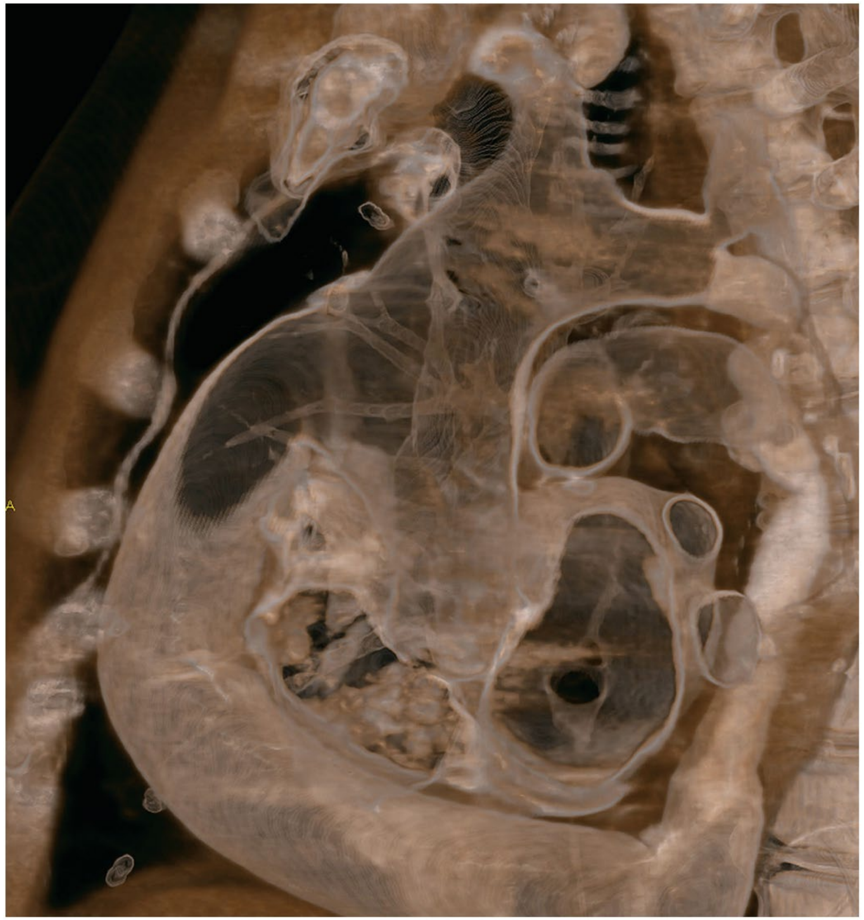
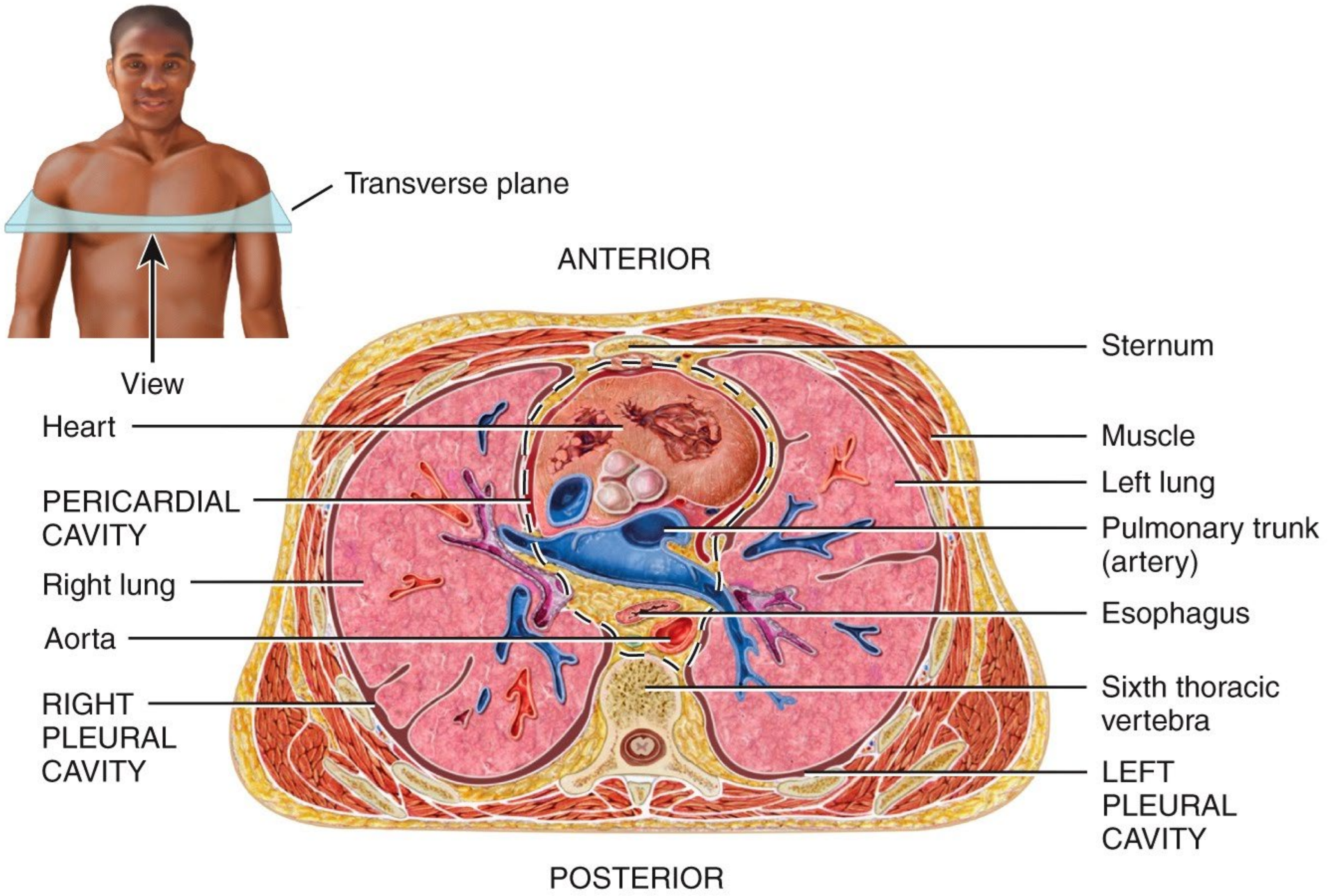
Chapter 19.1

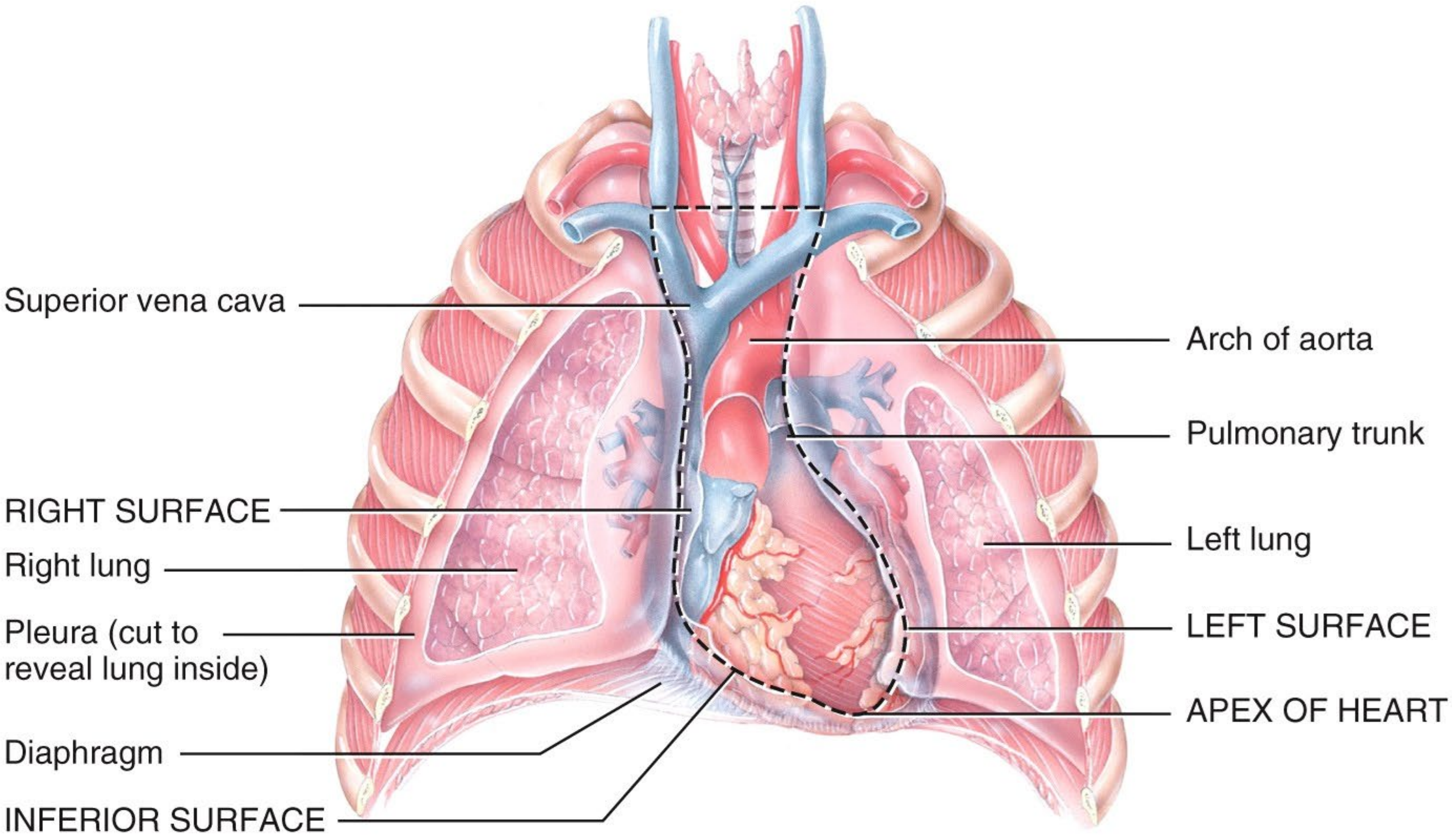
Heart Structure





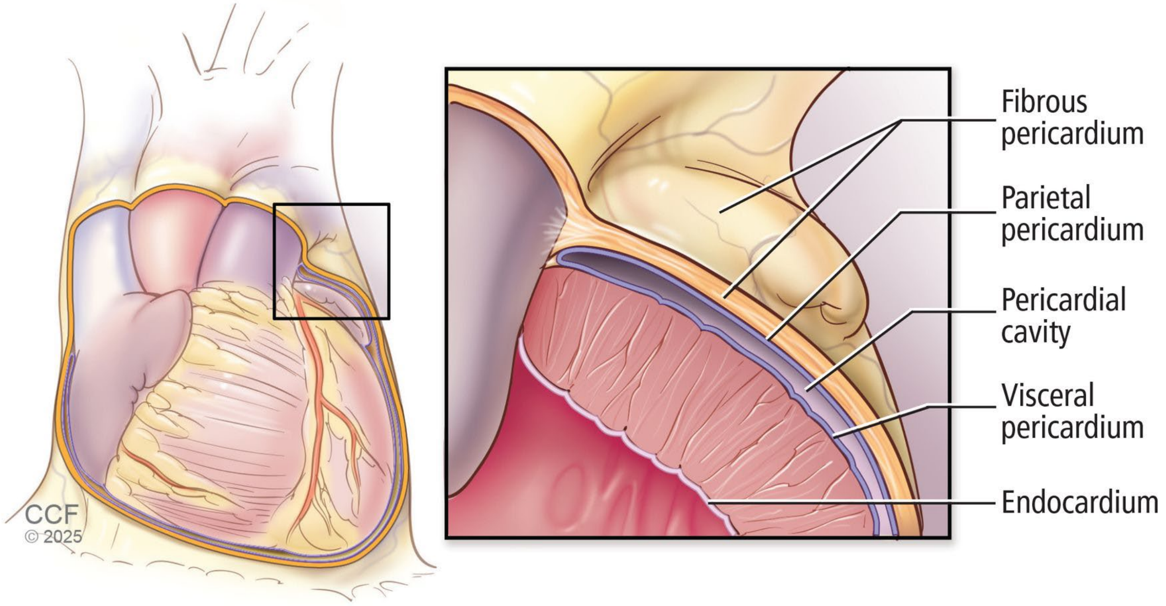
(a) Inferior view of transverse section of thoracic cavity showing the heart in the mediastinum

The Heart is Located in the Mediastinum



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

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 workload
– muscle spirals around heart which produces wringing motion

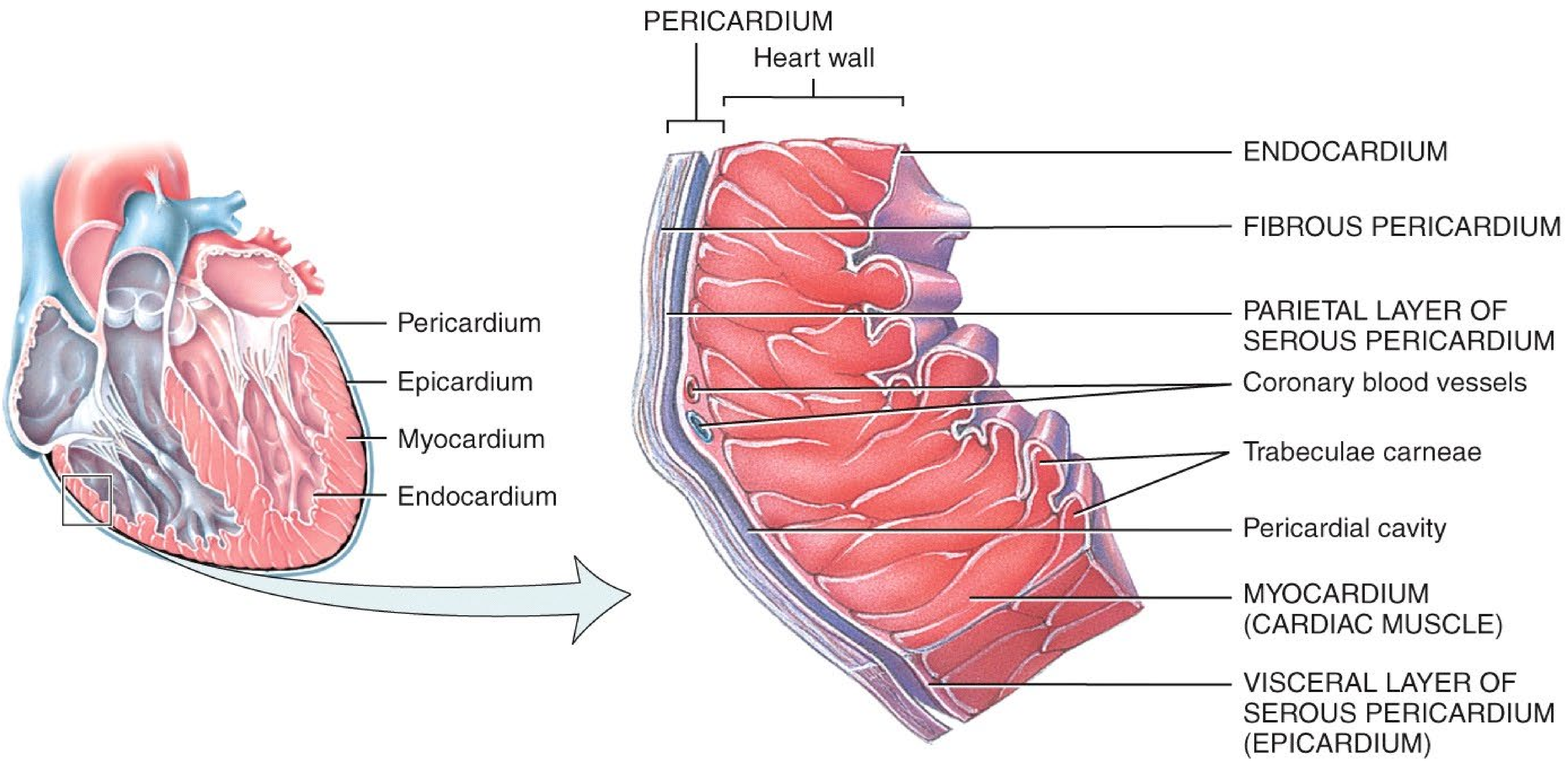
Heart Wall

Endocardium

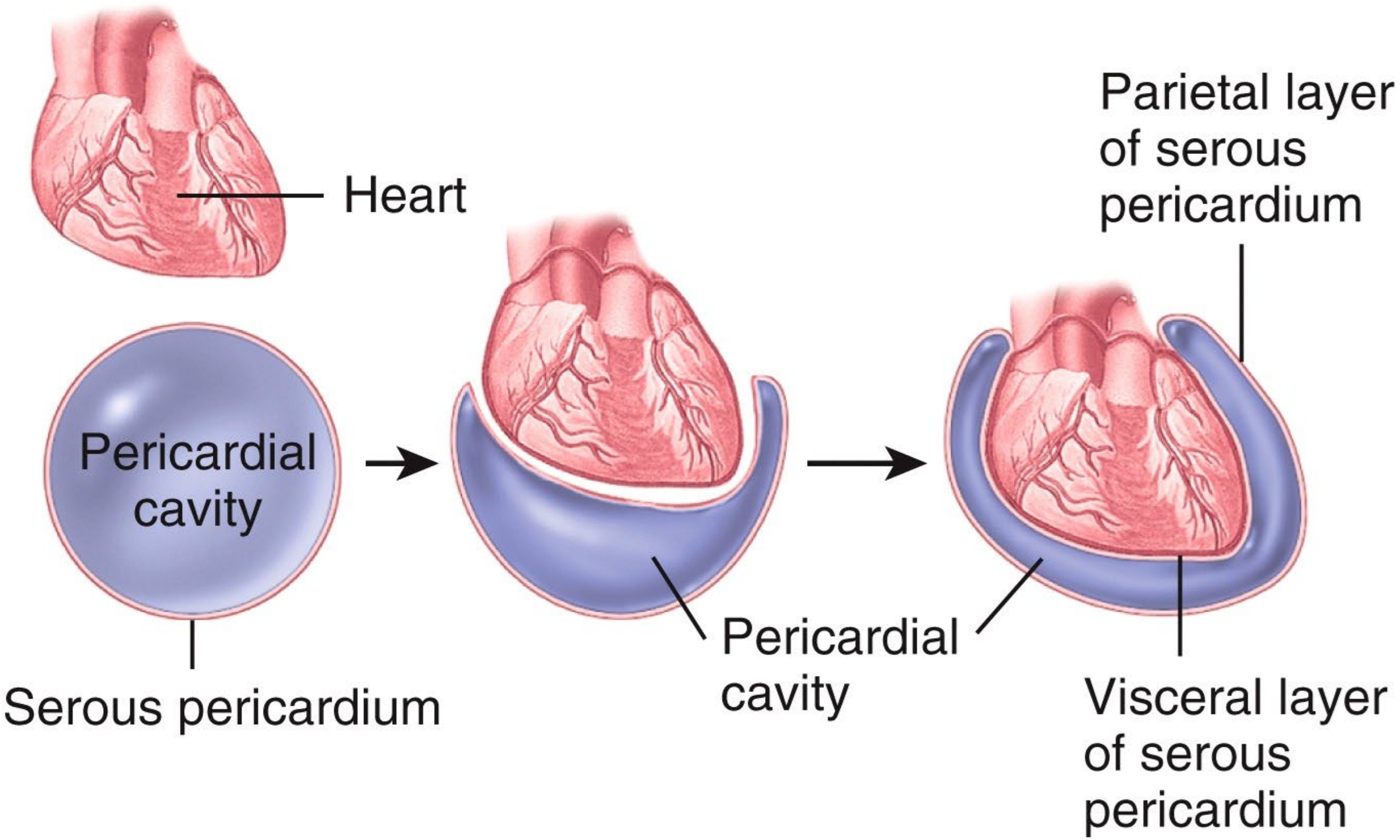
– smooth inner lining of heart and blood vessels
– covers the valve surfaces and continuous with endothelium of blood vessels
– simple squamous epithelial cells

Fibrous skeleton of the heart // connective tissue

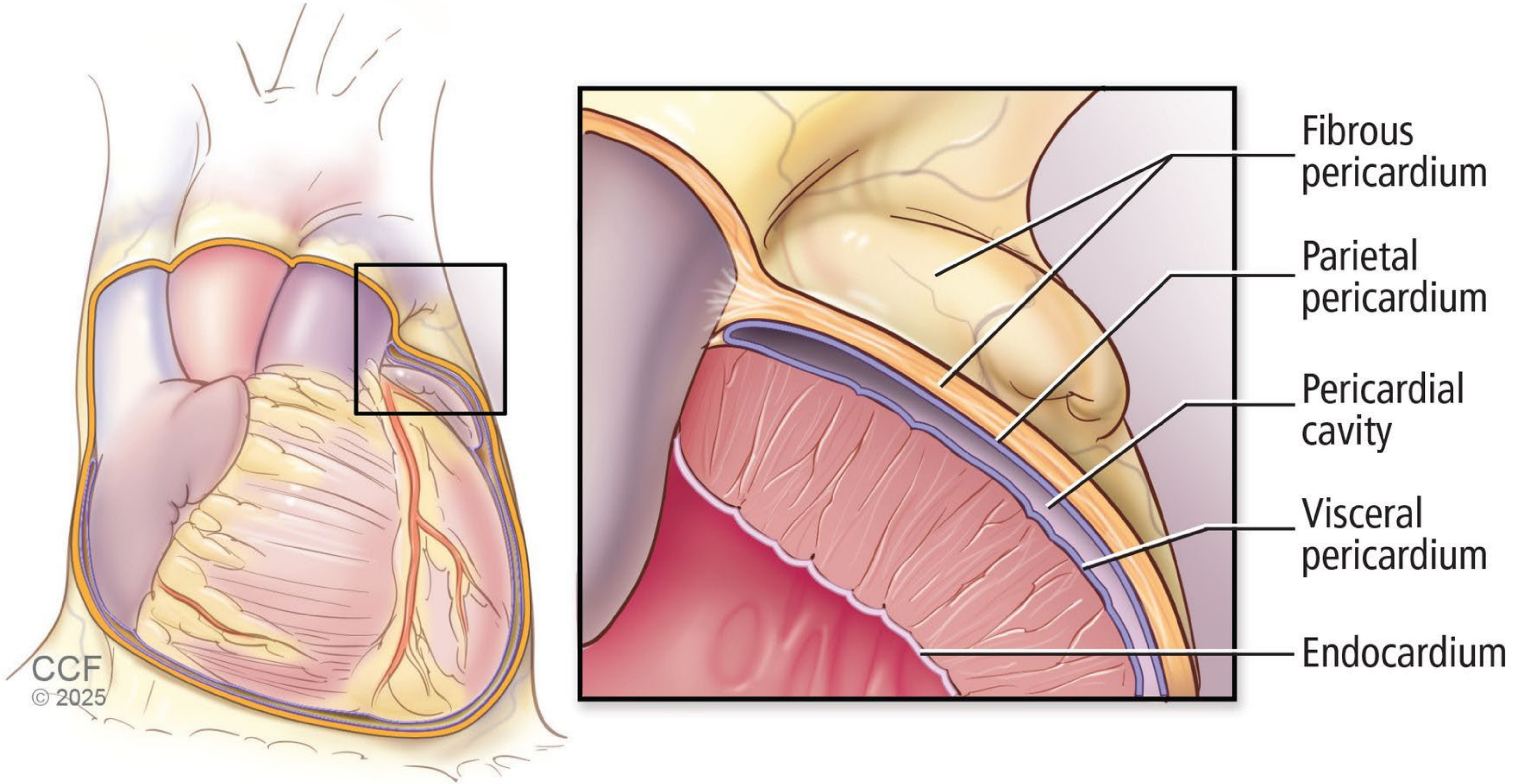
- framework of collagen and elastic fibers
- provides structural support and attachment for cardiac muscle
- firm support for valve tissue
- electrical insulation between atria and ventricles
- important in timing and coordination of contractile activity



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



(b) Simplified relationship of serous pericardium to heart


Fibrous pericardium
Parietal pericardium
Pericardial cavity
Visceral pericardium
Endocardium
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Pericardium

Pericardium

Double-walled sac (pericardial sac) that encloses the heart

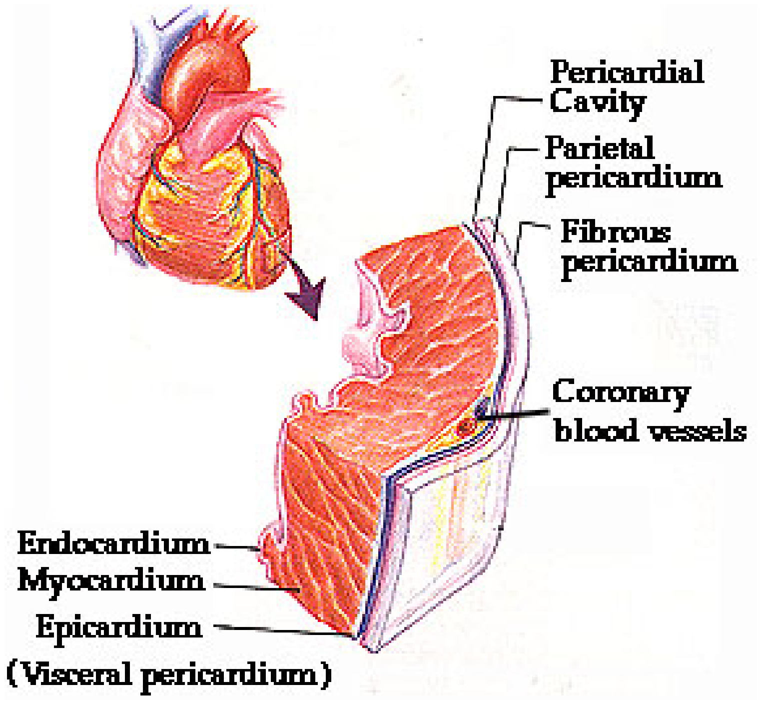
As heart enters pericardial sac a parietal and visceral pericardial surfaces are formed. // these are serous layers

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



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

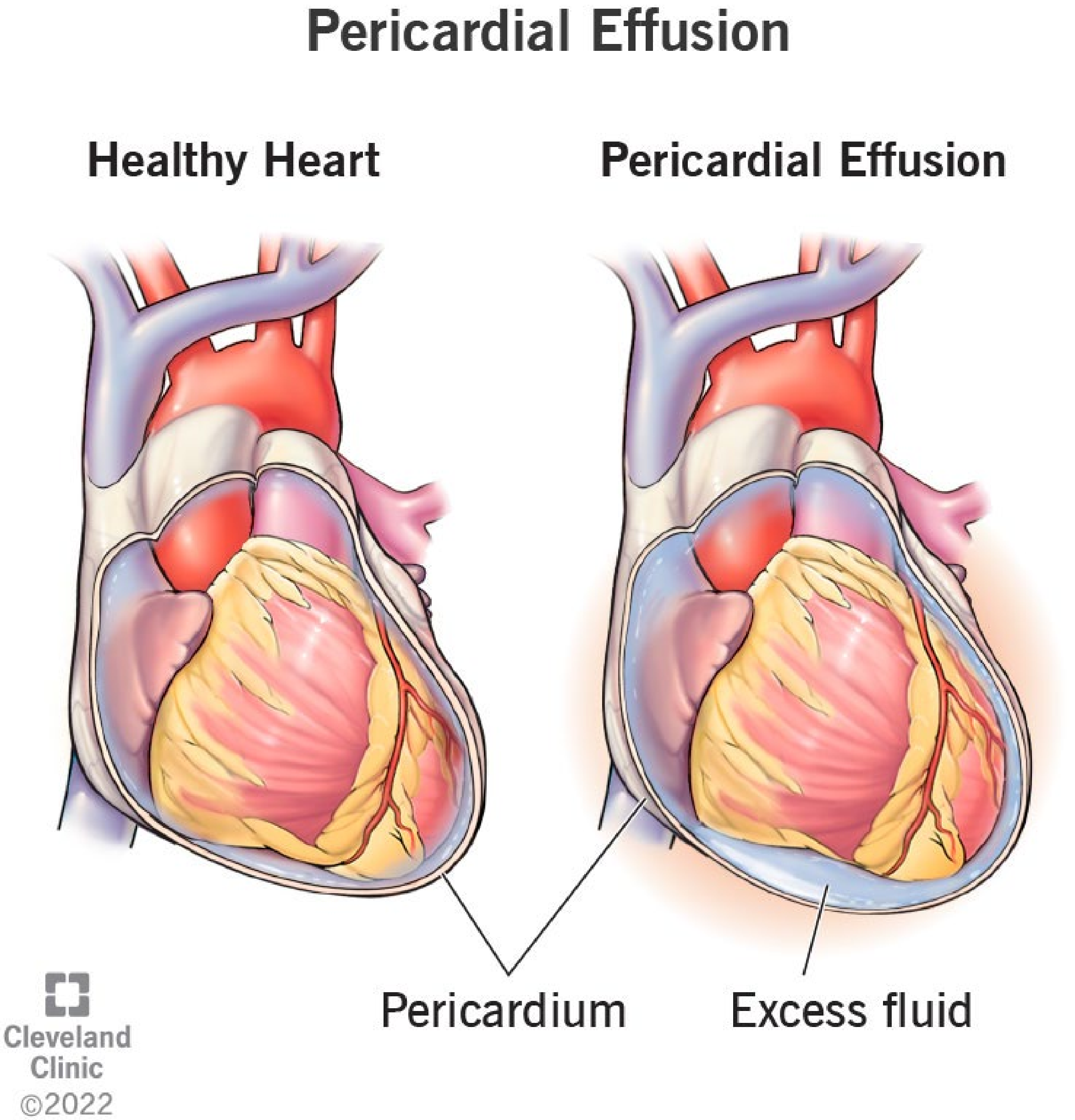
Pericardial Effusion

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



Three Circulatory Circuits of the Heart

Pulmonary circuit

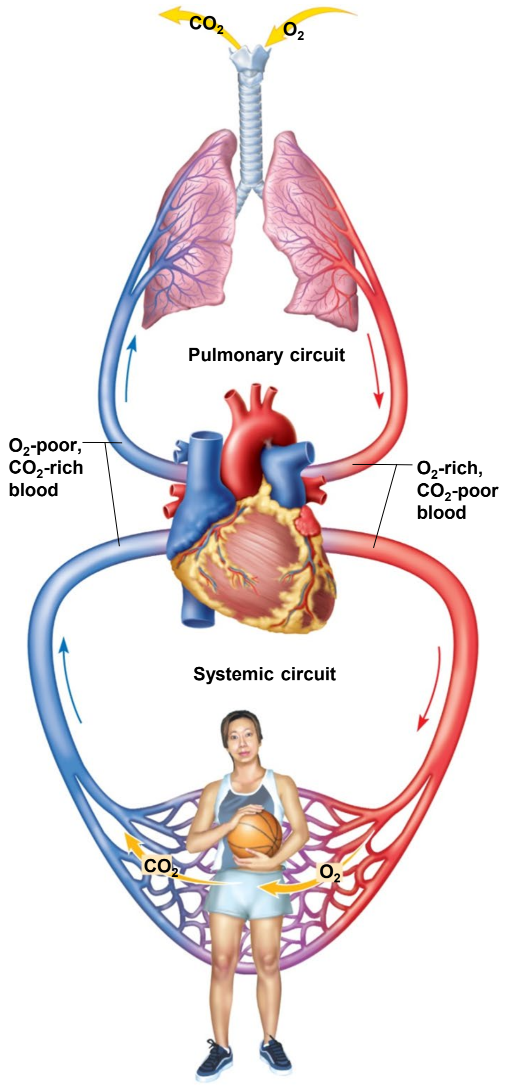
- right side of heart to lungs
- carries blood to lungs for gas exchange
- oxygenated blood back to left side of heart
- low pressure

Systemic circuit

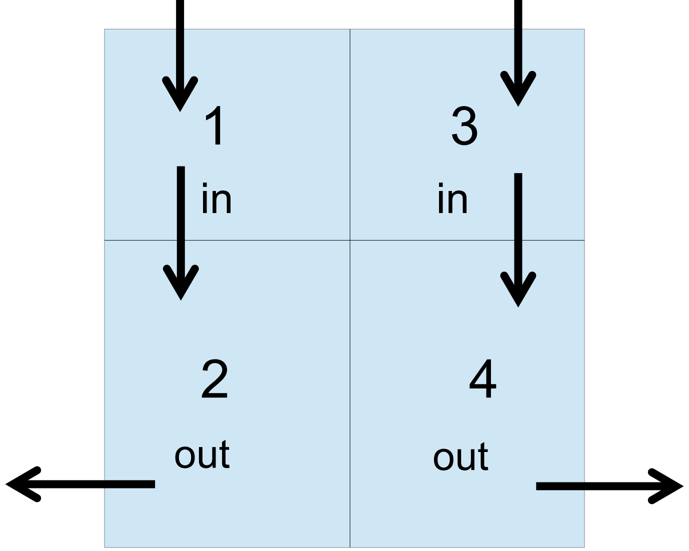
- left side of heart to all body
- supplies oxygenated blood to all tissues
- returns deoxygenated blood to rt. side of heart
- high pressure

Coronary circuit

- see next slide



Blood Flow



1. Blood enters right atria from superior vena cava, inferior vena cava, and coronary sinus

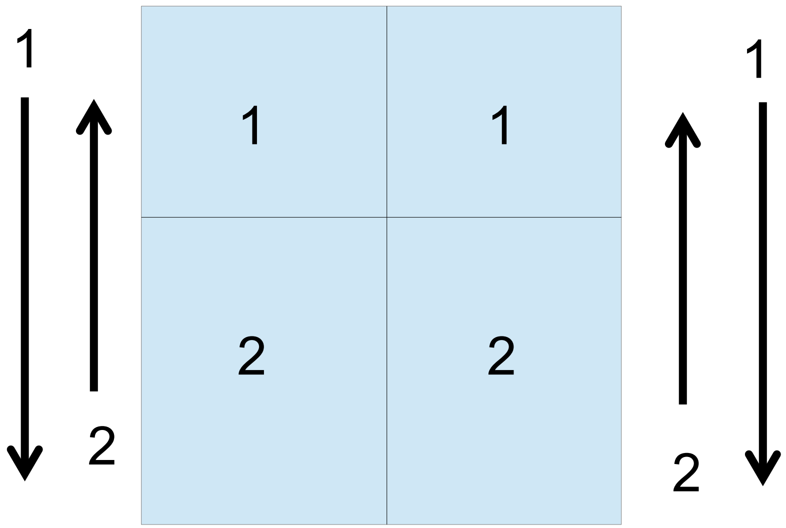
2. Blood moves into right ventricle and is ejected from heart into pulmonary trunk then to lungs

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.

Heart's Pumping Action



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.

Three Circulatory Circuits of the Heart

Coronary Circuit

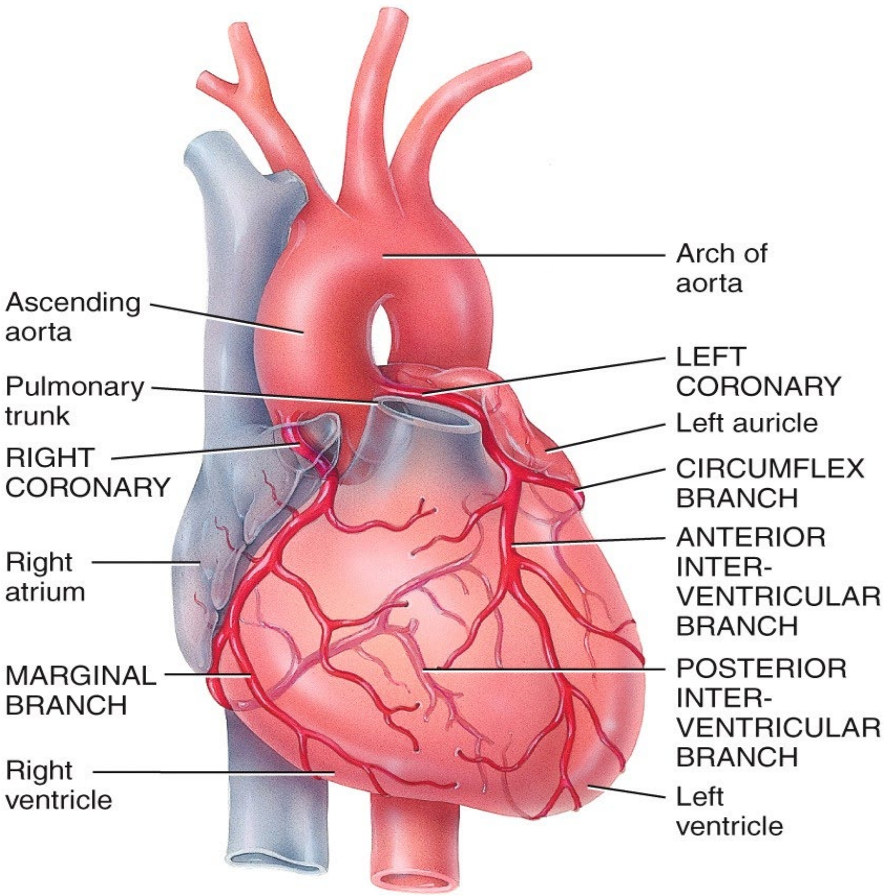
Branch off of the systemic circuit // first arteries coming off the ascending aorta

Aortic recoil moves blood into the coronary arteries

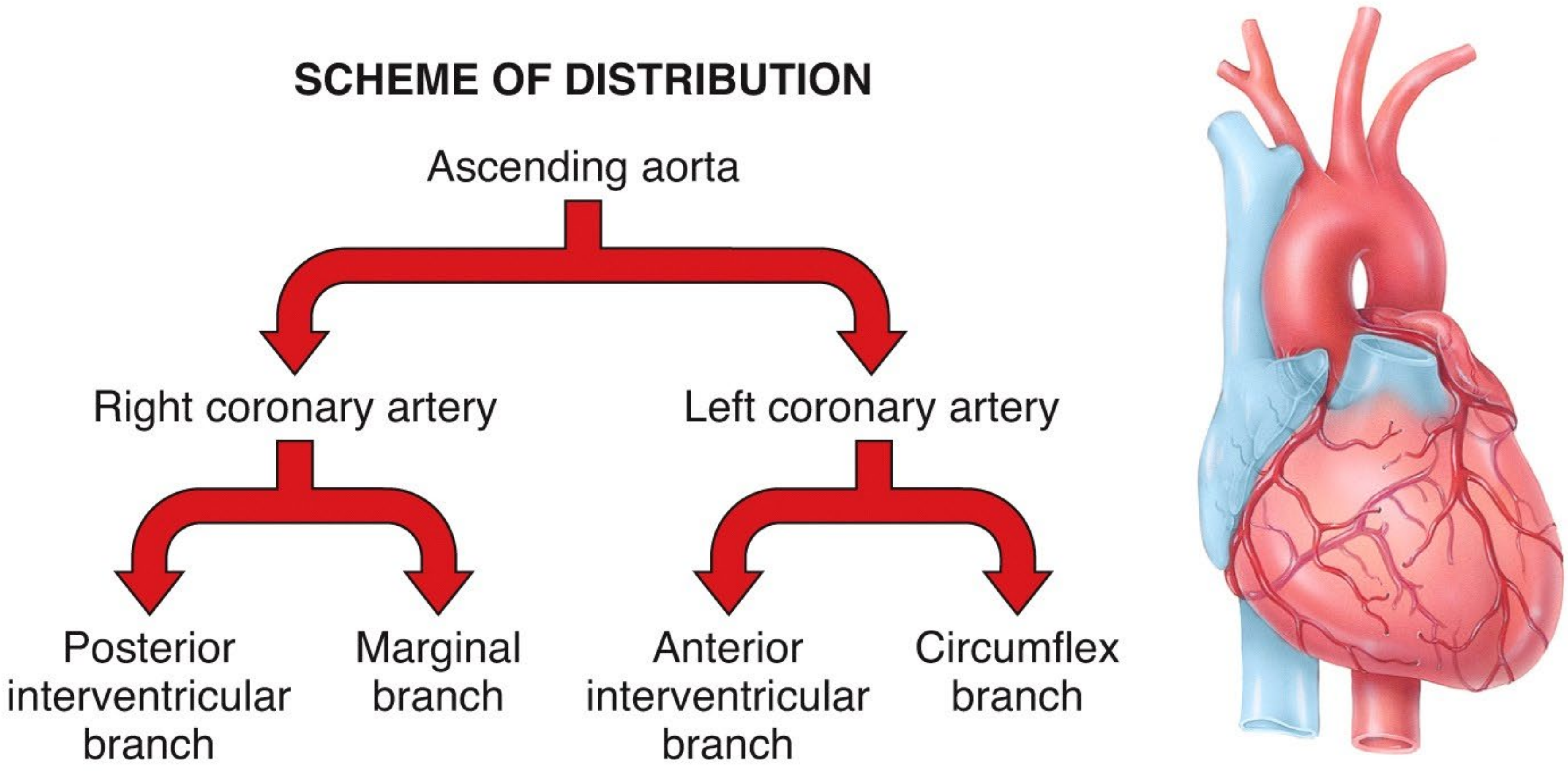
Supply the myocardiocytes (the cells making the walls of the heart) with blood circulation

RCA – divides into the marginal artery branch and the posterior interventricular branch

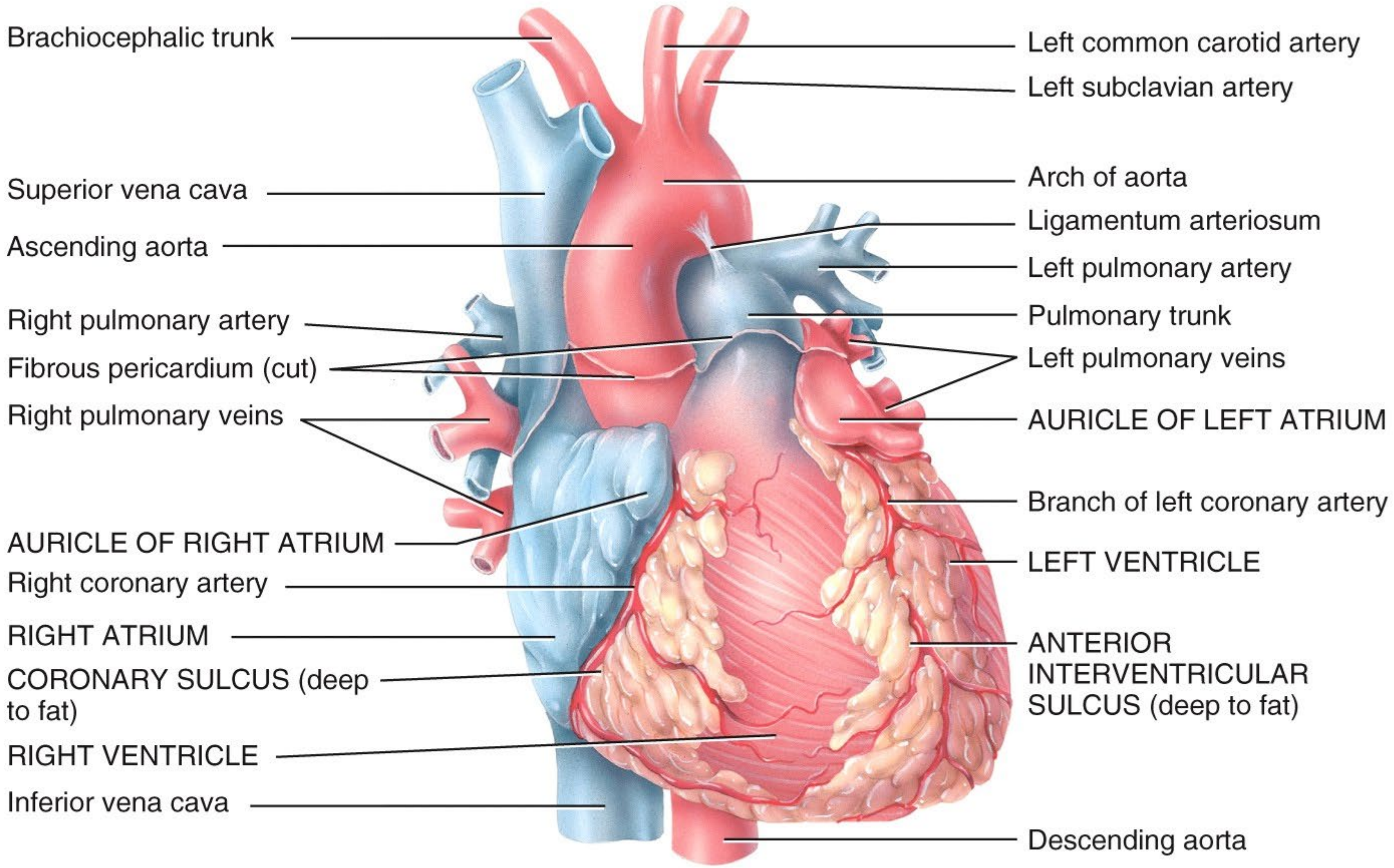
LCA – divides into circumflex brach and the anterior interventrcicular brach



(a) Anterior view of coronary arteries

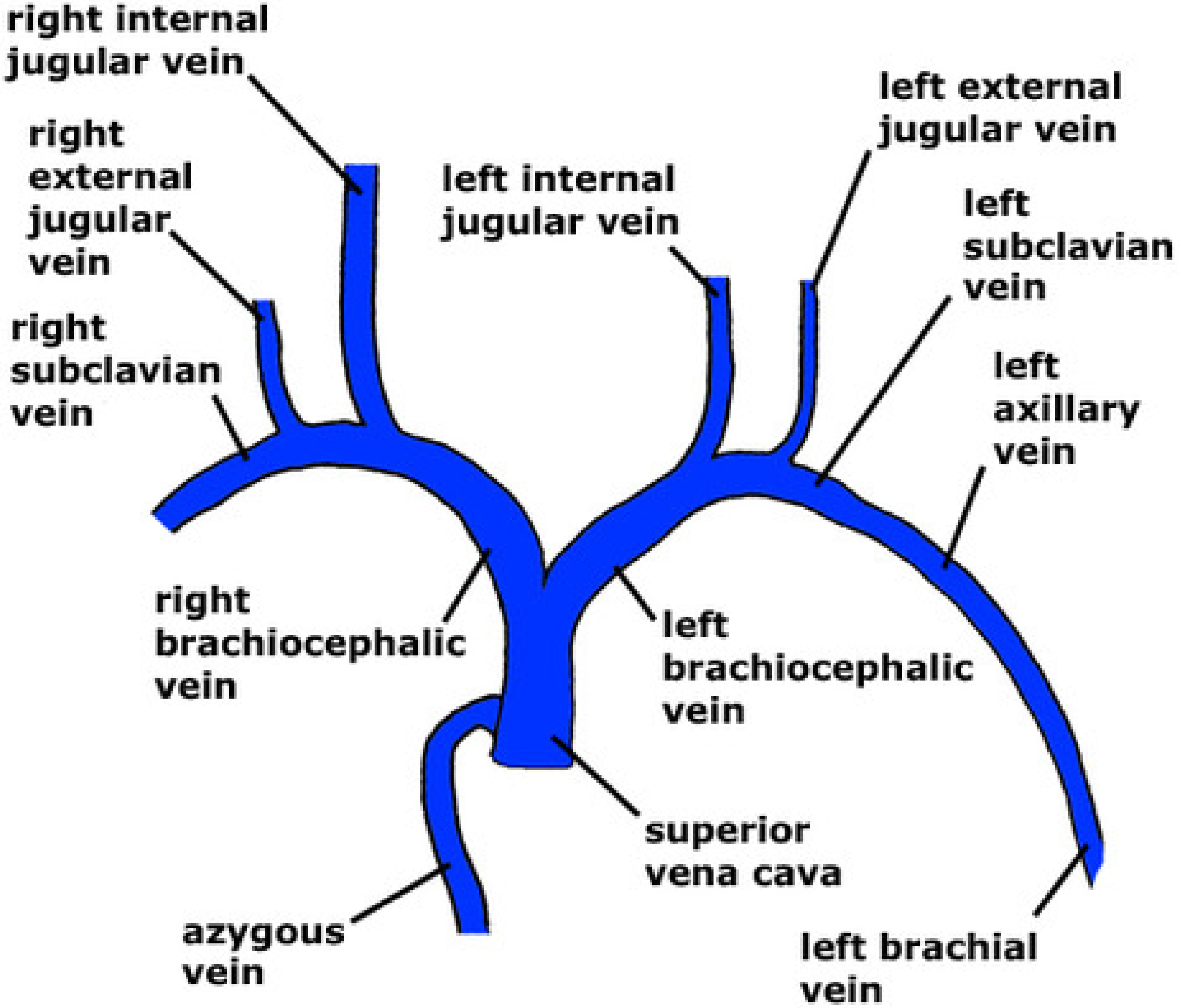


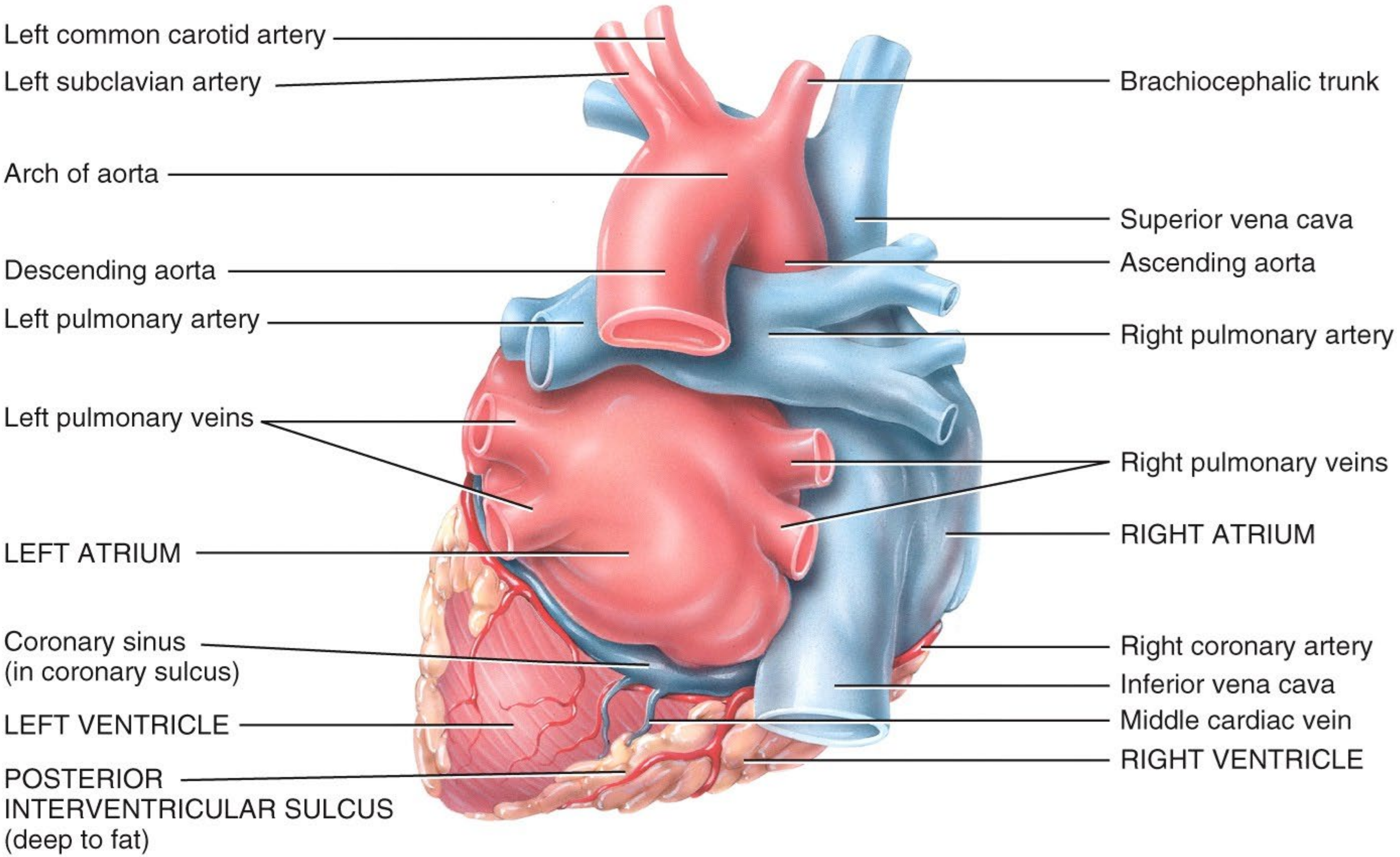
Important Lab Learning Objective!



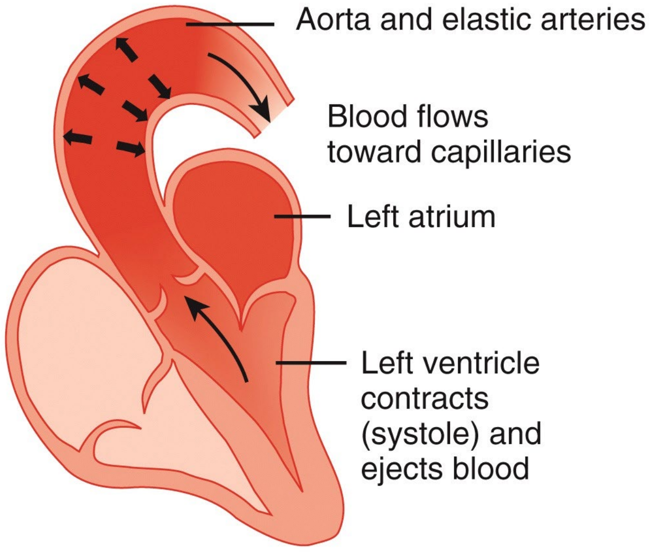
(a) Anterior external view showing surface features

Major veins superior to the heart

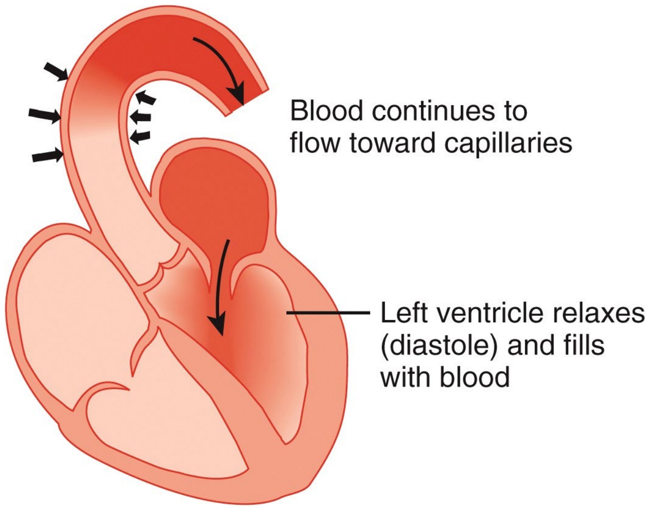




(c) Posterior external view showing surface features



(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.

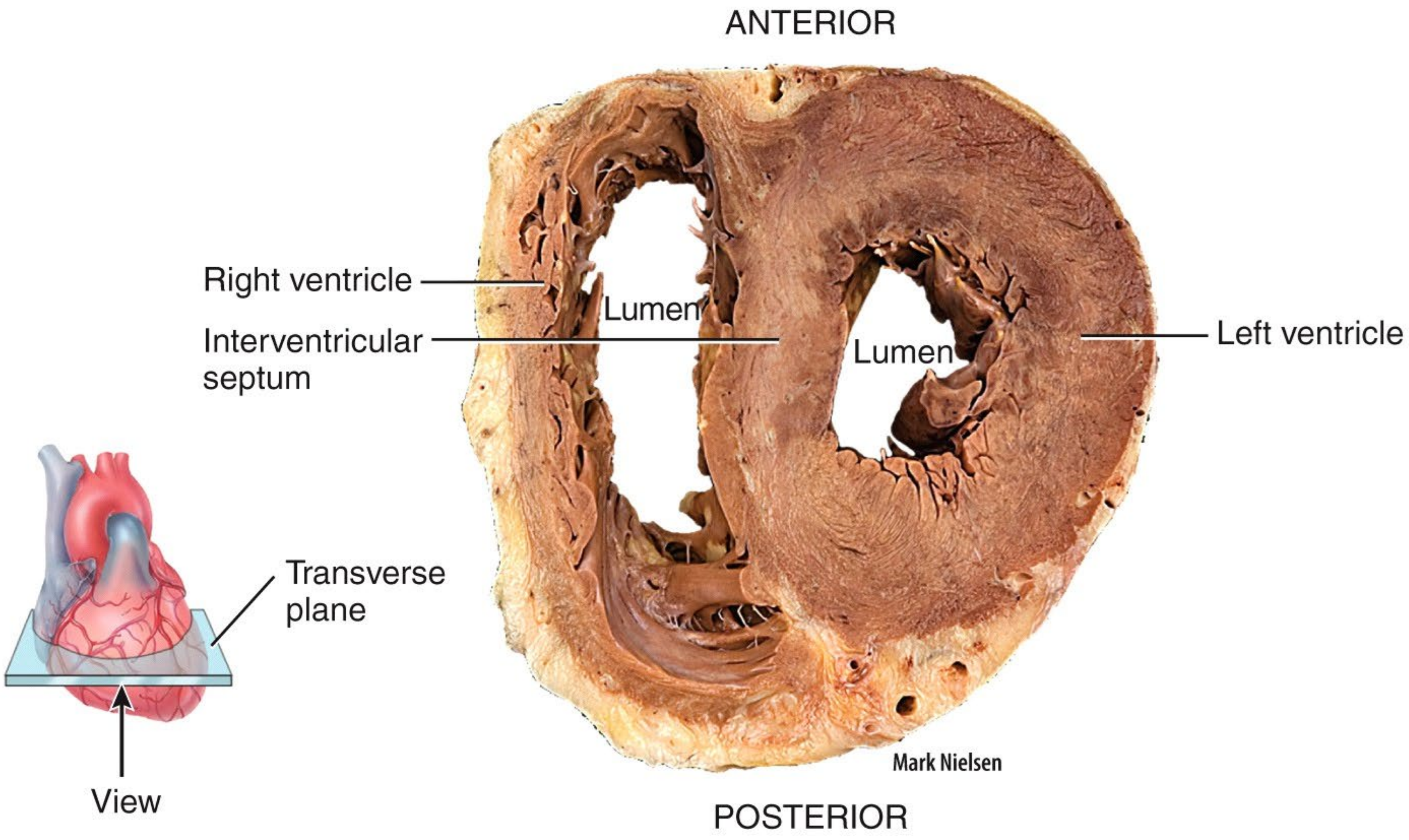
This continues to move blood into the systemic circuit and also starts to move blood back into the left ventricle. This movement of blood towards the left ventricle closes the aortic semilunar valve.

As the semilunar valve closes, now the passageway 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)
- Return to left atria
- Left ventricle
- Aorta to systemic circulation (all tissues of body)
- (see next slide)

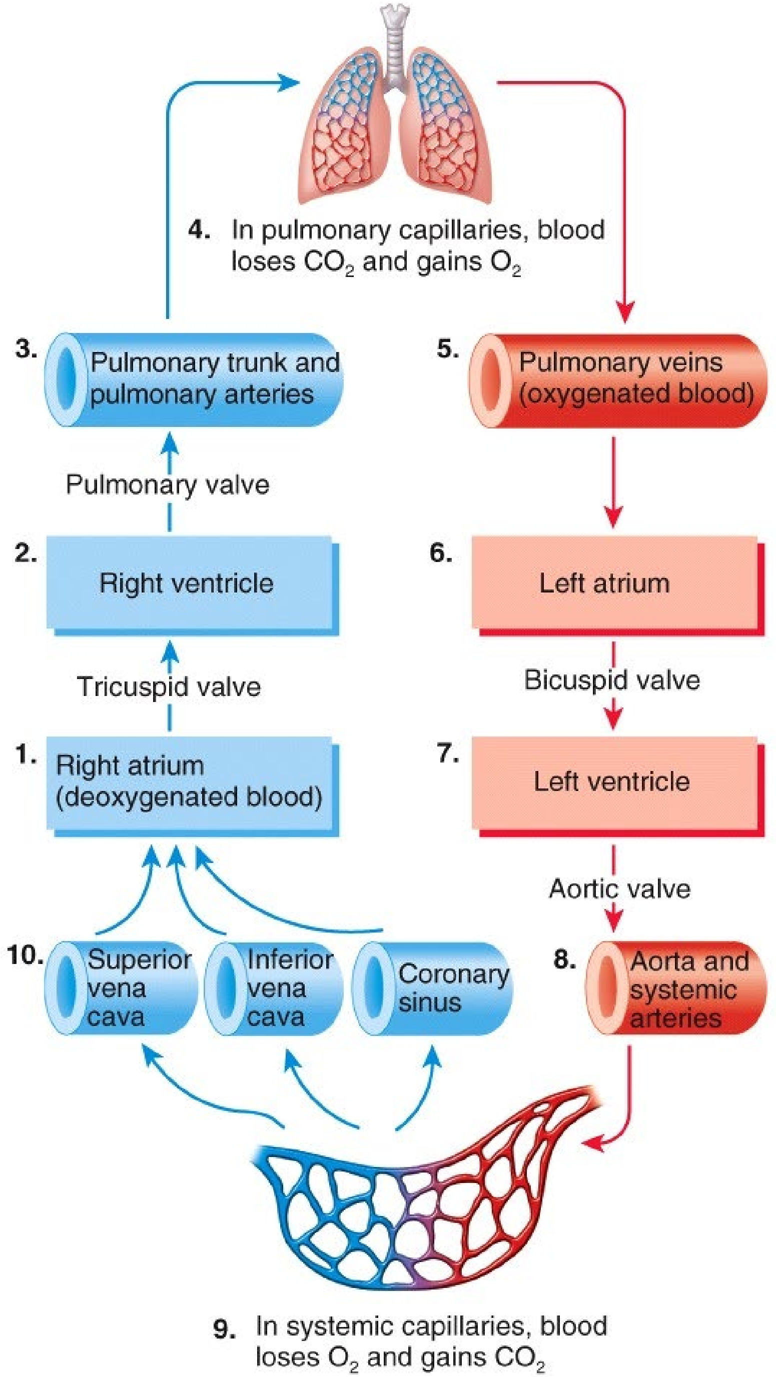
Note: blood enters the right atria via superior vena cava, inferior vena cava, coronary sinus, and thebesian veins (highest concentration in right atria and lowest concentration in left ventricle)

Note: <u>blood flow through the heart is different than the pumping action of the heart</u>

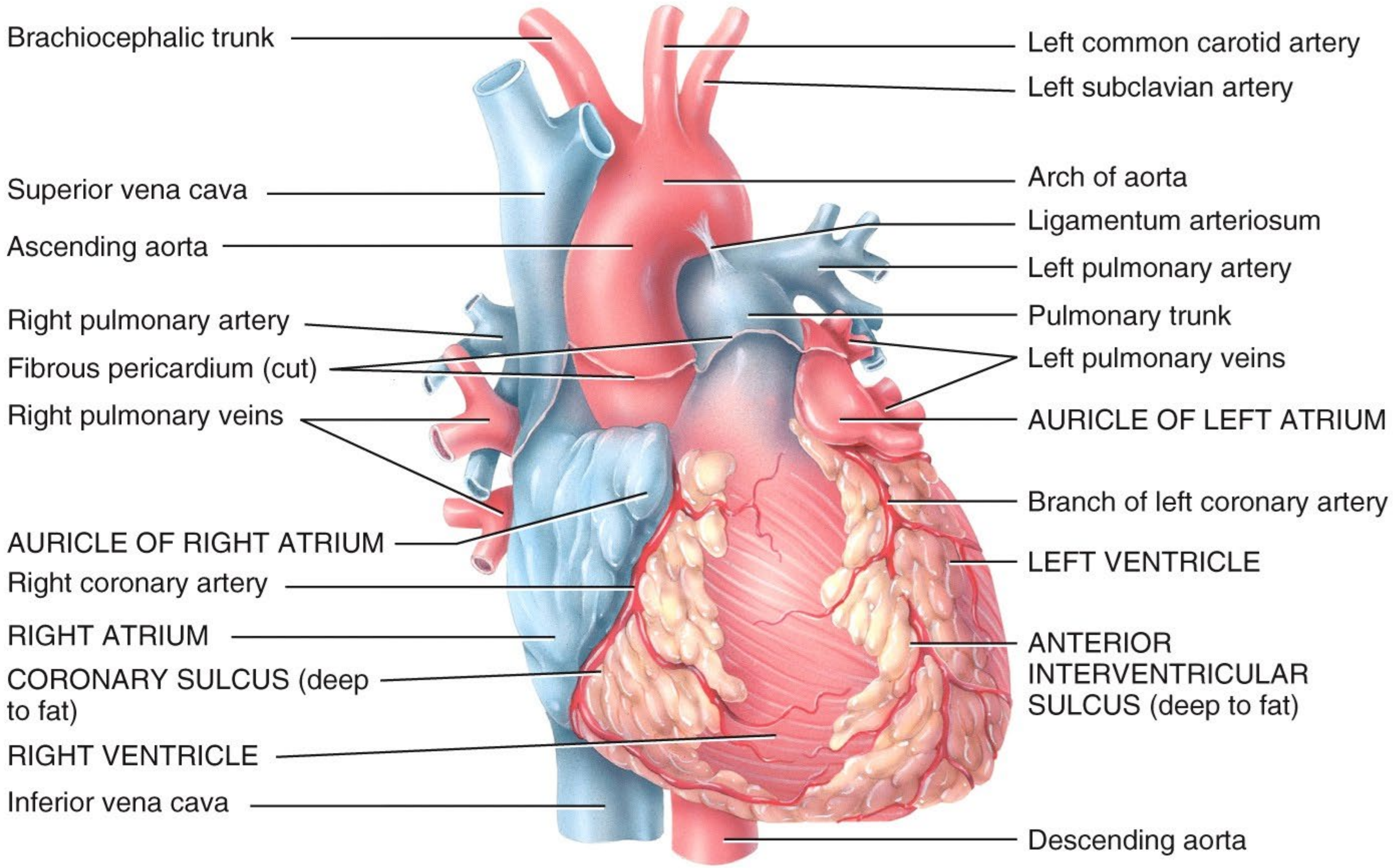
pumping action occurs as two separate pumps (right side & left side) working "in phase"

first action is to move blood downward in both pumps

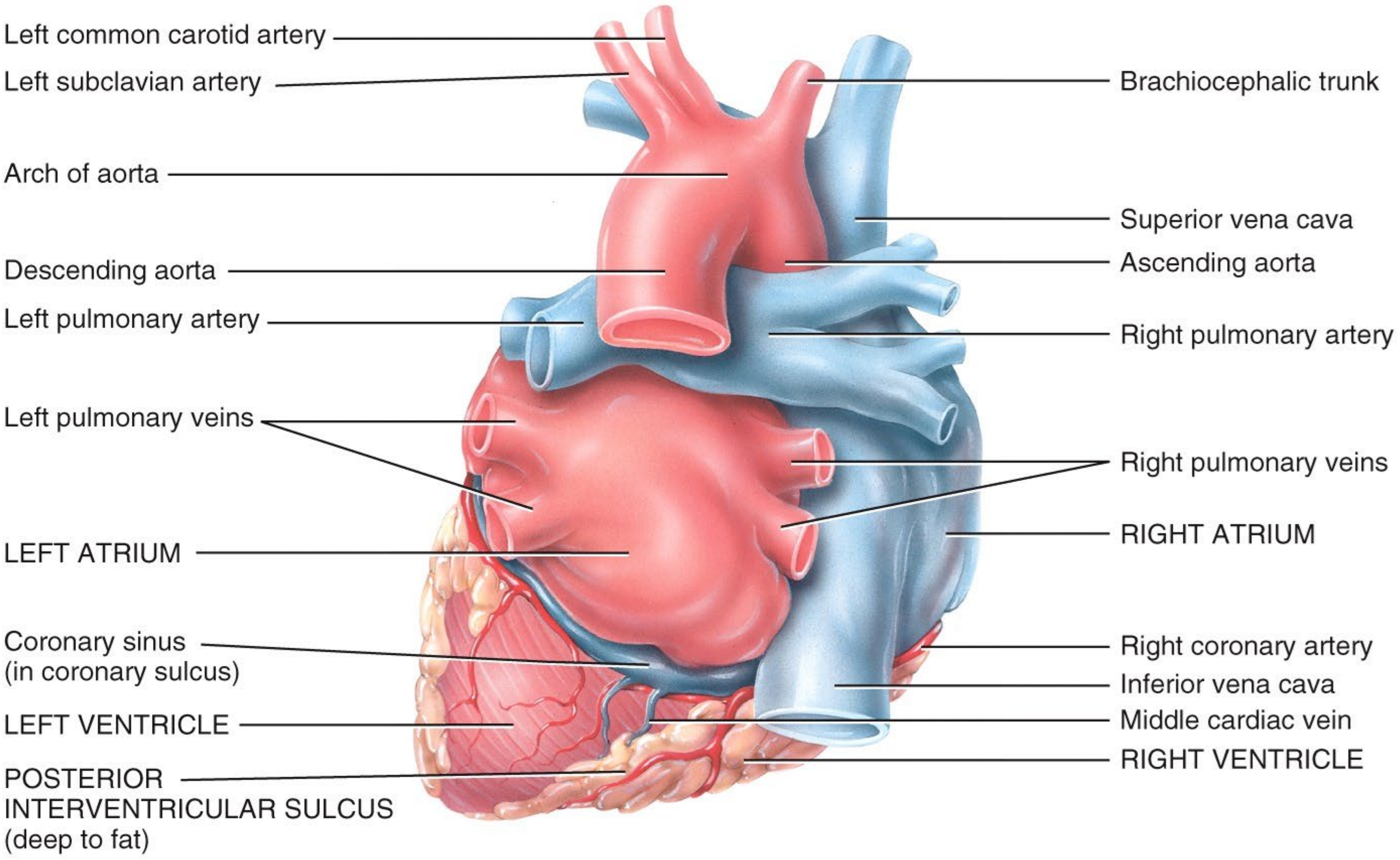
Second action is to pump blood upward



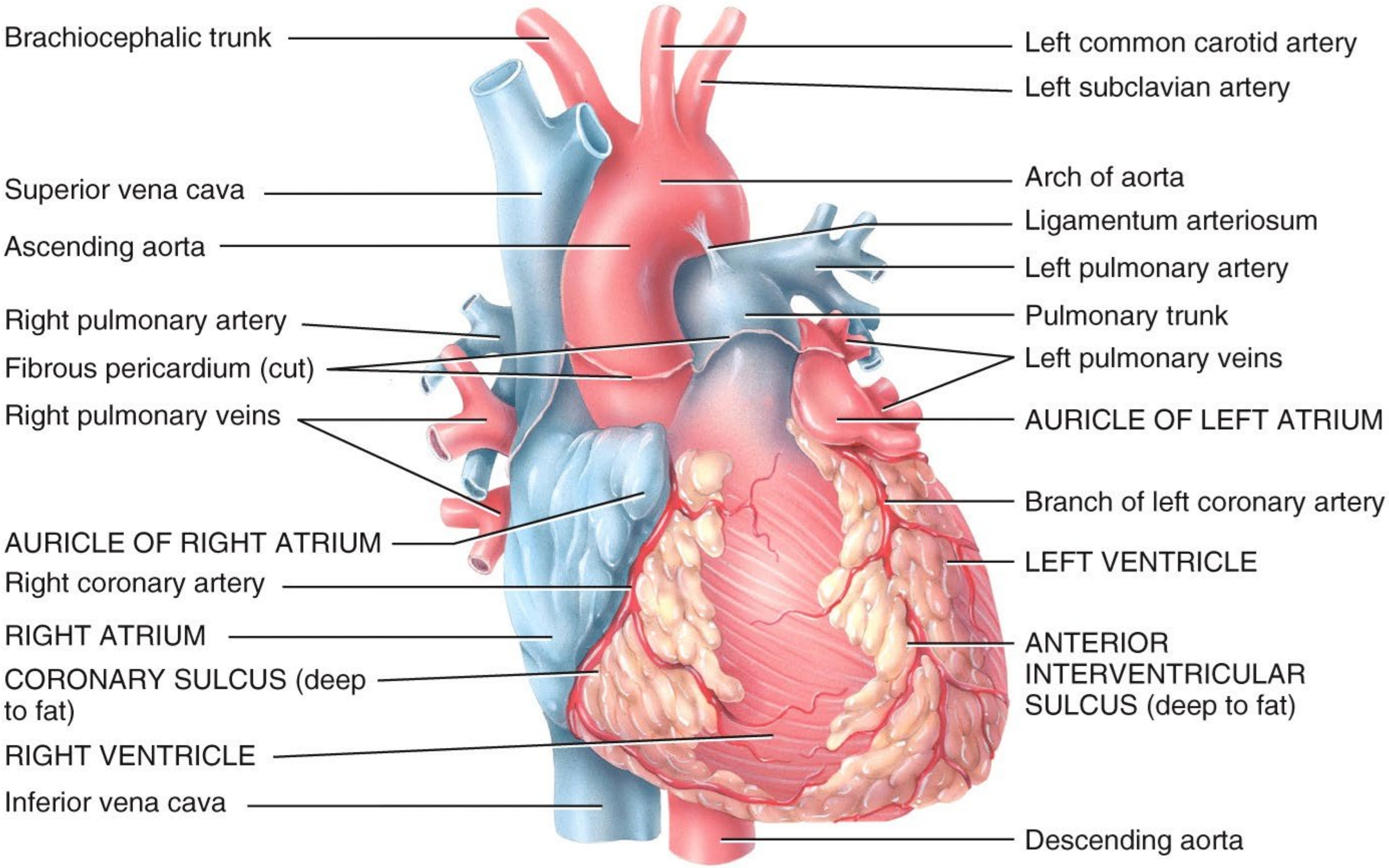
(b) Path of blood flow through systemic and pulmonary circulations



(a) Anterior external view showing surface features



(c) Posterior external view showing surface features



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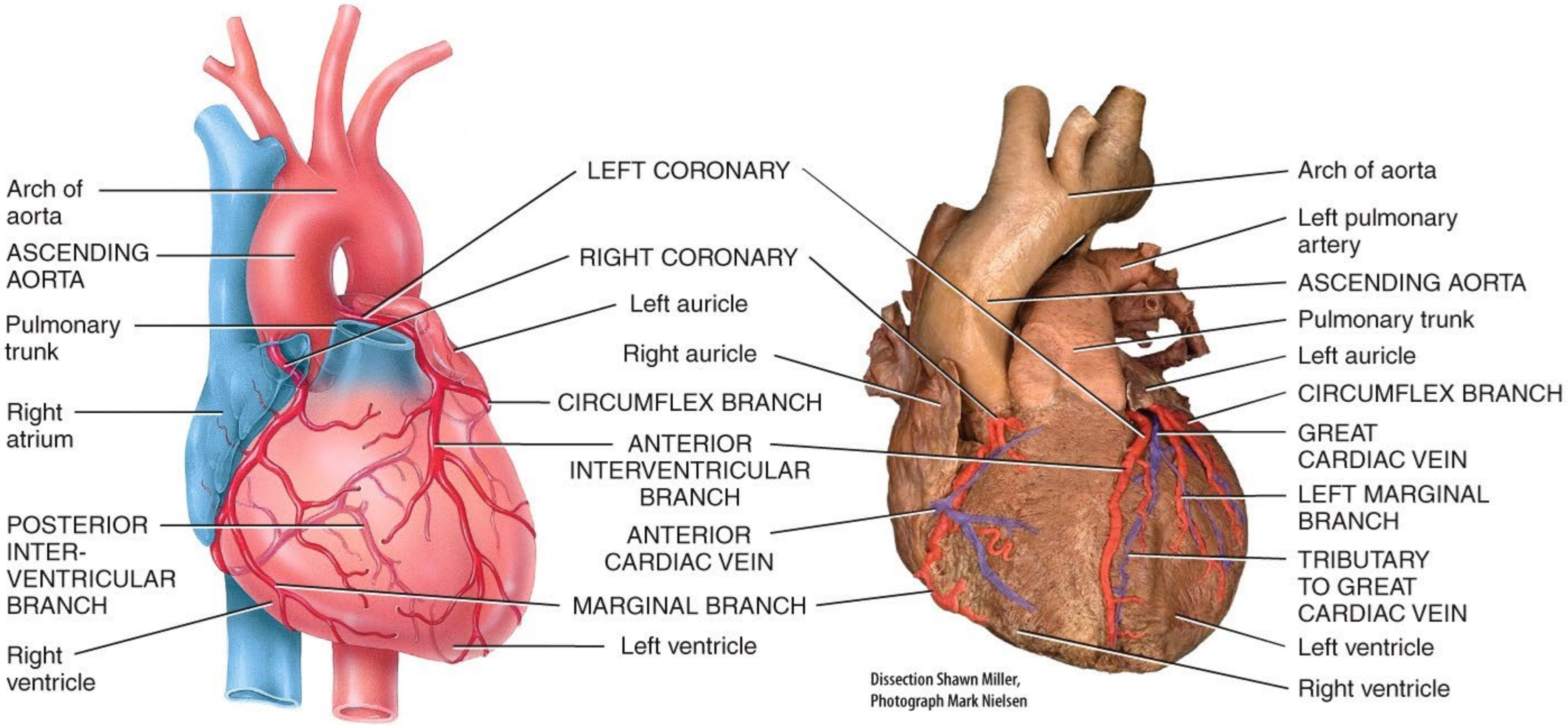
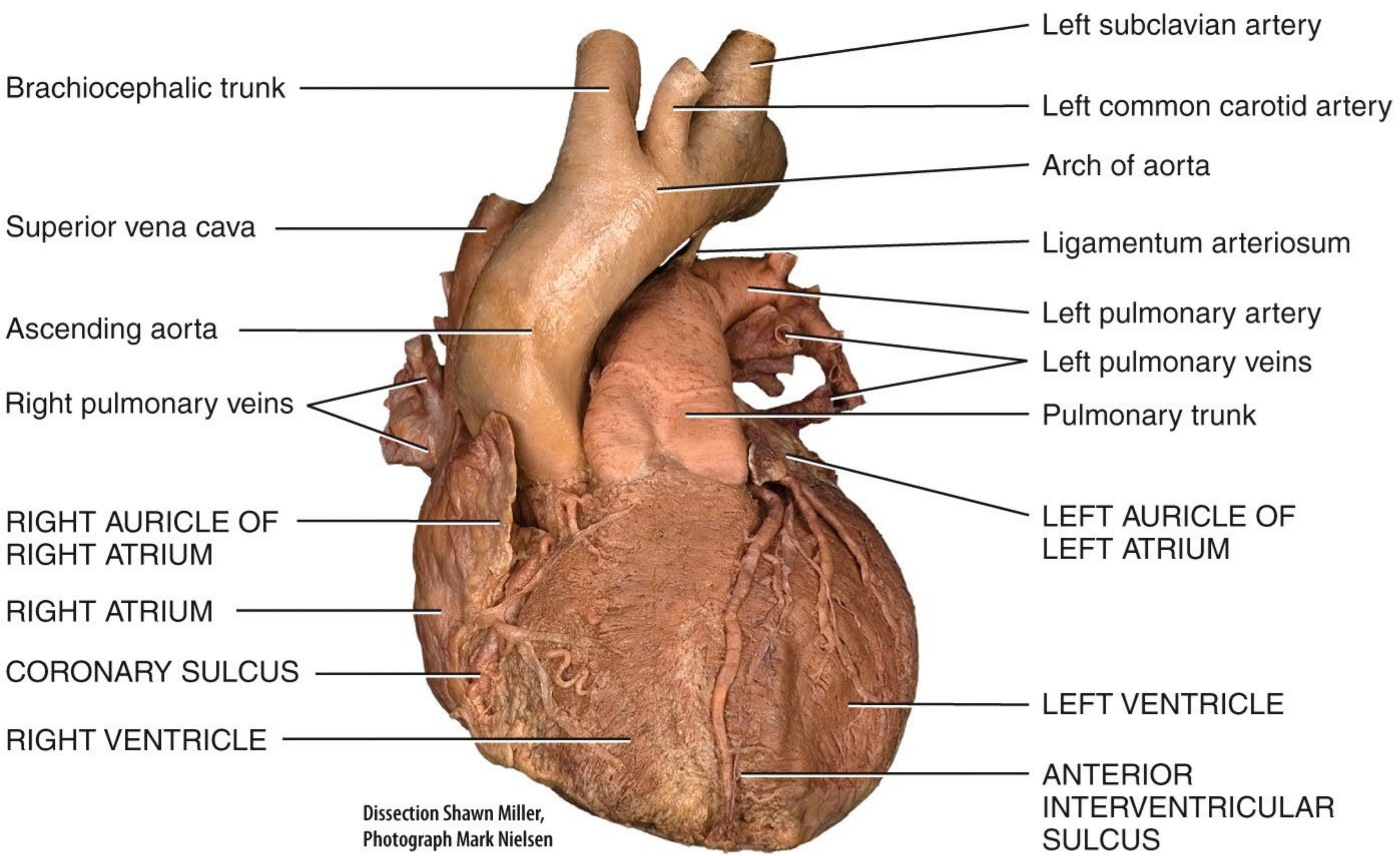
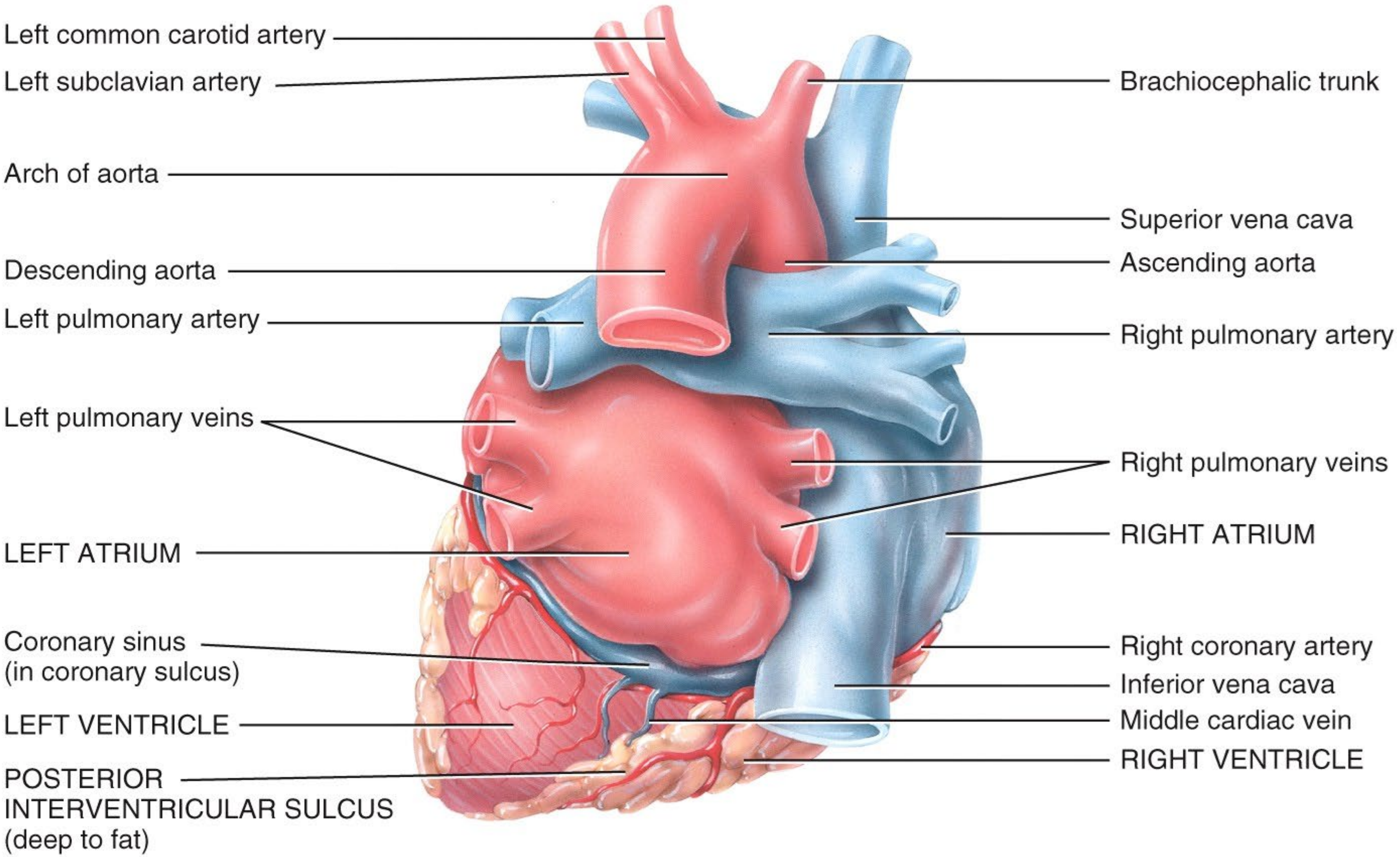


Anterior view of coronary arteries and their major branches



(b) Anterior external view



(c) Posterior external view showing surface features

Heart Chambers – Internal Structures

Interatrial septum

– wall that separates atria / connective tissue

Interventricular septum

– muscular wall that separates ventricles / connective tissue

Atrial ventricular septum

– septum between atria and ventricle

– AV valves built into this connective tissue wall

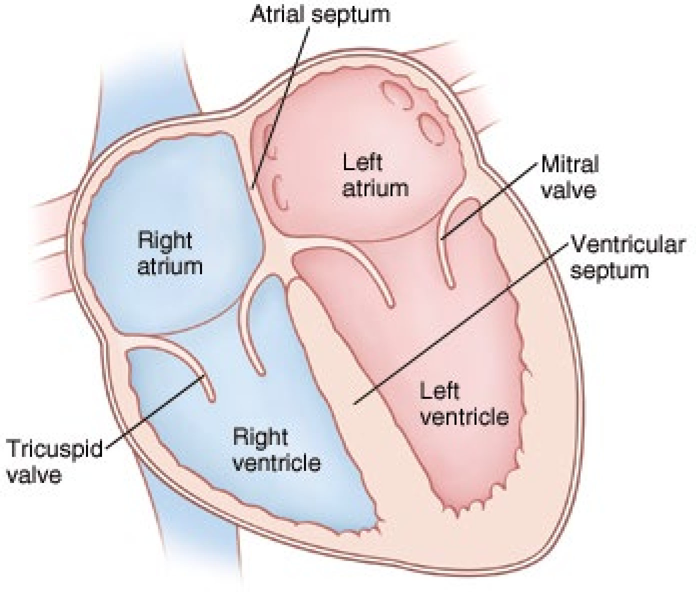
Pectinate muscles

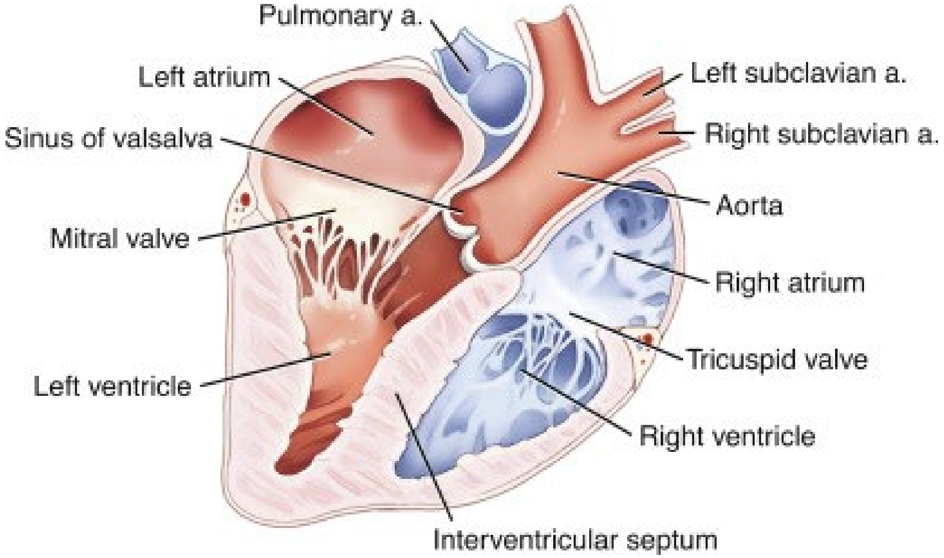
– internal ridges of myocardium

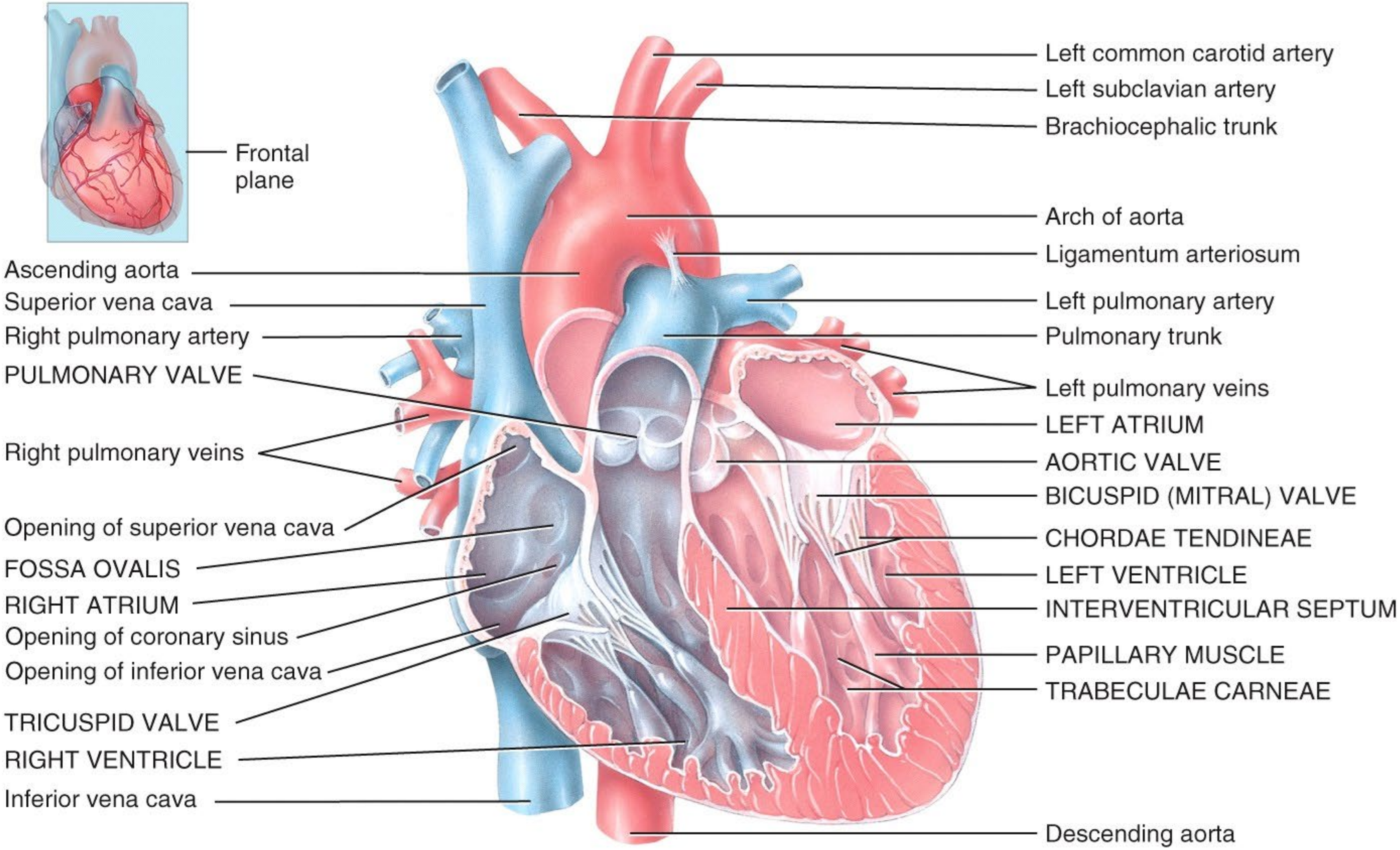
– in right atrium and both auricles

Trabeculae carneae

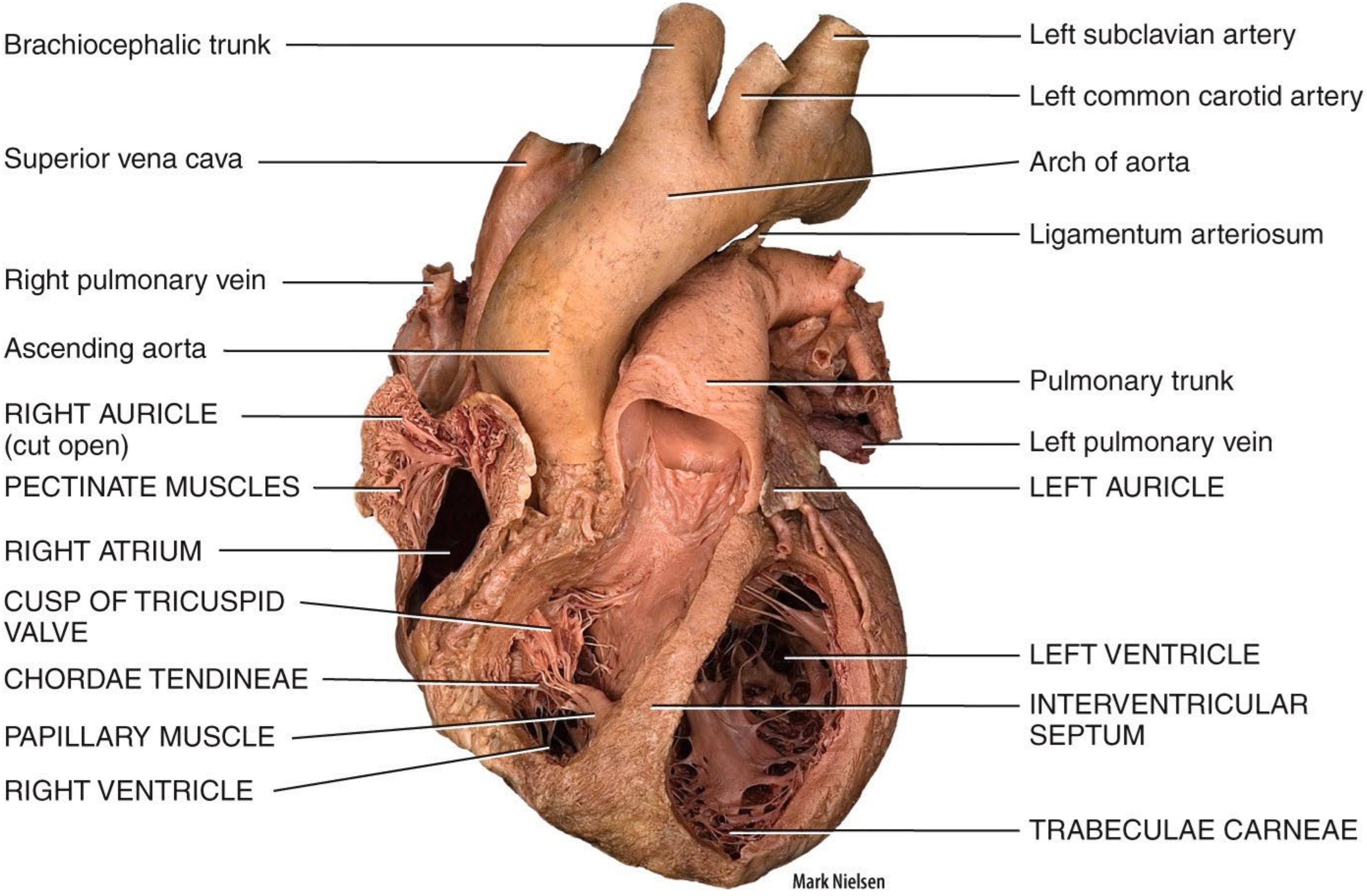
– internal ridges in both ventricles



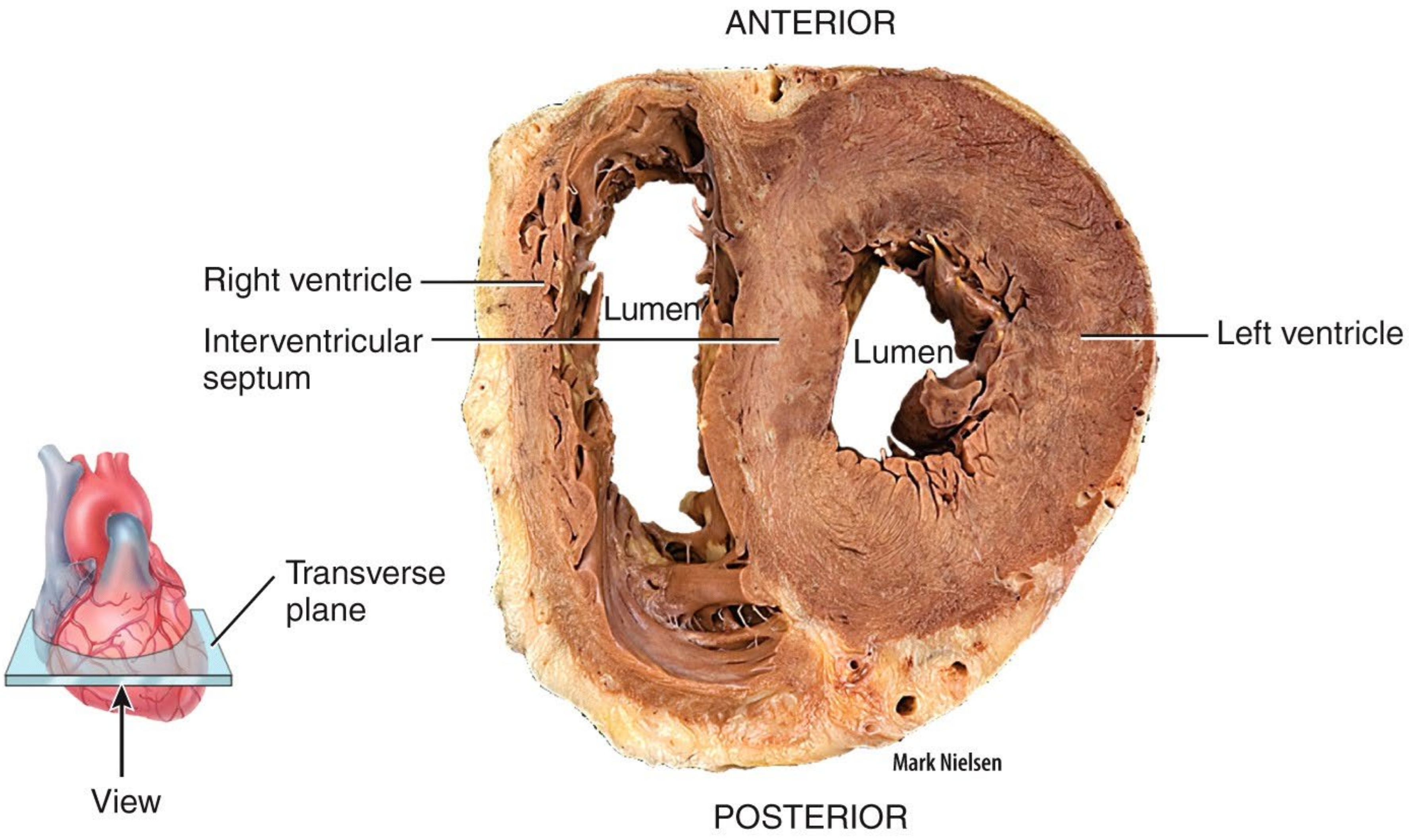




(a) Anterior view of frontal section showing internal anatomy

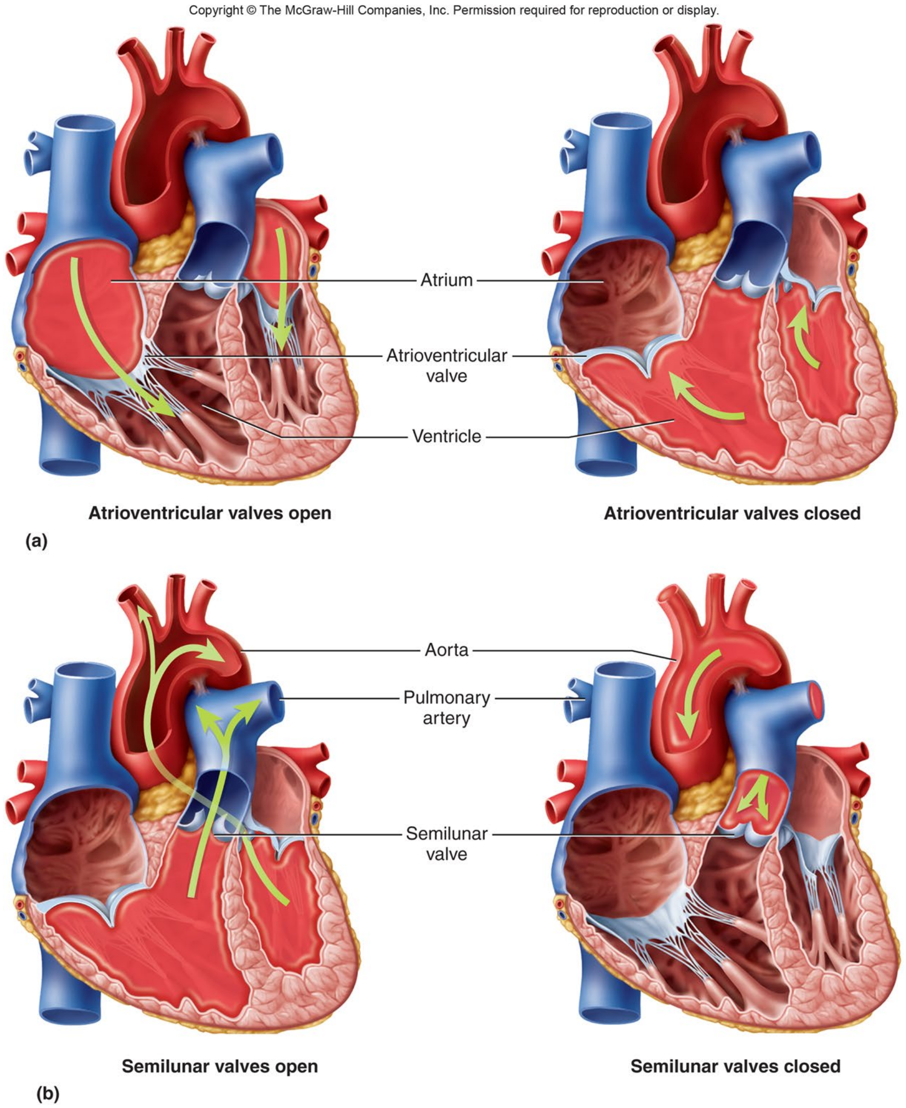


(b) Anterior view of partially sectioned heart



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

Function of Heart Valves

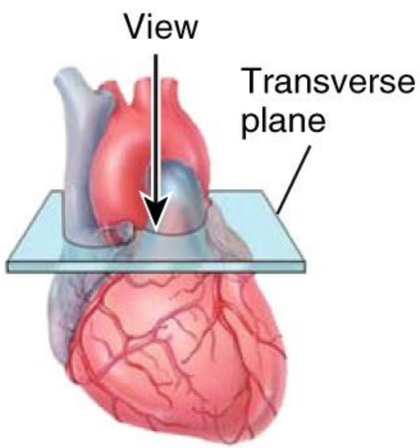


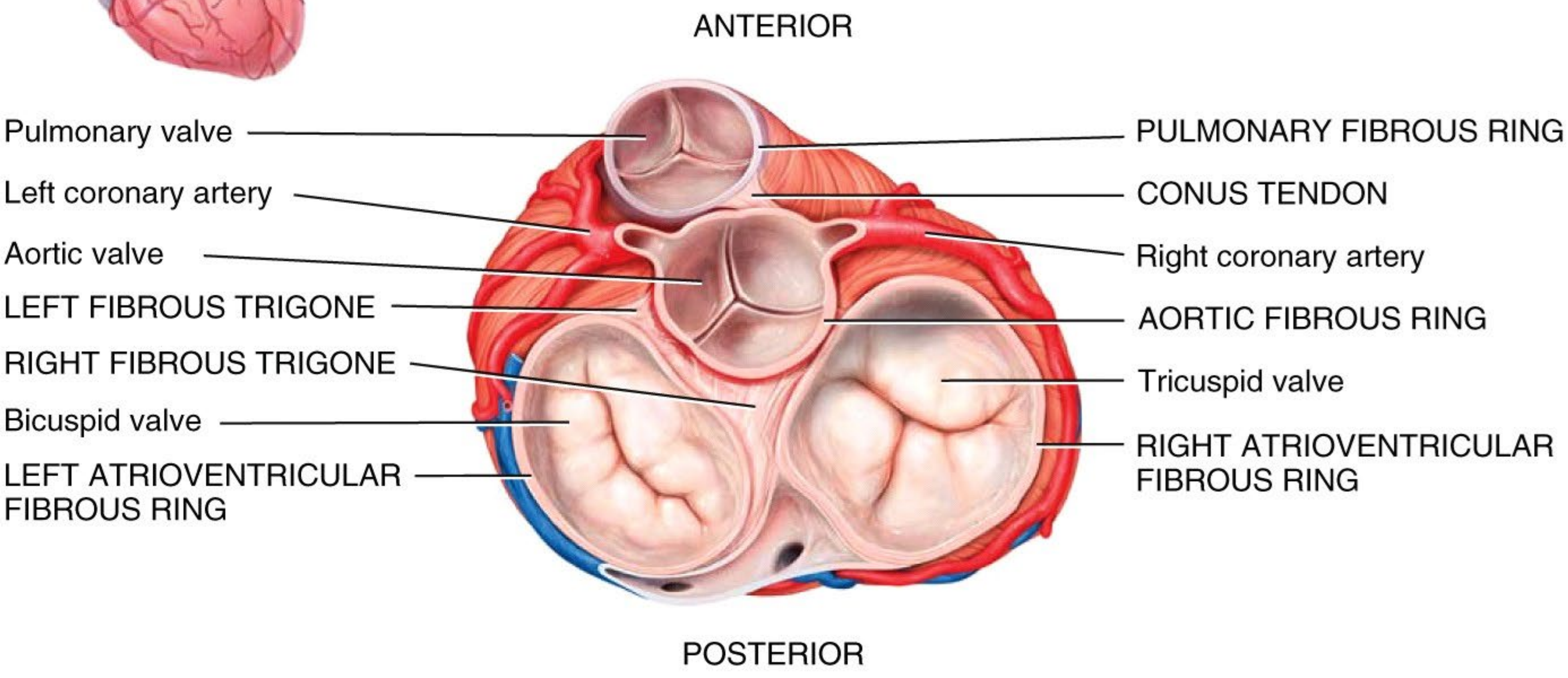
Valves ensure a one-way flow of blood through the heart

Blood flows from an area of high pressure to an area of low pressure

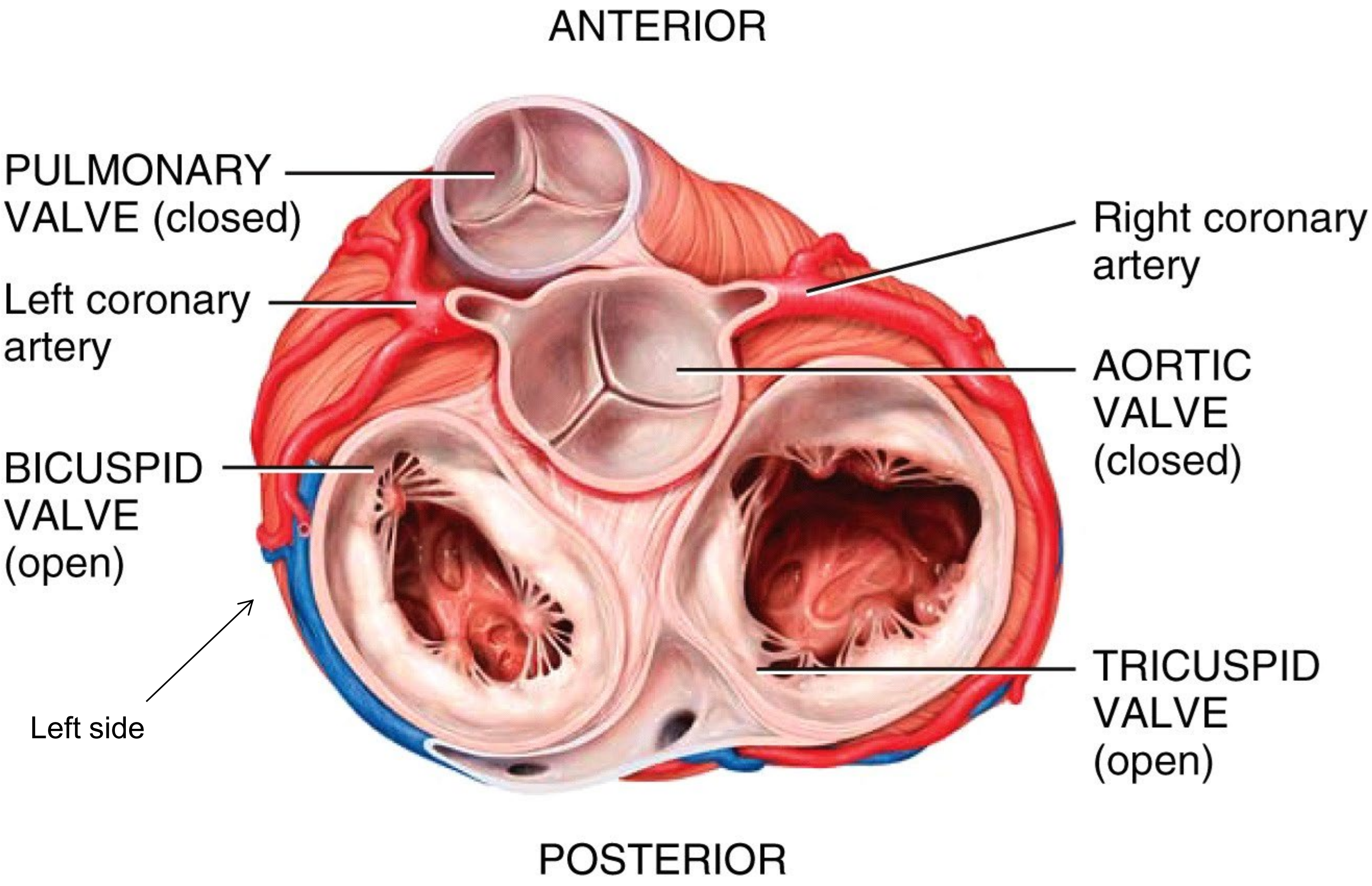
The pressure difference across the valve open and close these valves

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

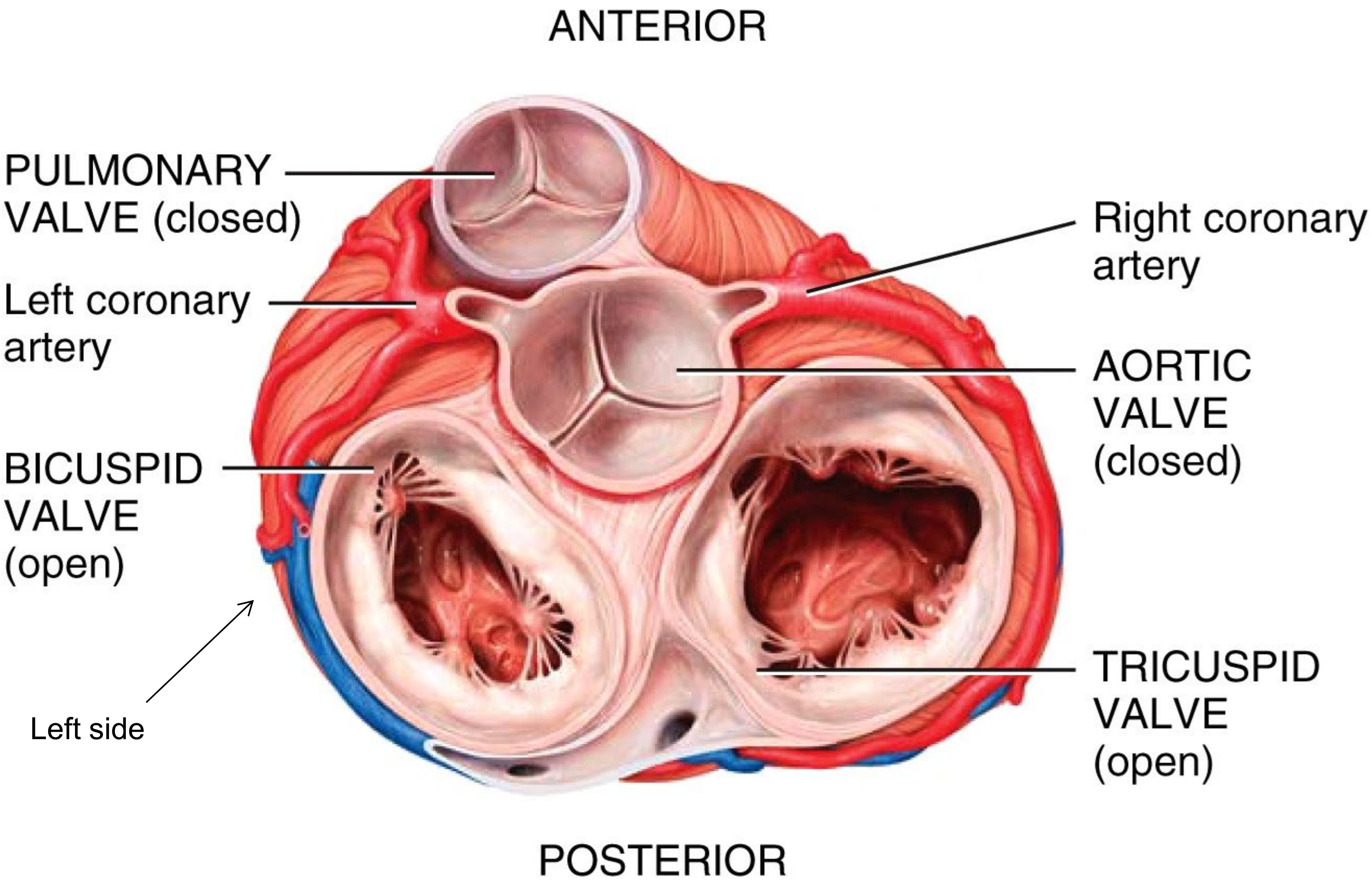




Superior view (the atria have been removed)



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



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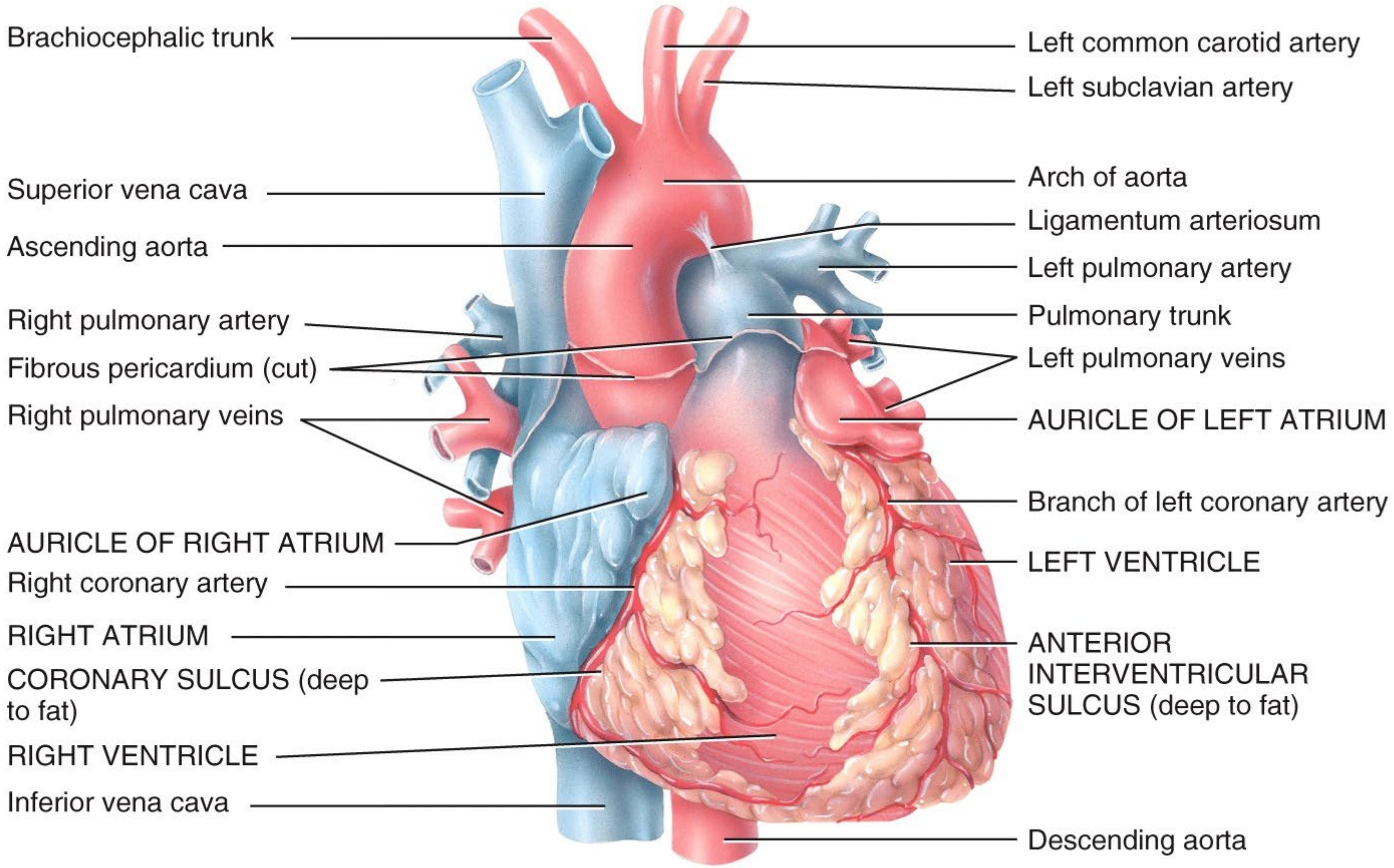
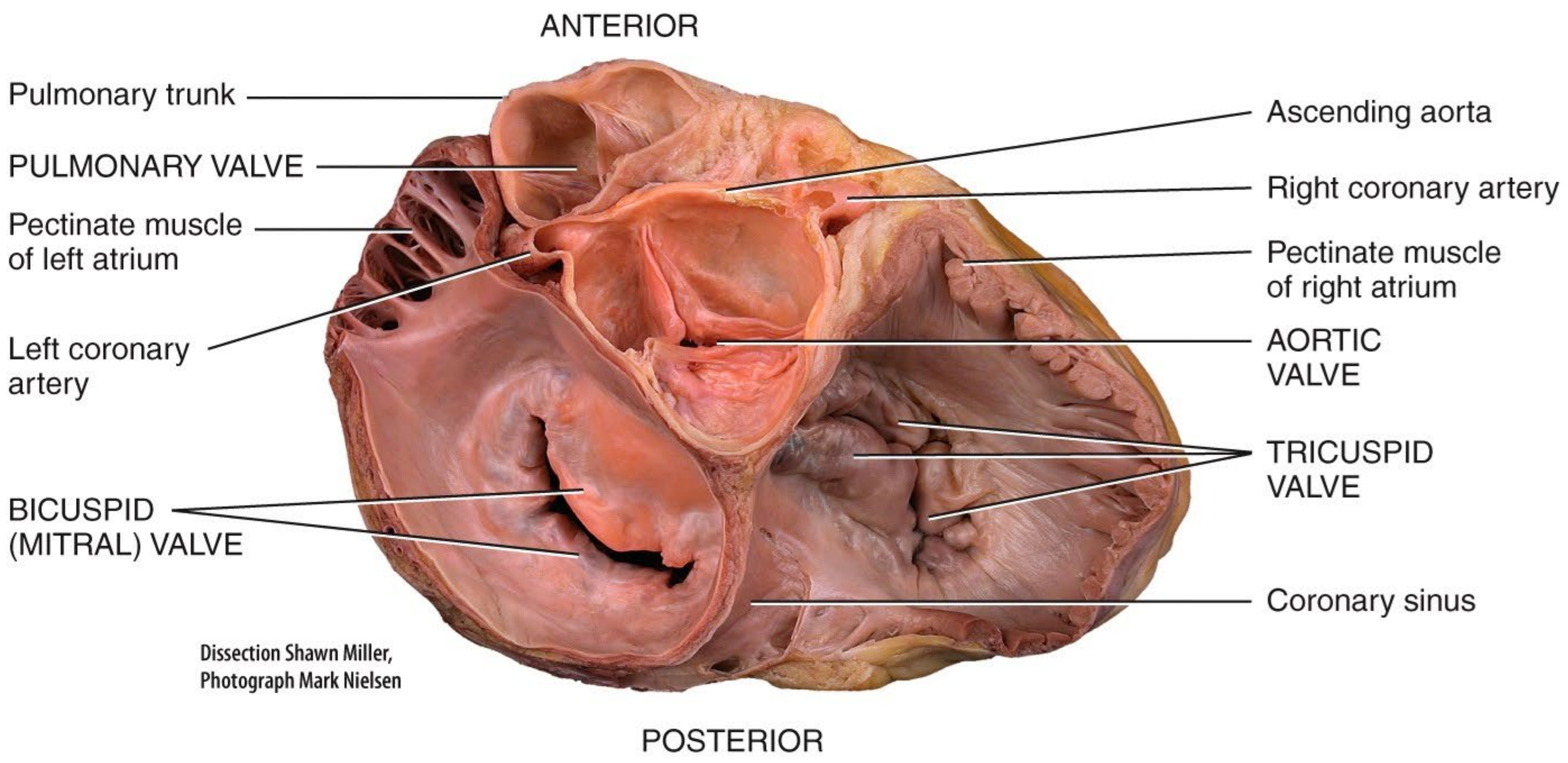
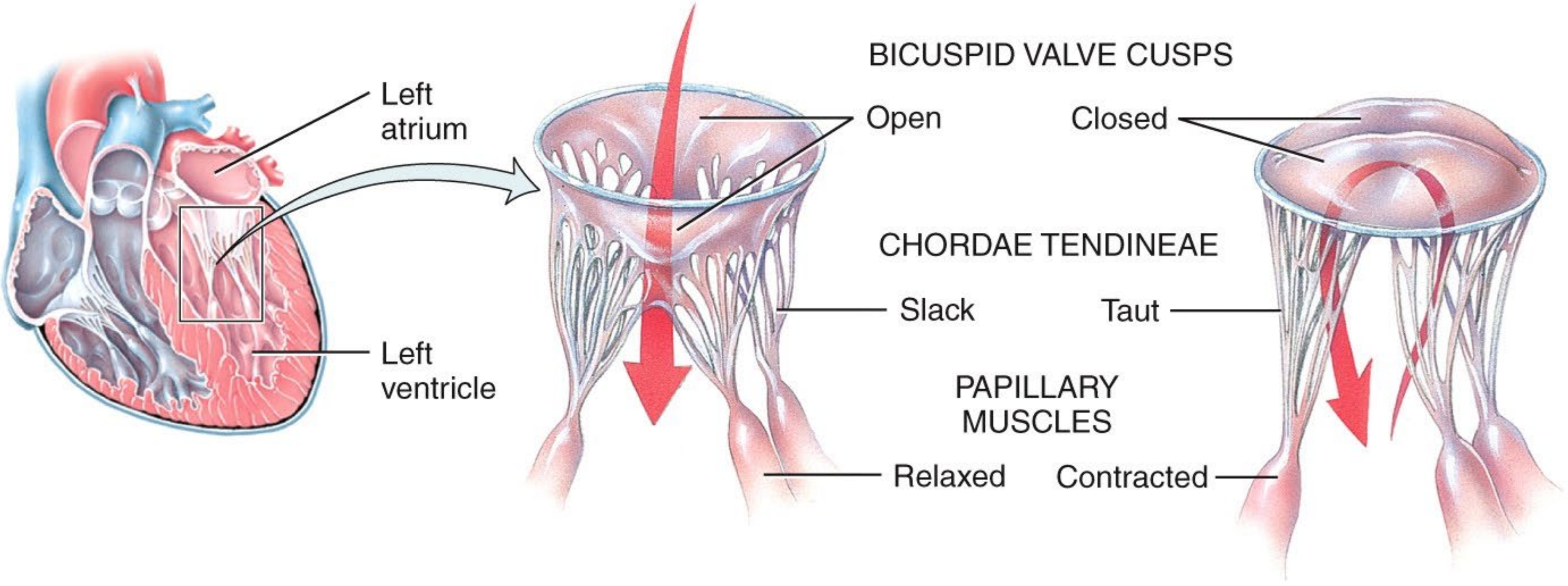


(a) Anterior external view showing surface features



(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!



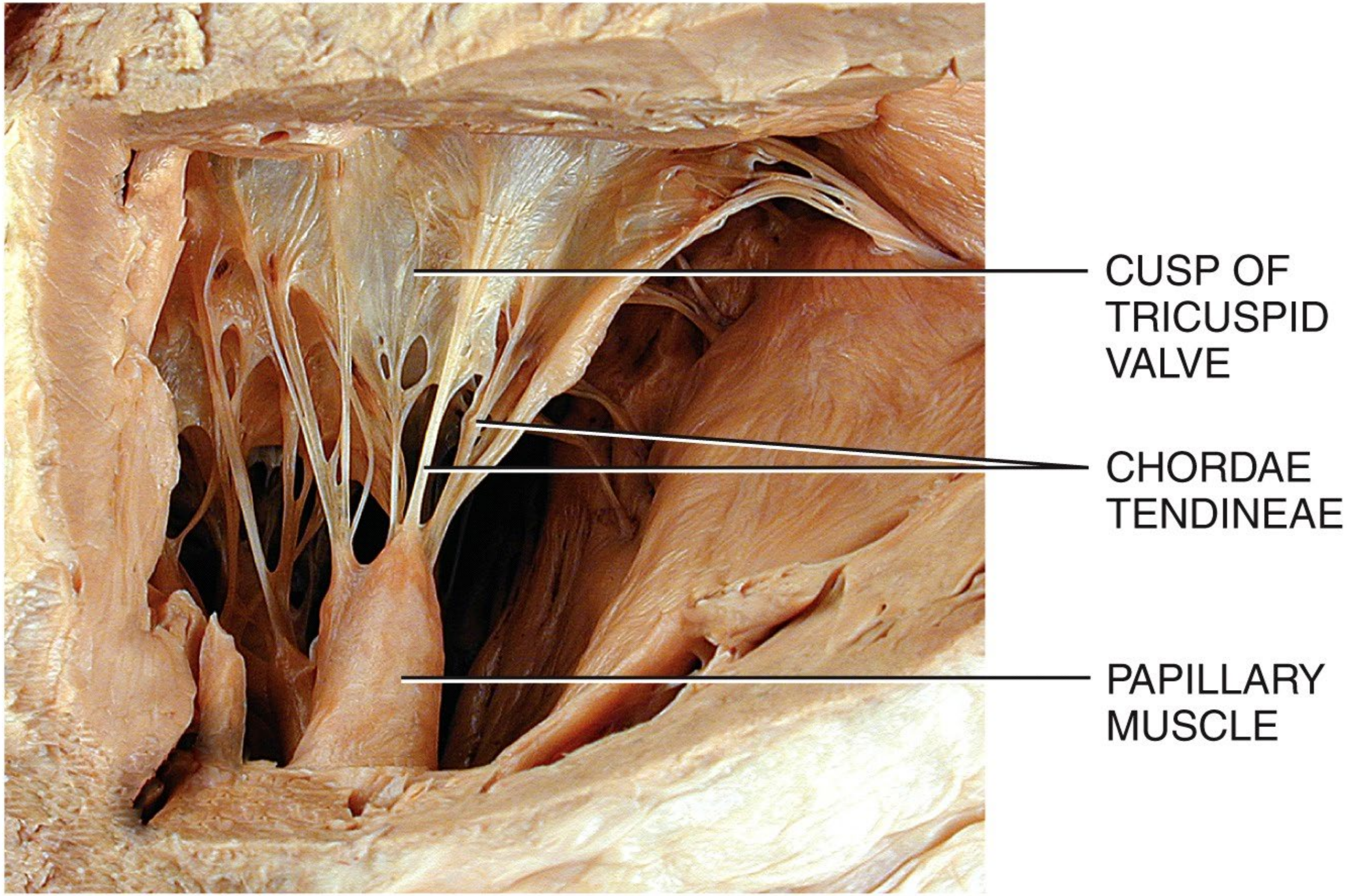
(a) Bicuspid valve open

(b) Bicuspid valve closed

- What is the function of the papillary muscles?

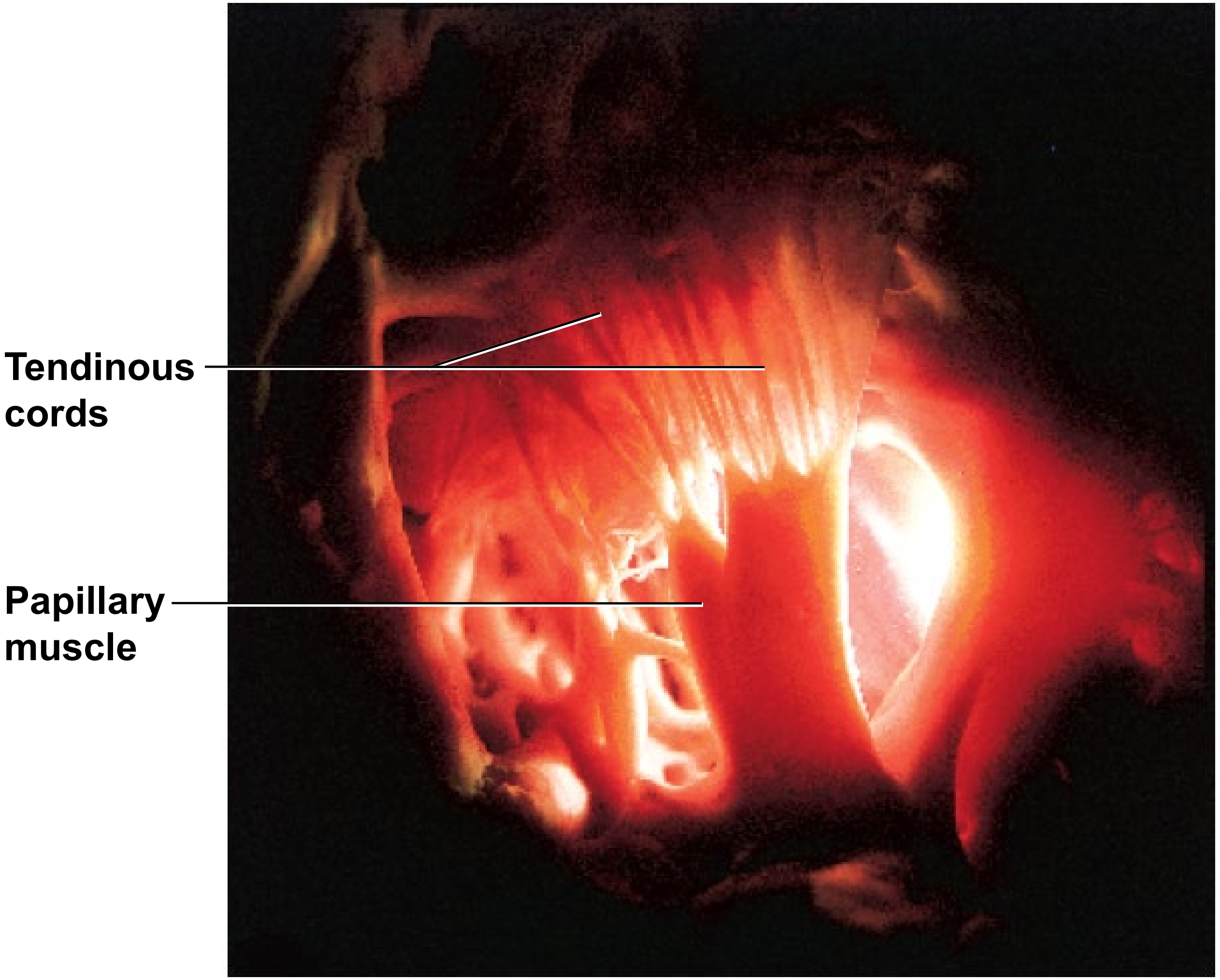
> What do papillary muscles prevent ?

Dissection Shawn Miller, Photograph Mark Nielsen



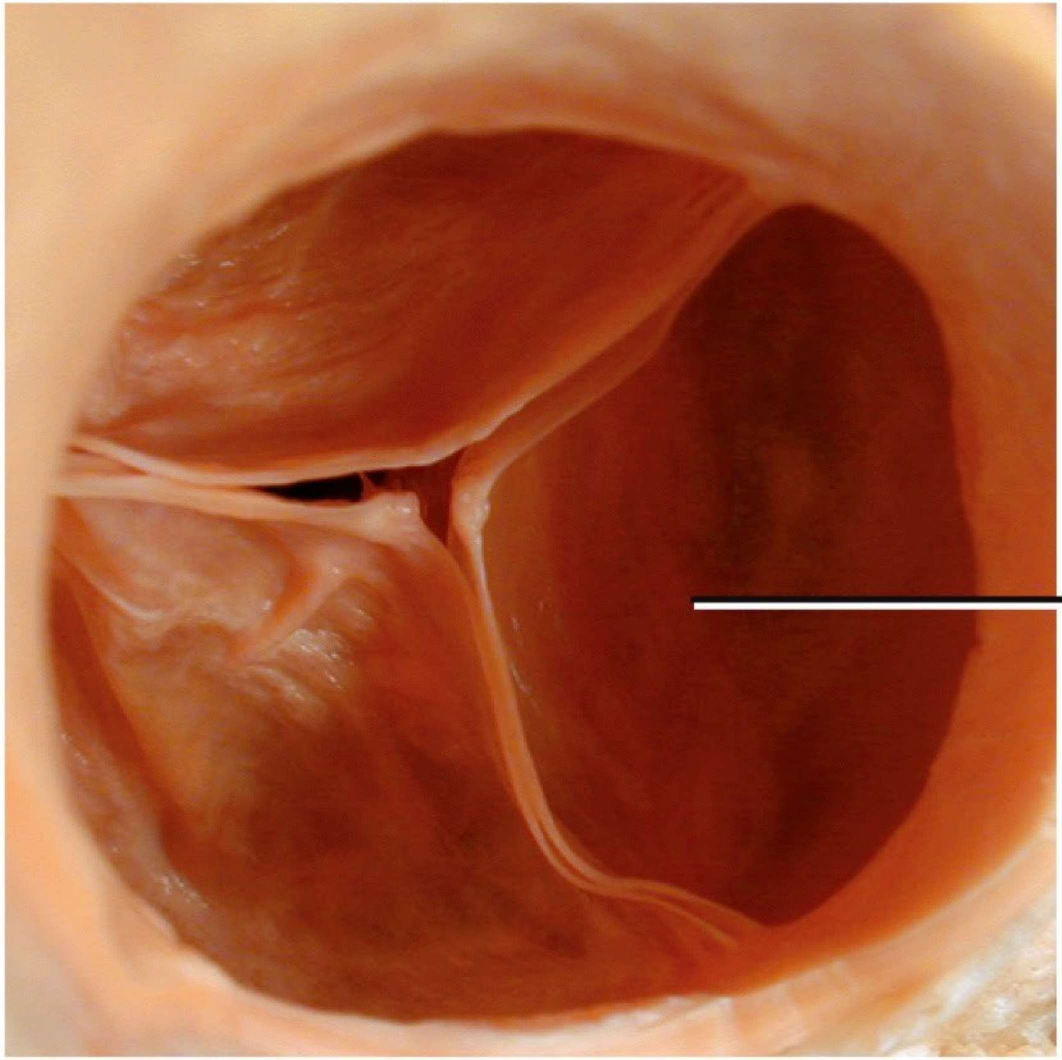
(c) Tricuspid valve open

AV Valves



Endoscopic View of Semi Lunar Heart Valve

Dissection Shawn Miller, Photograph Mark Nielsen



(g) Superior view of aortic valve

No papillary muscles or cordae tendinae

Heart Valve Functions / Atrioventricular

Controls blood flow between atria and ventricles

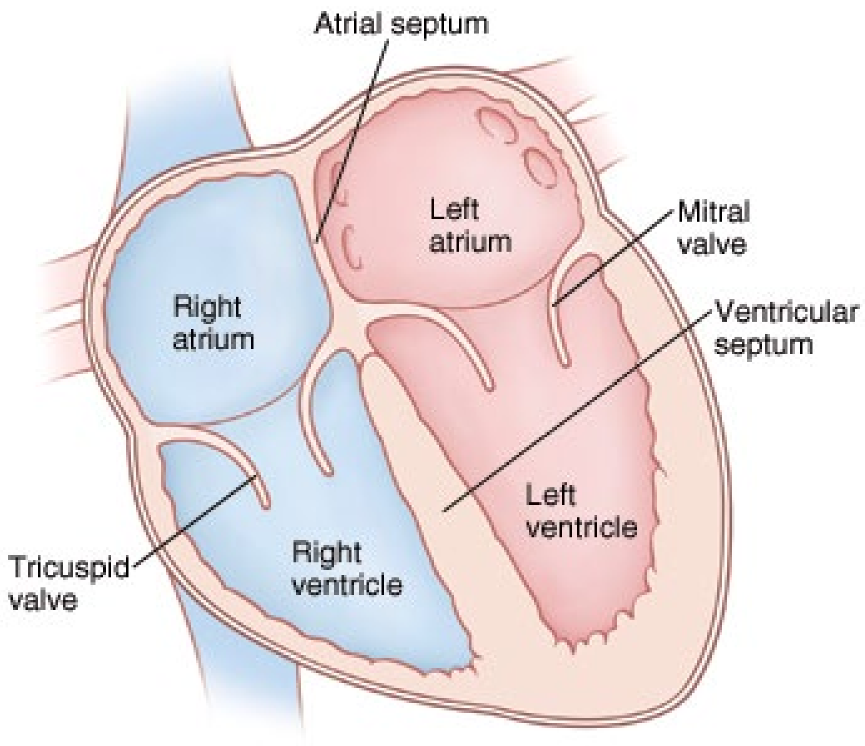
Valves open and close due to blood pressure between chambers guarded by valves

Right AV valve has 3 cusps (tricuspid valve)

Left AV valve has 2 cusps (mitral or bicuspid valve)

<u>Chordae tendineae</u> – connective tissue fibers that connect AV valves to <u>papillary muscles</u> on floor of ventricles

Papillary muscles prevent AV valves from flipping inside out or bulging into the atria when the ventricles contract



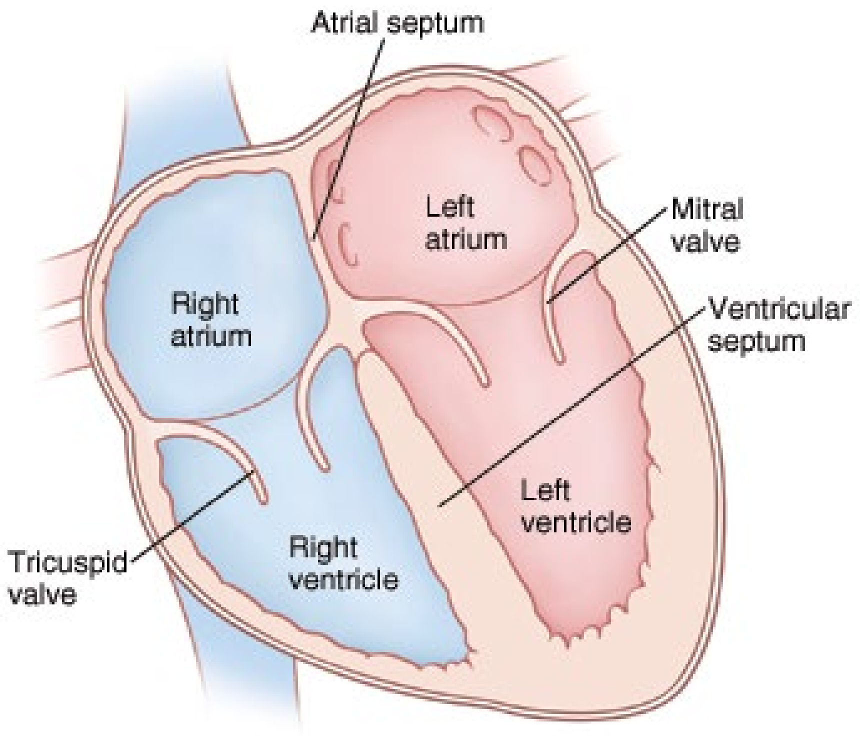
AV Valve Mechanics

When ventricles relax

– Pressure drops inside the ventricles
– Semilunar valves close as blood move into the ventricles
– 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
– Ssemilunar valves open and blood flows into great vessels



Heart Valve Function / Semilunar

Control flow into pulmonary truck 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

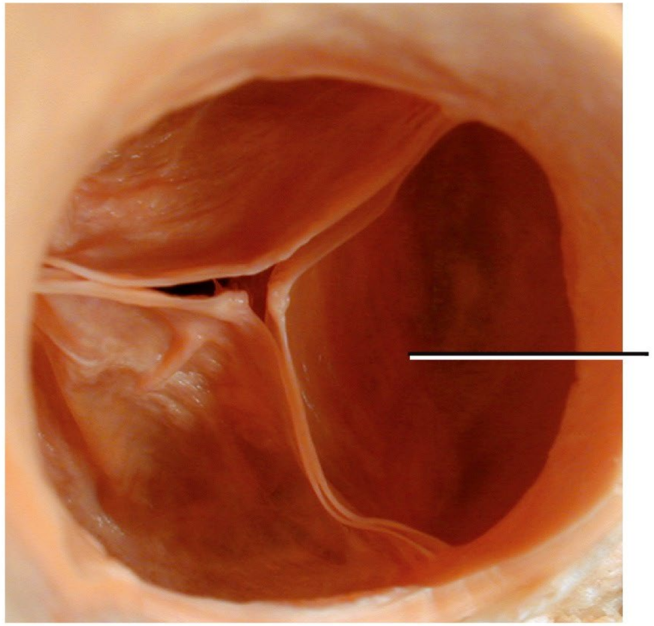
Aortic semilunar valve // between left ventricle and aorta

Semilunar valves do not have chordae tendineae

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.

Dissection Shawn Miller, Photograph Mark Nielsen



(g) Superior view of aortic valve