

Heart Structure



- Arch of aorta

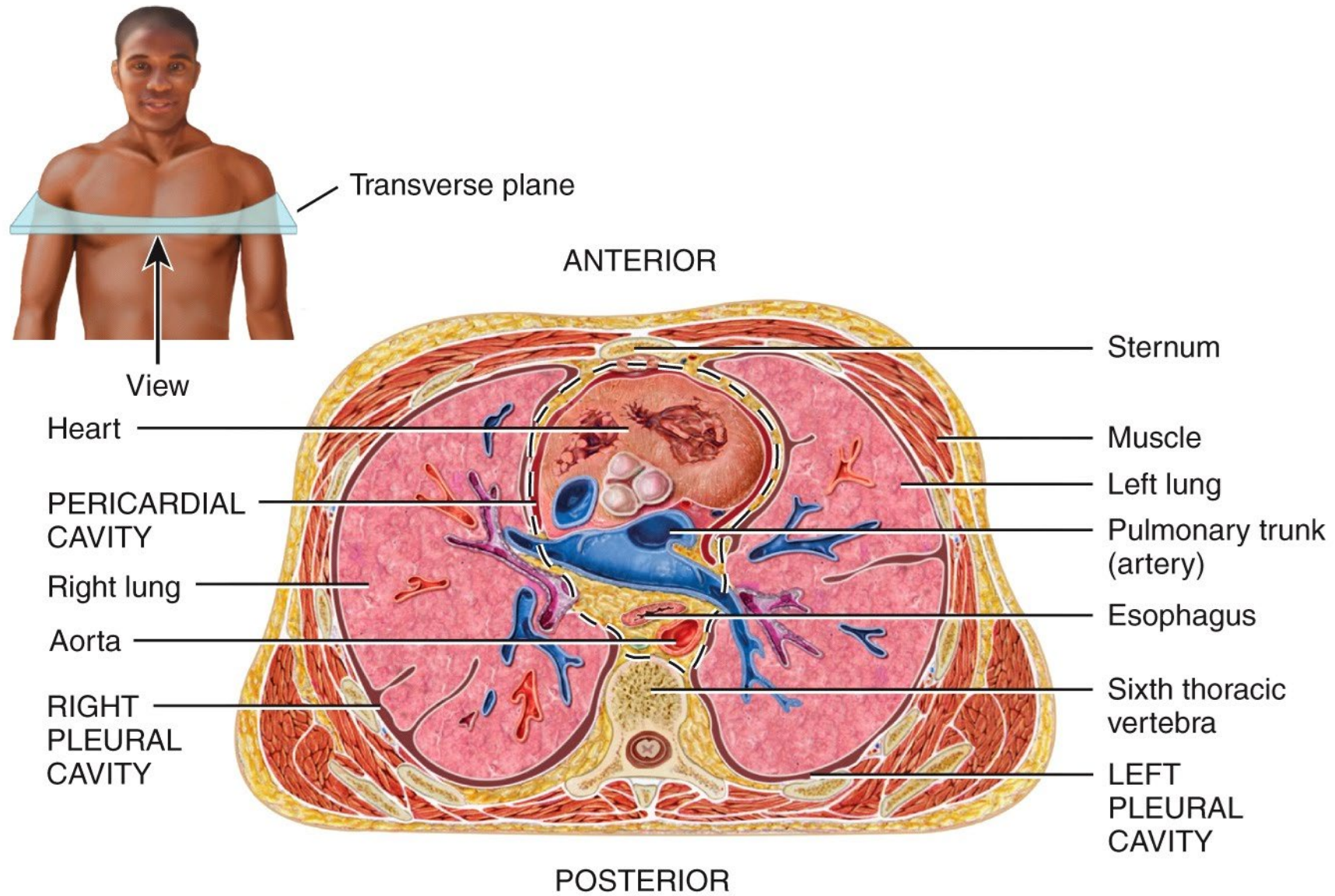
- Pulmonary trunk

- Left lung

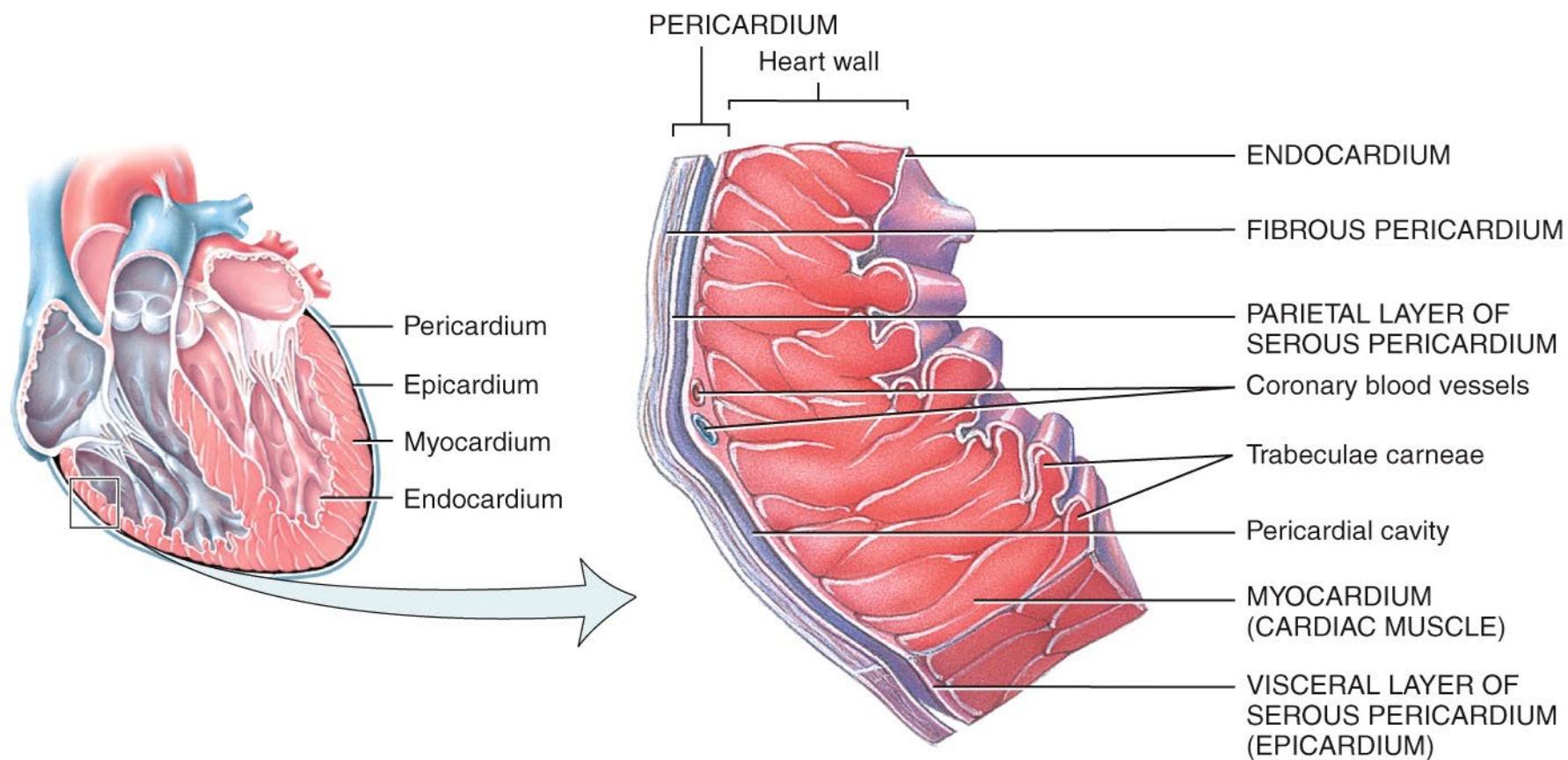
- LEFT SURFACE

- APEX OF HEART

(b) Anterior view of the heart in the thoracic cavity



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

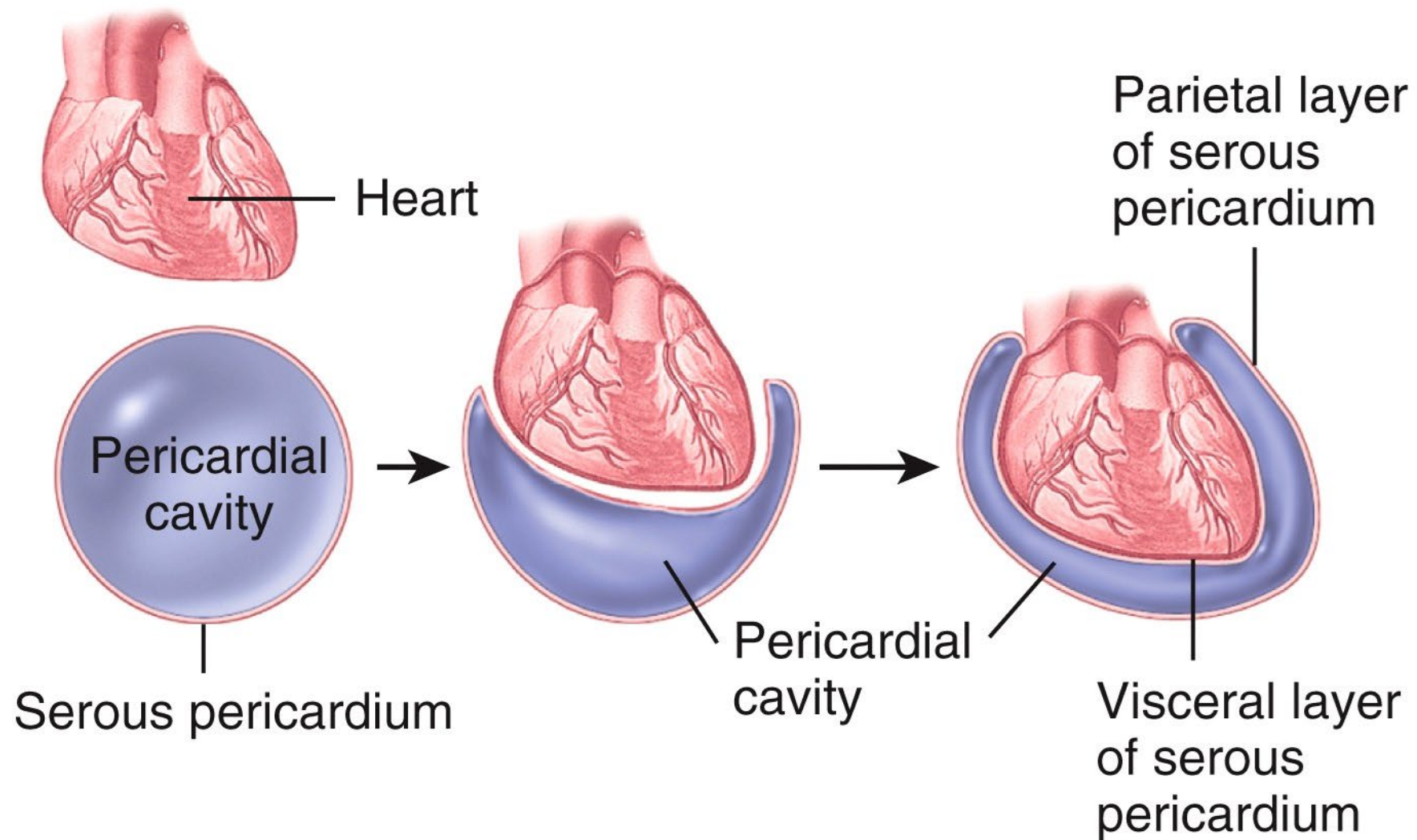


(a) Portion of pericardium and right ventricular heart wall showing divisions of pericardium and layers of heart wall

Pericardium

- Pericardium

- Double-walled sac (pericardial sac) that encloses the heart
- As heart enters pericardial sac a **parietal and visceral pericardial surfaces** are formed. // these are serous layers
- Pericardium has an inner and outer surface
- Allows heart to beat without friction, provides room to expand // resists excessive expansion
- Pericardial sac anchored to diaphragm inferiorly and sternum on anterior surface
- Outer surface of the pericardial sac forms the superficial a **fibrous layer** of connective tissue



(b) Simplified relationship of serous pericardium to heart

Heart Wall

- **Epicardium** (visceral pericardium)

- serous membrane covering heart
- adipose in thick layer in some places
- coronary blood vessels travel through this layer

- **Myocardium**

- layer of cardiac muscle proportional to work load
- muscle spirals around heart which produces wringing motion

Heart Wall

- Endocardium

- smooth inner lining of heart and blood vessels
- covers the valve surfaces and continuous with endothelium of blood vessels
- simple squamous epithelial cells

- Fibrous skeleton of the heart // connective tissue

- framework of collagen and elastic fibers
- provides structural support and attachment for cardiac muscle and firm support for valve tissue
- electrical insulation between atria and ventricles important in timing and coordination of contractile activity

Pericardium

- Visceral pericardium (also called epicardium)

–simple squamous epithelium / heart covering

–serous lining of pericardial sac // turns inward at base of heart to cover the heart surface

- Pericardial cavity // space inside the pericardial sac contains 5 to 30 mL of pericardial fluid

- Pericarditis // inflammation of the membranes // painful friction rub with each heartbeat // excess fluid accumulates in pericardial cavity

Pericardial Effusion

Pericardial effusion is a condition where excess fluid accumulates in the pericardium, the sac that surrounds the heart.

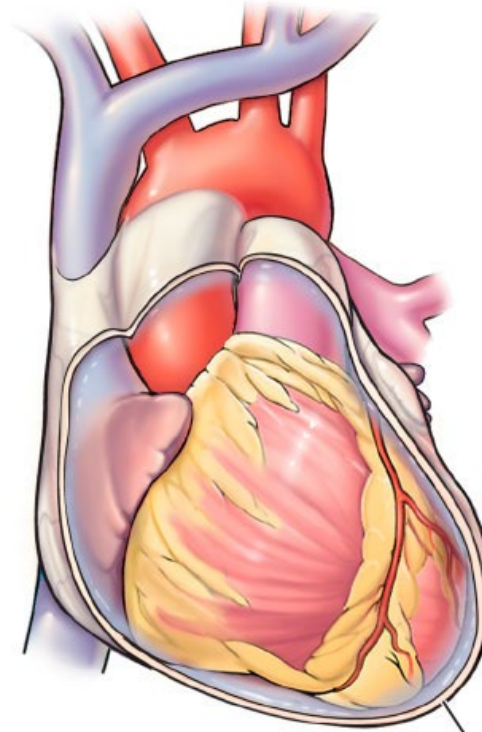
Causes: Infection (viral, bacterial, fungal) // Trauma (chest injury) // Autoimmune disorders (e.g., lupus, rheumatoid arthritis) // Cancer // Idiopathic (unknown cause)

Symptoms: Chest pain or pressure, Shortness of breath, Fatigue, Swelling in the legs or abdomen, and Difficulty swallowing.

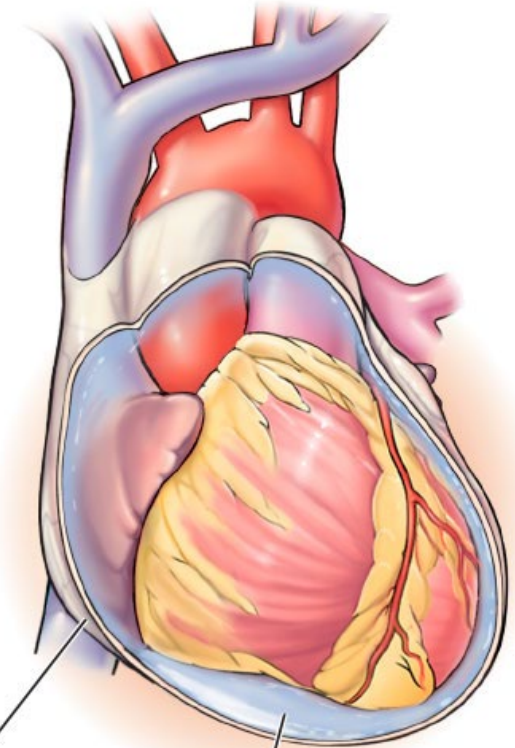
Complications: Cardiac tamponade (when the fluid builds up enough to prevent the heart from pumping properly) // Heart failure

Pericardial Effusion

Healthy Heart

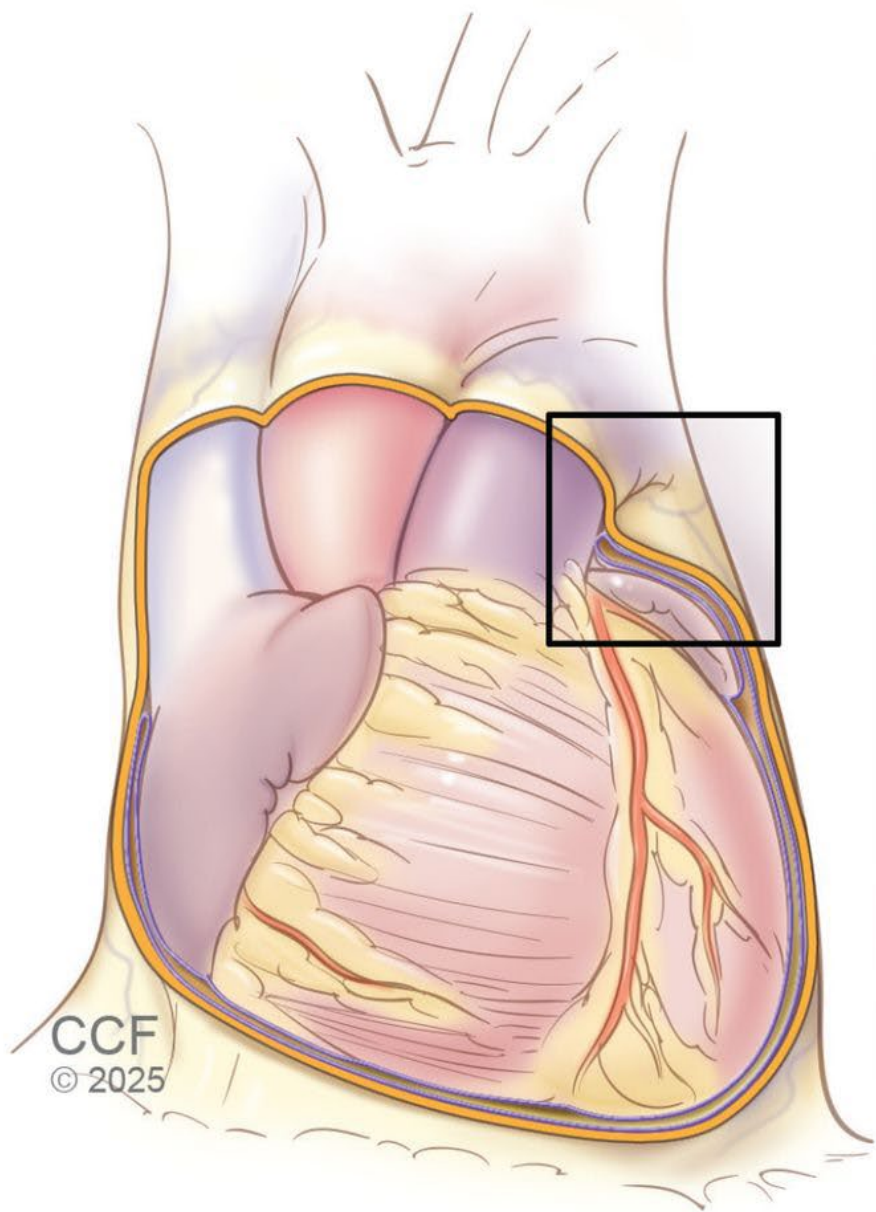


Pericardial Effusion

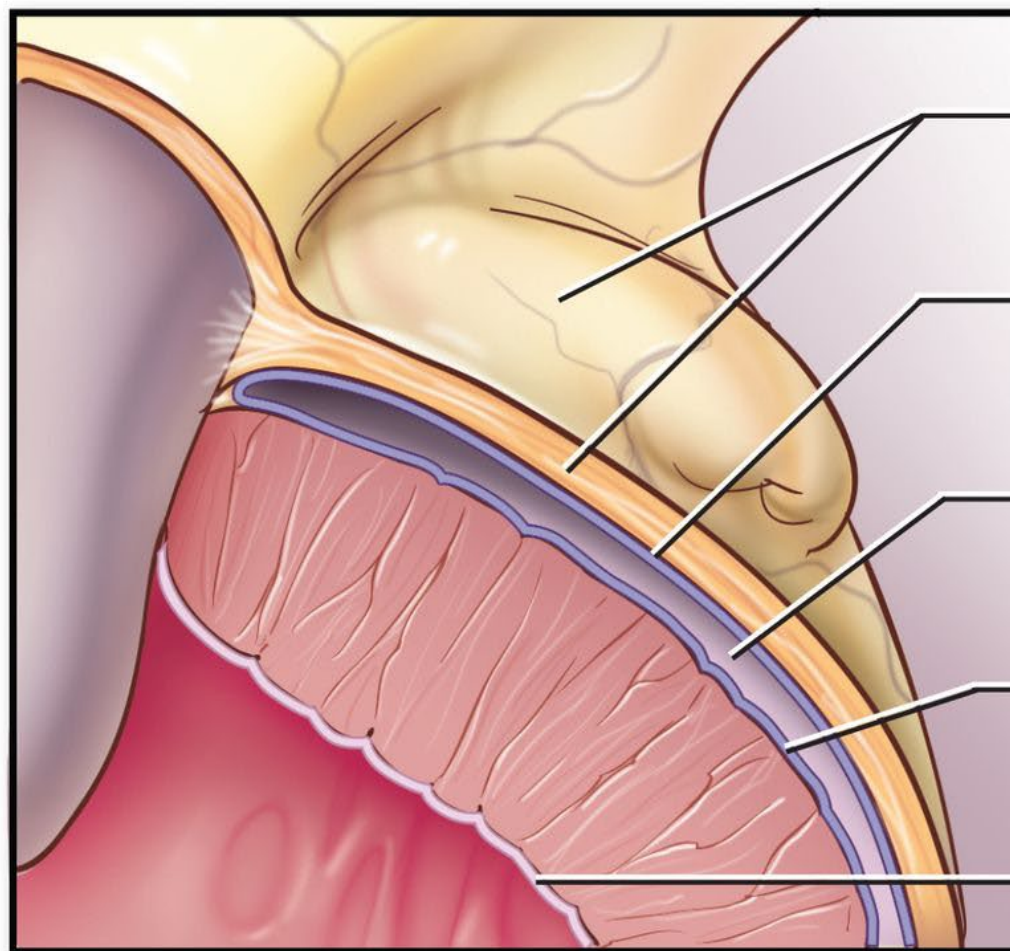


Pericardium

Excess fluid



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Fibrous
pericardium

Parietal
pericardium

Pericardial
cavity

Visceral
pericardium

Endocardium

Three Circulatory Circuits of the Heart

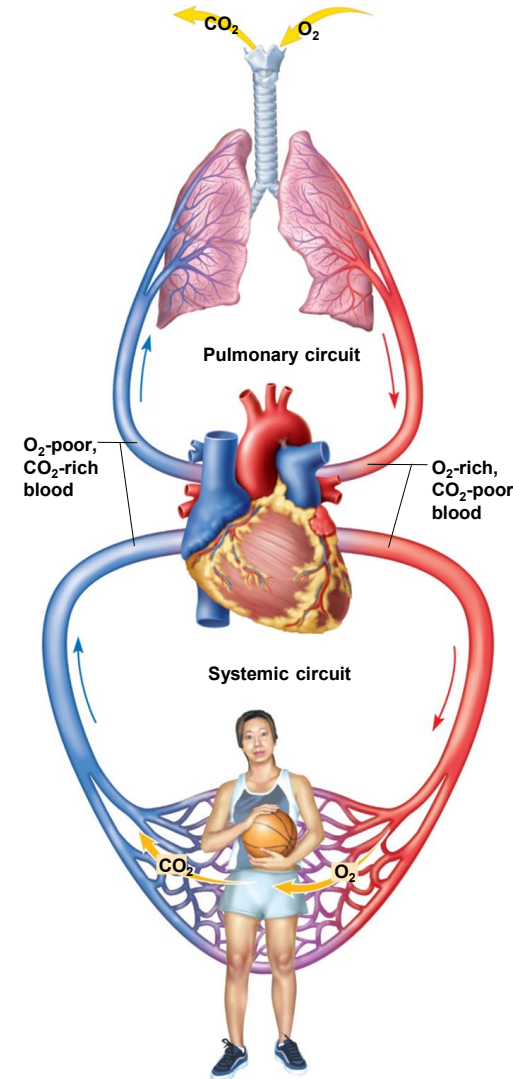


–Pulmonary circuit

- right side of heart to lungs
- carries blood to lungs for gas exchange and back to heart // low pressure

–Systemic circuit

- left side of heart to all tissue of body except lungs
- supplies oxygenated blood to all tissues of the body and returns it to the heart // high pressure

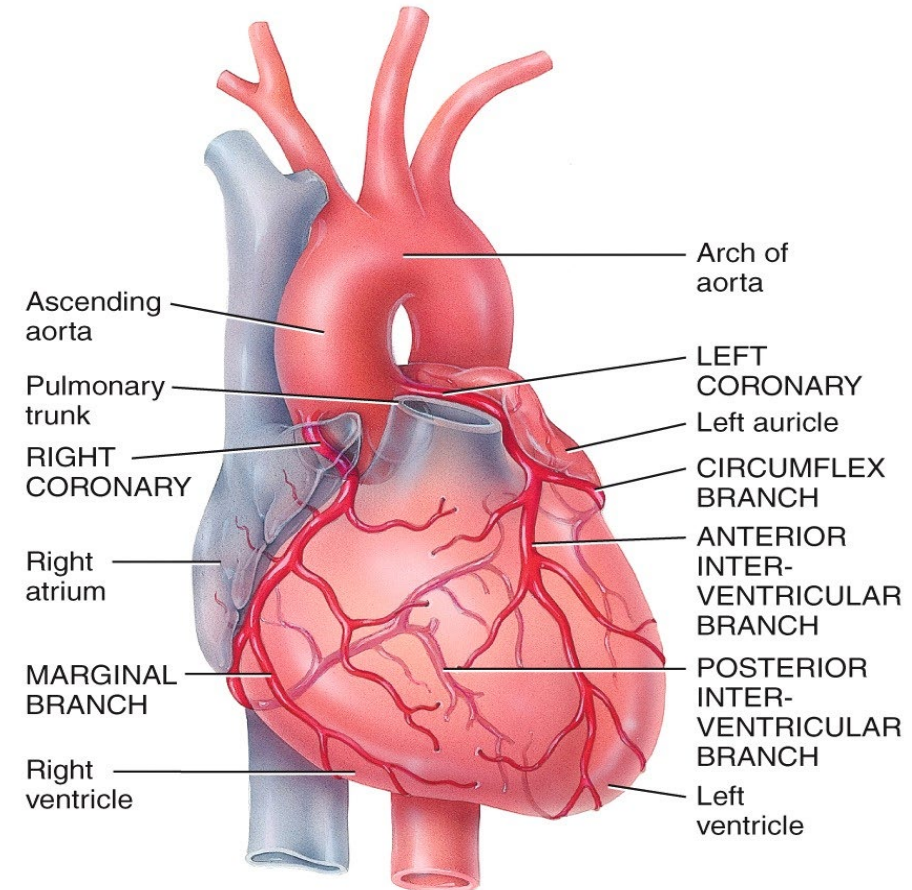


Three Circulatory Circuits of the Heart



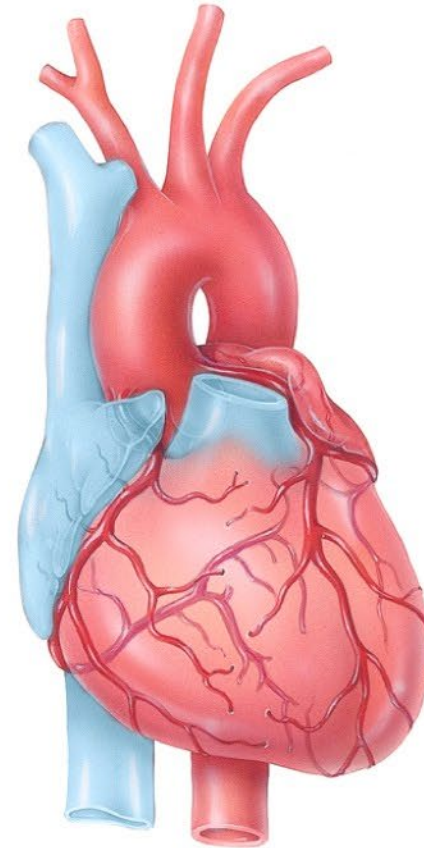
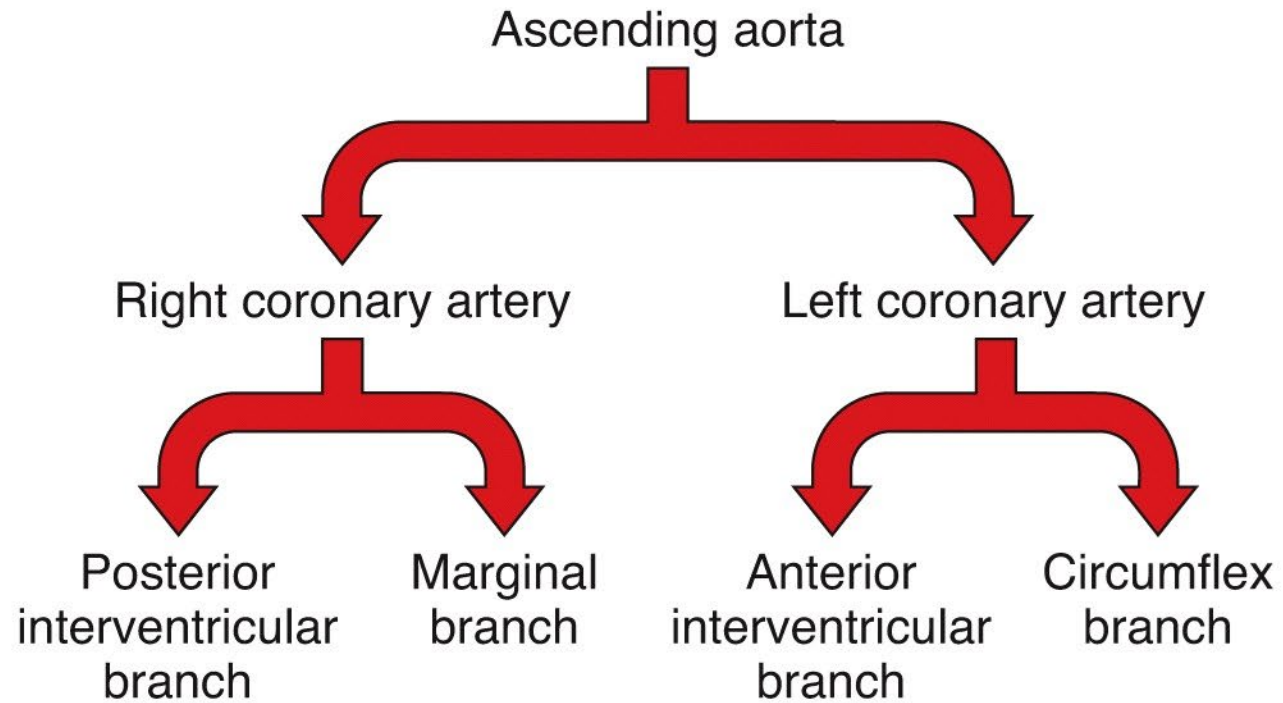
Coronary Circuit

- part of the systemic circuit
- aortic recoil moves blood into the coronary arteries
- supply the myocardiocytes (the cells making the walls of the heart) with blood circulation
- RCA** – divides into the marginal artery branch and the posterior interventricular branch
- LCA** – divides into circumflex branch and the anterior interventricular branch

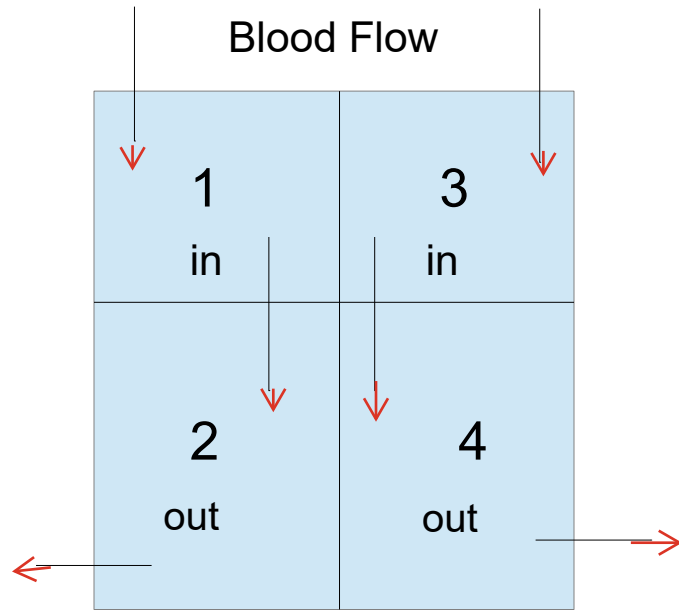


(a) Anterior view of coronary arteries

SCHEME OF DISTRIBUTION

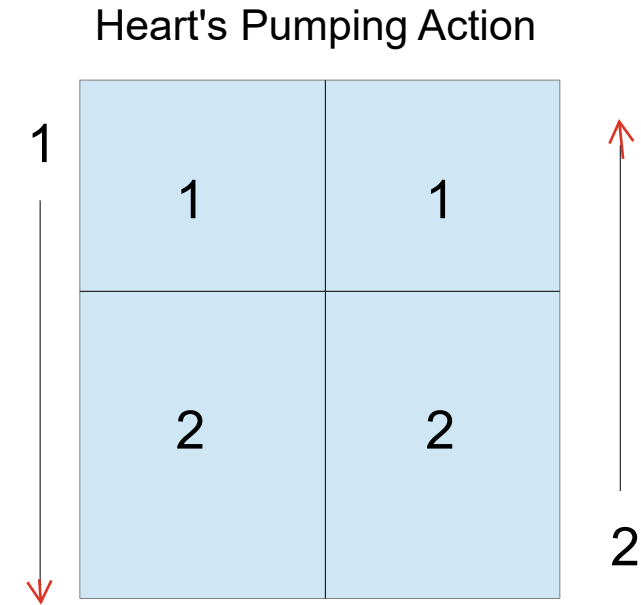


Important Lab Learning Objective!



1. Blood enters right atria from superior vena cava, inferior vena cava, and coronary sinus
2. Blood moves into right ventricle and is ejected from heart into pulmonary trunk then to lungs
3. Blood returns from lungs to fill left atria.
4. Blood moves into left ventricle and then ejected from heart and moves into the aorta.

Note: the blood flow is a closed system. So the amount of blood moving through the right and left side of the heart must be the same volume.

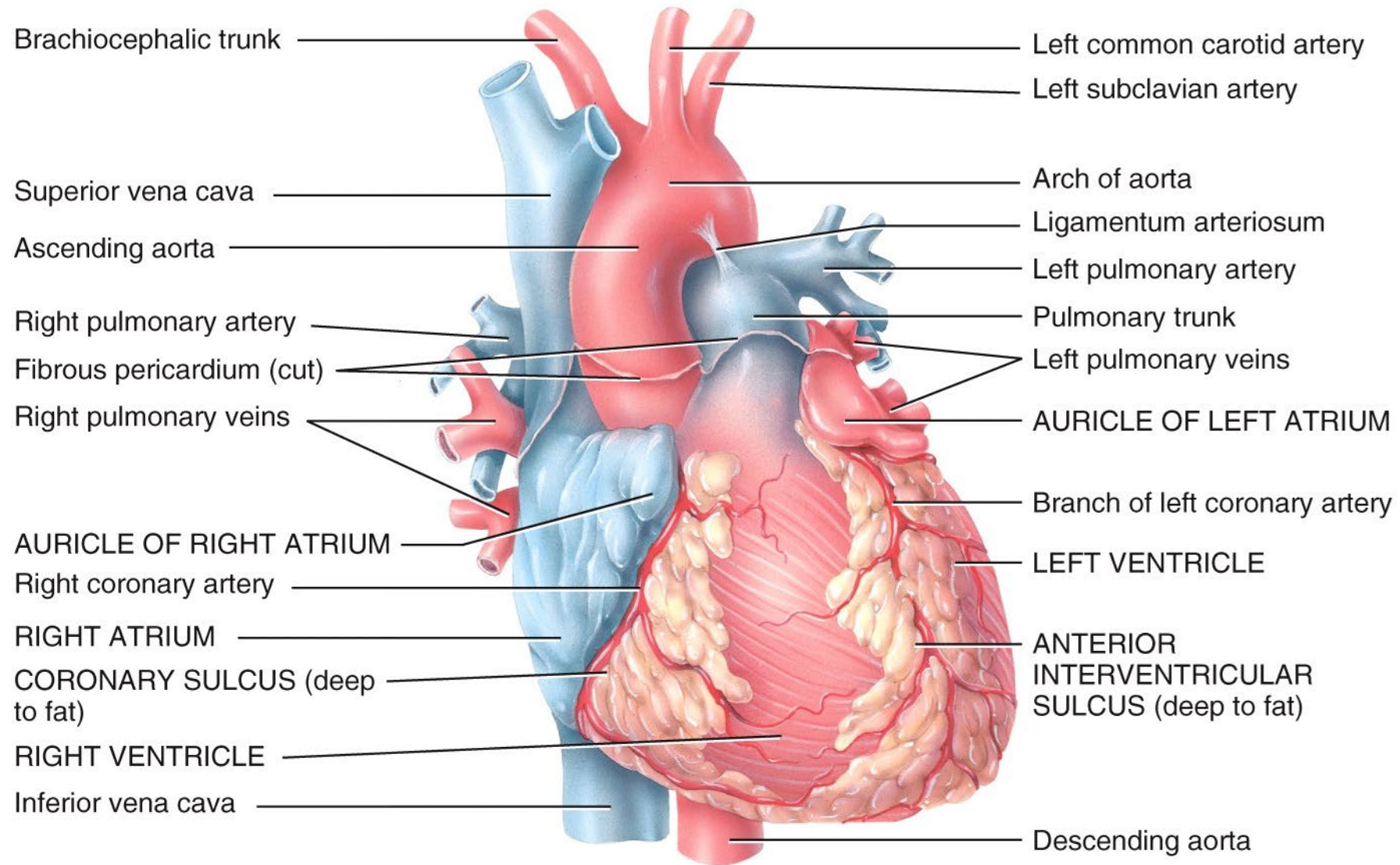


The cardiac cycle at rest is 0.8 sec. During the cycle the atria and ventricle muscles complete a single contraction and relaxation

The cardia cycle occurs in two phases. The first phase forces blood down (1). The second phase pushes blood up (2).

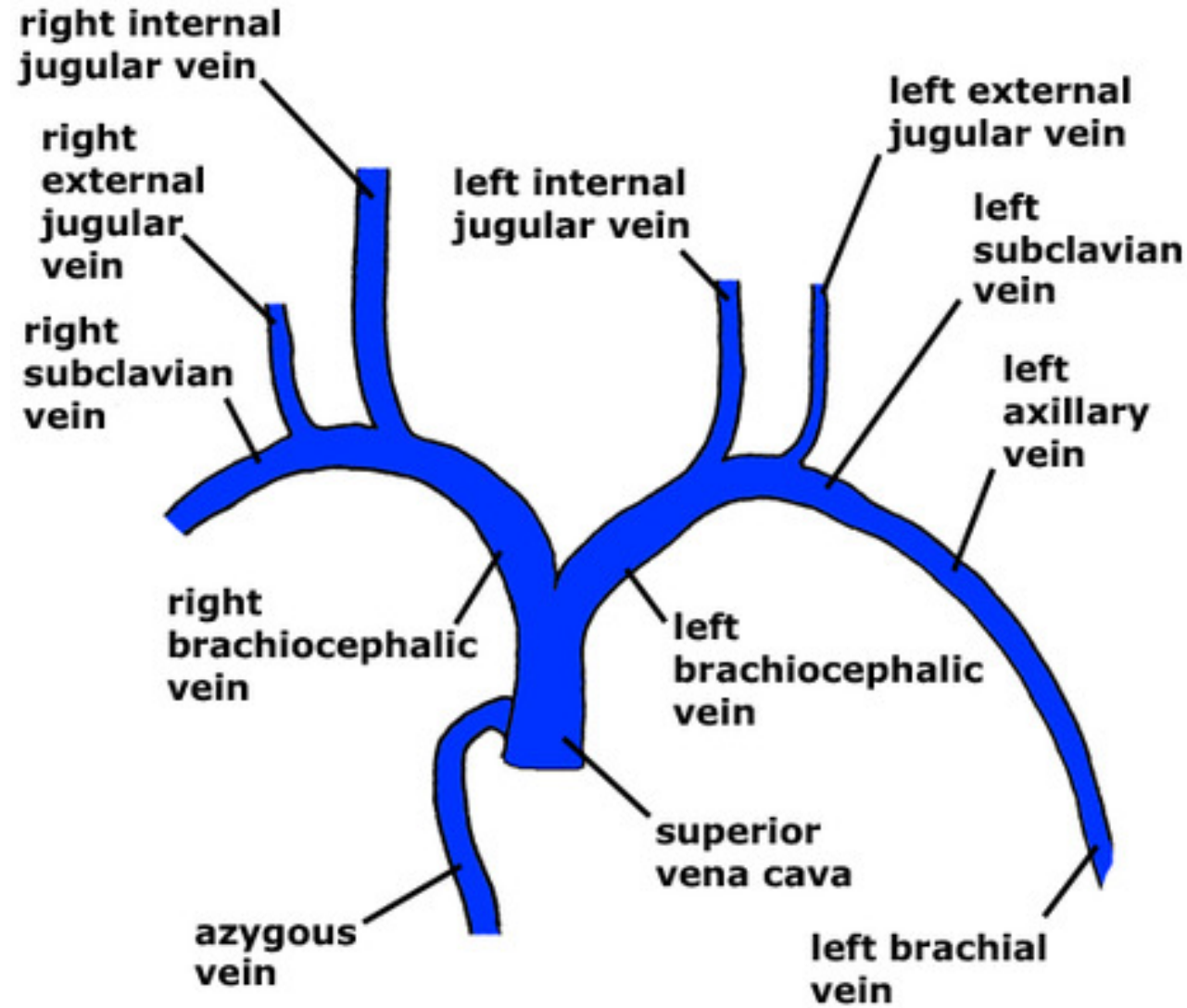
1. The first phase occurs when the right and left atria contract, forcing blood into the ventricles. While the atria contract the ventricles are relaxed.

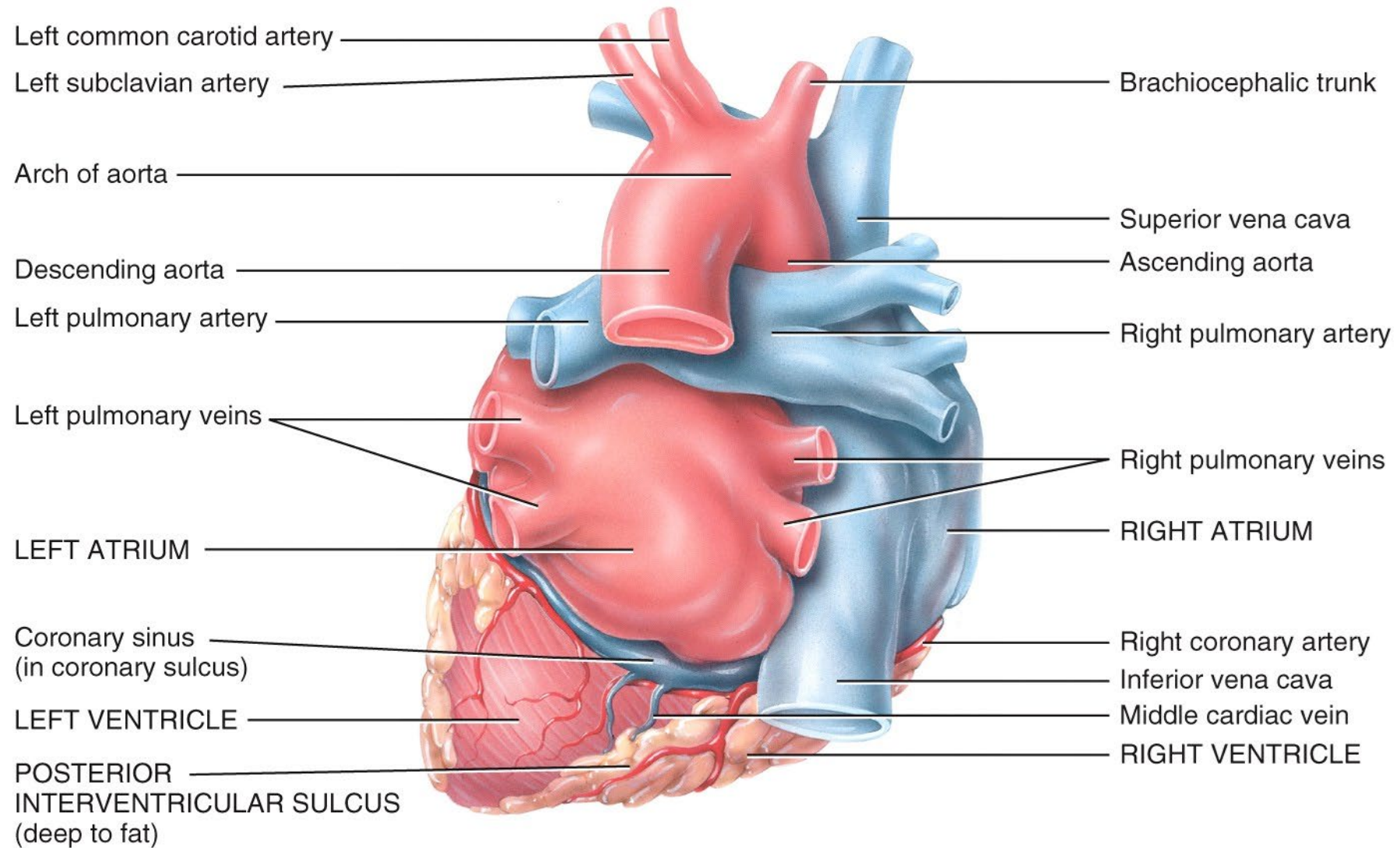
4. The second phase occurs after the atria completes its contraction. Then the ventricles contract to close the AV valves, open the semilunar vales, and efect blood from the heart. As the ventricles contract the atria relax.



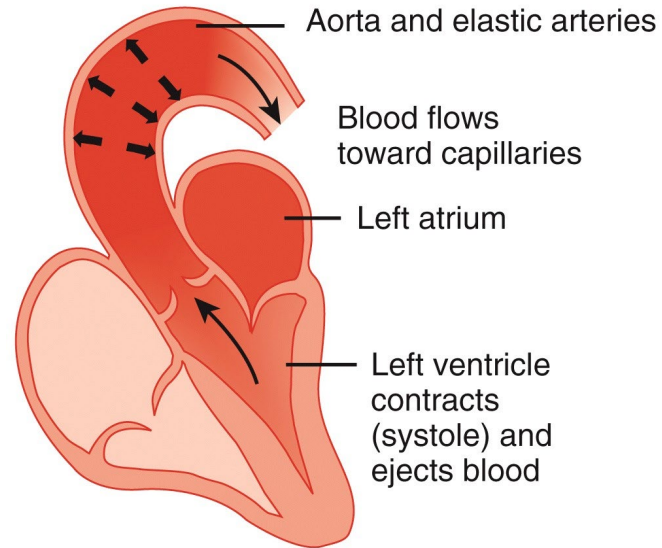
(a) Anterior external view showing surface features

Major veins superior to the heart

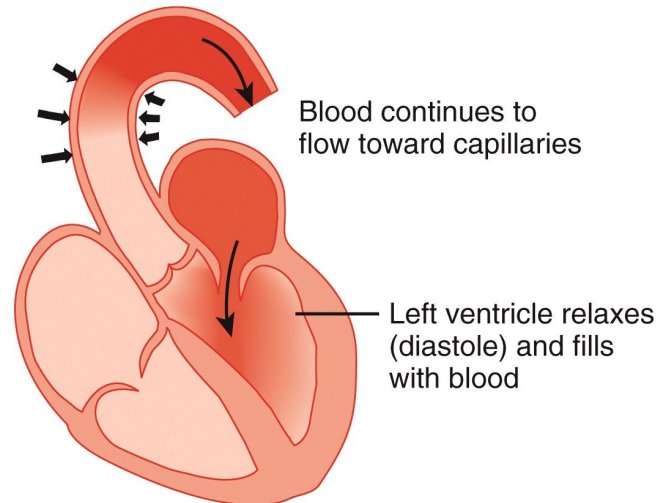




(c) Posterior external view showing surface features



(a) Elastic aorta and arteries stretch during ventricular contraction



(b) Elastic aorta and arteries recoil during ventricular relaxation

The start of ventricular diastole (relaxation) occurs when aortic recoil starts.

As blood moves into the systemic circuit, the walls of the aorta are initially stretched then elastic fibers recoil.

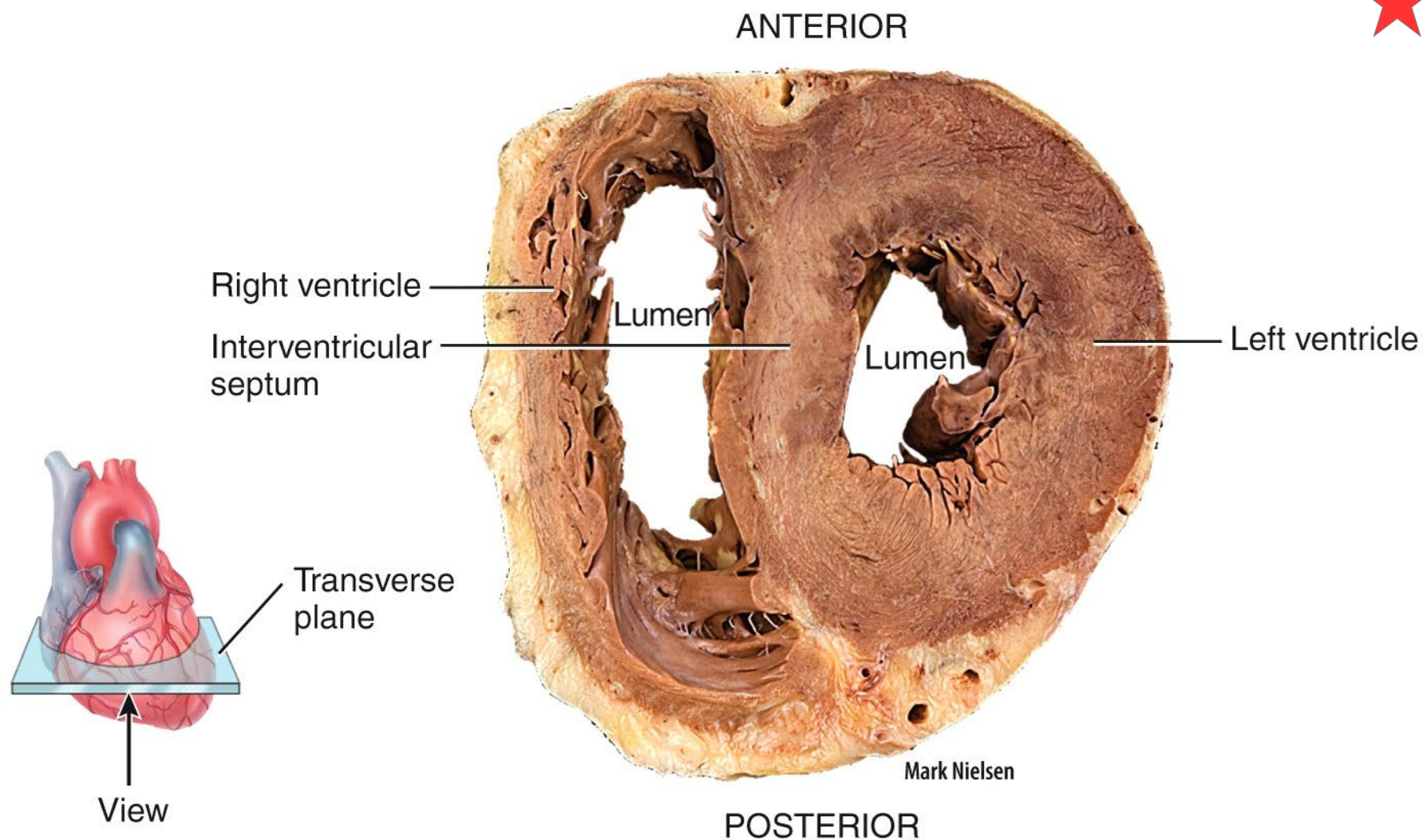
This continues to move blood into the systemic circuit and also starts to move blood back into the left ventricle. This movement of blood towards the left ventricle closes the aortic semilunar valve.

As the semilunar valve closes, now the passage way into the right and left coronary arteries are open.

The force of the recoiling aorta moves blood into the coronary circuit at the same time as the myocardium enters into a relaxed state.

Why does this make sense?

Similar events occur on right side of heart to regulate pulmonary semilunar value.



(c) Inferior view of transverse section showing differences in thickness of ventricular walls

How may you determine low from high pressure side of the heart?

Blood Flow Through Heart

- Right atria
- Right ventricle
- Pulmonary truck into
- pulmonary circulation (lungs)
- Left atria
- Left ventricle
- Aorta to systemic circulation (all tissues of body except lungs)
- (see next slide)

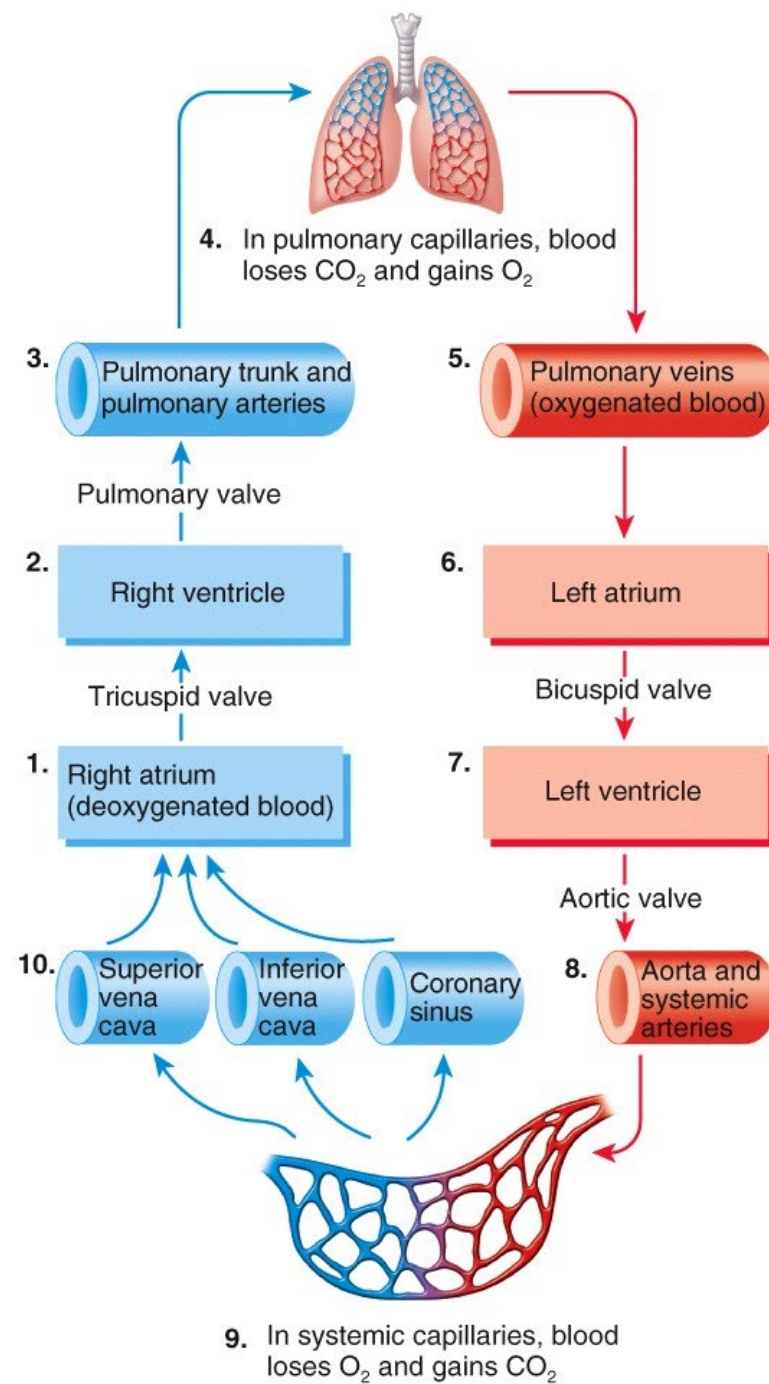
Note: blood enters the right atria via superior vena cava, inferior vena cava, coronary sinus, and thebesian veins (highest concentration in right atria and lowest concentration in left ventricle)

Note: blood flow through the heart is different than the pumping action of the heart

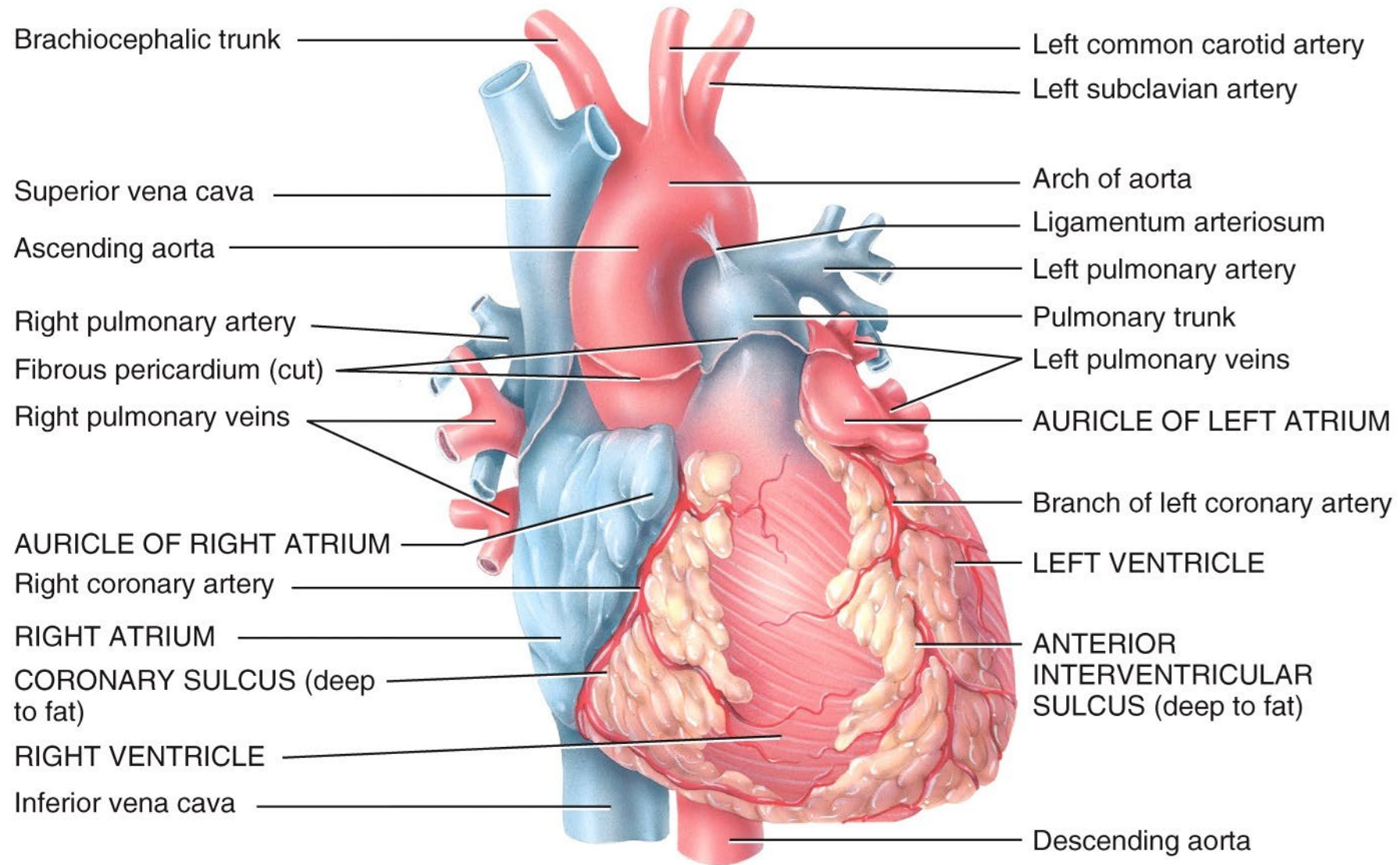
pumping action occurs as two separate pumps (right side & left side) working “in phase”

first action is to move blood downward in both pumps

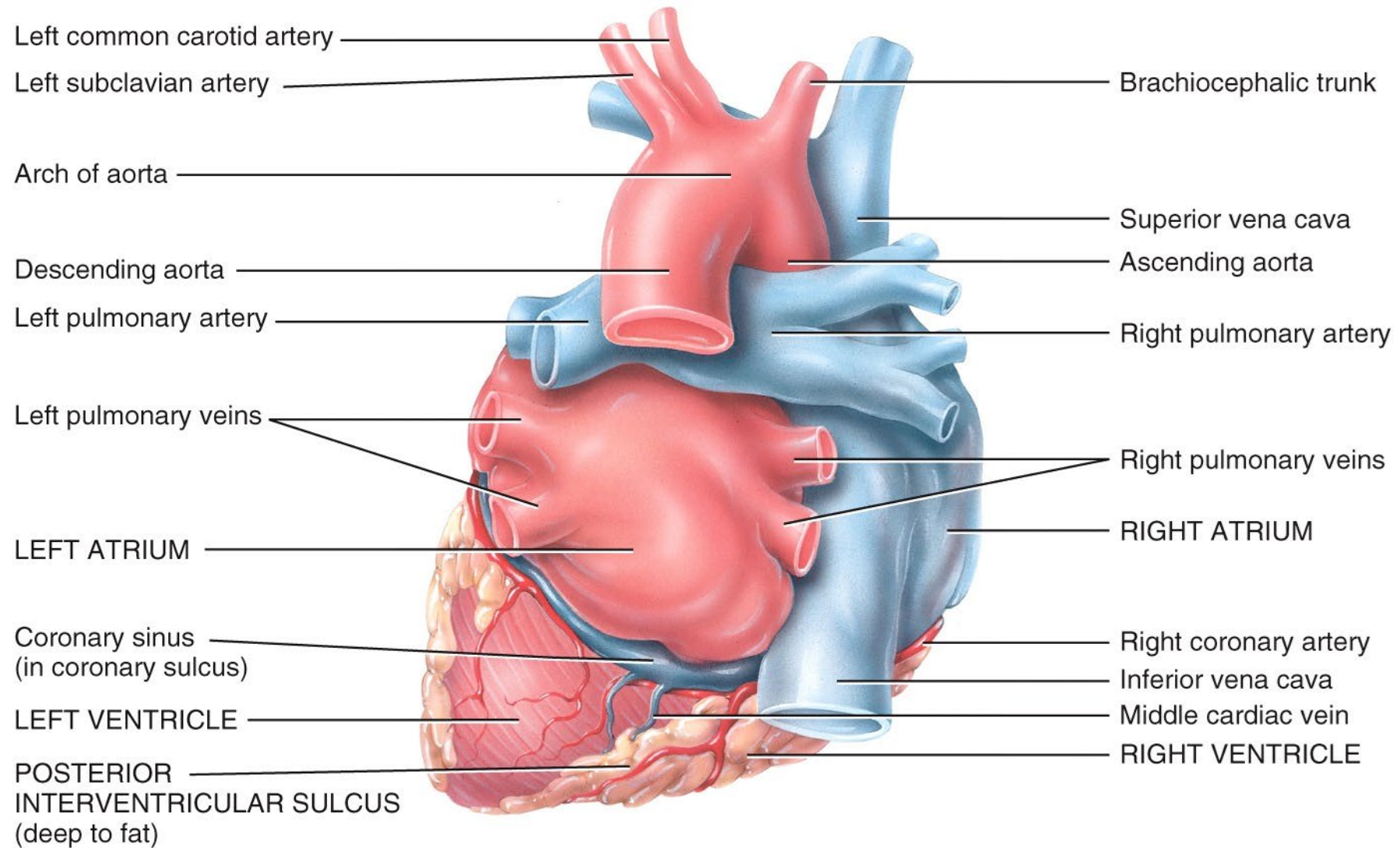
Second action is to pump blood upward



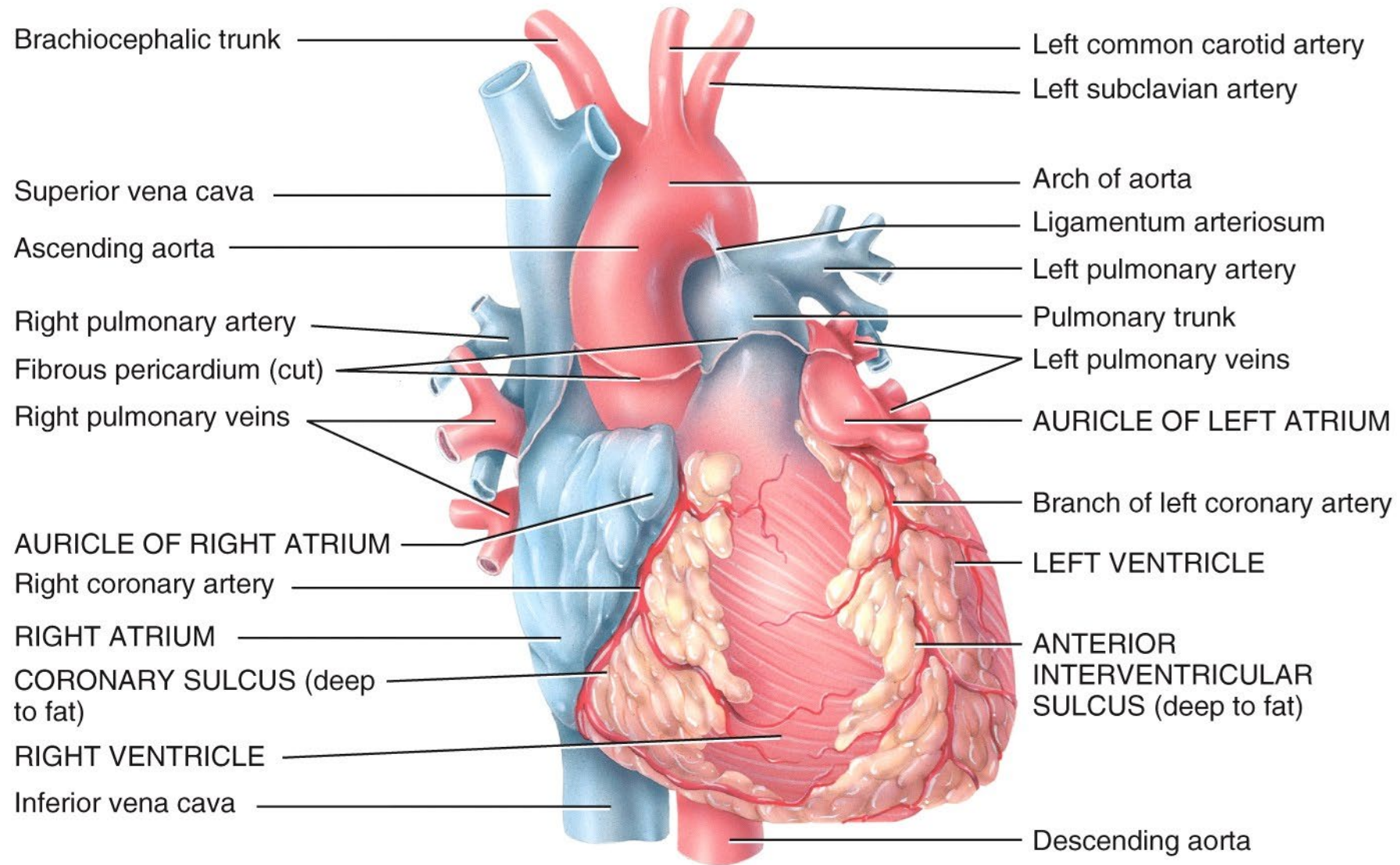
(b) Path of blood flow through systemic and pulmonary circulations



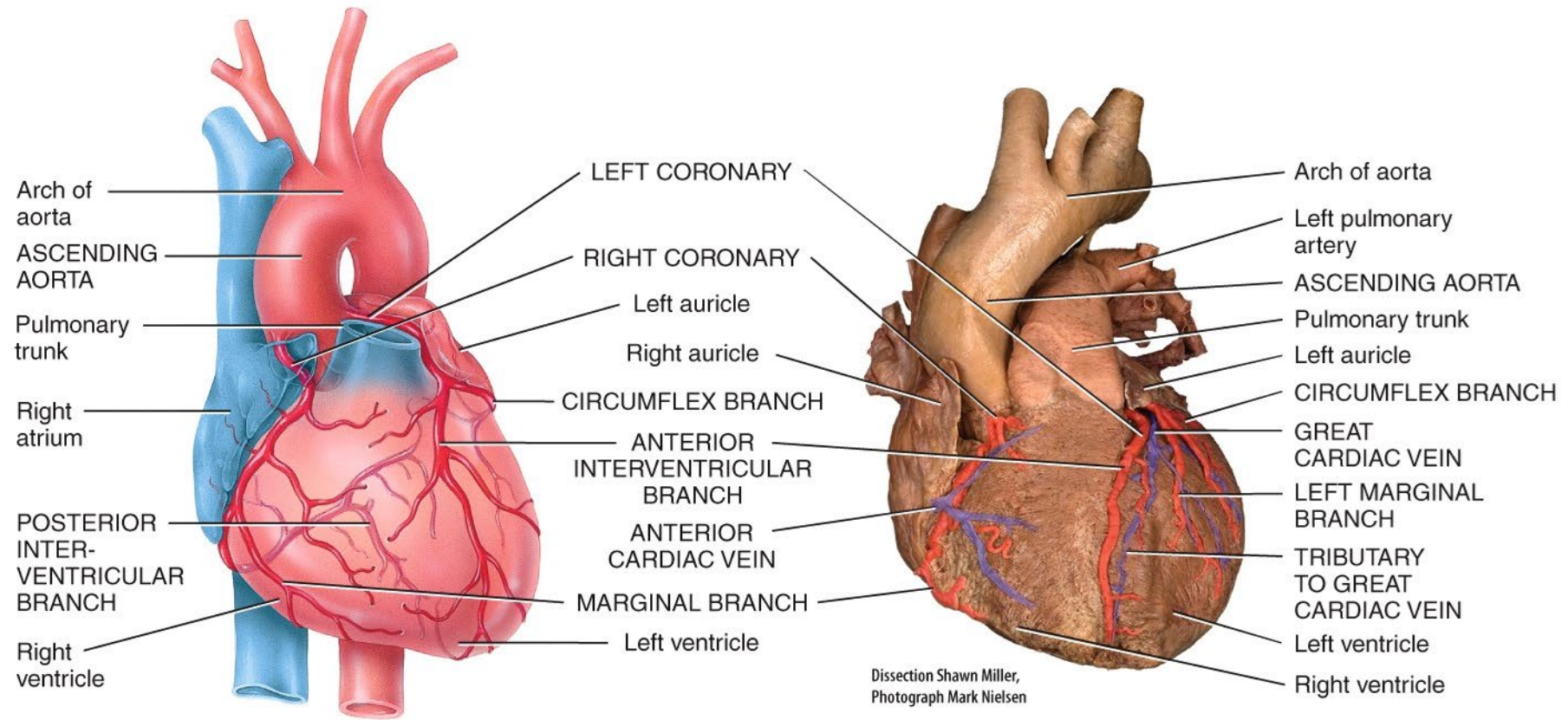
(a) Anterior external view showing surface features



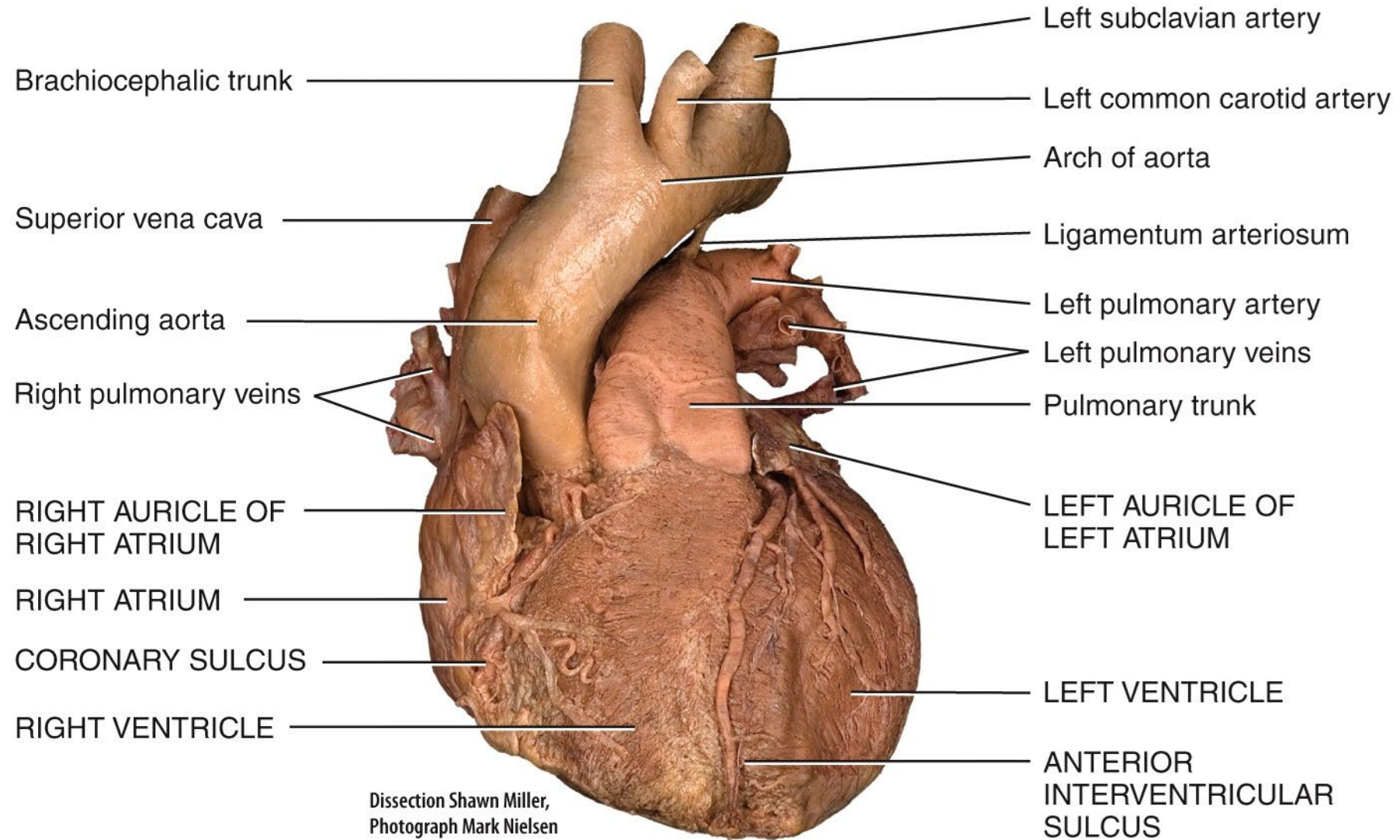
(c) Posterior external view showing surface features



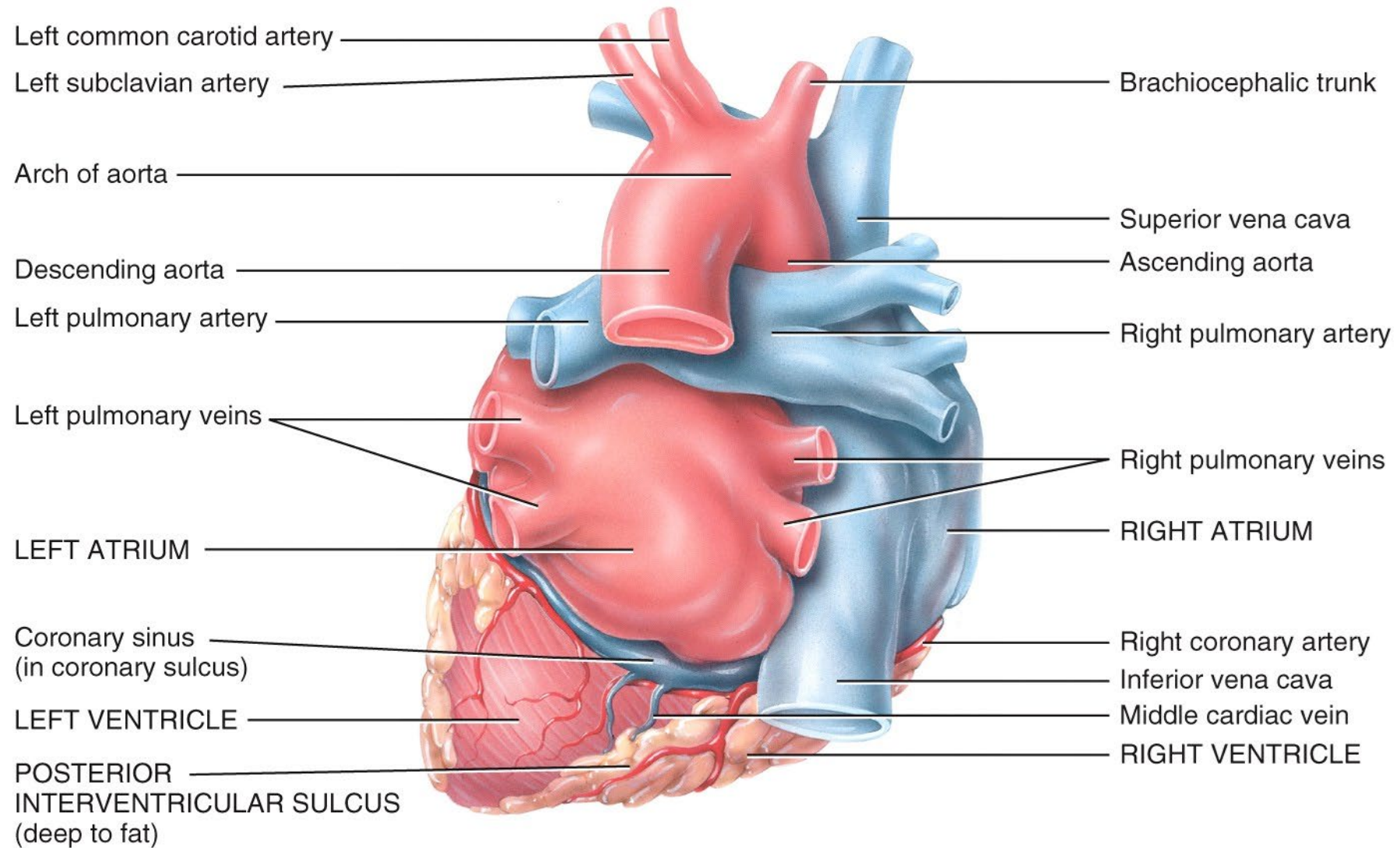
(a) Anterior external view showing surface features



Anterior view of coronary arteries and their major branches



(b) Anterior external view



(c) Posterior external view showing surface features

Heart Chambers – Internal Structures

- interatrial septum

- wall that separates atria

- pectinate muscles

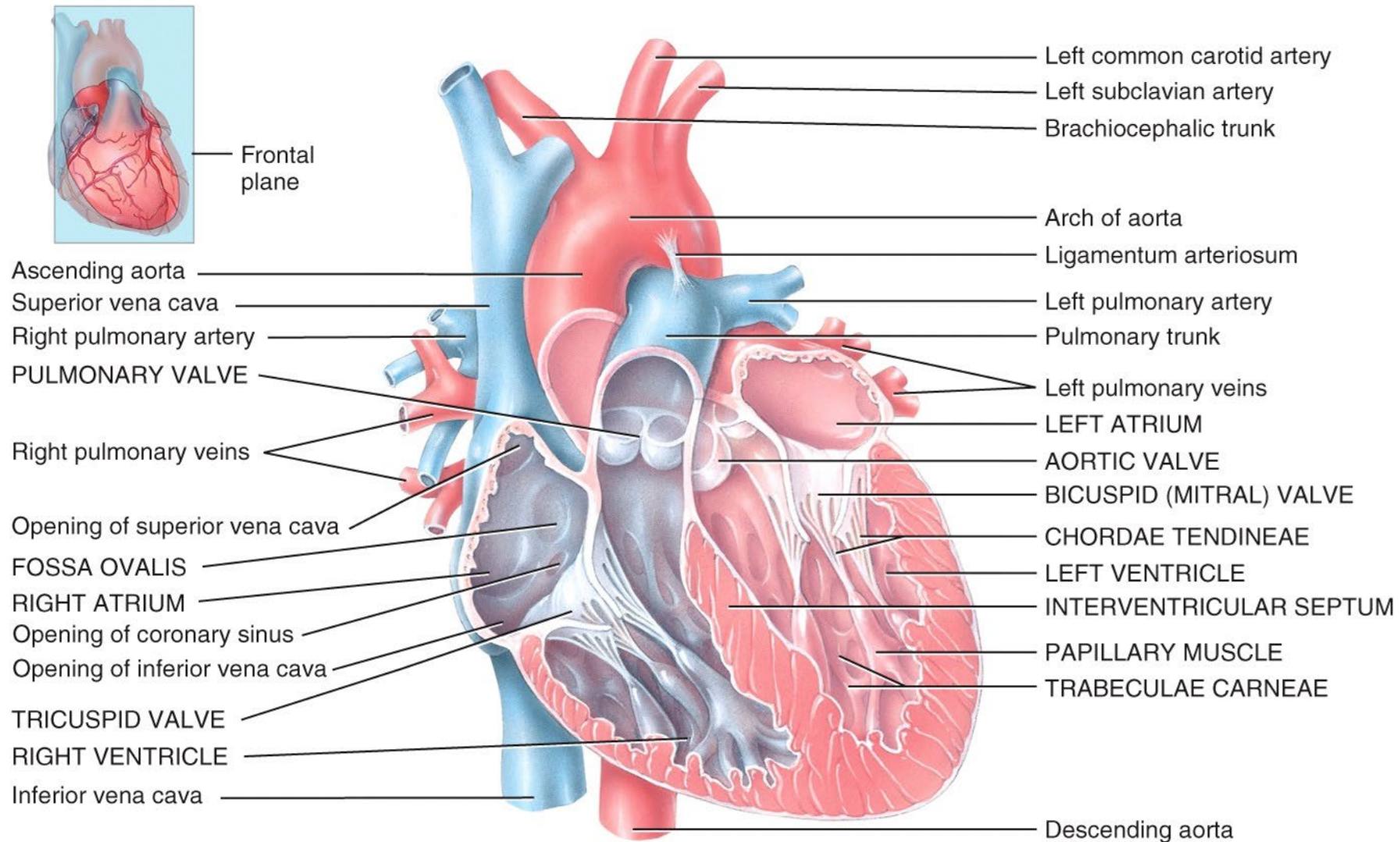
- internal ridges of myocardium in right atrium
and both auricles

- interventricular septum

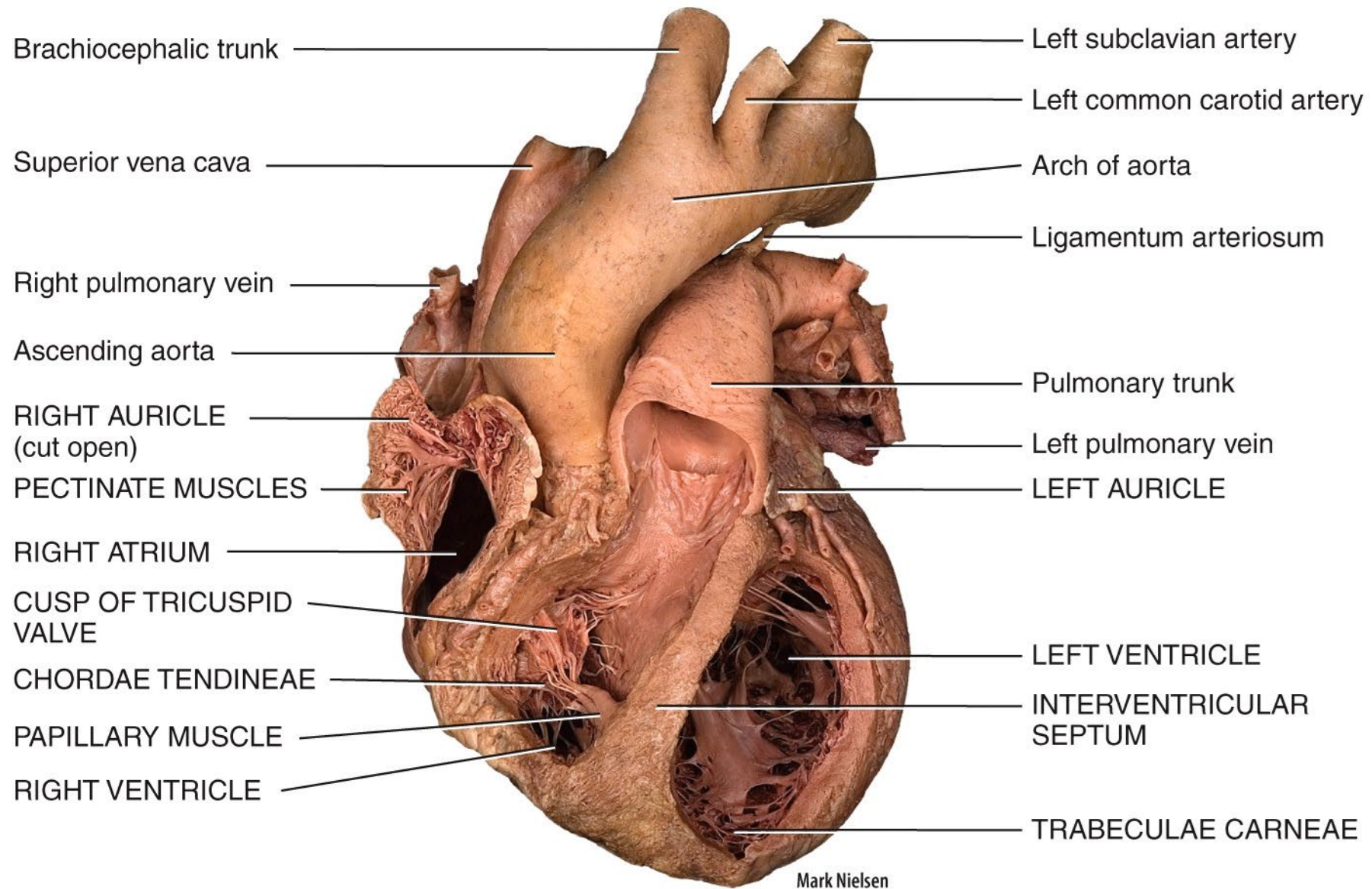
- muscular wall that separates ventricles

- trabeculae carneae

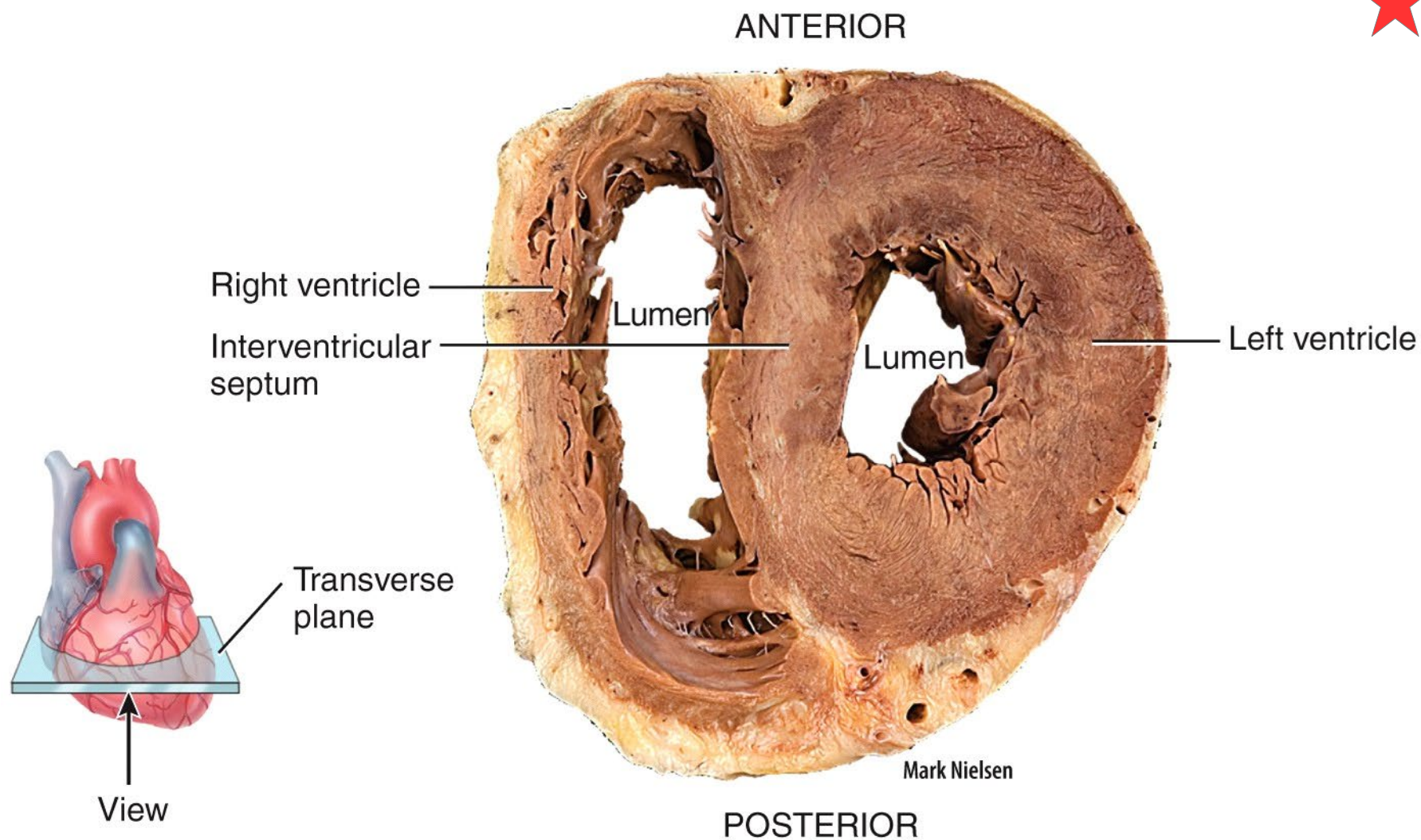
- internal ridges in both ventricles



(a) Anterior view of frontal section showing internal anatomy



(b) Anterior view of partially sectioned heart

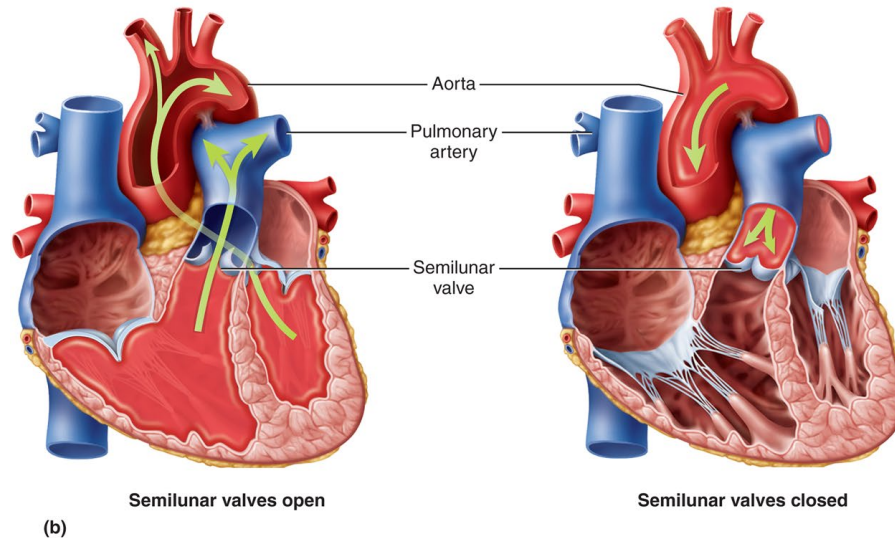
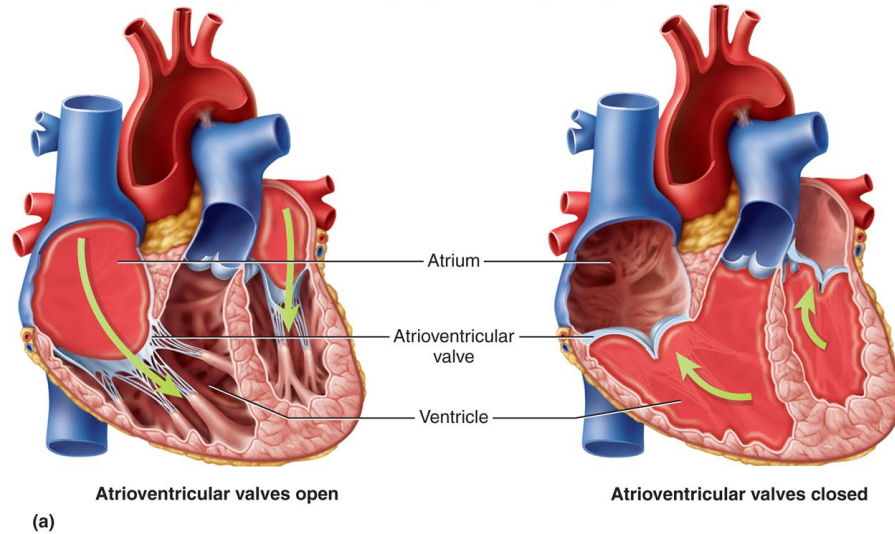


(c) Inferior view of transverse section showing differences in thickness of ventricular walls

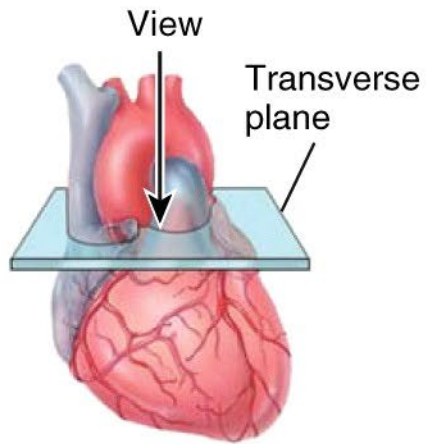
Function of Heart Valves



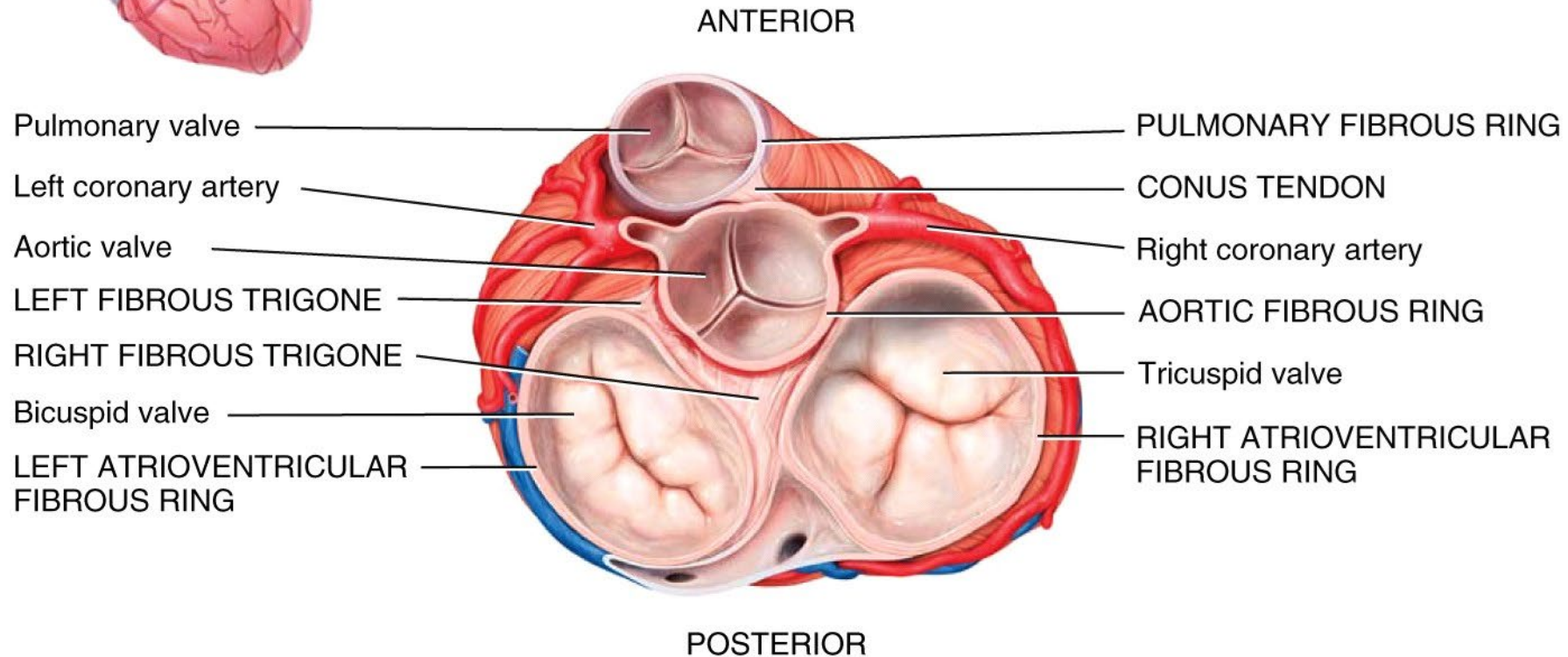
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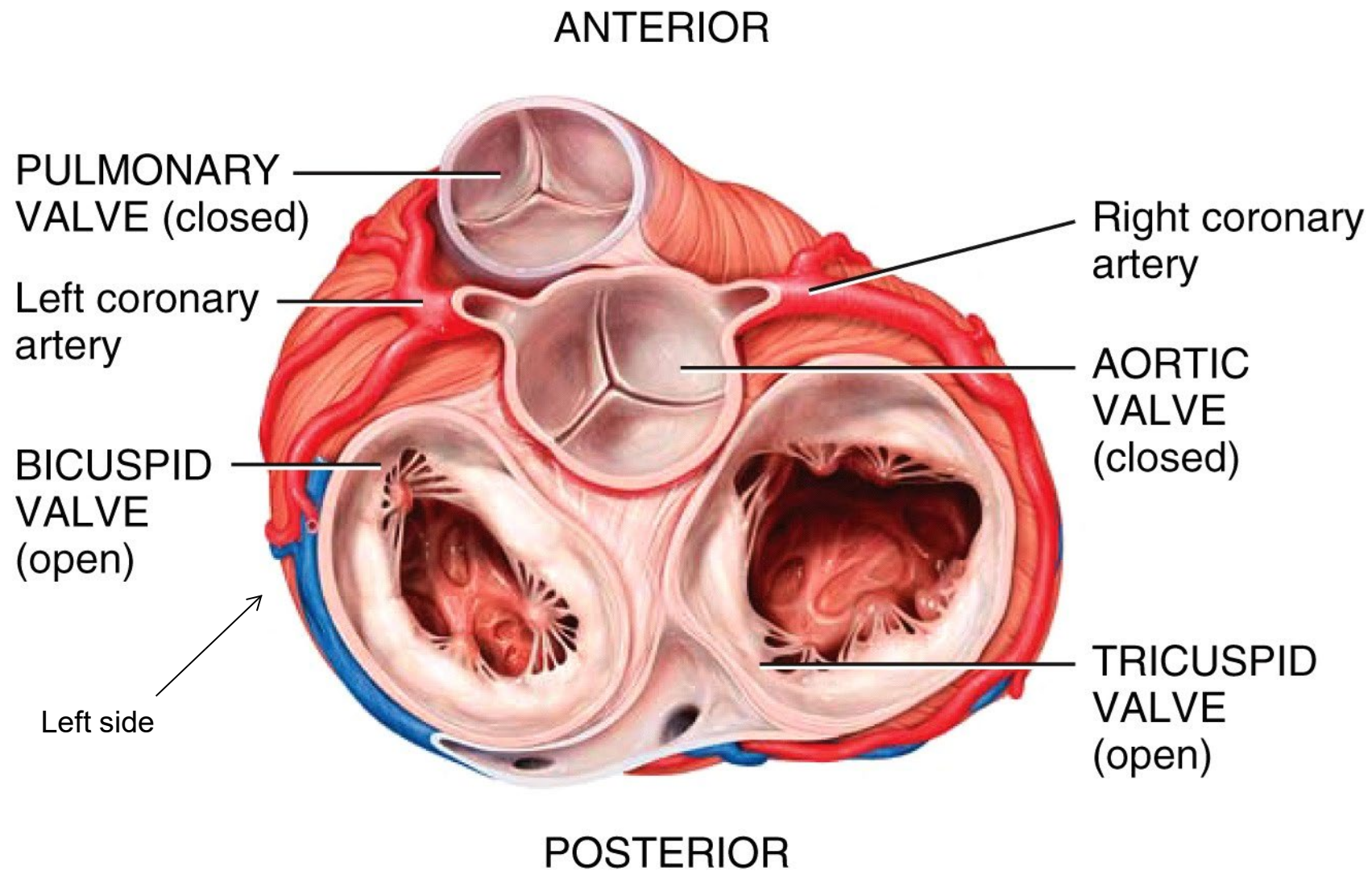
- Valves ensure a one-way flow of blood through the heart
- Blood flows from an area of high pressure to an area of low pressure
- The pressure difference across the valve open and close these valves



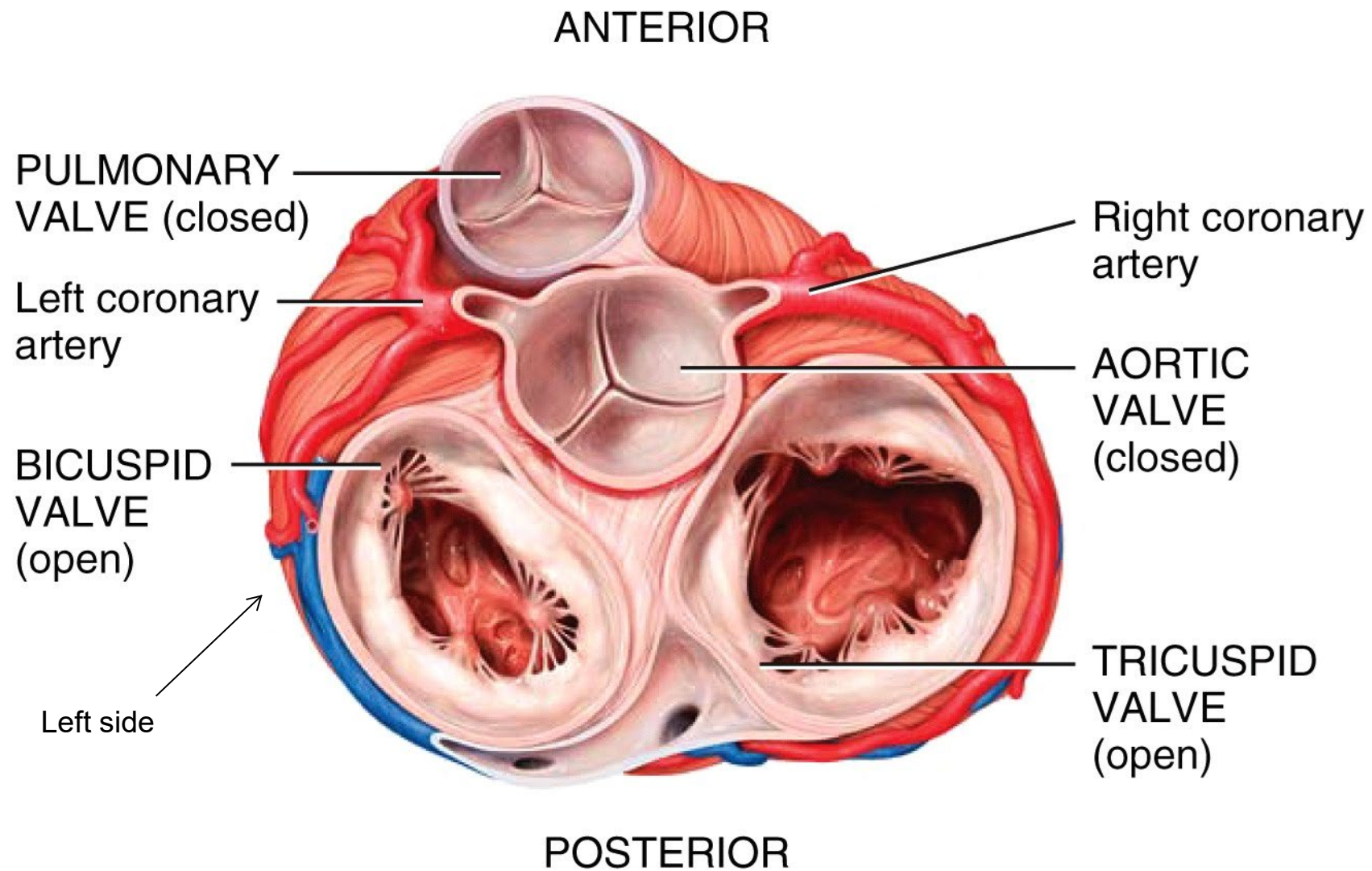
Note: all valves are “built” into the atrioventricular septum / it is a strong connective tissue transverse plane / this also prevents action potentials from moving into ventricles via gap junctions



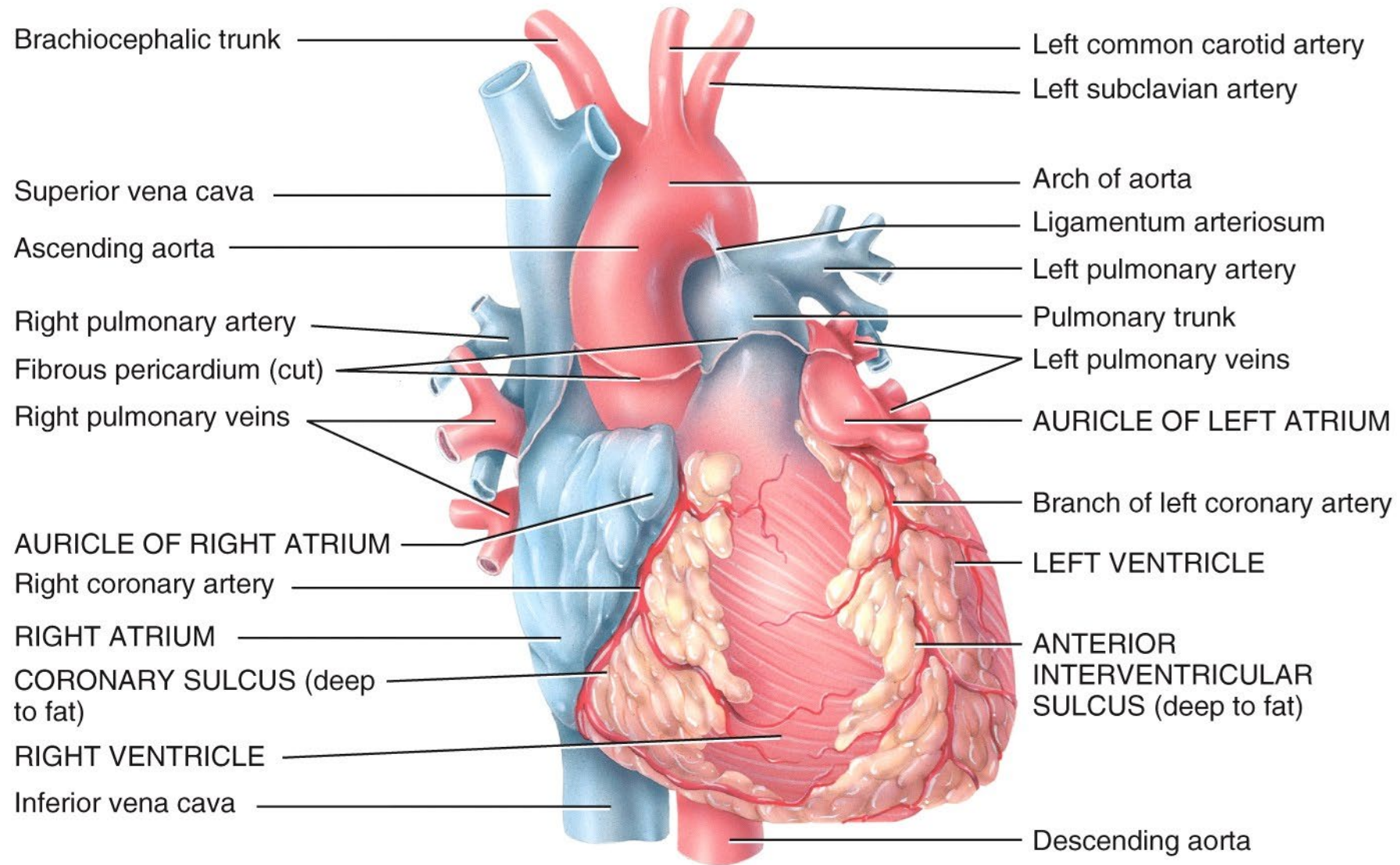
Superior view (the atria have been removed)



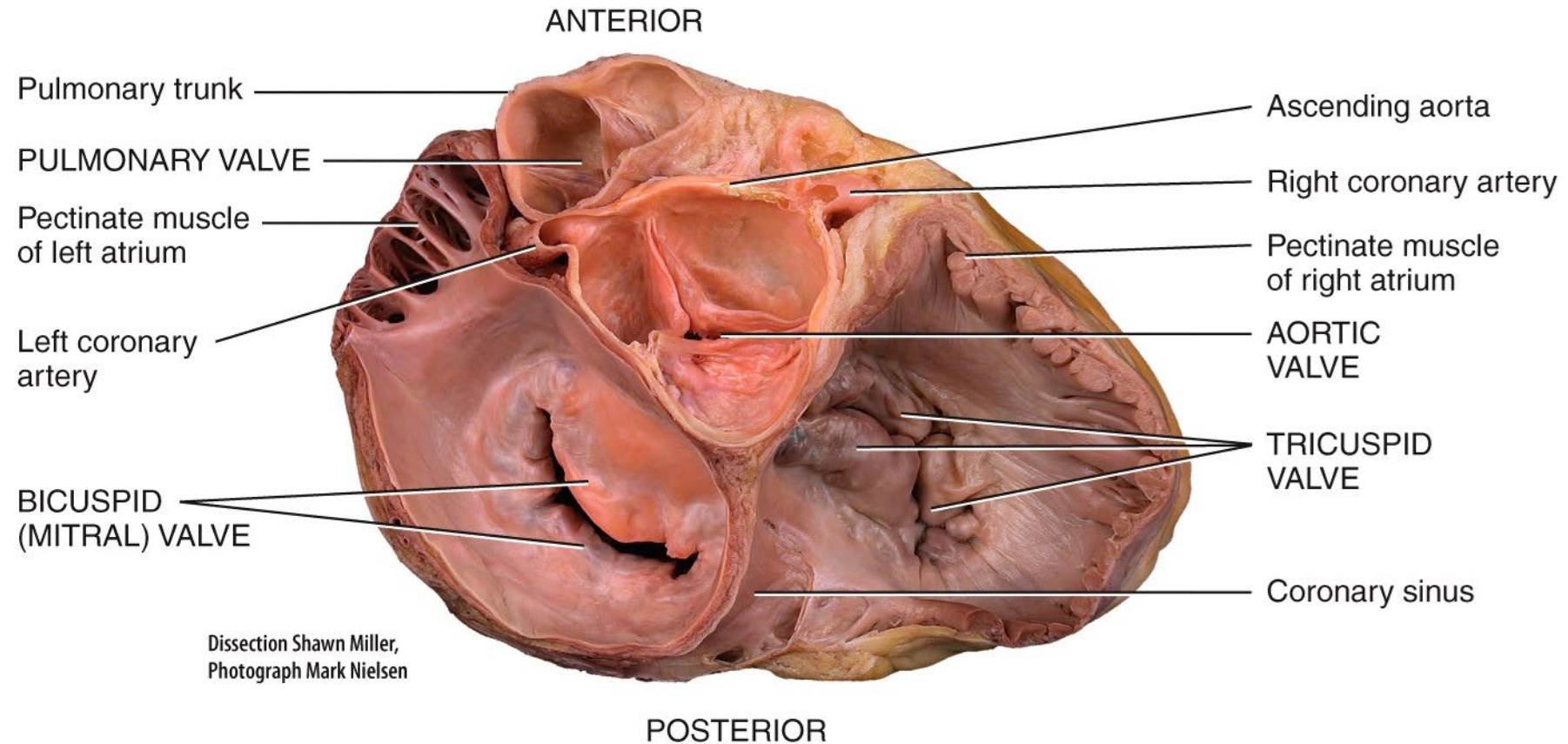
(d) Superior view with atria removed: pulmonary and aortic valves closed, bicuspid and tricuspid valves open



(d) Superior view with atria removed: pulmonary and aortic valves closed, bicuspid and tricuspid valves open

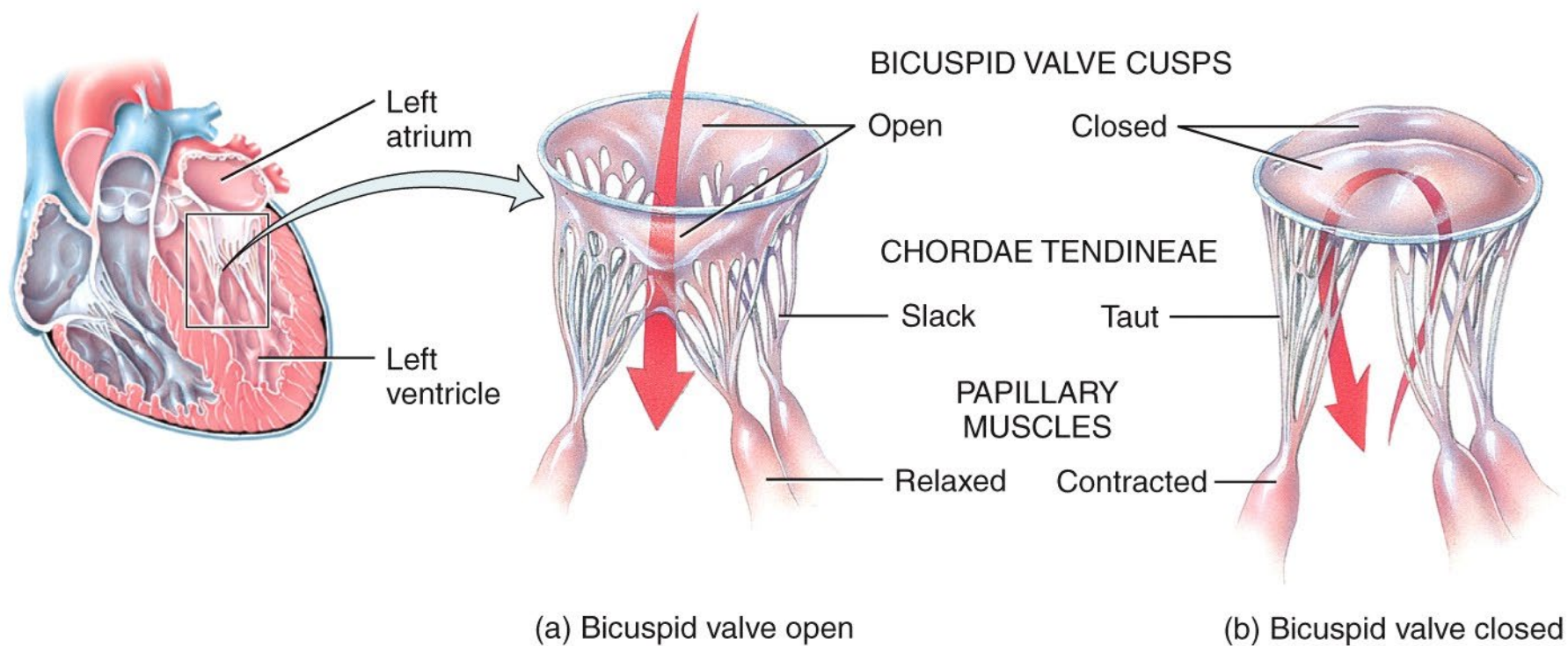


(a) Anterior external view showing surface features



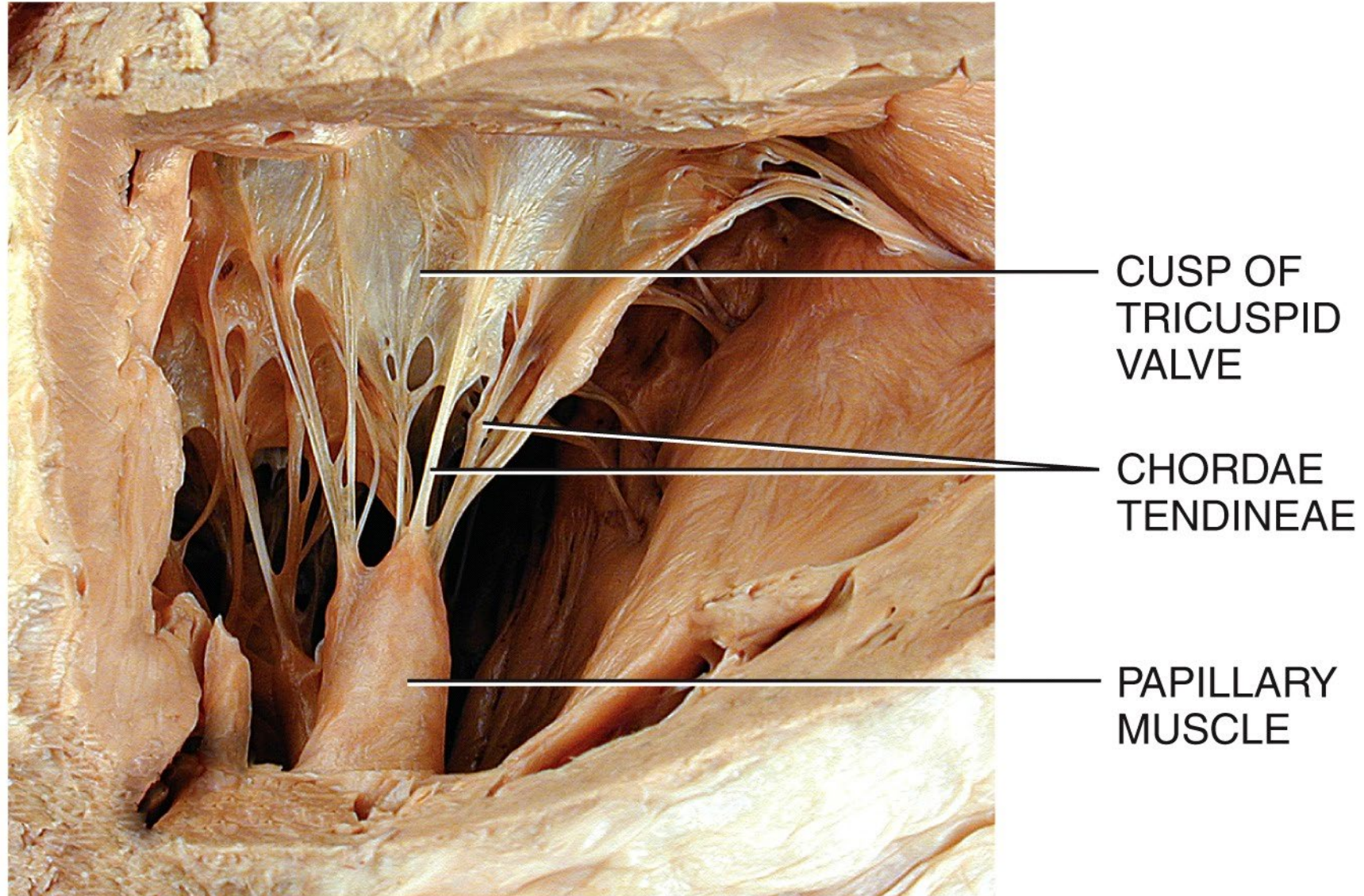
(f) Superior view of atrioventricular and semilunar valves

Note: All four valves are on same plane // the atrialventricular septum – connective tissue – no gap junctions unite atrial and ventricular myocariocytes!



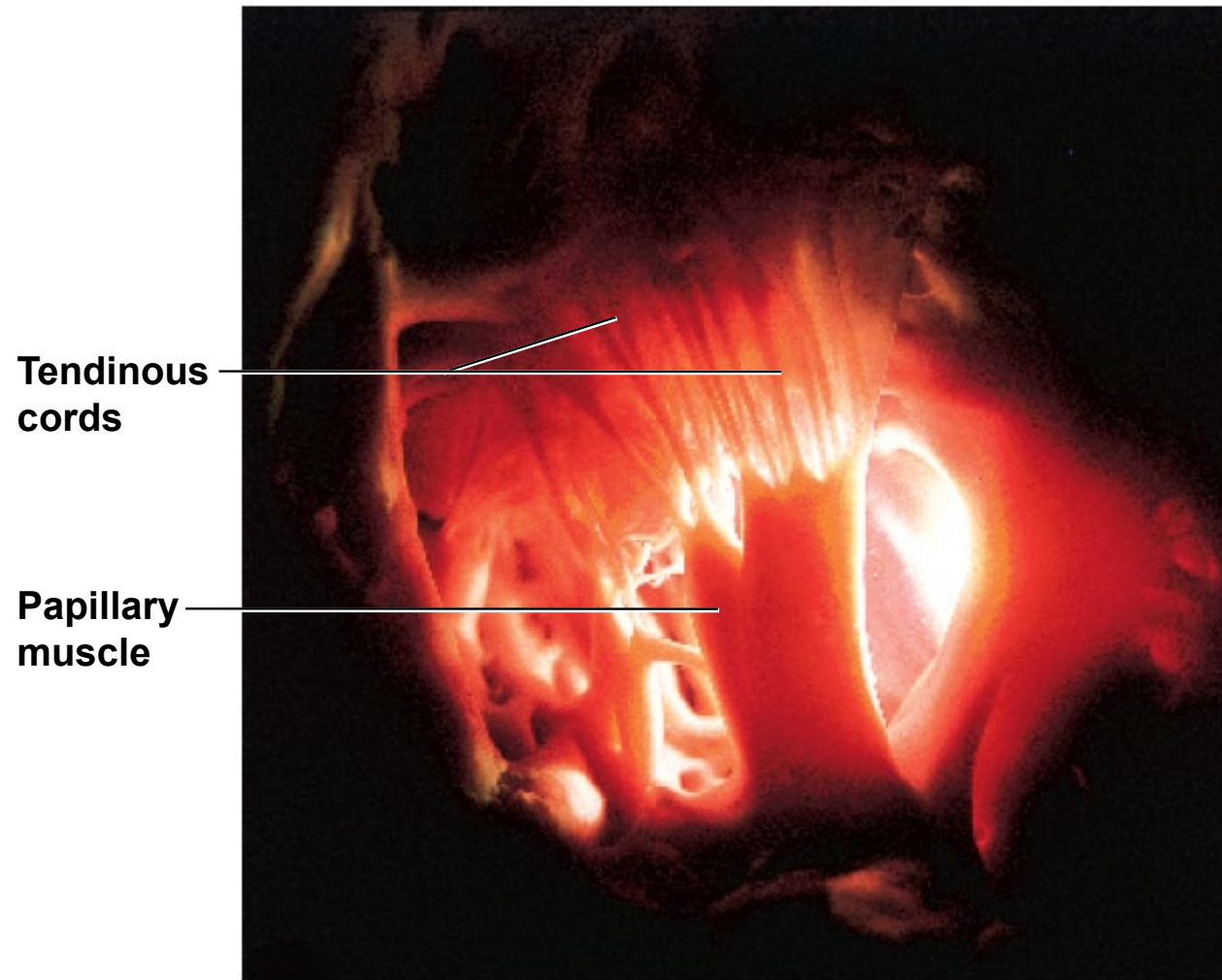
- > What is the function of the papillary muscles?
- > What do papillary muscles prevent ?

Dissection Shawn Miller, Photograph Mark Nielsen



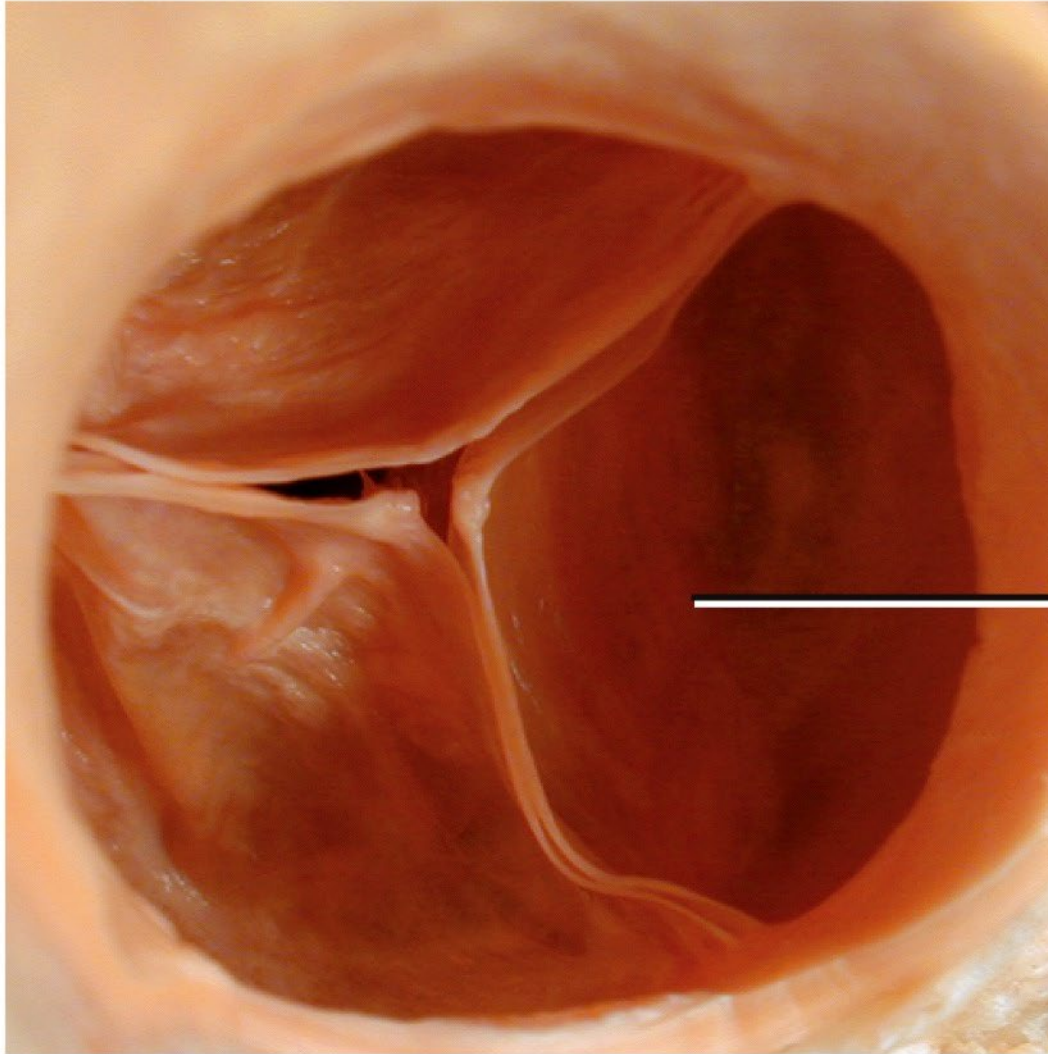
(c) Tricuspid valve open

AV Valves



Endoscopic View of Semi Lunar Heart Valve





Semilunar
cusp of aortic
valve

**No papillary
muscles or
cordae tendinae**

(g) Superior view of aortic valve

Heart Valve Functions / Atrioventricular

- controls blood flow between atria and ventricles
- Valves open and close due to blood pressure between chambers guarded by valves
- right AV valve has 3 cusps (**tricuspid valve**)
- left AV valve has 2 cusps (**mitral or bicuspid valve**)
- chordae tendineae – connective tissue fibers that connect AV valves to papillary muscles on floor of ventricles
- papillary muscles prevent AV valves from flipping inside out or bulging into the atria when the ventricles contract

AV Valve Mechanics

- When ventricles relax

- pressure drops inside the ventricles
- semilunar valves close as blood attempts to back up into the ventricles from the vessels
- AV valves open
- blood flows from atria to ventricles

- When ventricles contract

- AV valves close as blood attempts to back up into the atria
- pressure rises inside of the ventricles
- semilunar valves open and blood flows into great vessels

Heart Valve Function / Semilunar

- control flow into pulmonary trunk and aorta // the great arteries of the heart
- these valves open and close because of blood pressure (causes blood to flow)
- pulmonary semilunar valve // between right ventricle and pulmonary trunk
- aortic semilunar valve // between left ventricle and aorta
- semilunar valves do not have chordae tenineae
- cusps of valves close as ventricles relax and blood starts to flow back towards ventricles // back flow of blood fill cusps which cause them to close
- valves closed when afterload greater than ventricle pressure // valves open when pressure in ventricle is greater than pressure above valves.