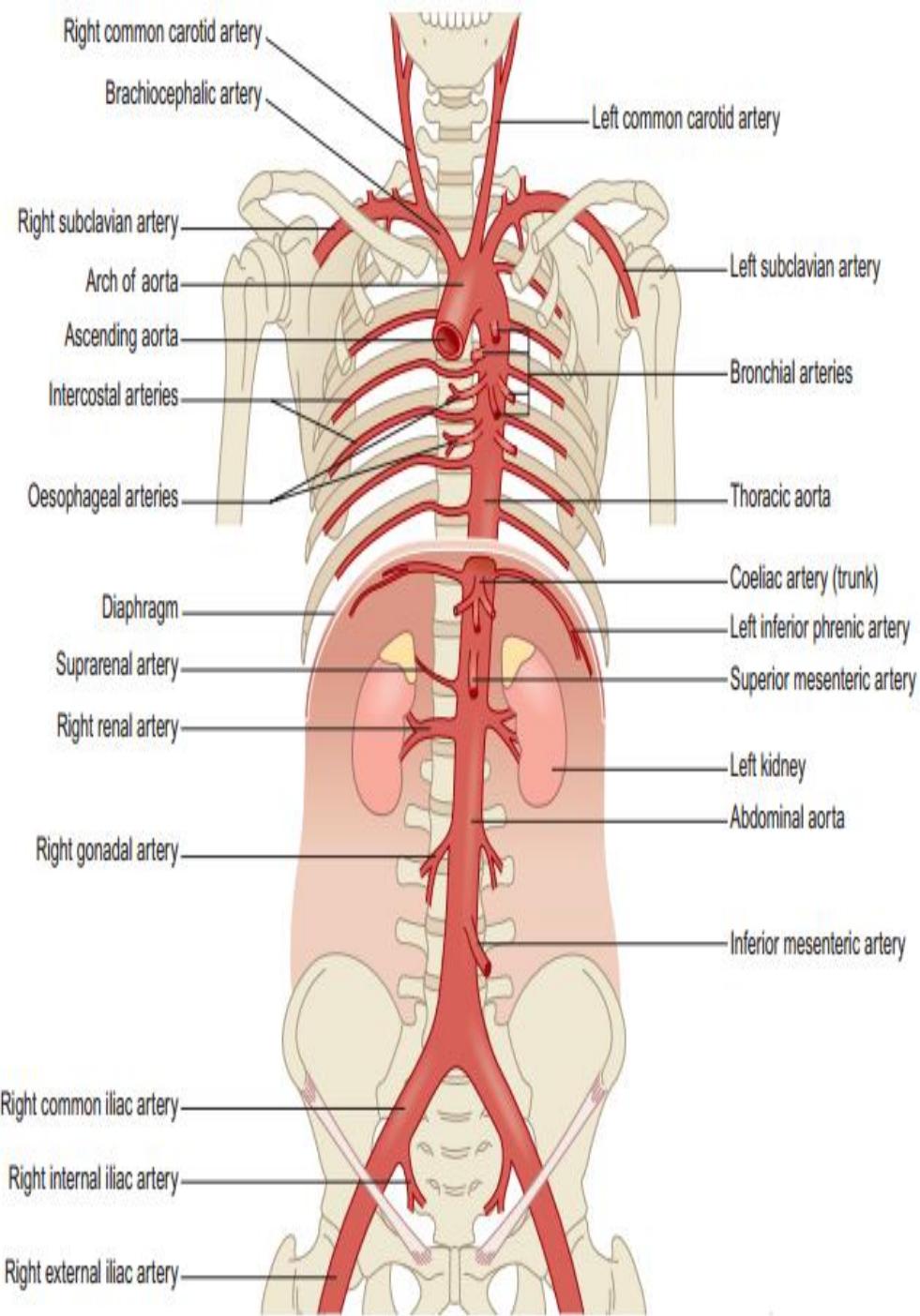
Systemic/ General circulation

- Blood is then returned to RA by SVC and IVC



Aorta

- Begins at LV
- Ascends for a short way
- Arches backwards and to left
- Descends behind the heart through the thoracic cavity
- Pierces diaphragm at T12
- Divides into the *right* and *left common iliac arteries* at L4
- Gives numerous branches



Thoracic aorta

- Above the diaphragm

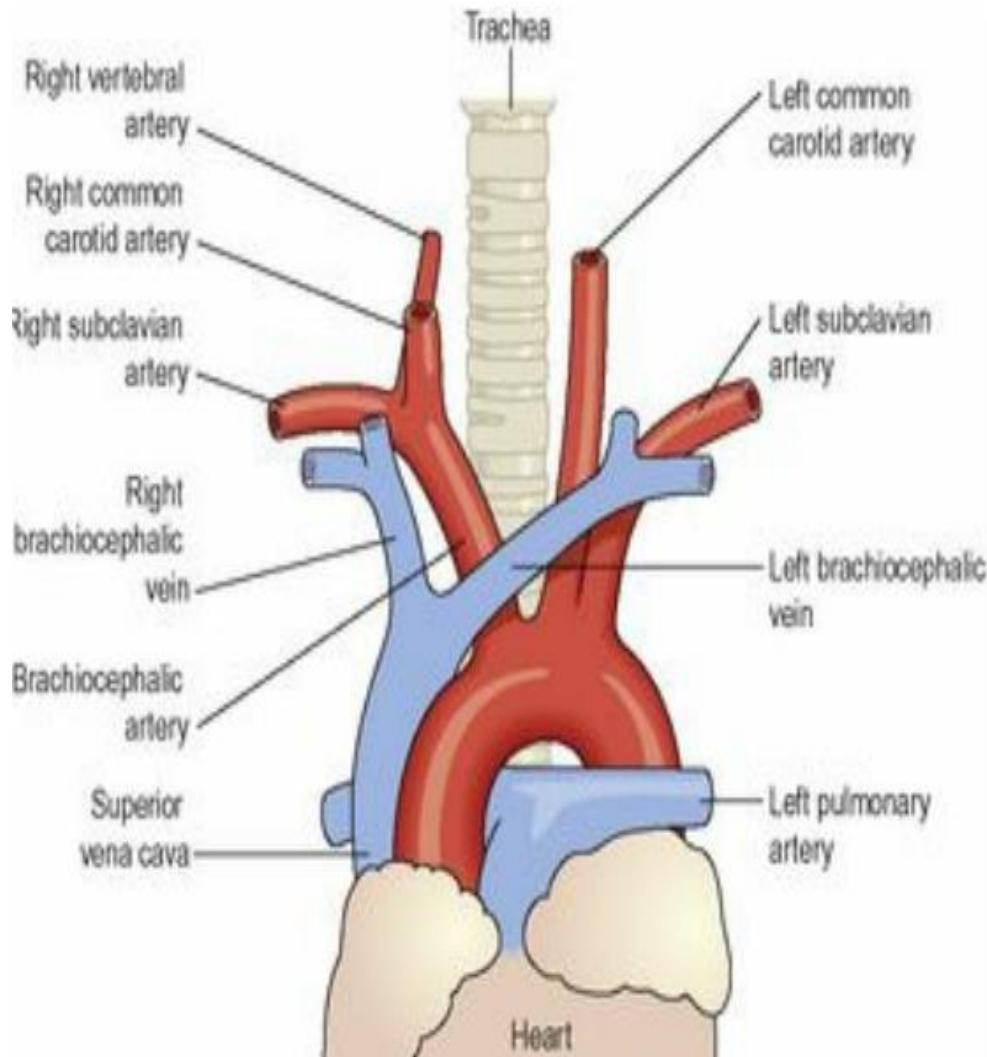
- 3 parts:

1. **Ascending aorta**- R and L coronary a

2. **Arch of aorta-**
Brachiocephalic a, L
common carotid a, L
subclavian a

Brachiocephalic a divides into
R common carotid a and R
subclavian a

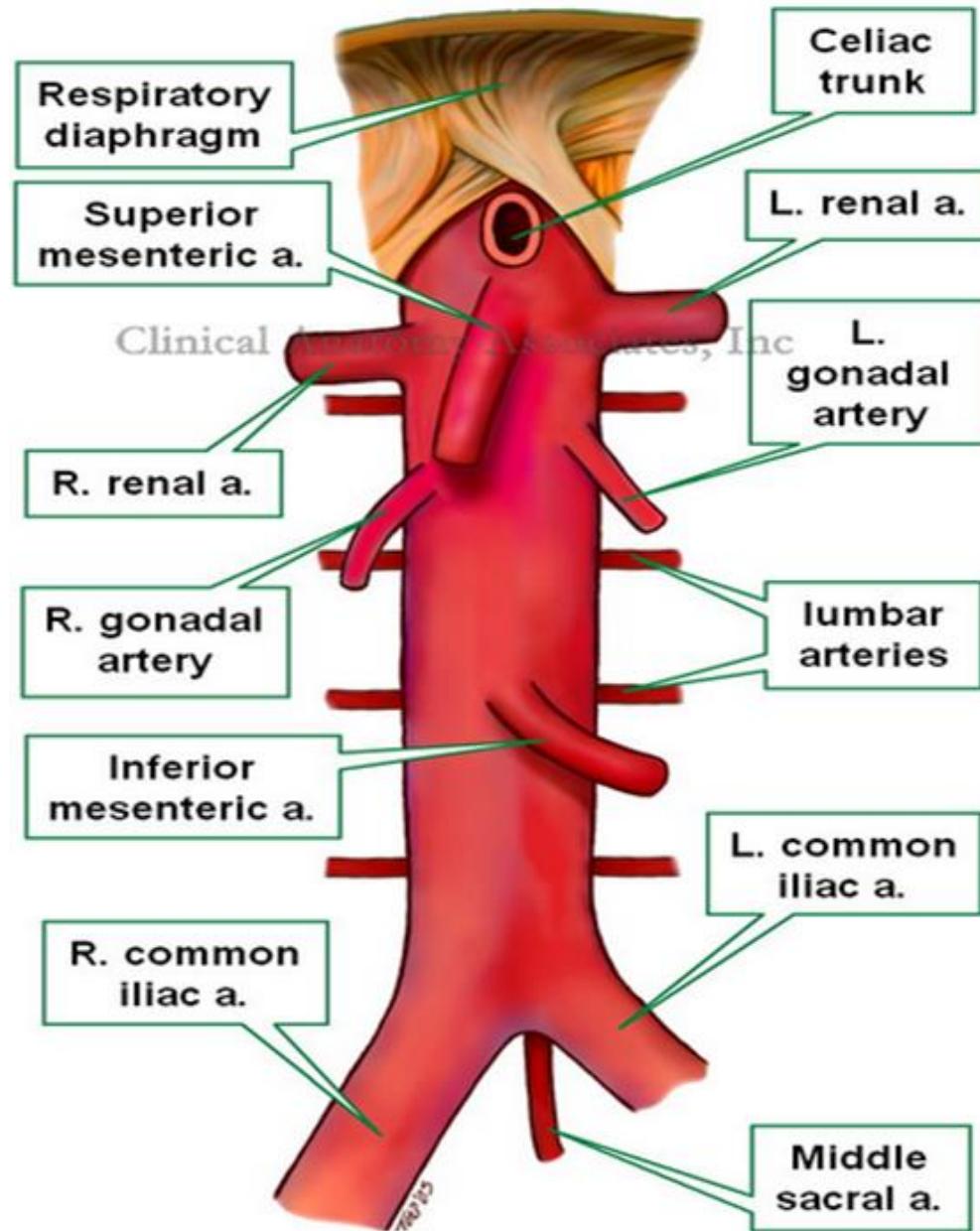
3. **Descending aorta**- Intercostal a, Esophageal a, Bronchial a



Abdominal Aorta

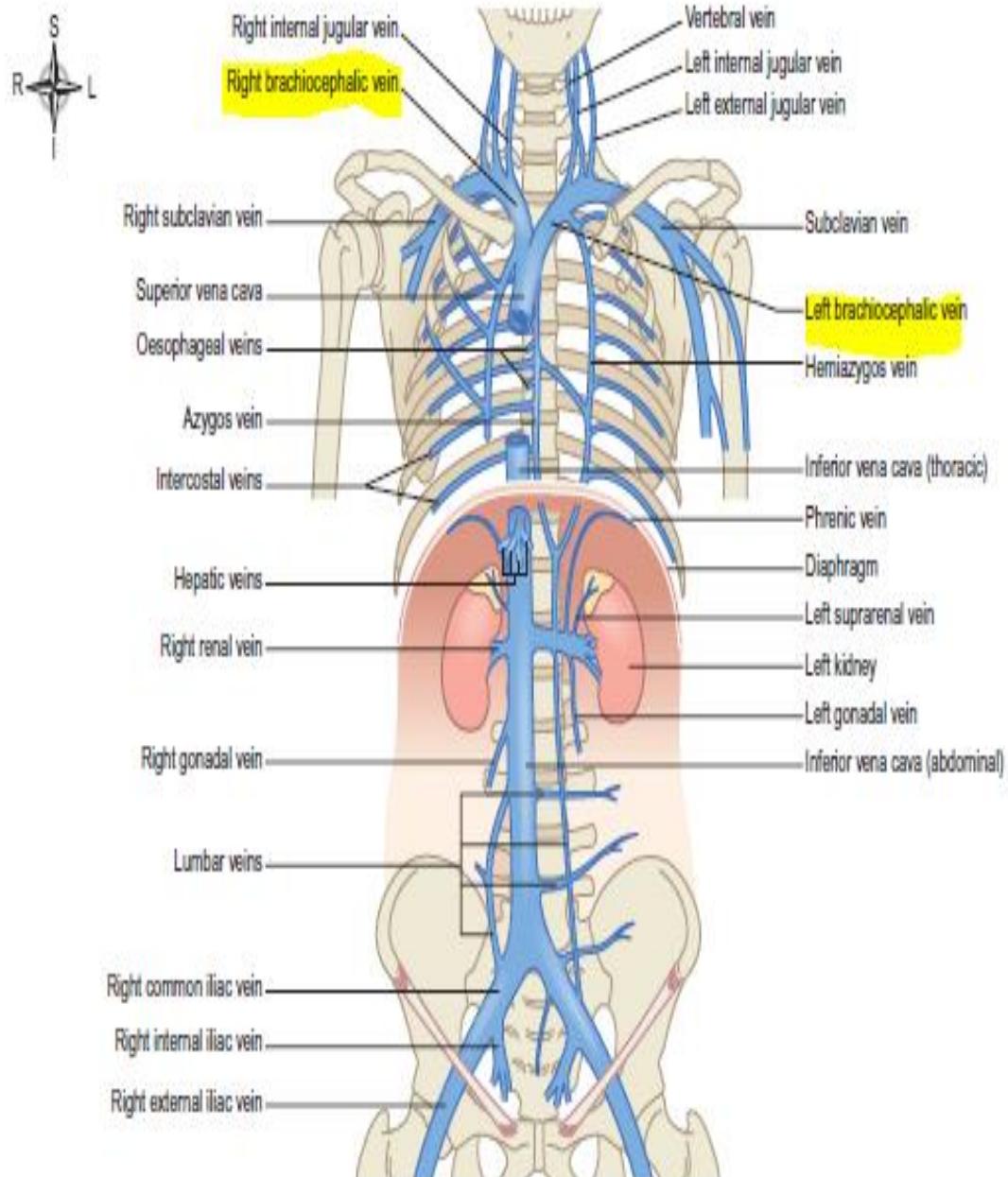
Abdominal aorta

- Below the diaphragm
- Diaphragm is pierced at...
- Divides into at
- Paired and some unpaired branches arise
- Supply abdominal structures and organs



Venae cavae

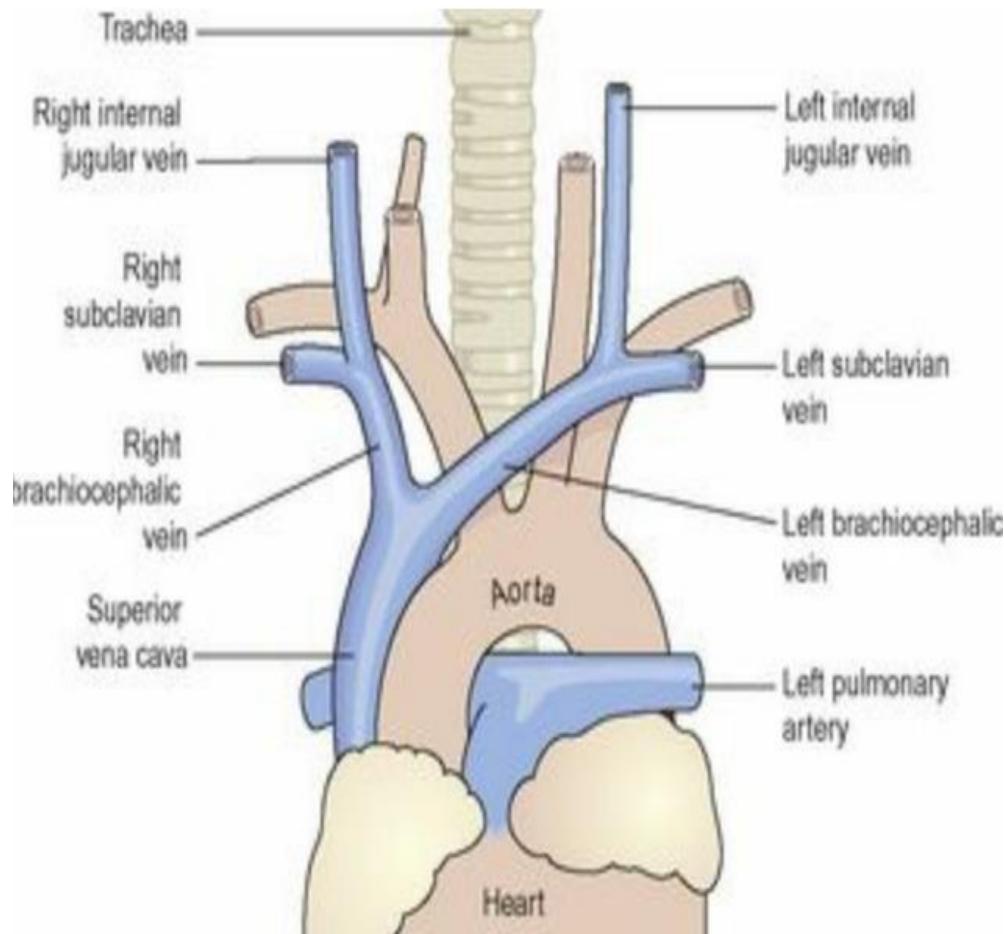
- Largest veins in body
- Empty blood directly into RA
- SVC - above the diaphragm
- IVC - below the diaphragm



Superior vena cava

About 7 cm long

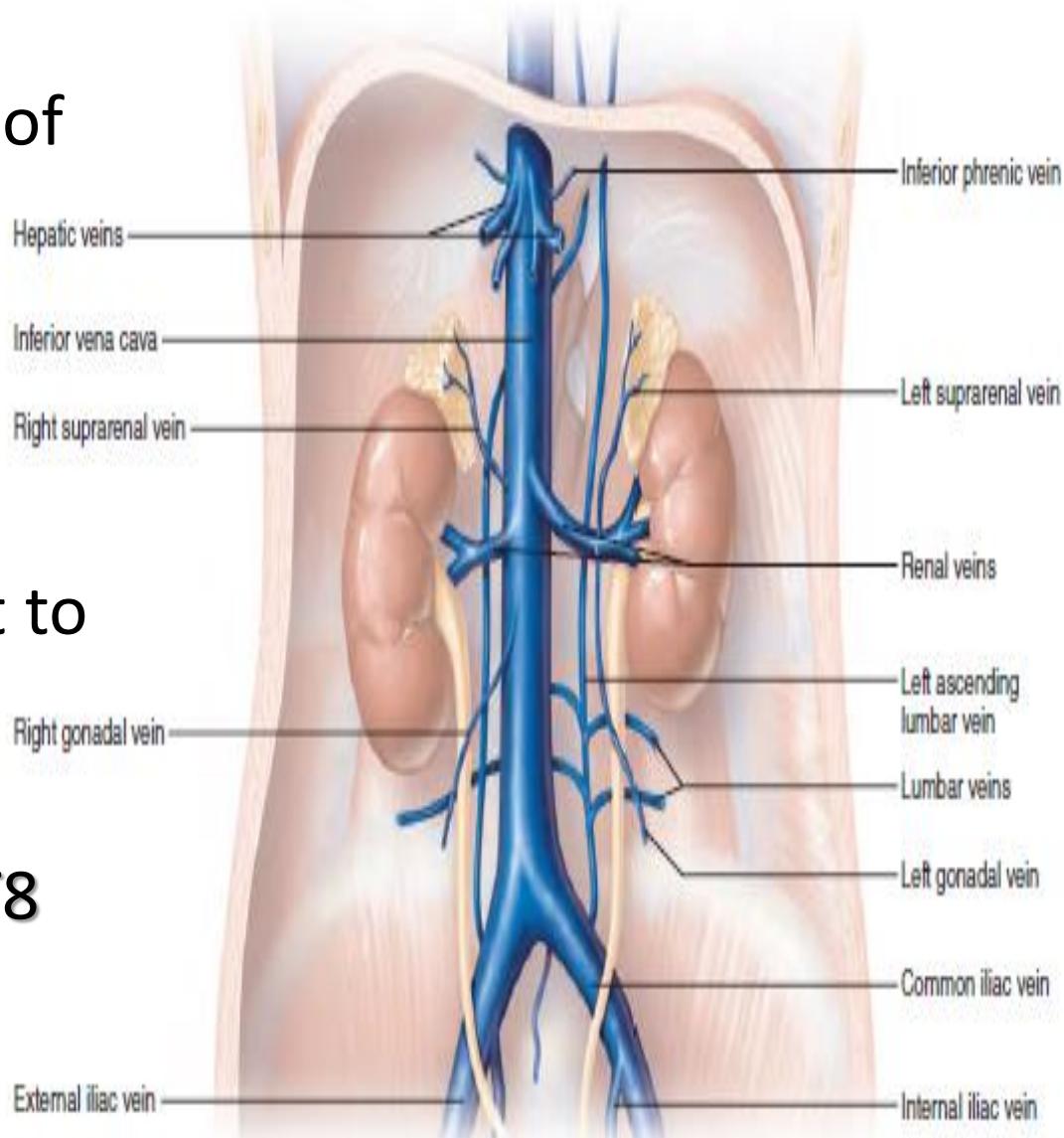
- Formed by union of R and L brachiocephalic veins



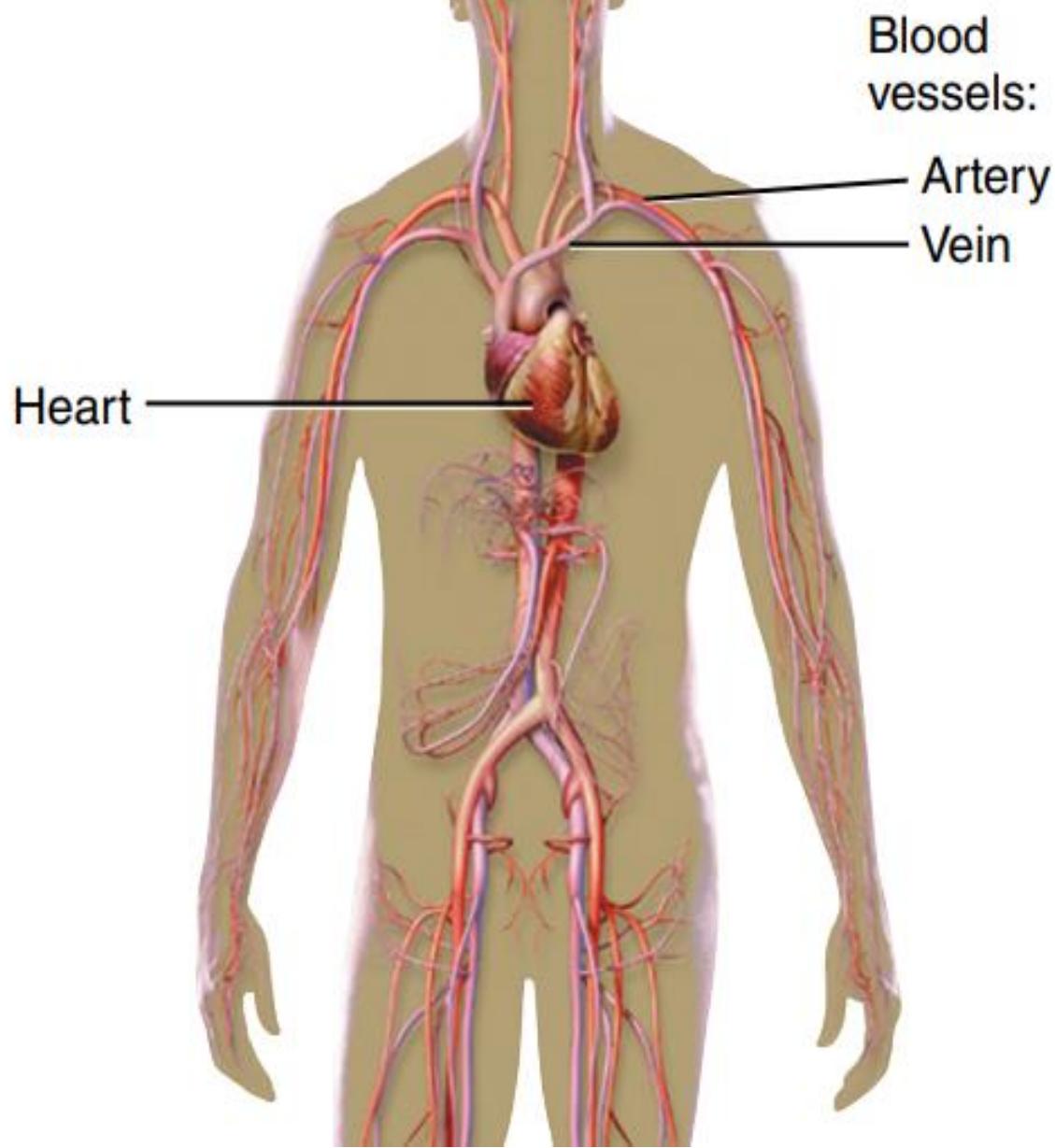
Inferior vena cava

At L5 by the union of
R and L common iliac
veins

- Ascends through abdomen
- Lies parallel to and just to R of descending abdominal aorta
- Pierces diaphragm at T8
- Drain pelvic and abdominal organs



Cardiovascular System

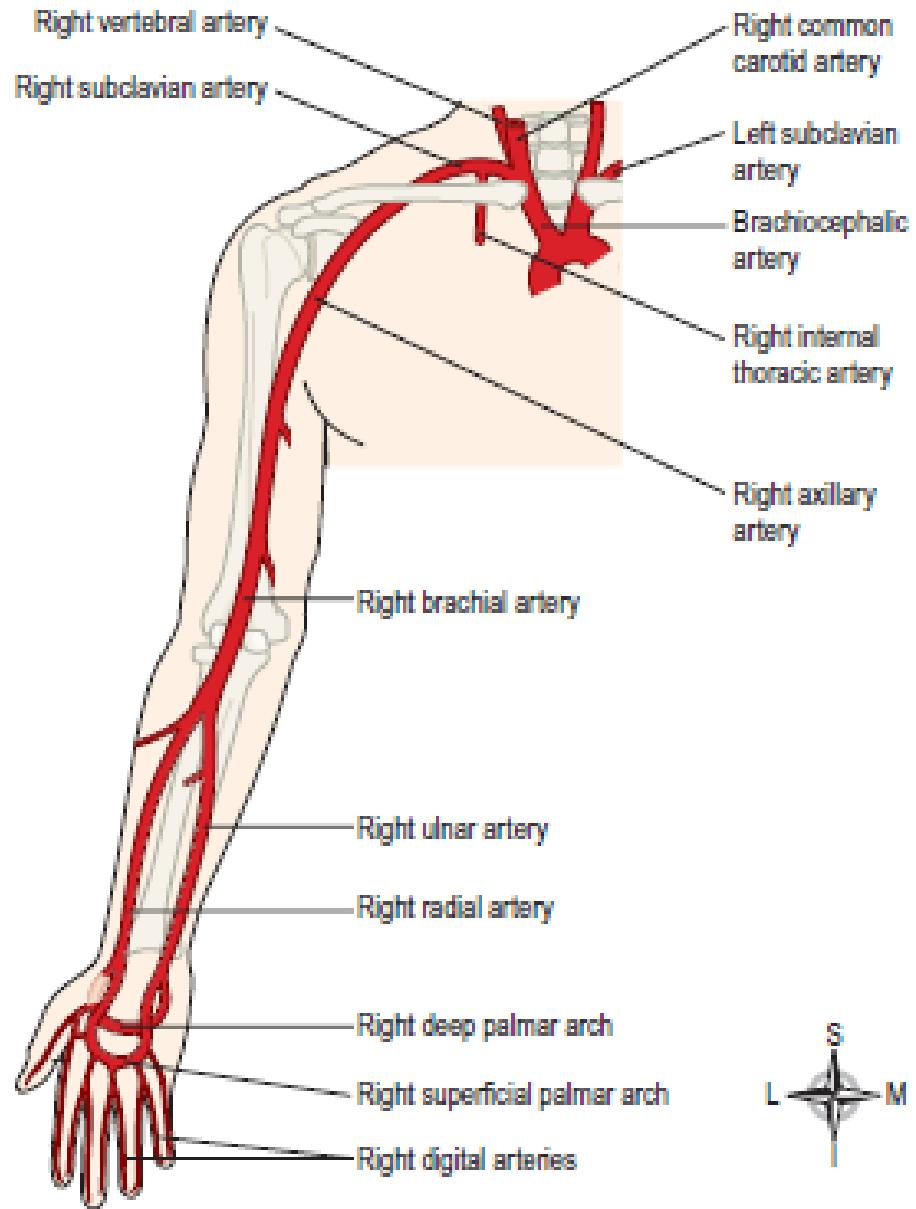


Dr. Aman Shakya

2080.02.26

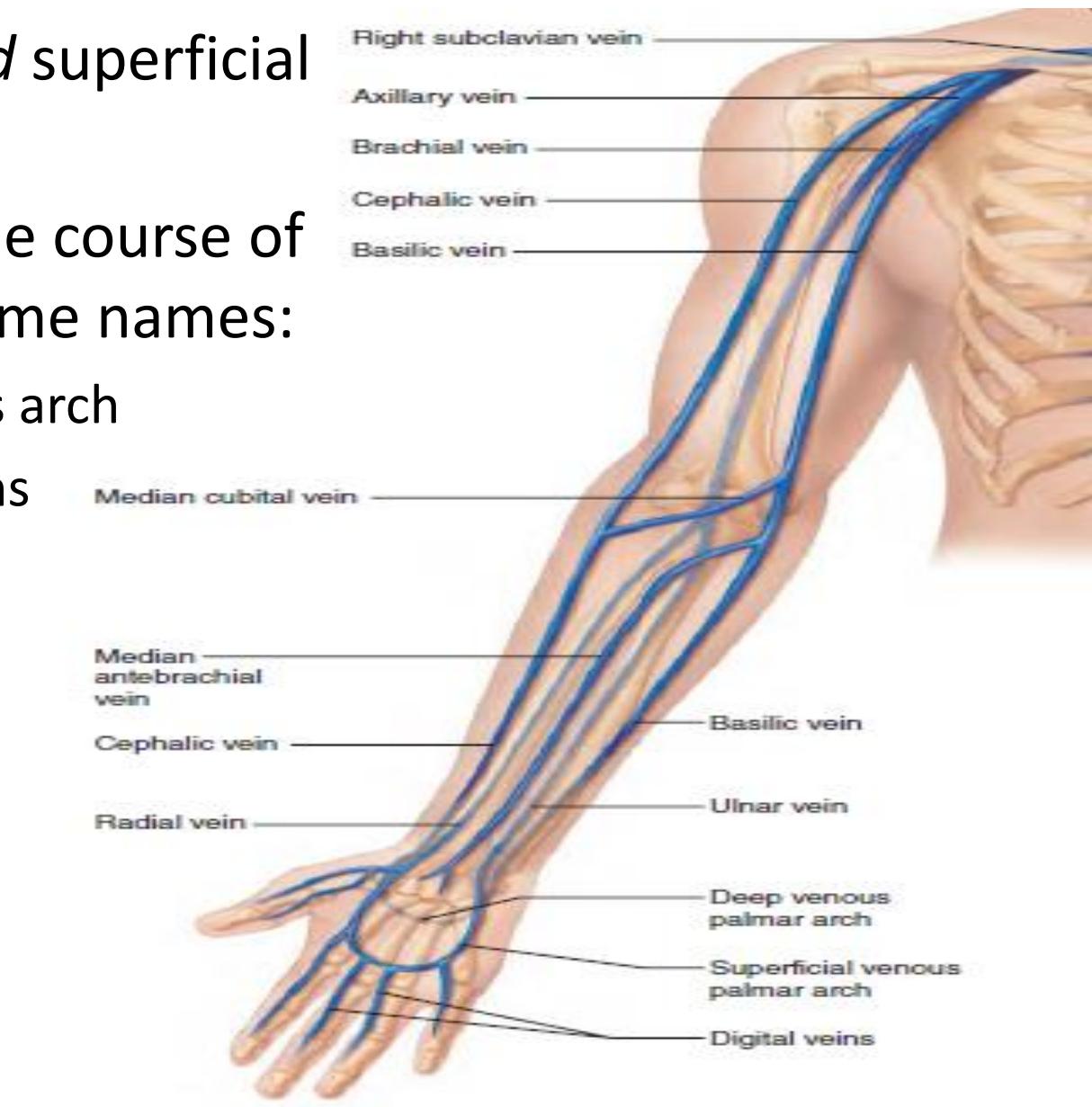
Circulation in Upper limb-A

- R and L subclavian artery
- Enter axillae - axillary a
- Continues as brachial a
- Divides into radial and ulnar a
- Anastomose forming deep and superficial palmar arches



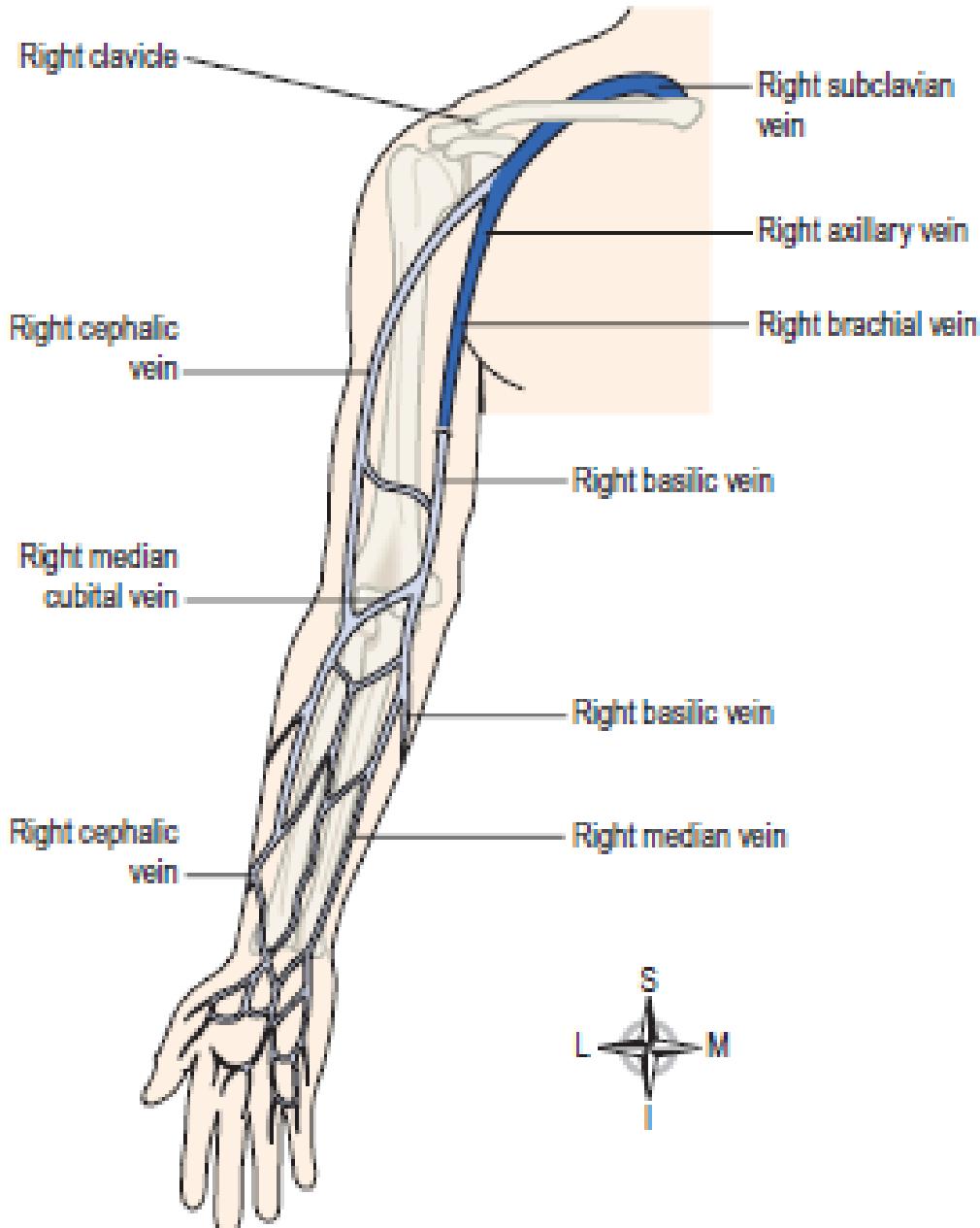
Circulation in Upper limb-V

- Drained by deep *and* superficial veins
- Deep veins follow the course of arteries and have same names:
 - Deep palmar venous arch
 - Ulnar and radial veins
 - Brachial vein
 - Axillary vein
 - Subclavian vein



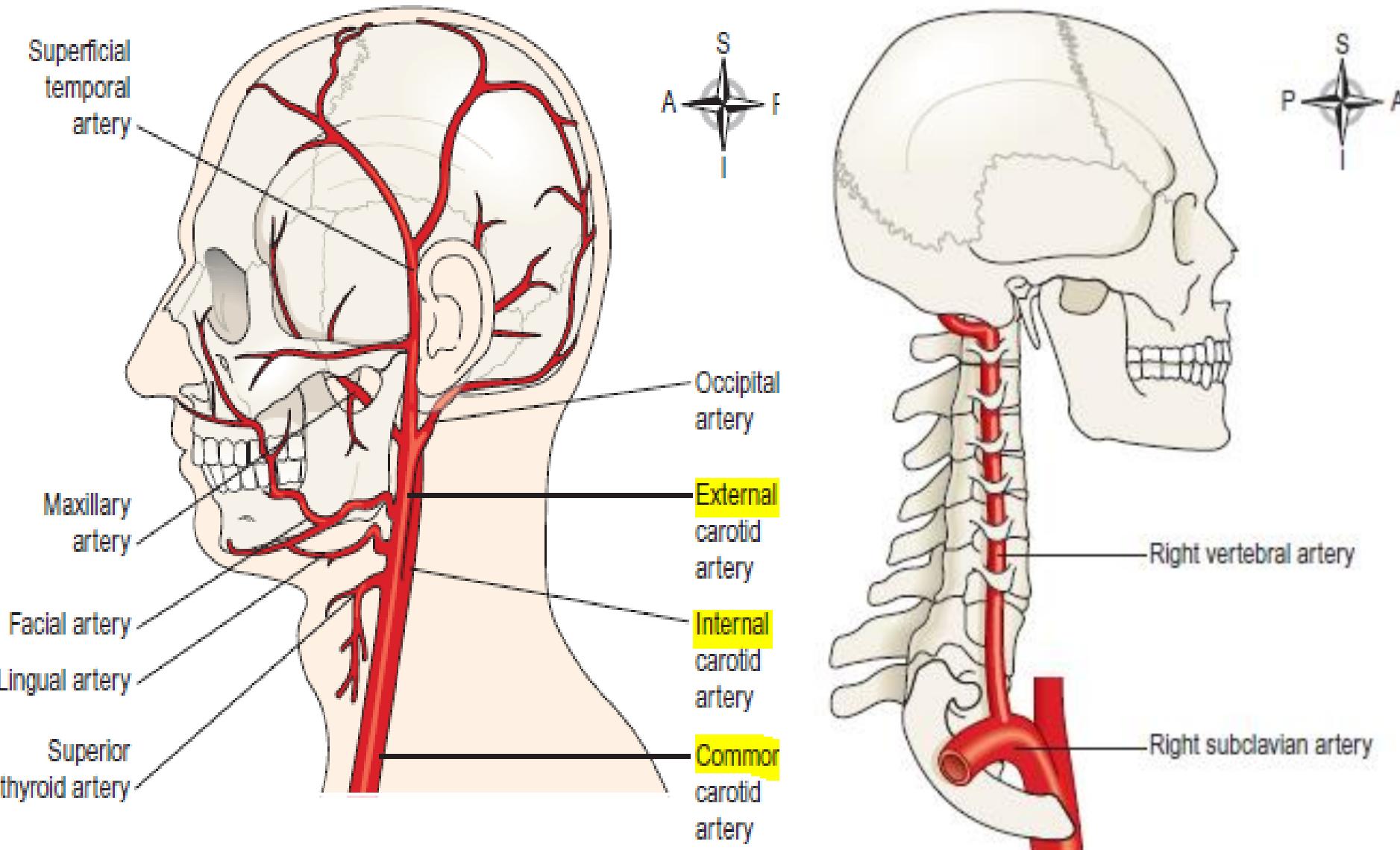
Circulation in Upper limb-V

- Superficial veins begin in hand
- Consist of following:
 - Cephalic vein
 - Basilic vein
 - Median vein
 - Median cubital vein



Circulation in Head and Neck-A

Common carotid arteries and vertebral arteries

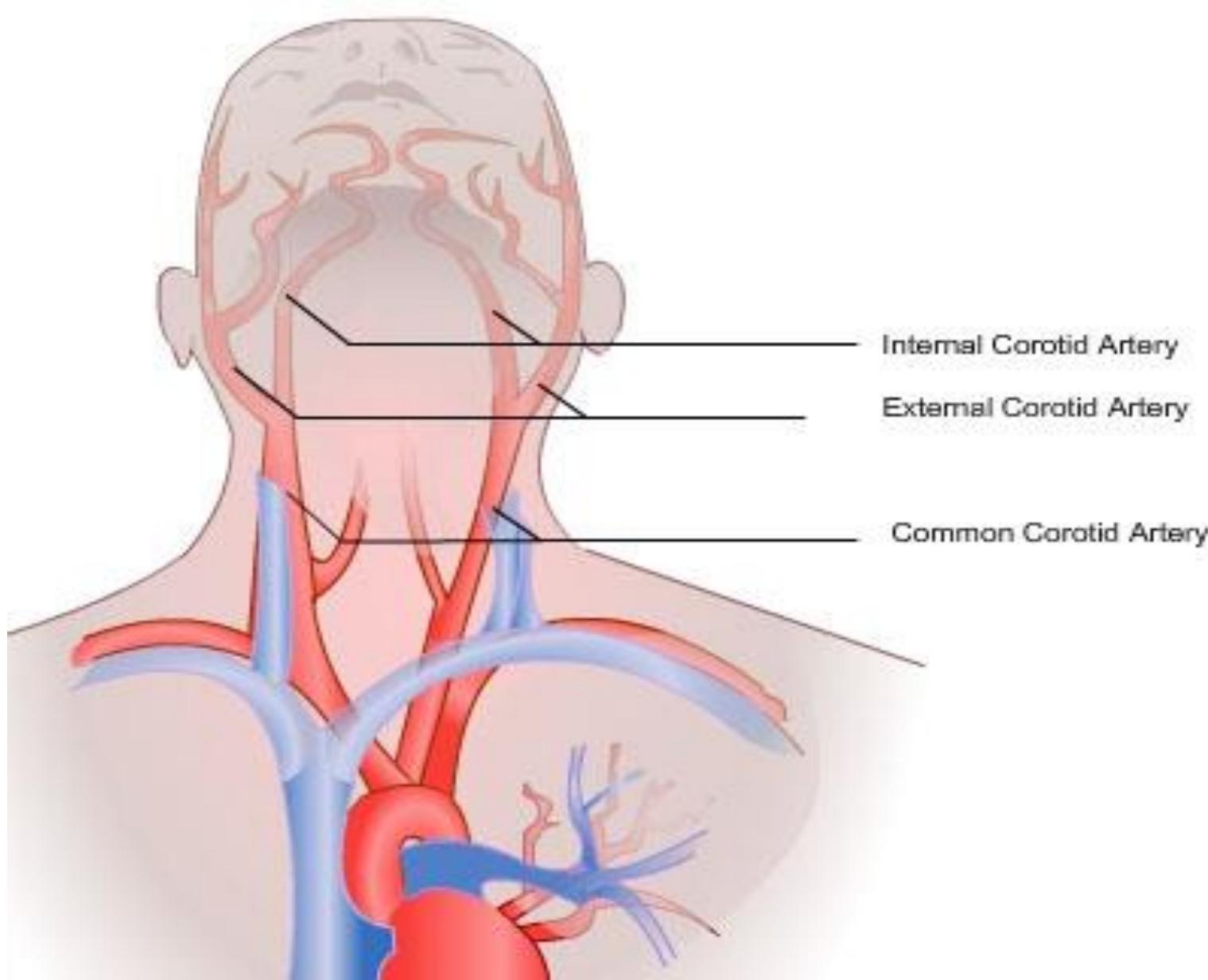


Circulation in Head and Neck-A

Common carotid artery

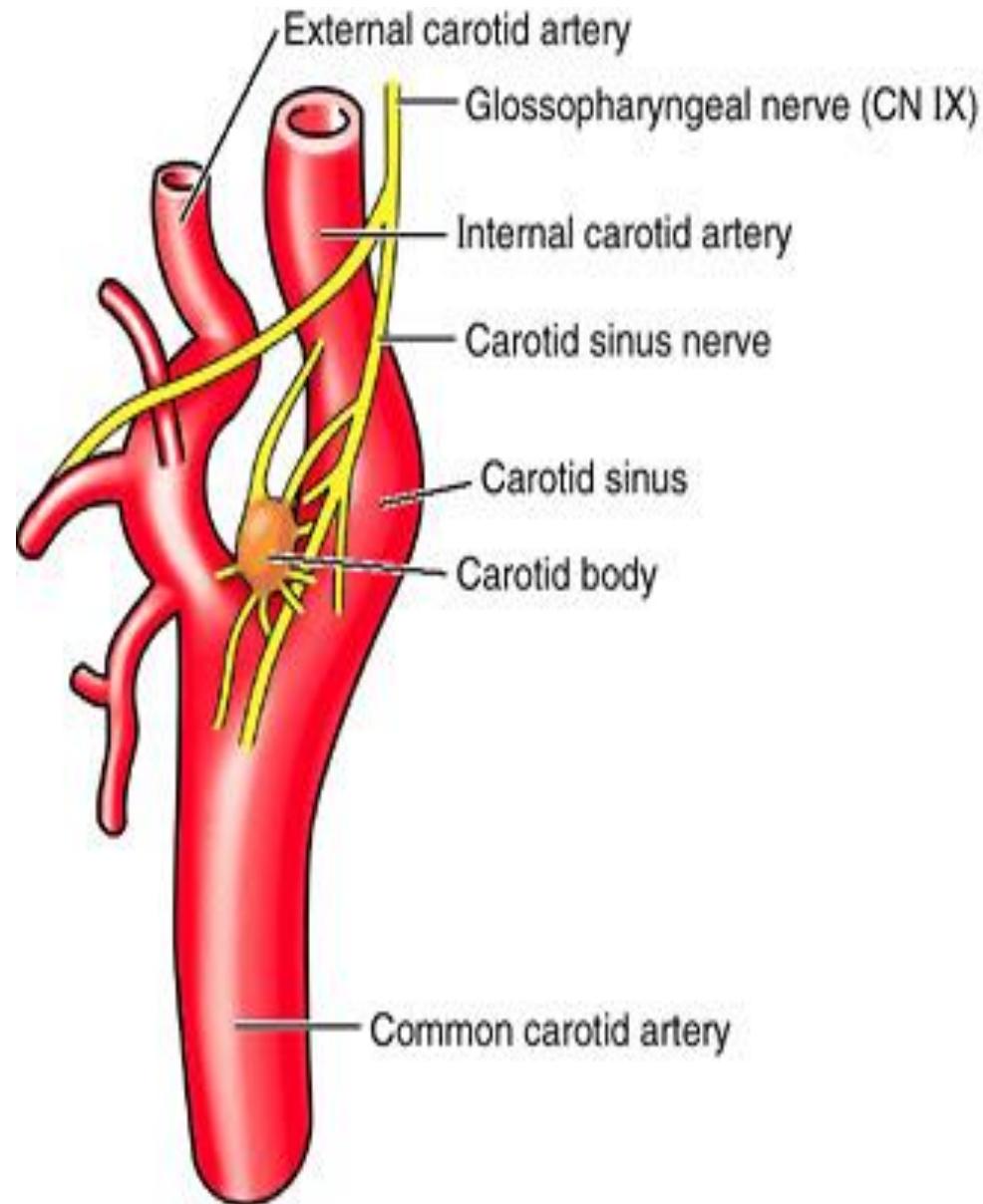
- Pass upwards on either side of neck
- Embedded in fascia, called *carotid sheath*
- At the level of upper border of thyroid cartilage, it divides into:
 - *Internal carotid artery* – Forms circle of Willis and supplies brain;
Also supplies eyes, forehead and nose
 - *External carotid artery* – Superficial tissues of the head and neck

Circulation in Head and Neck-A



Circulation in Head and Neck-A

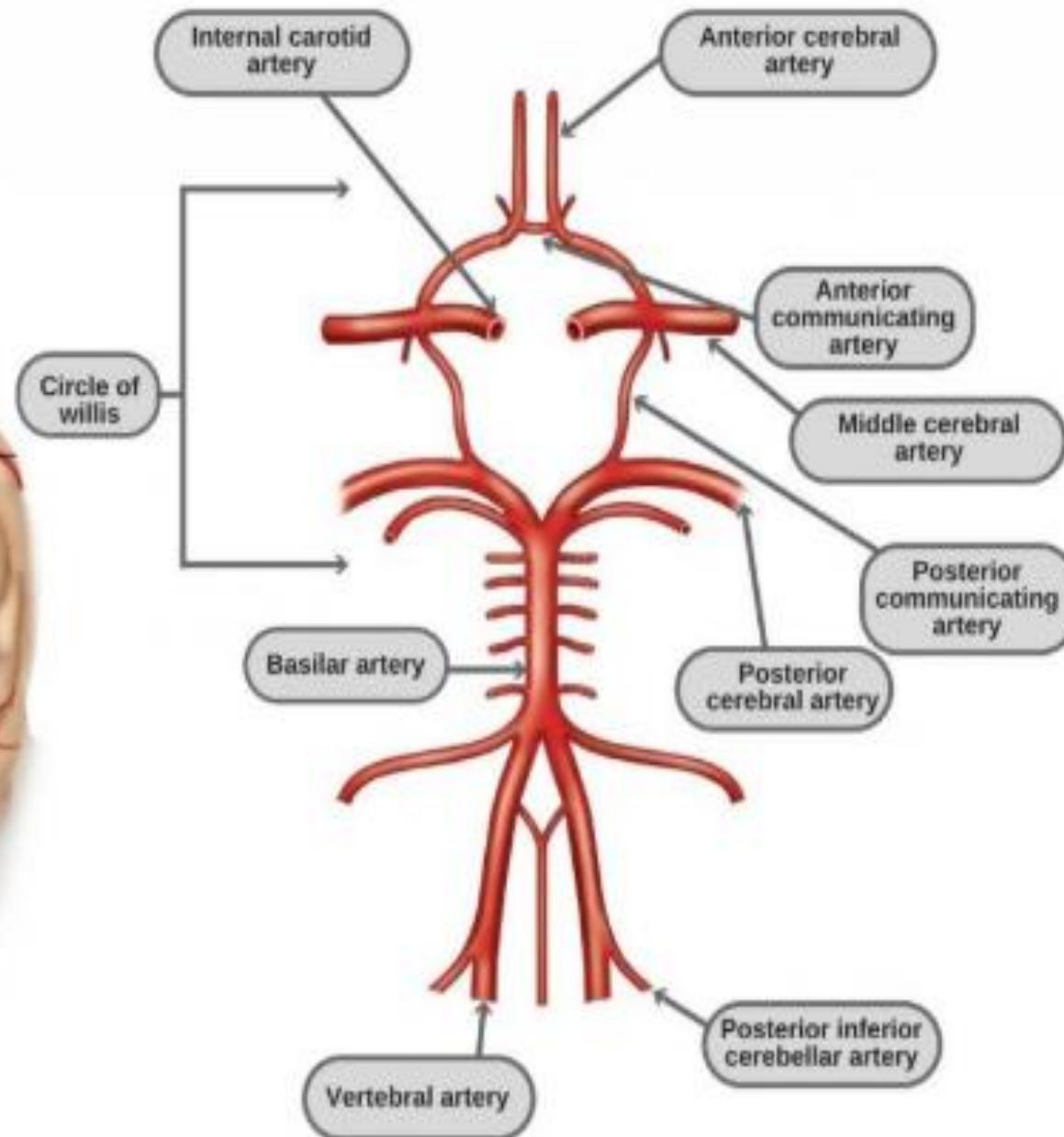
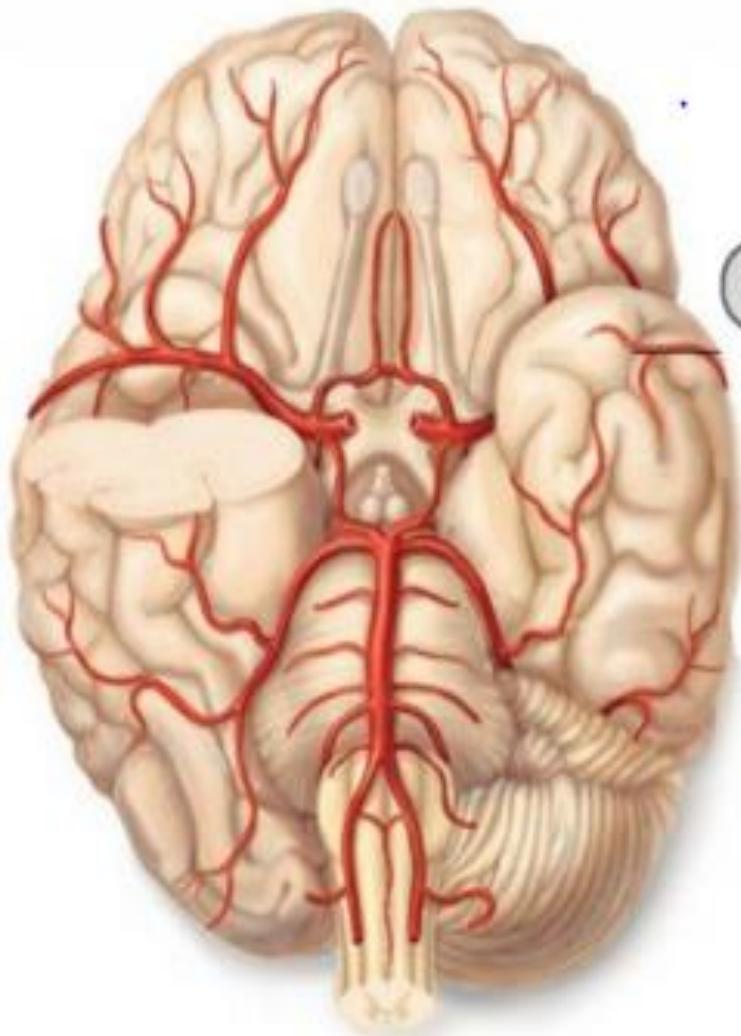
- Slight dilations are present at bifurcation – Carotid sinuses
- Contain nerve endings of glossopharyngeal nerves k/a *baroreceptors*
- Two small groups of *chemoreceptors*, one each at bifurcation of common carotid artery – Carotid bodies



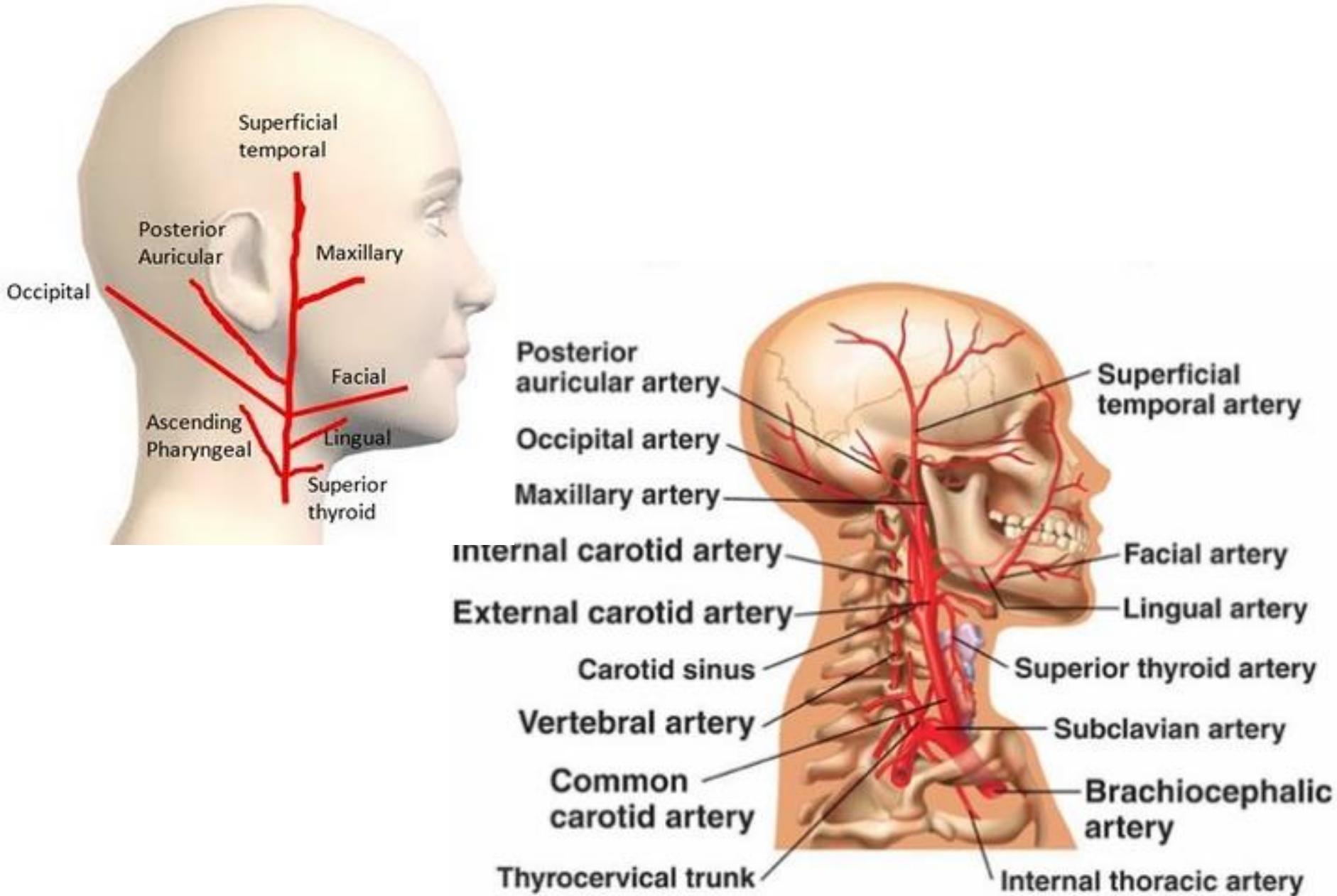
Circle of Willis (Circulus arteriosus)

- Supplies greater part of the brain
- Arrangement of arteries so that brain receives an adequate blood supply even when a contributing artery is damaged and during extreme movements of head and neck.
- Formed by:
 - *Two internal carotid arteries*
 - *Two vertebral arteries*

Circle of Willis (Circulus arteriosus)

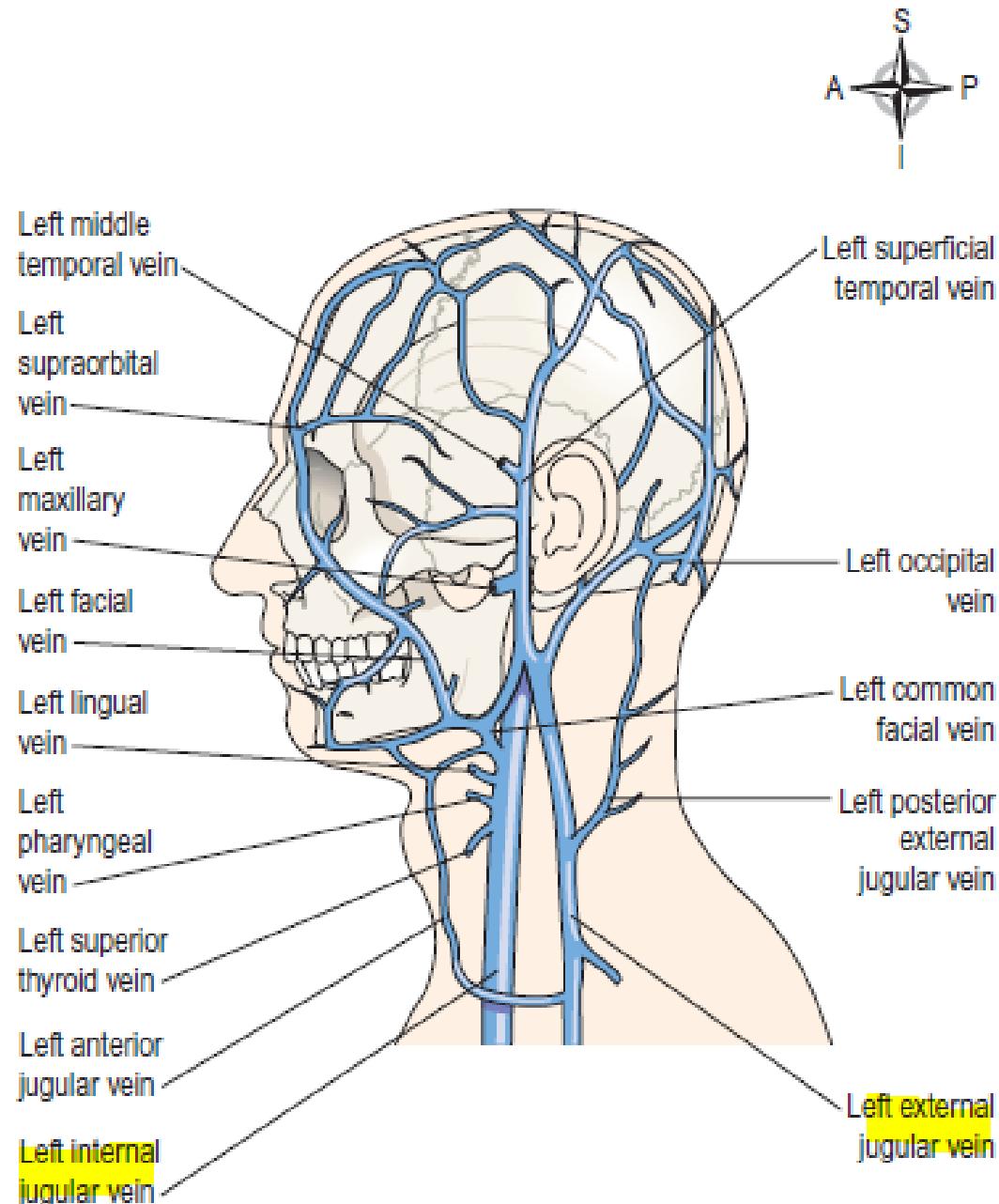


External carotid artery



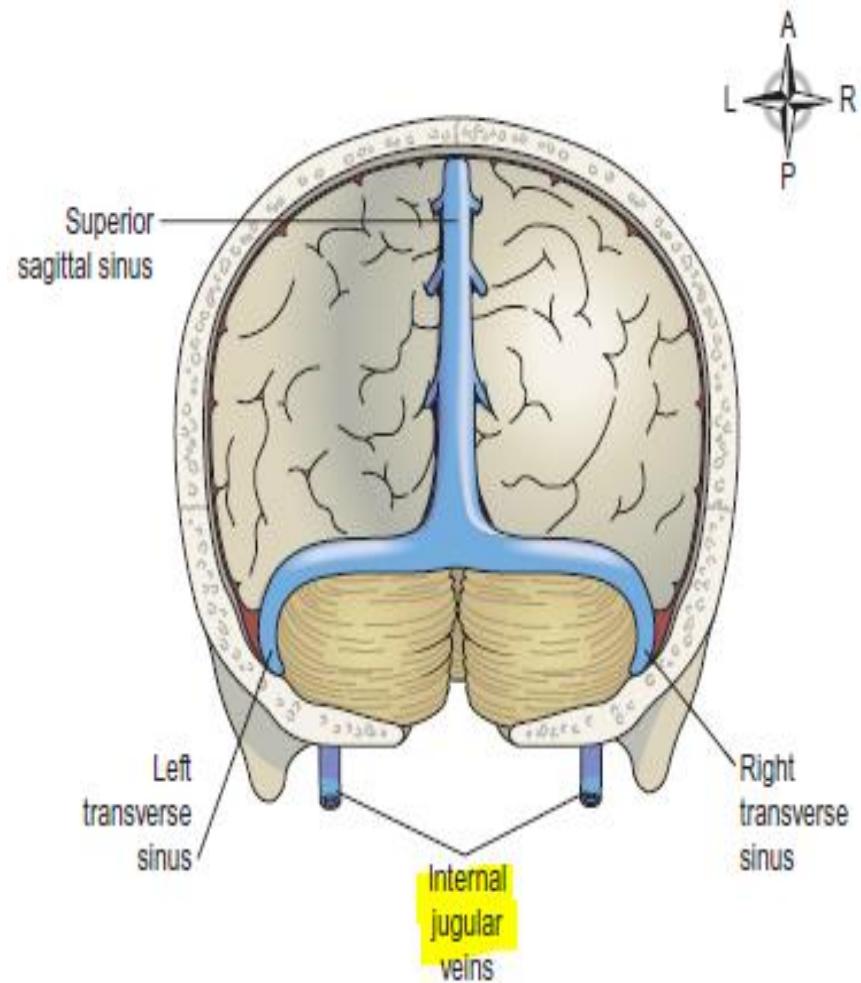
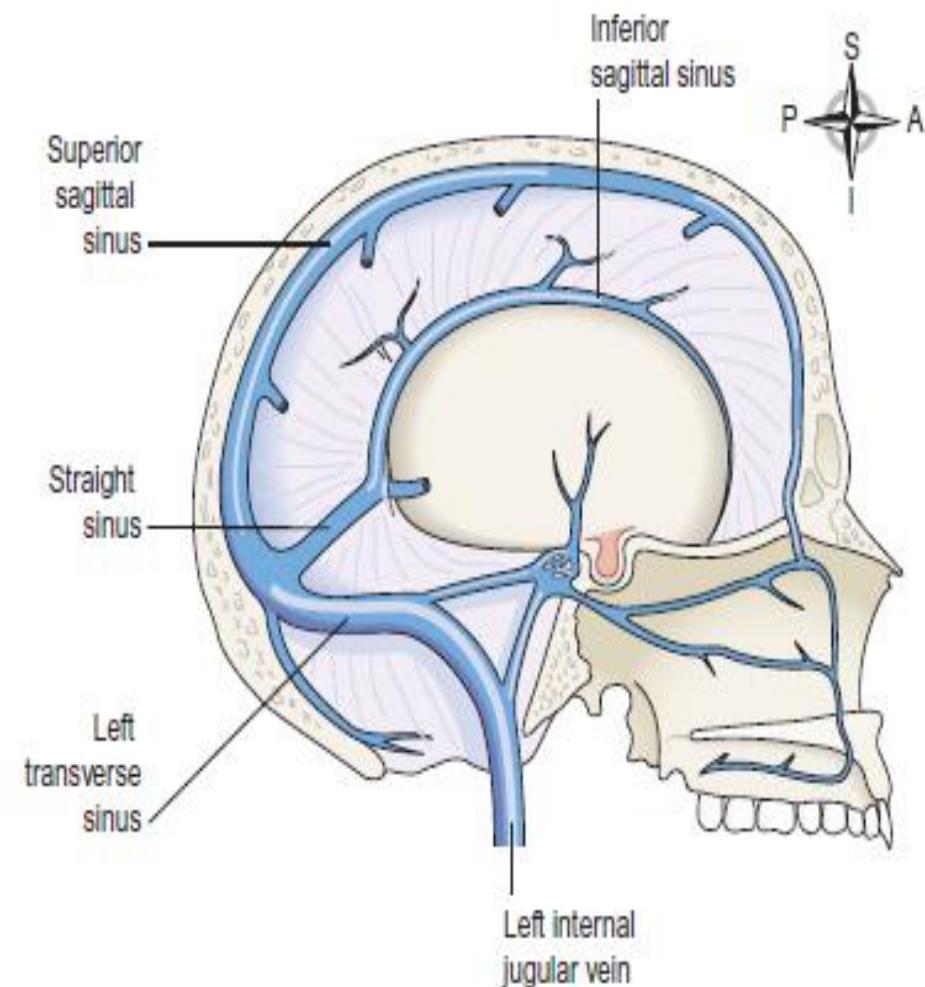
Circulation in Head and Neck-V

- Drained by deep and superficial veins
- Superficial veins return venous blood from superficial structures of face and scalp
- Unite to form External jugular vein
Subclavian vein



Circulation in Head and Neck-V

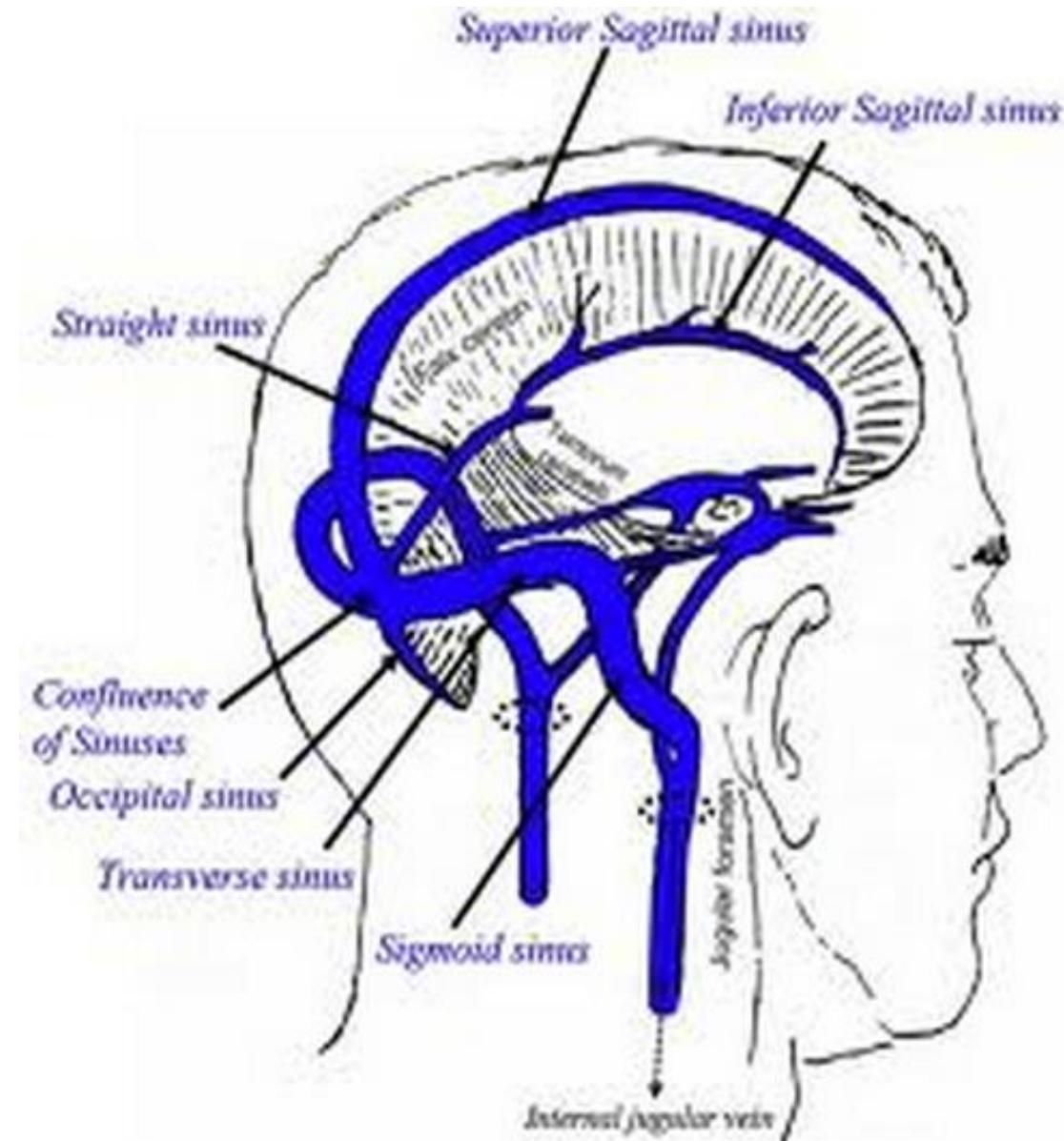
- Venous blood from deep areas of brain is collected into channels - *dural venous sinuses*
- Formed by layers of dura mater lined with endothelium



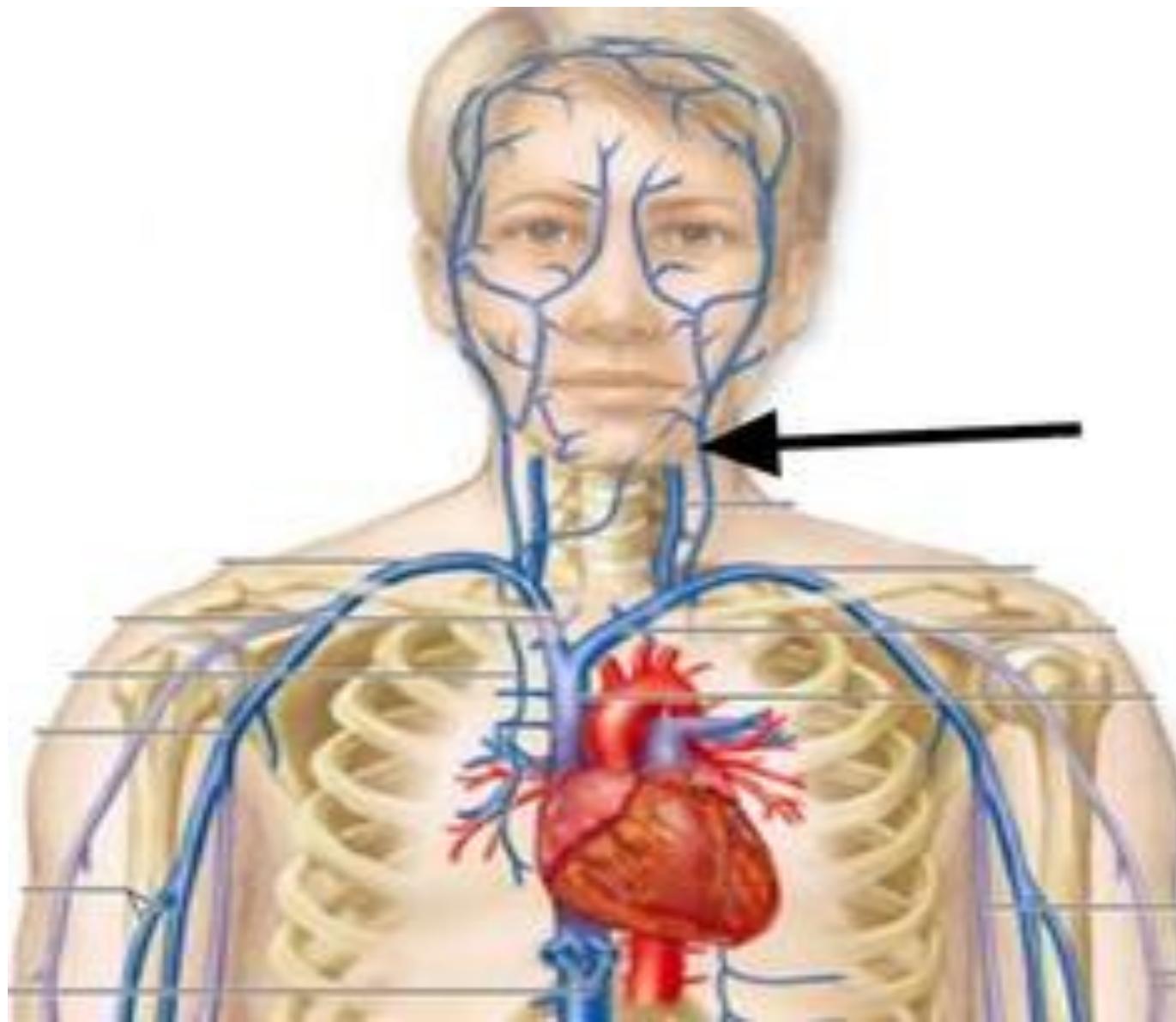
Circulation in Head and Neck-V

- Chief venous sinuses are:
 - *Superior sagittal sinus*
 - *Inferior sagittal sinus*
 - *Straight sinus*
 - *Transverse sinuses*
 - *Sigmoid sinuses*

↓
Internal jugular vein

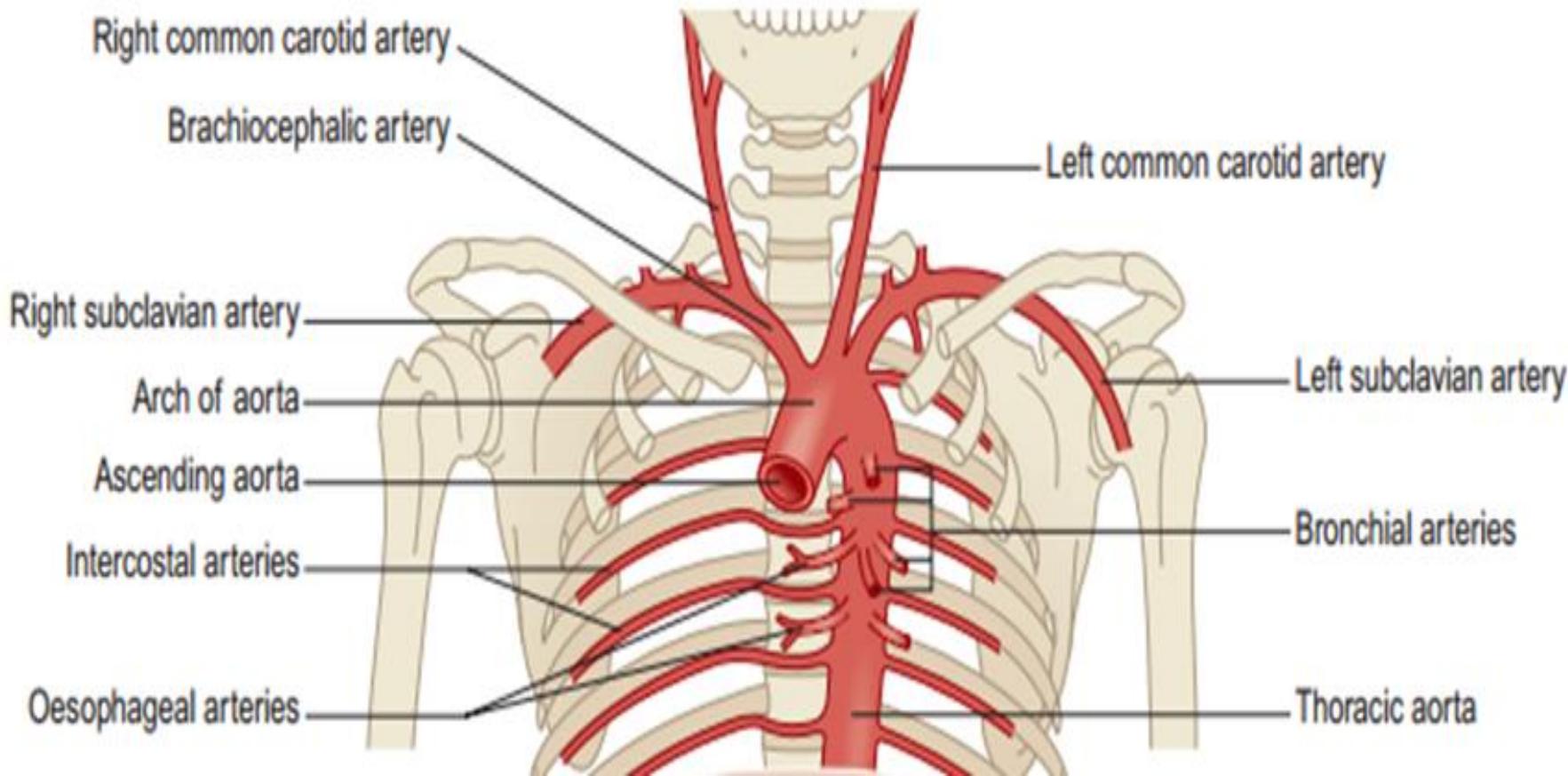


Circulation in Head and Neck-V



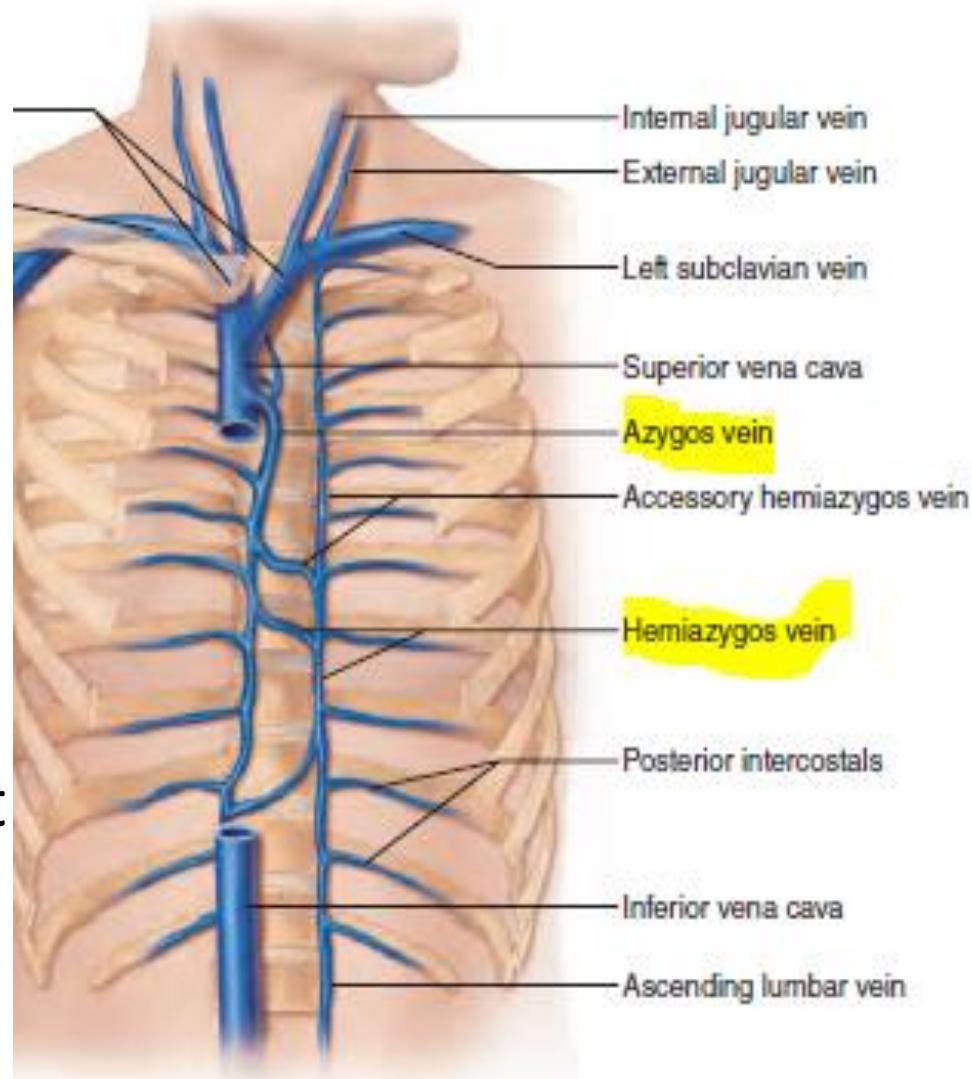
Circulation in Thorax-A

- Branches of the thoracic aorta which include:
 - Bronchial arteries
 - Esophageal arteries
 - Intercostal arteries



Circulation in Thorax-V

- Drained into azygos vein and hemiazygos vein
- Some of main veins that join them are:
 - Bronchial v
 - Esophageal v
 - Intercostal v
- *Azygos vein* joins SVC
- *Hemiazygos vein* joins Left brachiocephalic vein

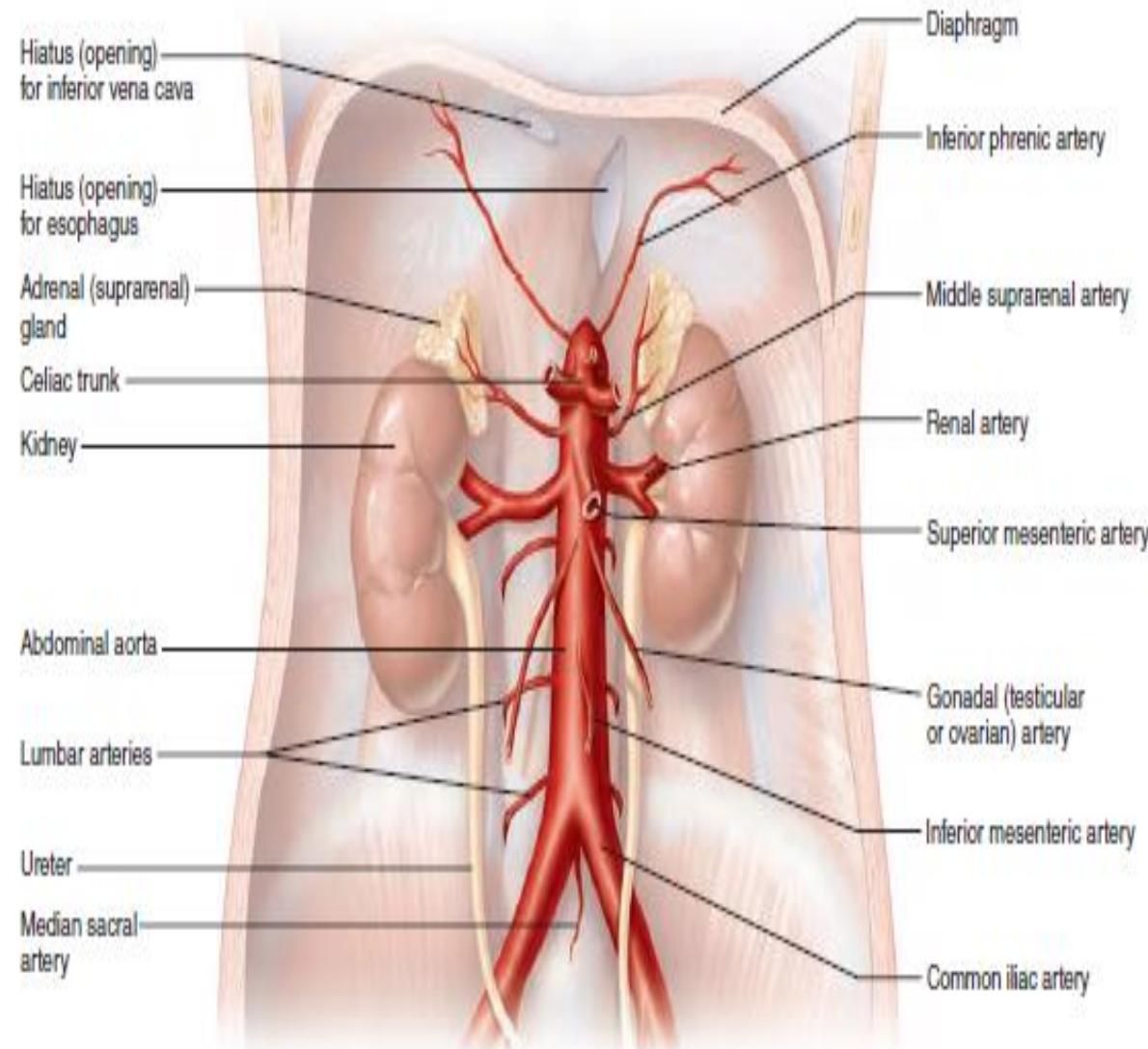


Circulation in Abdomen-A

- Branches of abdominal aorta

- **Paired branches:**

- *Phrenic arteries*
- *Renal arteries*
- *Suprarenal arteries*
- *Gonadal arteries*
(Testicular/Ovarian arteries)

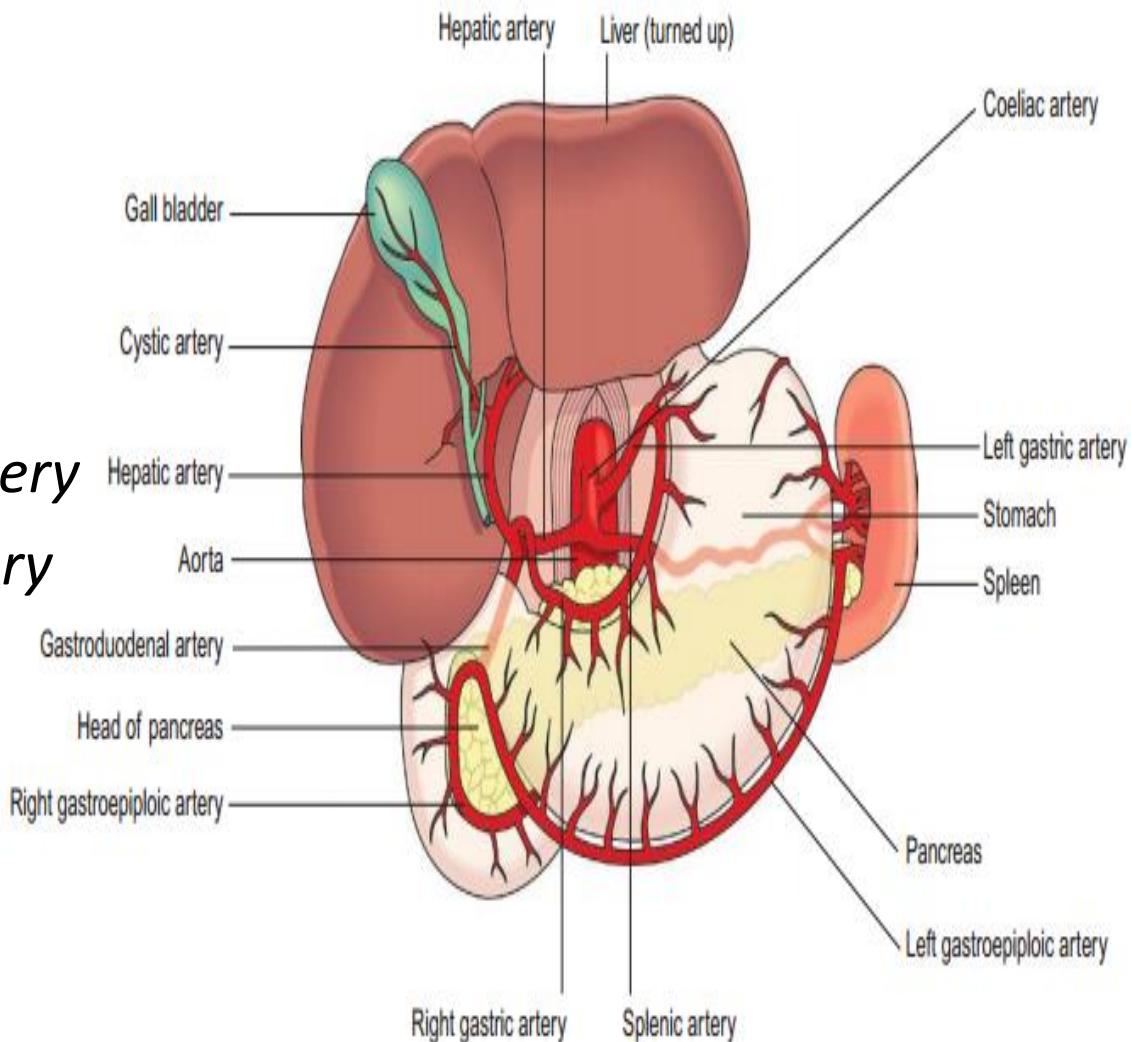


Circulation in Abdomen-A

- Unpaired branches:

- *Coeliac artery*
 - ❖ *Left gastric artery*
 - ❖ *Splenic artery*
 - ❖ *Hepatic artery*

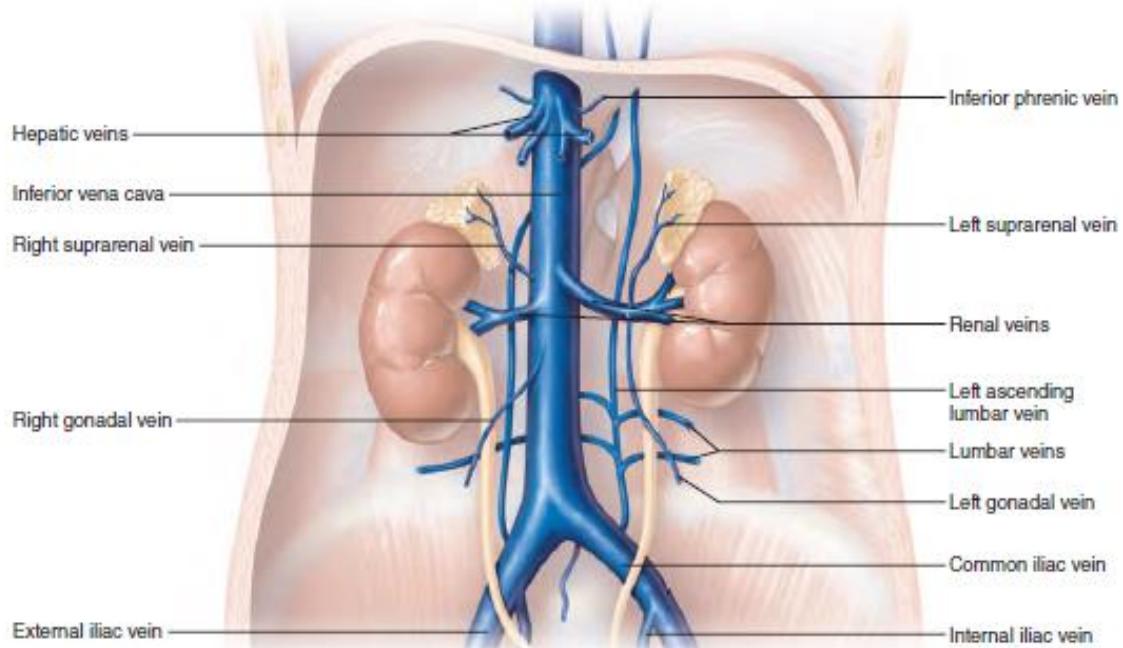
- *Superior mesenteric artery*
- *Inferior mesenteric artery*



Circulation in Abdomen-V

- Blood drains from some abdominal organs directly into IVC:

- *Hepatic veins*
- *Renal veins*
- *Suprarenal veins*
- *Gonadal veins...*

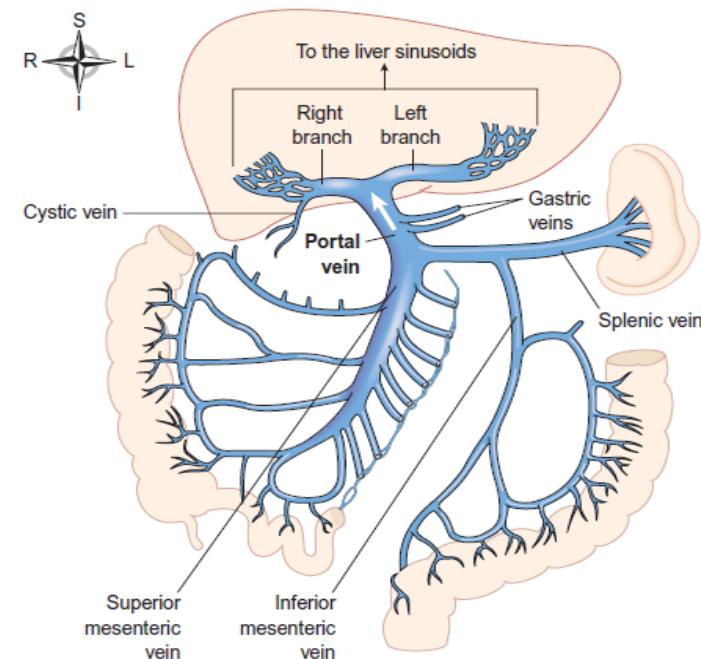


- However, most blood from digestive organs in abdomen is

- Drained into *hepatic portal vein*
- Passes through liver before being emptied into IVC
(Portal circulation)

Portal Circulation

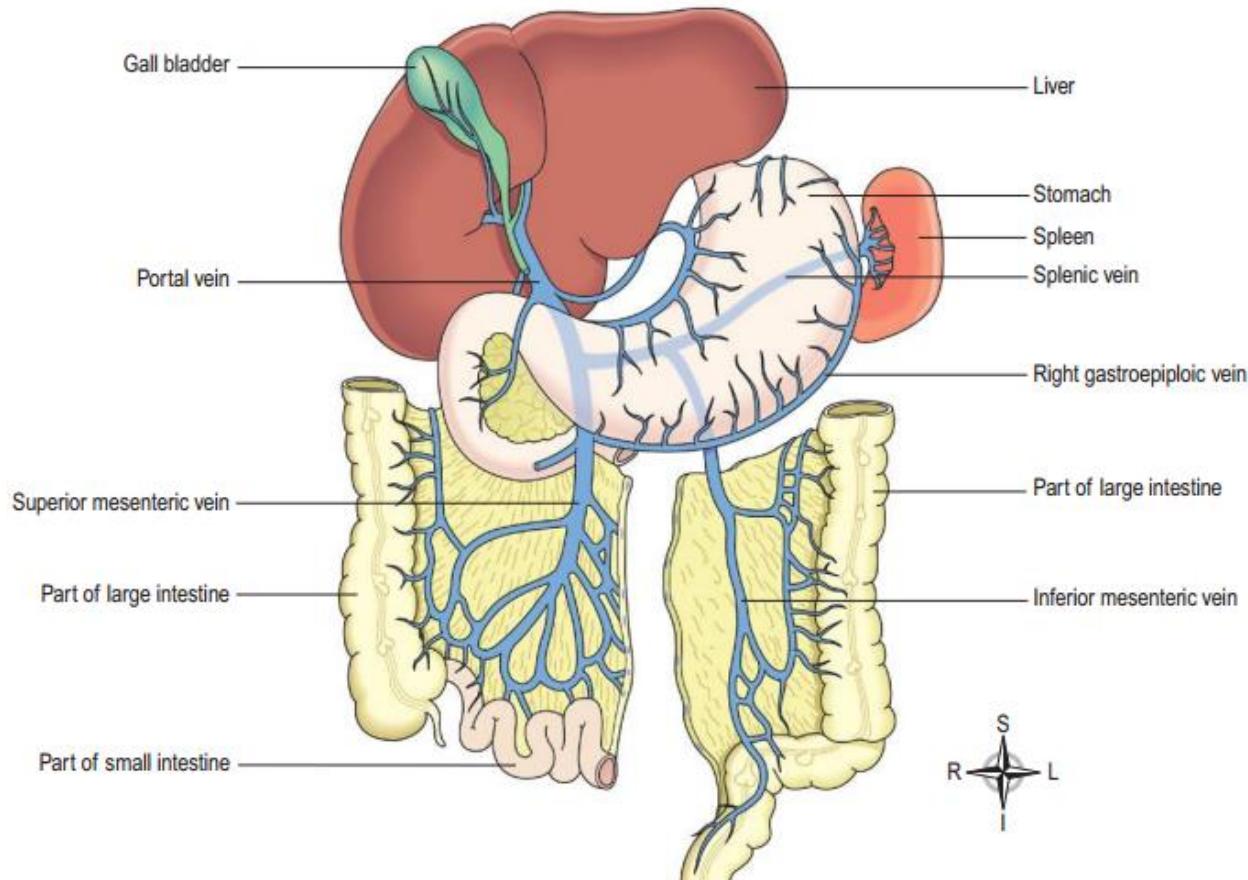
- Constitute of vessels that begin in capillaries and end in capillaries
- Venous blood from capillary beds of digestive system, spleen and pancreas travels first to liver
- Passes through a 2nd capillary bed and enters general circulation
- **Functions:**
 - Detoxification
 - Nutrients storage
 - Metabolism



Portal Circulation

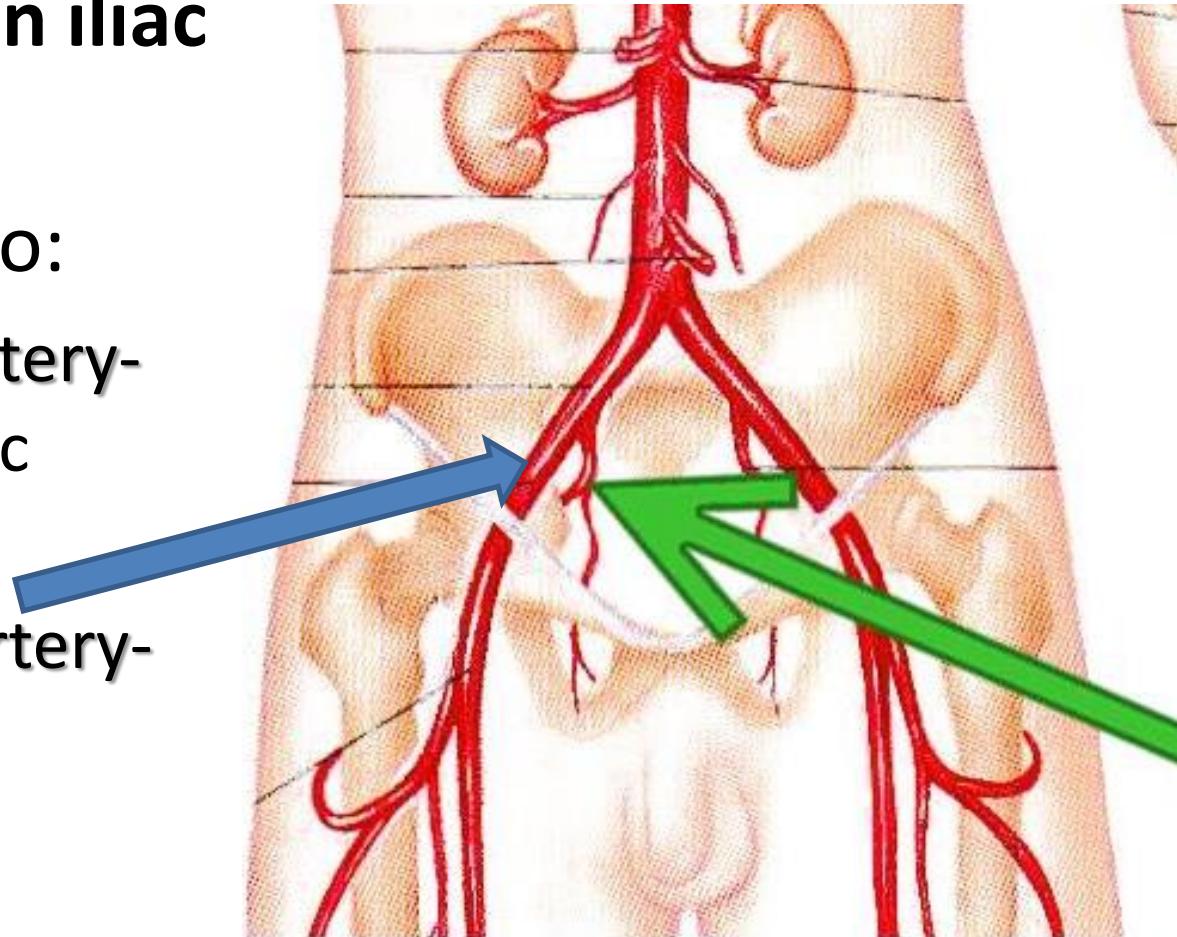
Portal vein

- Formed by splenic vein and superior mesenteric vein
- Inferior mesenteric vein also joins splenic vein

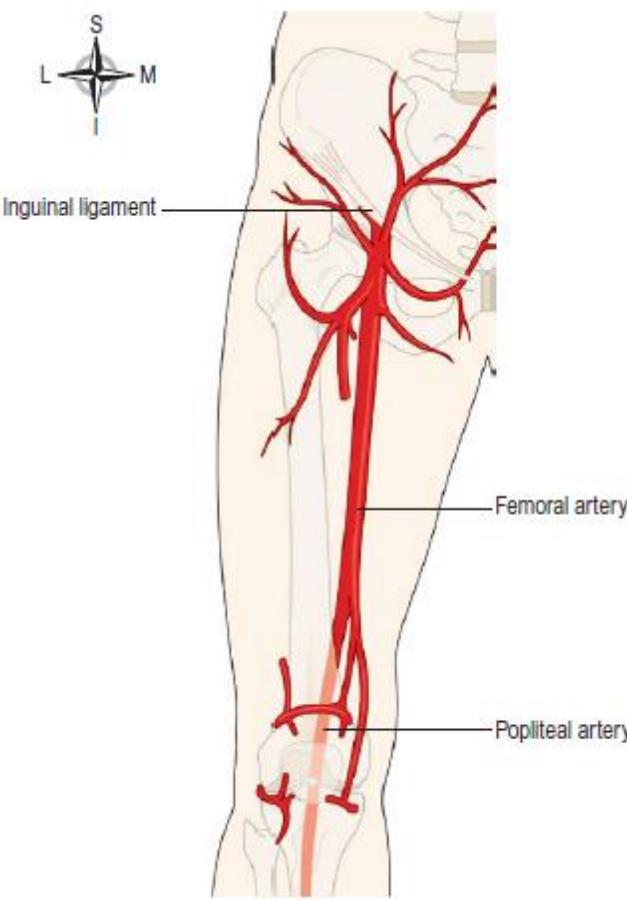


Circulation in Pelvis and Lower limb-A

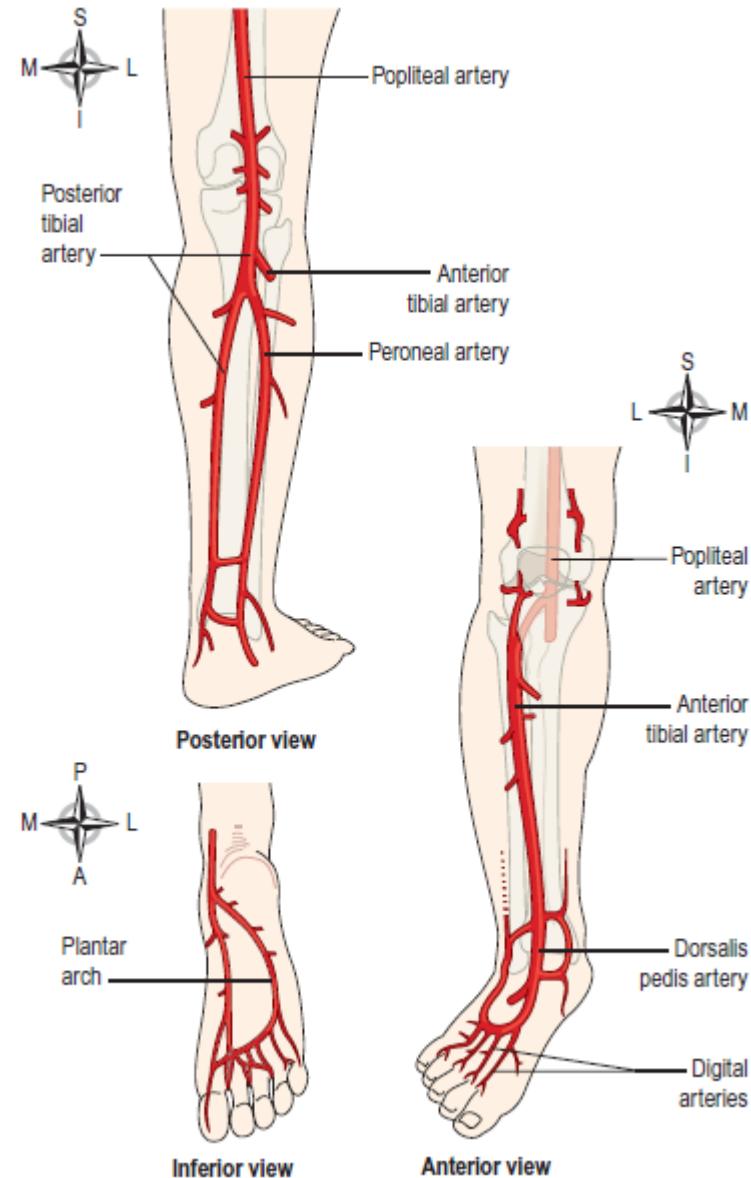
- R and L common iliac arteries...L4
- Each divides into:
 - Internal iliac artery-
Organs of pelvic cavity
 - External iliac artery-
Lower limb



Circulation in Pelvis and Lower limb-A

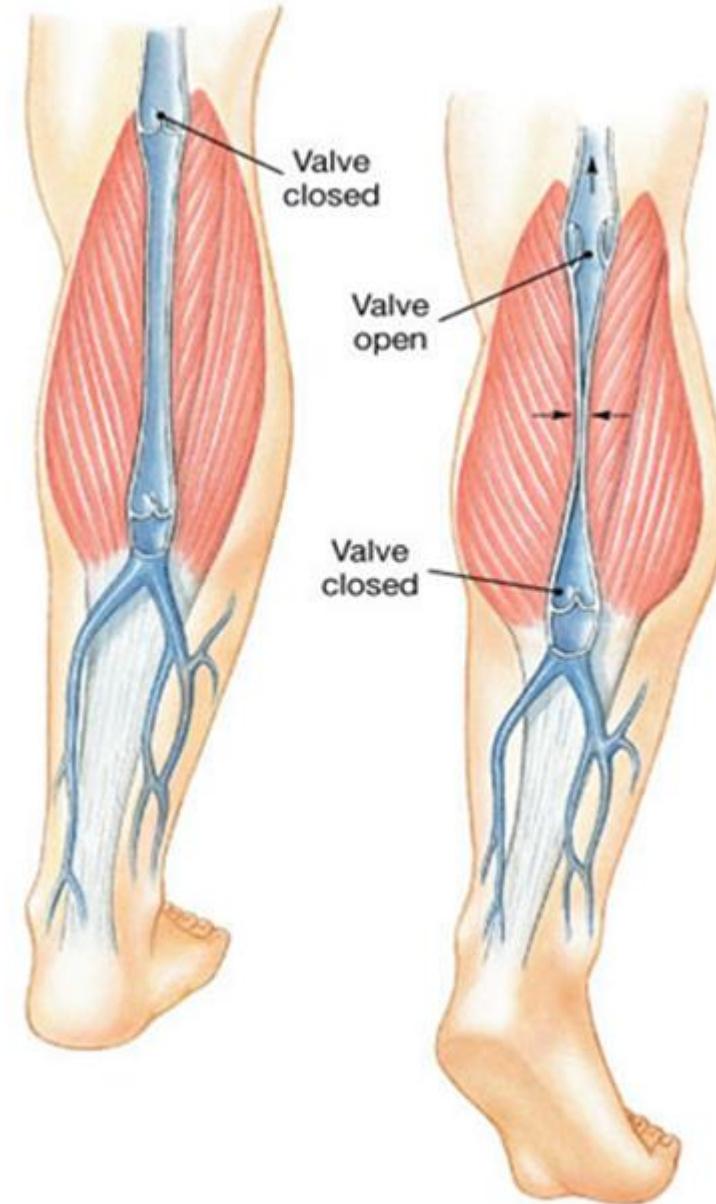


- Femoral a
- Popliteal a
- Anterior and posterior tibial a
- Dorsalis pedis a
- Plantar a
- Plantar arch



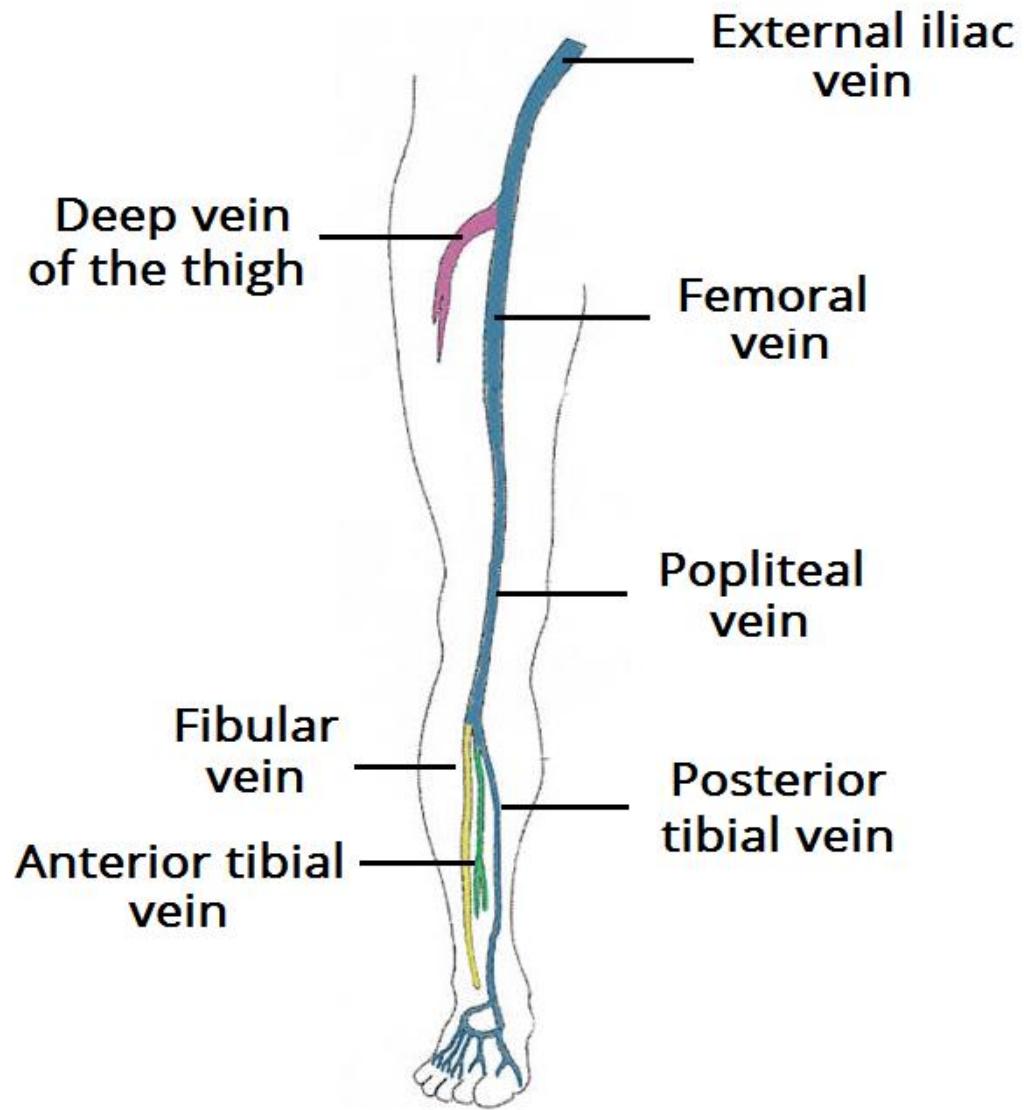
Circulation in Lower limb-V

- Drained by deep and superficial veins
- Blood passes to deep veins by *communicating veins*
- Blood flow is partly dependent on contraction of skeletal muscles
- Valves are present



Circulation in Lower limb-V

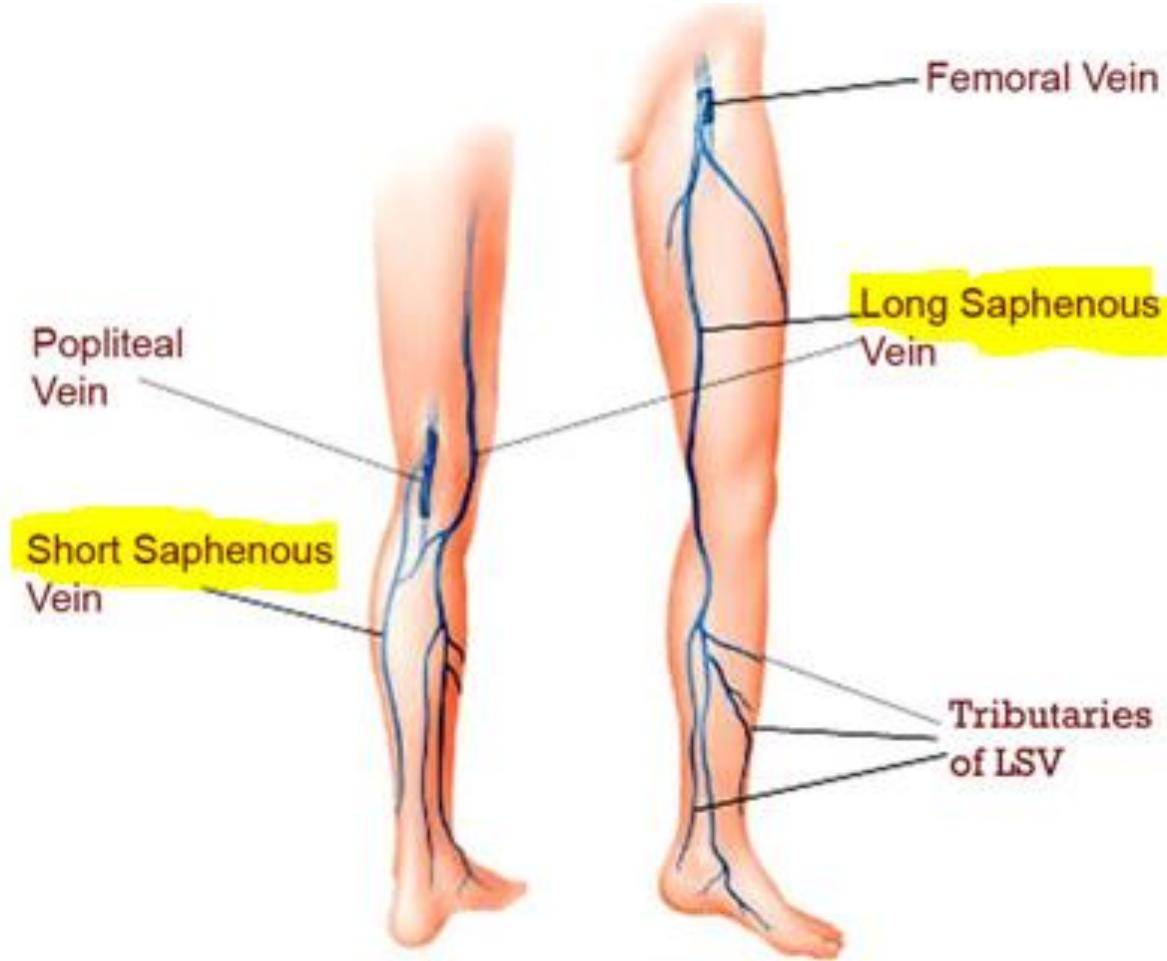
- Deep veins accompany the arteries and have same names
- Femoral v
- Popliteal v
- Anterior and posterior tibial v
- Fibular v



Circulation in Lower limb-V

- **Superficial veins:**

- *Small saphenous vein*
- *Great saphenous vein is the longest vein in the body*



Thank you