Cardiovascular system

The Heart

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Cardiovascular system

The bodily system consisting of the heart, blood vessels, and blood that circulates blood throughout the body, delivers nutrients and other essential materials to cells, and removes waste products - called the cardiovascular system.

The cardiovascular system is controlled, primarily, by the cardiac centre in the medulla of the brain.

The cardiovascular System

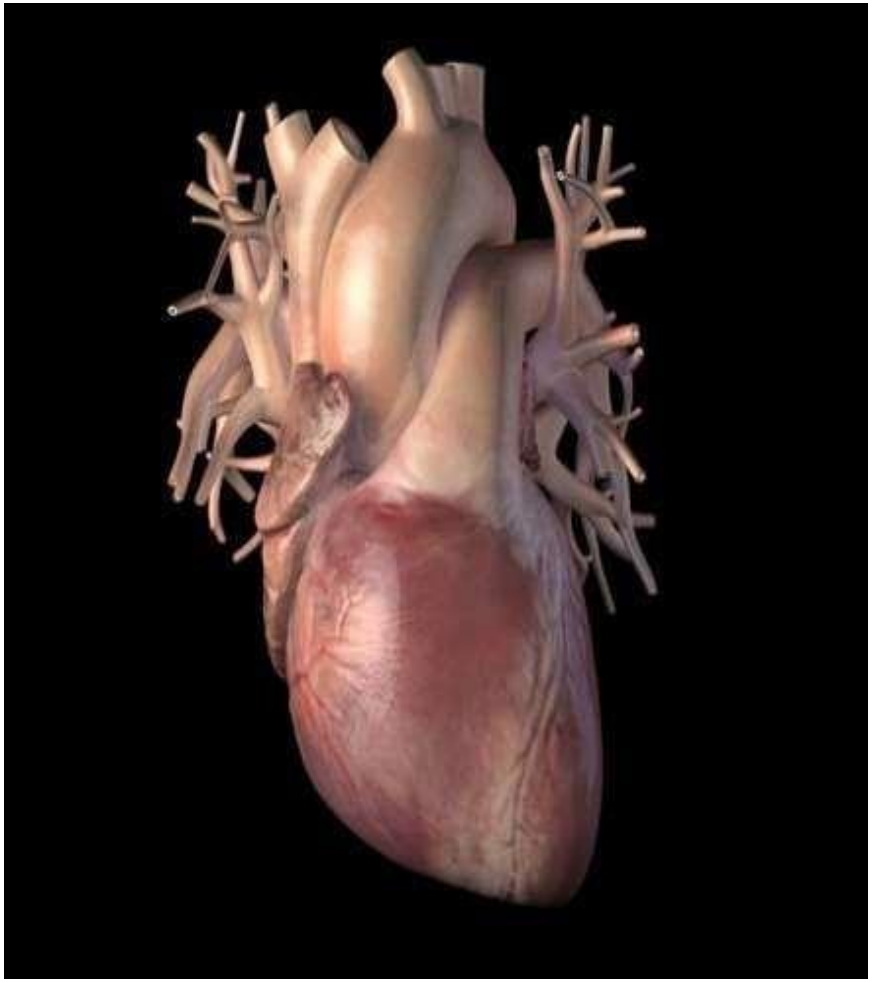
What it consists of:

- Heart
- Blood Vessels
- Blood

What it does:

- Circulates blood throughout the body
- Delivers nutrients to cells
- Removes waste products from cells

The Heart



A hollow muscular organ that pumps the blood through the circulatory system by rhythmic contraction and dilation.

located in the thorax mostly left side in the middle mediastinum

Heart: Anatomy

The heart is a 4-chambered muscular pumping organ made primarily of cardiac muscle tissue.

The heart is divided into 4 chambers:

- 2 upper chambers for receiving blood from the great vessels, known as the right and left atriam and
- 2 stronger lower chambers, known as the right and left ventricles, which pump blood throughout the body.

Blood flows through the heart in 1 direction, moving from the right side of the heart, through the lungs, and then returning to the left side of the heart, where it is pumped out to the rest of the body.

As blood moves through the heart, 4 important valves prevent backflow.

The heart muscle itself is supplied by the coronary arteries.

The heart also has its own conduction system, triggering its own rhythmic contractions.

General Structure and Location of the Heart

Overview of the heart structure

The heart is a 4-chambered muscular Pump made of cardiac muscle tissue.

4 primary muscular chambers:

- Right atrium (RA)
- Right ventricle (RV)
- Left atrium (LA)
- Left ventricle (LV)

Connections to the great vessels:

Veins (bring blood back to the heart):

Superior and inferior vena cava (deoxygenated) → RA

Pulmonary veins (oxygenated) → LA

Arteries(carry blood away):

Pulmonary trunk and pulmonary arteries (deoxygenated) → from the RV

Aorta(oxygenated) → from the LV

Aortic Arch

The aortic arch is a continuation of the ascending aorta and begins at the level of the second sternocostal joint. It arches superiorly, posteriorly and to the left before moving inferiorly.

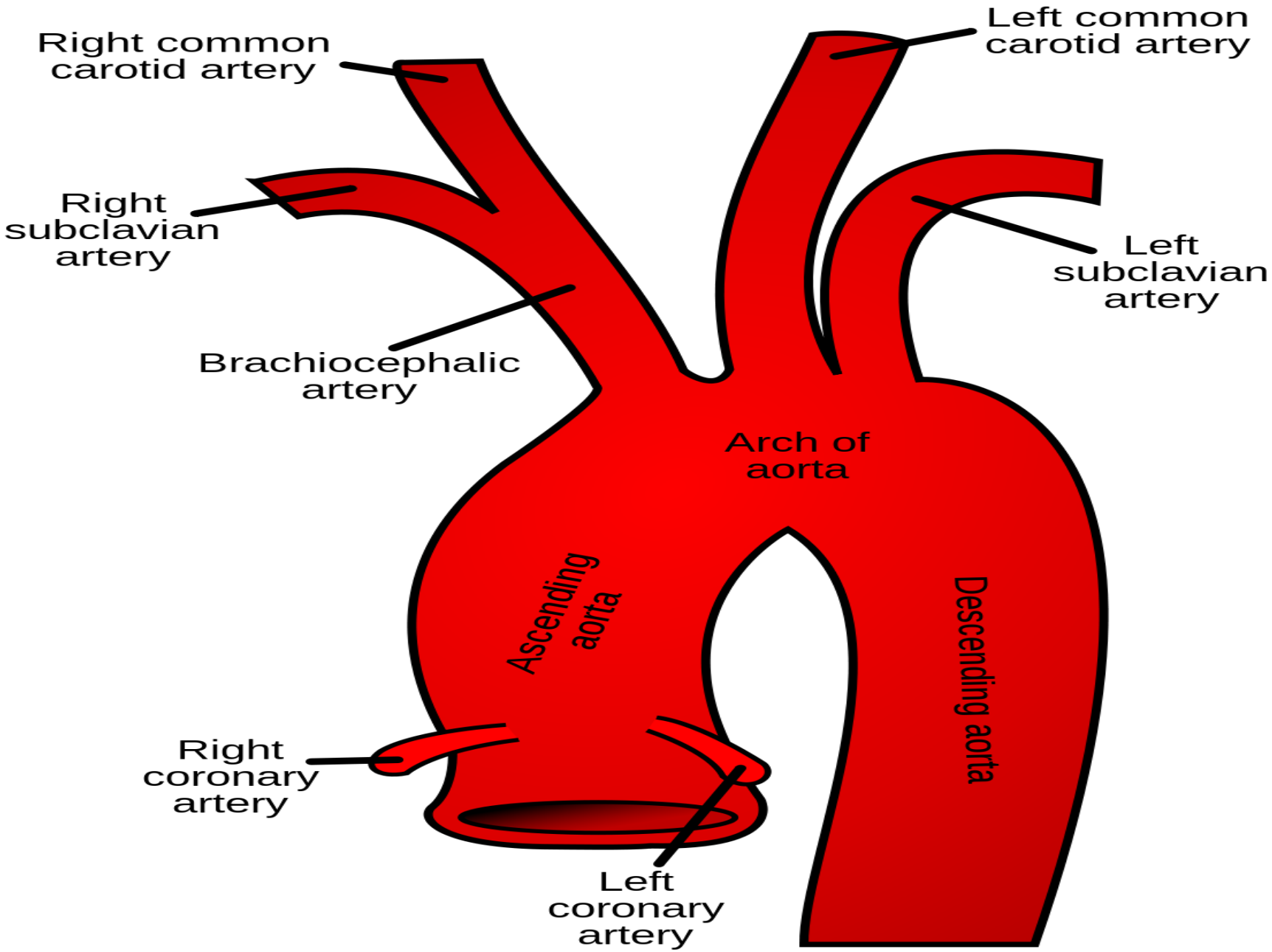
Branches of arch of aorta

There are three major branches arising from the aortic arch. Proximal to distal:

Brachiocephalic trunk: The first and largest branch that ascends laterally to split into the right common carotid and right subclavian arteries. These arteries supply the right side of the head and neck, and the right upper limb.

Left common carotid artery: Supplies the left side of the head and neck.

Left subclavian artery: Supplies the left upper limb.


Right common carotid artery
Left common carotid artery
Right subclavian artery
Left subclavian artery
Brachiocephalic artery
Arch of aorta
Ascending aorta
Descending aorta
Right coronary artery
Left coronary artery

Valves: Located between different vessels and chambers

Blood flows in one direction into, through, and out of the heart; valves prevent backflow.

Named valves (in order through which blood passes):

- Tricuspid valve
- Pulmonic valve
- Mitral valve
- Aortic valve

Opening of the atrium

Superior venacava

Inferior venacava

coronary sinus

Atrioventicular orifice

Opening of the heart

Superior venacava

Inferior venacava

Pulmonary opening

Pulmonary vein

Aortic opening

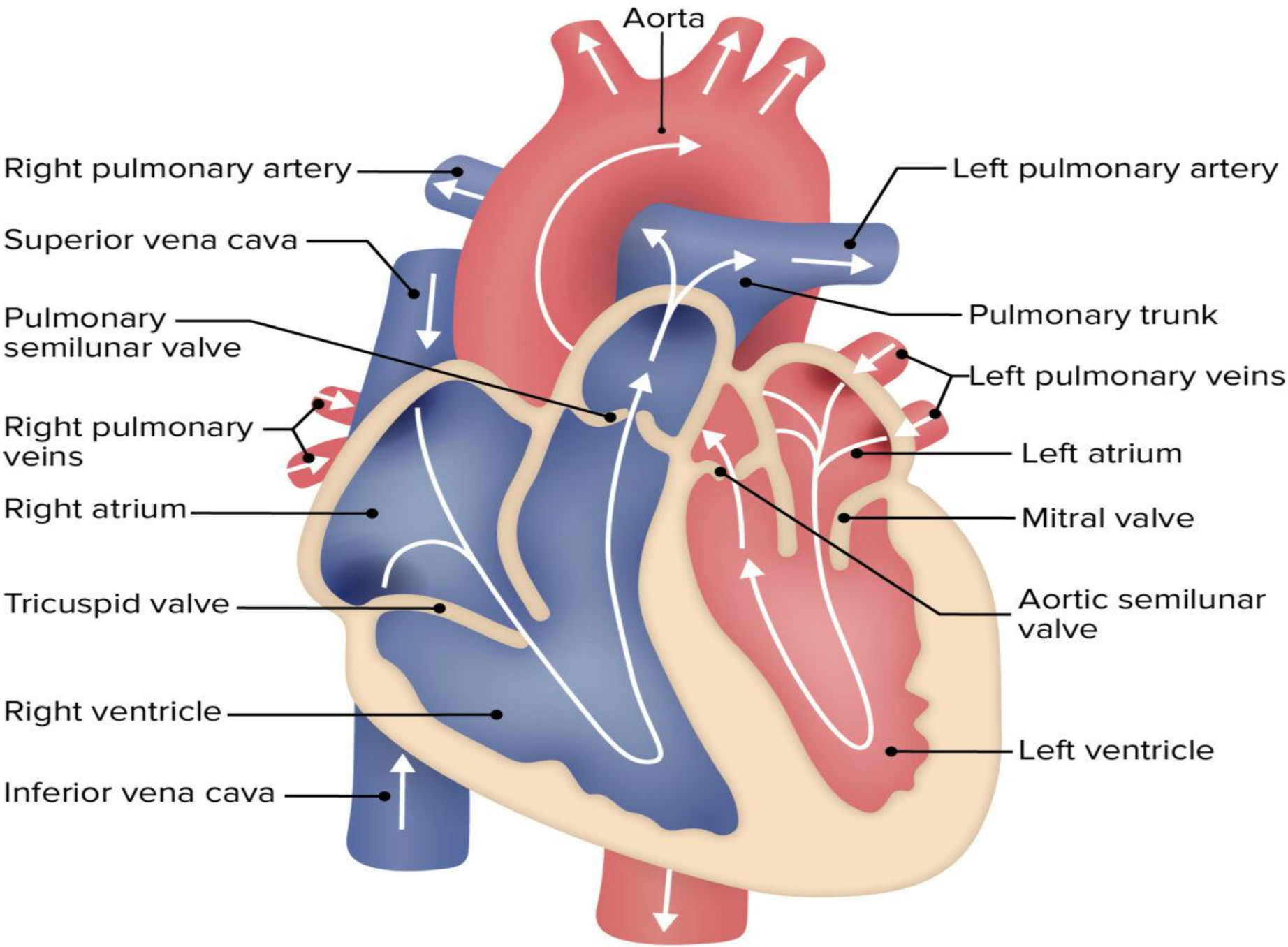
Vasculature:

Heart muscle itself is supplied by the coronary arteries and drained by coronary veins

Conduction system:

Electrical “wiring” that generates and allows conduction of the electrical signal throughout the heart.This electrical signal triggers the heart to contract.

Protective covering: surrounded by a tough 2-layered membrane called the pericardium


Aorta
Right pulmonary artery
Left pulmonary artery
Superior vena cava
Pulmonary semilunar valve
Pulmonary trunk
Left pulmonary veins
Right pulmonary veins
Left atrium
Right atrium
Mitral valve
Tricuspid valve
Aortic semilunar valve
Right ventricle
Left ventricle
Inferior vena cava

Size and shape

Shape: upside-down pyramid or cone

- **Base:** superior portion of the heart, made up of the atrium
- **Apex:** inferior, rounded tip pointing downward and to the left

Dimensions of the adult heart:

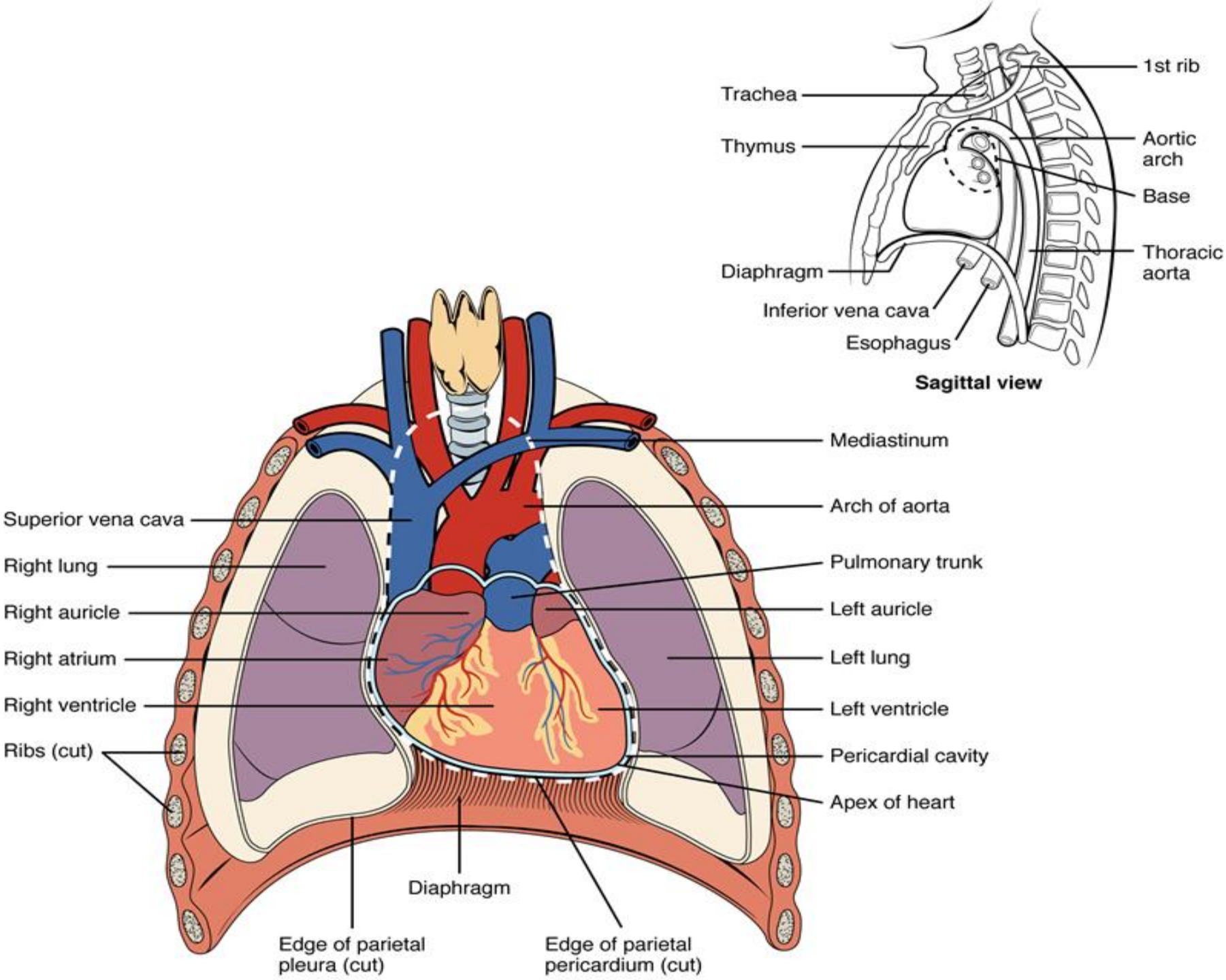
- **Width** (at the base): approximately 9 cm
- **Length** (from base to apex): approximately 13 cm
- **Depth** (thickest point): approximately 6 cm
- **Weight:** approximately 300 g

Location of the Heart

The human heart is located within the thoracic cavity mostly left side ,medially between the lungs in the space known as the middle mediastinum.

The dorsal surface of the heart lies near the bodies of the vertebrae, and its anterior surface sits deep to the sternum and costal cartilages. The great veins, the superior and inferior venae cavae, and the great arteries, the aorta and pulmonary trunk, are attached to the superior surface of the heart, called the base.

The base of the heart is located at the level of the third costal cartilage,
the apex lies just to the left of the sternum between the junction of the fourth and fifth ribs near their articulation with the costal cartilages.
The right side of the heart is deflected anteriorly, and the left side is deflected posteriorly.


1st rib
Trachea
Thymus
Aortic arch
Base
Thoracic aorta
Diaphragm
Inferior vena cava
Esophagus
Sagittal view
Mediastinum
Superior vena cava
Arch of aorta
Right lung
Pulmonary trunk
Right auricle
Left auricle
Right atrium
Left lung
Right ventricle
Left ventricle
Ribs (cut)
Pericardial cavity
Apex of heart
Diaphragm
Edge of parietal pleura (cut)
Edge of parietal pericardium (cut)

Layers of the heart

The Pericardium

the pericardial cavity around the heart is enclosed in a double layer of fibroelastic connective tissue known as pericardium.

Layers of the pericardium

Outer layer: Defines outer layer of pericardial cavity

Made up of :

Fibrous pericardium: dense fibrous tissue

Serous pericardium: thin, smooth, inner serous layer

Fibrous and serous pericardial layers are in direct contact with one another

Anchors the heart to: Diaphragm below,Great vessels above

Visceral pericardium: Directly covers the surface of the heart

Serous layer of connective tissue

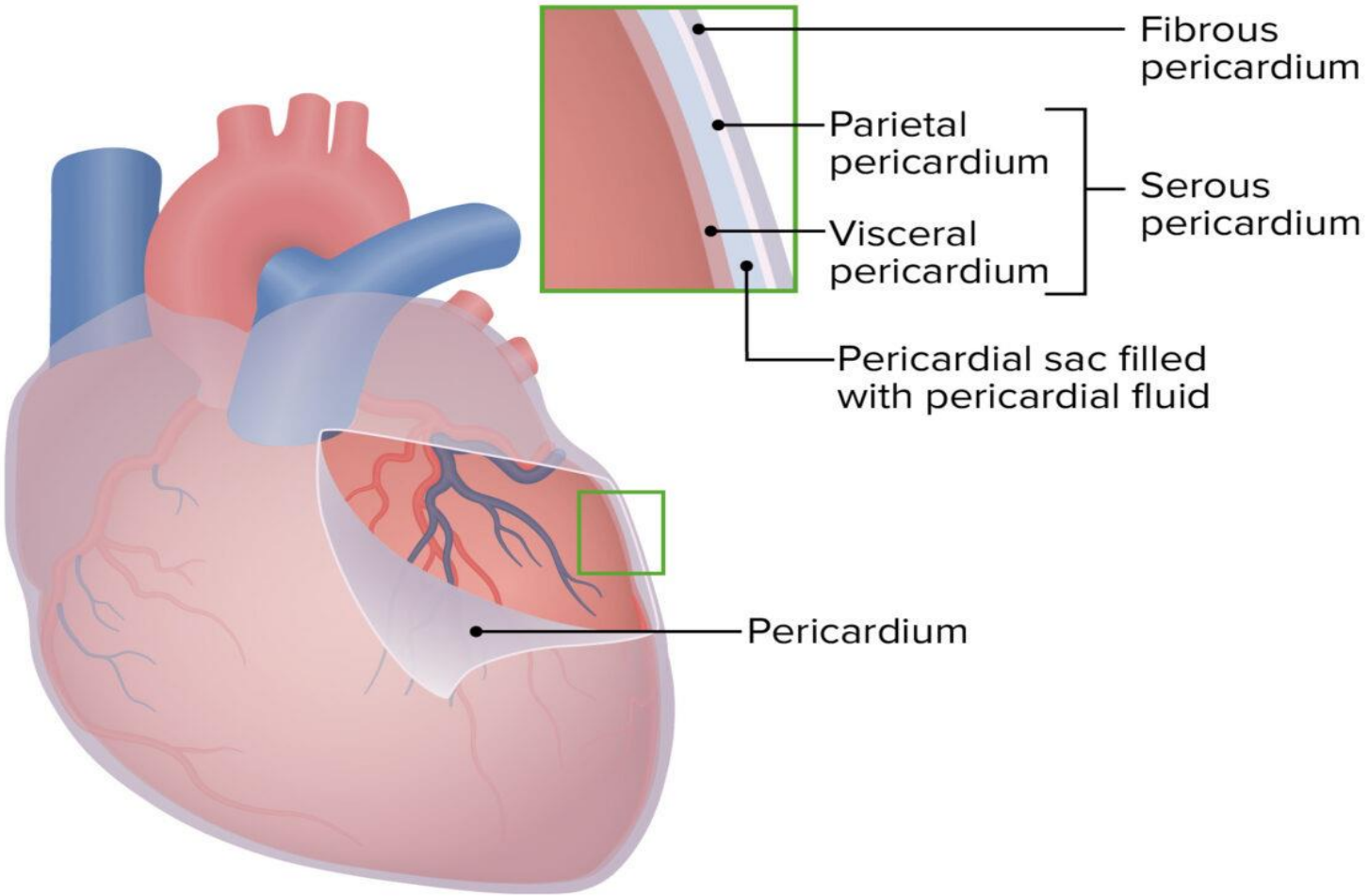
made up of:Simple squamous epithelium

Areolar tissue that fills in grooves on the heart surface → protects the coronary vessels

Also known as the epicardium (outer layer of the heart wall)

Continuous with the parietal pericardium at the base of the heart

Pericardial sac:The space between the parietal and visceral layers of pericardium
Contains about 15–50 mL of pericardial fluid (an ultrafiltrate of plasma)



Layers of the heart wall

Epicardium:

- Outermost layer of the heart
- Formed by the visceral layer of the pericardium

Myocardium:

- Middle muscular layer
- Thickest layer of the heart
- Composed of: Helical layers of cardiac muscle
- Fibrous

Endocardium: Innermost layer

Forms a smooth inner lining within heart and over valves

Continuous with endothelium of blood vessels

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Heart Chambers and Valves

Cardiac chambers

The heart has 4 chambers: 2 atria (receiving chambers) and 2 ventricles (pumping chambers).

RA: Receives deoxygenated blood from the systemic circulation via:

Superior vena cava (SVC): drains the upper portion of the body

Inferior vena cava (IVC): drains the lower portion of the body

Coronary sinus: drains the heart muscle itself

After collecting the blood returning from systemic circulation, RA pumps it into the RV.

Right atrial appendage (auricle): Muscular sac overlying the atria, close to the ascending aorta

Slightly increases atrial capacity

Sinus venarum: Smooth, thin-walled area on the posterior portion of the RA

Entry point of the SVC and IVC into the RA

Pectinate muscles:

Rough, muscular ridges of myocardium

Located on anterior wall and within (both right and left) auricles

Crista terminalis: separation between sinus venarum and pectinate muscles

Interatrial septum: muscular wall separating RA from LA

LA:

Collects oxygenated blood from the:

Left and right superior pulmonary veins

Left and right inferior pulmonary veins

After collecting blood returning from the lungs, LA pumps it into the LV.

RV:

Receives deoxygenated blood from RA through the tricuspid valve Pumps blood out through the pulmonic valve to the pulmonary trunk → lungs

Walls are thicker than those in the RA, but thinner than in the LV.

Trabeculae carneae: internal muscular ridges in the ventricles (similar to the pectinate muscles of the atria)

Papillary muscles: muscles arising from the floor of the RV that control closure of the tricuspid valve

Chordae tendineae: tendinous cord-like structures that connect the papillary muscles to the tricuspid valve

Interventricular septum

(IVS):Wall between RV and LV

Has membranous and muscular components

LV:

Receives oxygenated blood from LA through mitral valve

Pumps blood through aortic valve into aorta → systemic circulation

Has the thickest layer of the myocardium (highest-pressure chamber)

Sulci

Visible grooves on the surface of the heart

Mark the boundaries of the 4 chambers

Contain:

- Coronary vessels
- Adipose tissue

Atrioventricular (AV) sulcus:

- Divides the atria from the ventricles
- Commonly called the coronary sulcus because the coronary vessels run within it

Anterior interventricular sulcus: marks location of IVS on anterior surface of heart

Posterior interventricular sulcus: marks location of IVS on posterior surface of heart

Valves:

Anchored on fibrous rings ,Prevent retrograde flow

Closure produces audible heart sounds on auscultation of the chest

Tricuspid valve:

Between the RA and RV

Also called the right AV valve

3 cusps: anterior, posterior, and septal

Mitral valve:

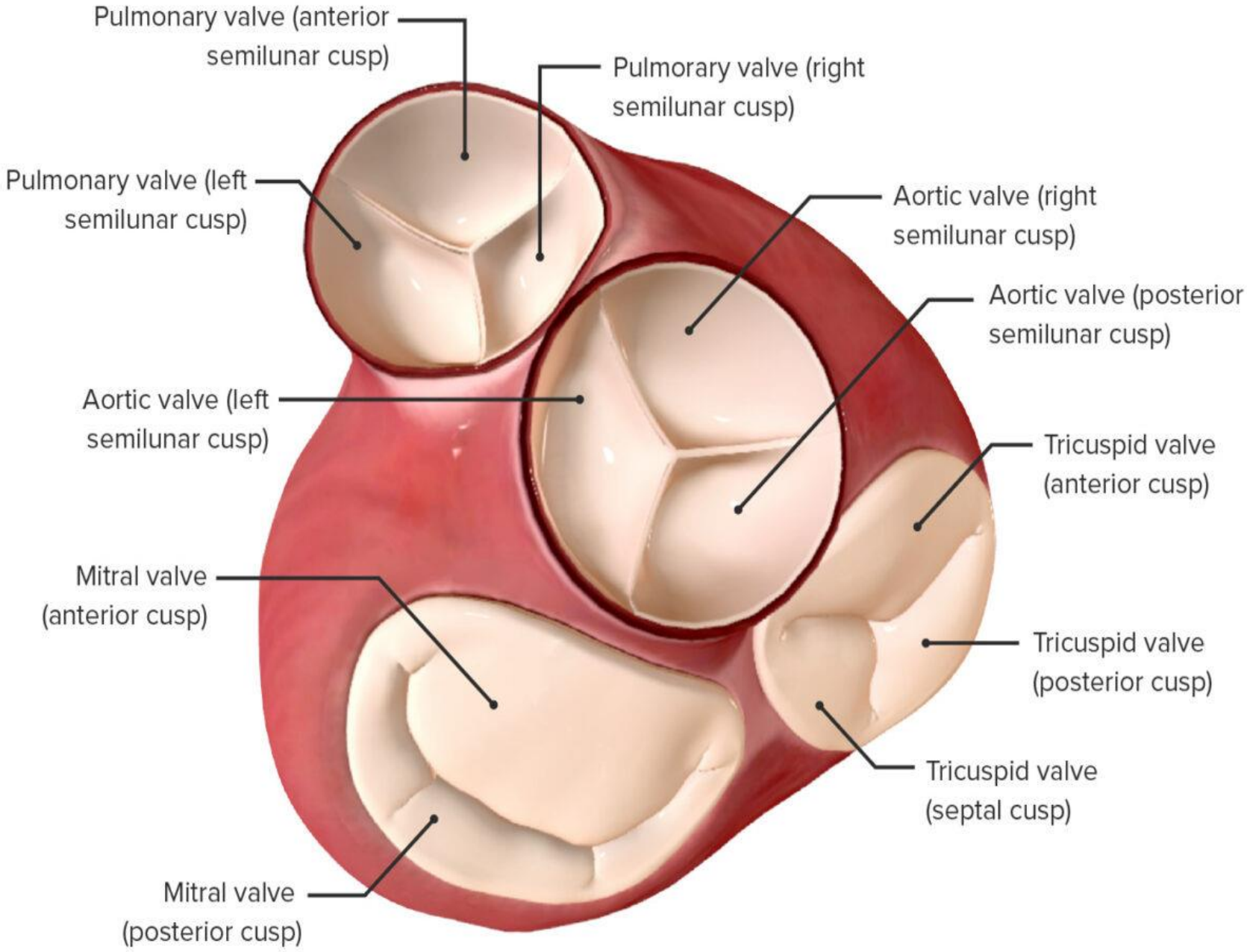
- Between LA and LV
- Also called the left AV valve
- Bicuspid = 2 cusps: anterior and posterior

Pulmonary valve:

- Between RV and pulmonary trunk
- Semilunar in shape, with 3 cusps: right, left, and anterior

Aortic valve:

- Between left ventricle and aorta
- Semilunar in shape, with 3 cusps: right, left, and posterio


Pulmonary valve (anterior semilunar cusp)
Pulmorary valve (right semilunar cusp)
Pulmonary valve (left semilunar cusp)
Aortic valve (right semilunar cusp)
Aortic valve (posterior semilunar cusp)
Aortic valve (left semilunar cusp)
Tricuspid valve (anterior cusp)
Mitral valve (anterior cusp)
Tricuspid valve (posterior cusp)
Tricuspid valve (septal cusp)
Mitral valve (posterior cusp)

Borders and surfaces

- Inferior border
- Left border
- right border

Surfaces of the heart

- diaphragmatic surface
- sternocostal and
- left surfaces.

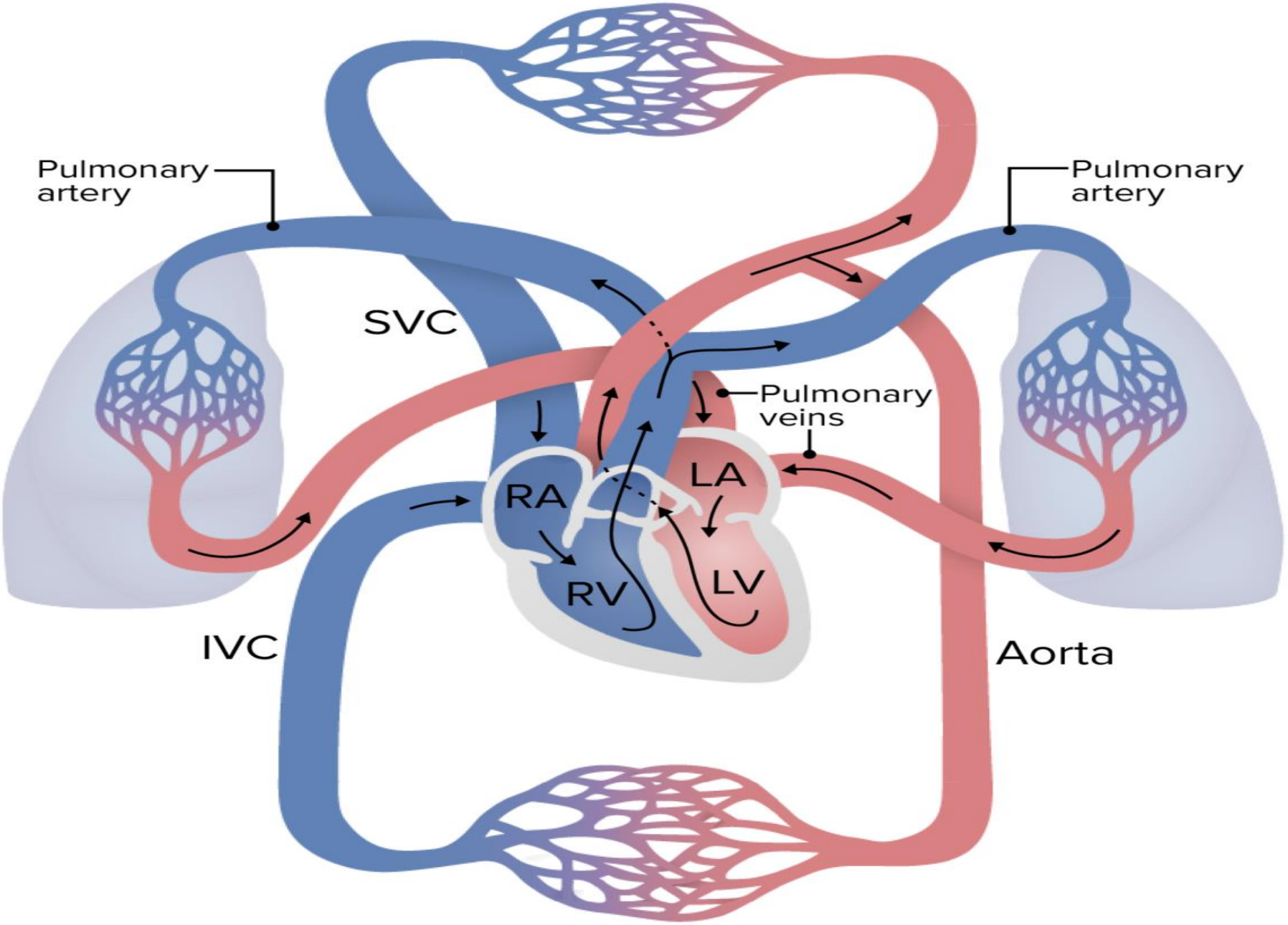
Septums

- Interatrial septum
- Interventricular septum

Blood Flow through the Heart

Blood flows into, through, and out of the heart by sequentially passing through the following structures (in order):

Deoxygenated blood enters the heart via the SVC/IVC → RA → Tricuspid valve → RV → Pulmonary valve → Pulmonary trunk → Pulmonary arteries → Lungs(blood is oxygenated) → Pulmonary veins → LA → Mitral valve → LV → Aortic valve→ Aorta → Systemic arteries → capillaries (blood is deoxygenated) → veins→ SVC/IVC Back to the heart


Pulmonary artery
Pulmonary artery
SVC
Pulmonary veins
RA
LA
RV
LV
IVC
Aorta

Circulation of blood through the body:
Deoxygenated blood enters the right side of the heart and passes through the pulmonary trunk to the lungs, where it is oxygenated. The blood then returns to the left side of the heart via the pulmonary veins, where it is pumped into the aorta and distributed throughout the body. The blood travels through systemic capillaries, where it is deoxygenated again, and travels back to the heart via the superior and inferior vena cava.

Coronary Circulation

Coronary circulation describes the flow of blood through the vessels supplying the heart muscle itself. There are 2 primary coronary arteries: the left and the right, and both originate from the aorta, just above the aortic valve.

Left coronary artery (LCA)

Runs posterior to the pulmonary trunk→ around the left side of the heart under the left auricle in the coronary (AV) sulcus

Branches into:

Anterior interventricular artery:

Commonly referred to as the left anterior descending (LAD) artery

Travels down the anterior interventricular sulcus toward the apex

Supplies the septum and anterior wall of both ventricles

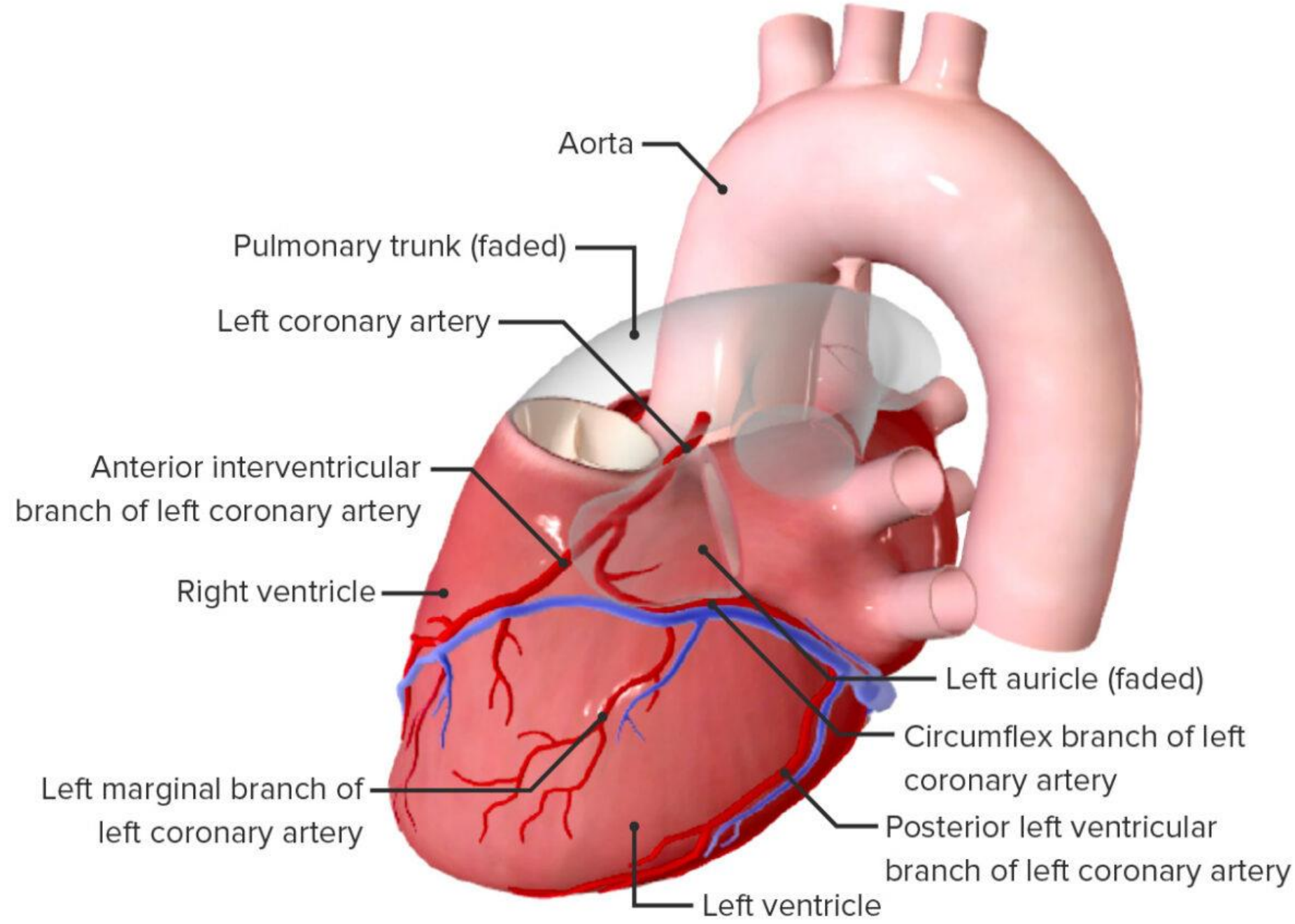
Clinical relevance: artery most frequently occluded, causing MI

Circumflex artery:

Continuous around the left side of the heart in the coronary sulcus

Anastomoses with small branches of the right coronary artery

Supplies the LA and posterior wall of the LV


Aorta
Pulmonary trunk (faded)
Left coronary artery
Anterior interventricular branch of left coronary artery
Right ventricle
Left auricle (faded)
Circumflex branch of left coronary artery
Left marginal branch of left coronary artery
Posterior left ventricular branch of left coronary artery
Left ventricle

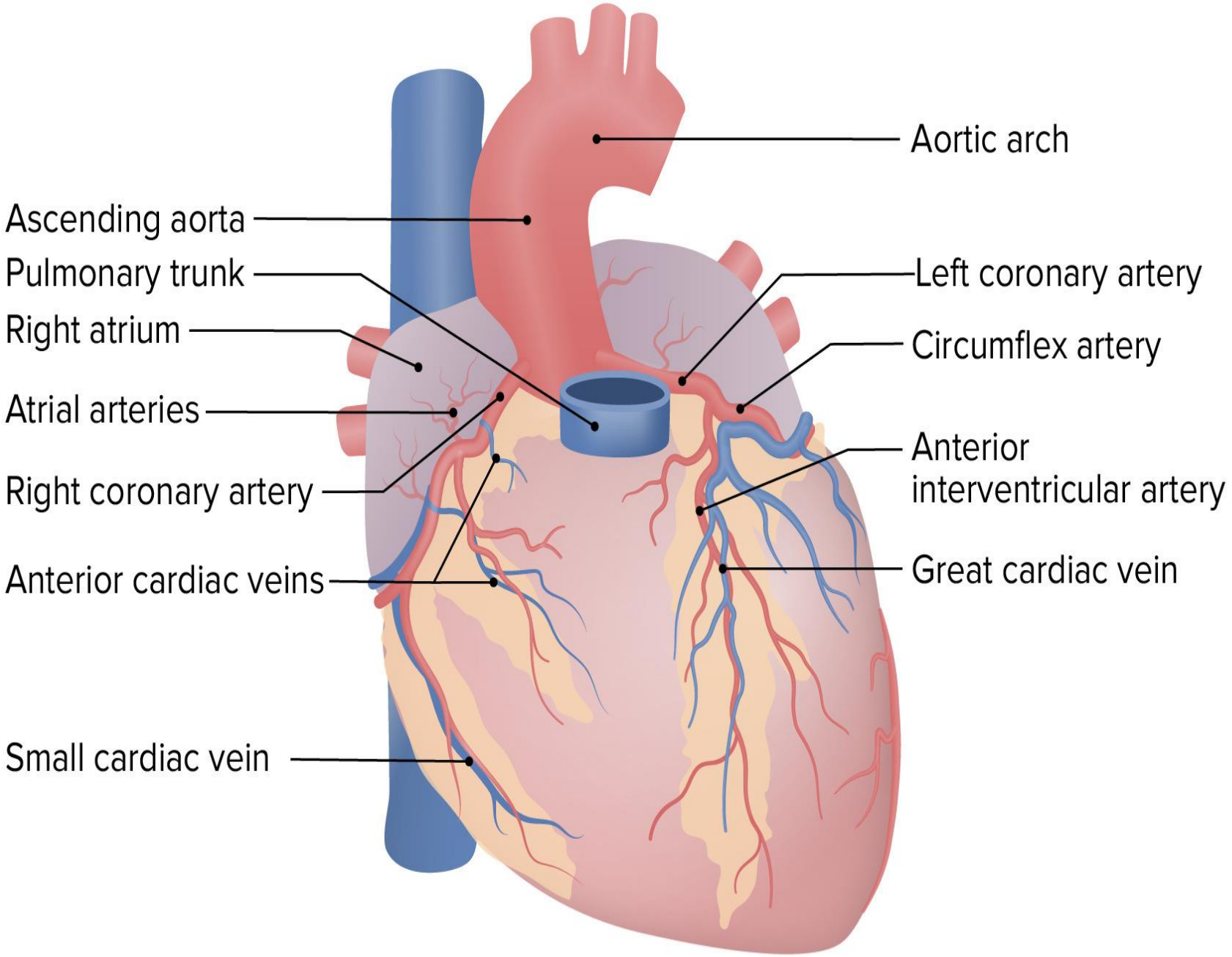
Right coronary artery (RCA)

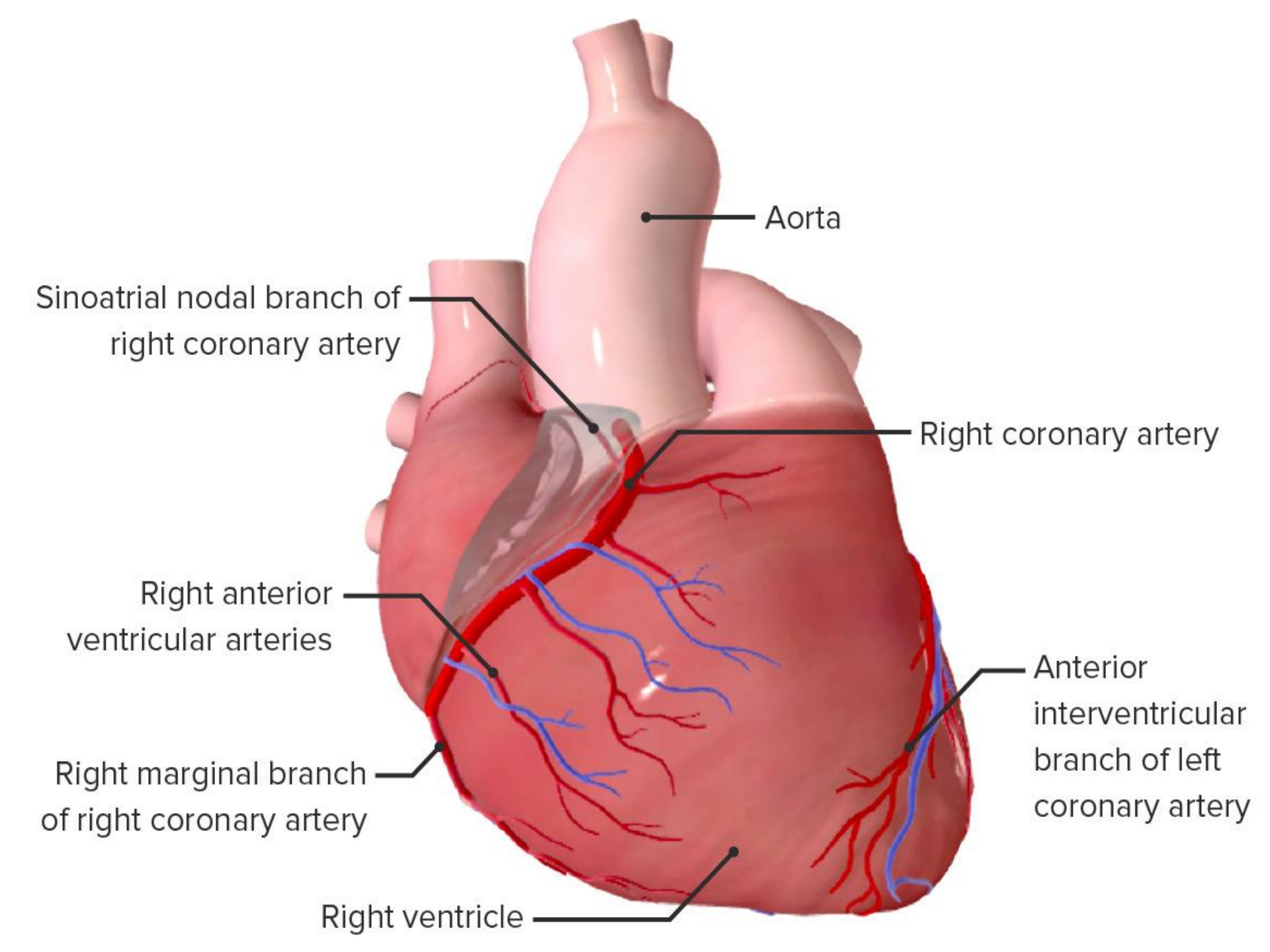
Runs around the right side of the heart, under the right auricle in the coronary sulcus

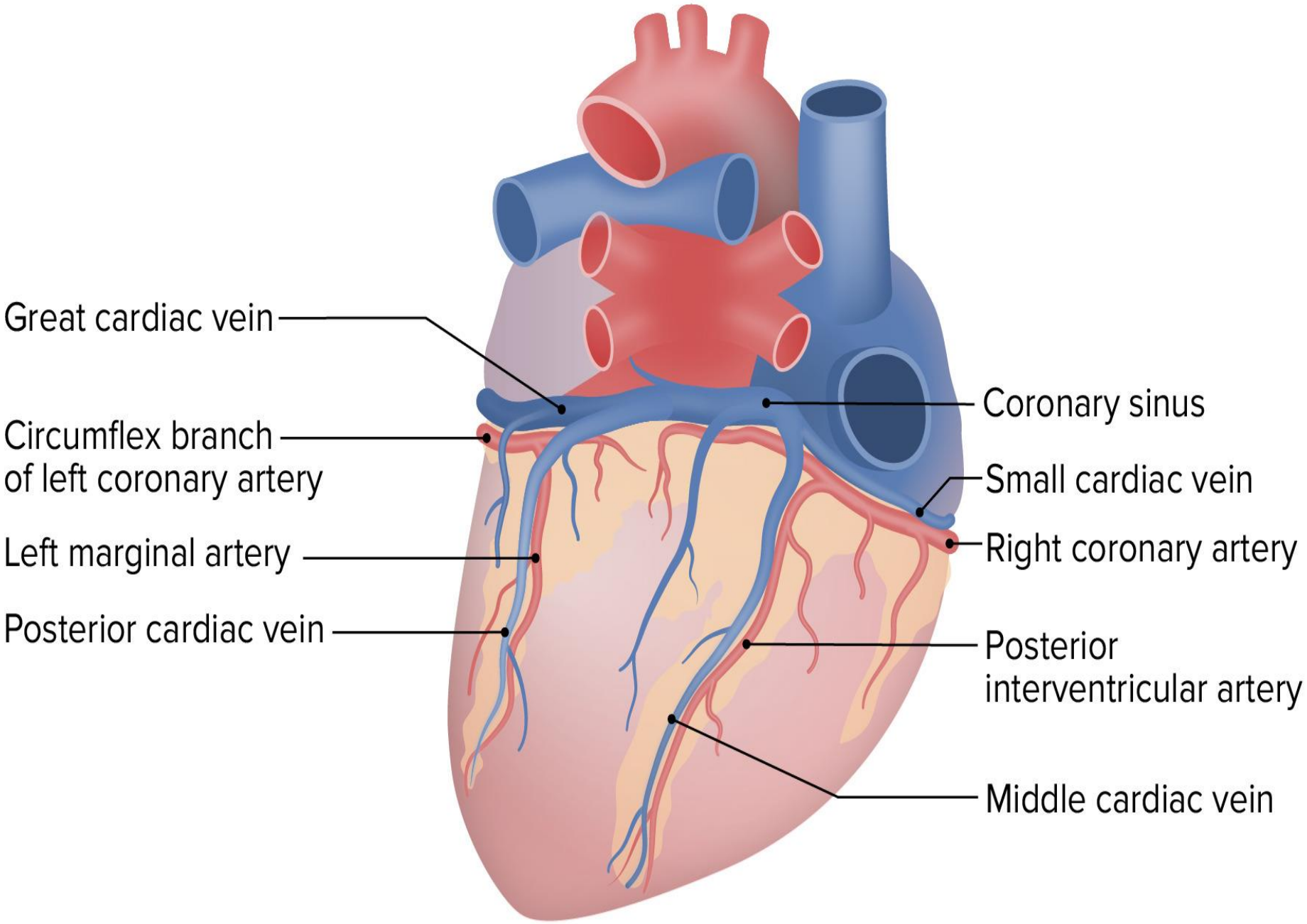
Primary blood supply for:

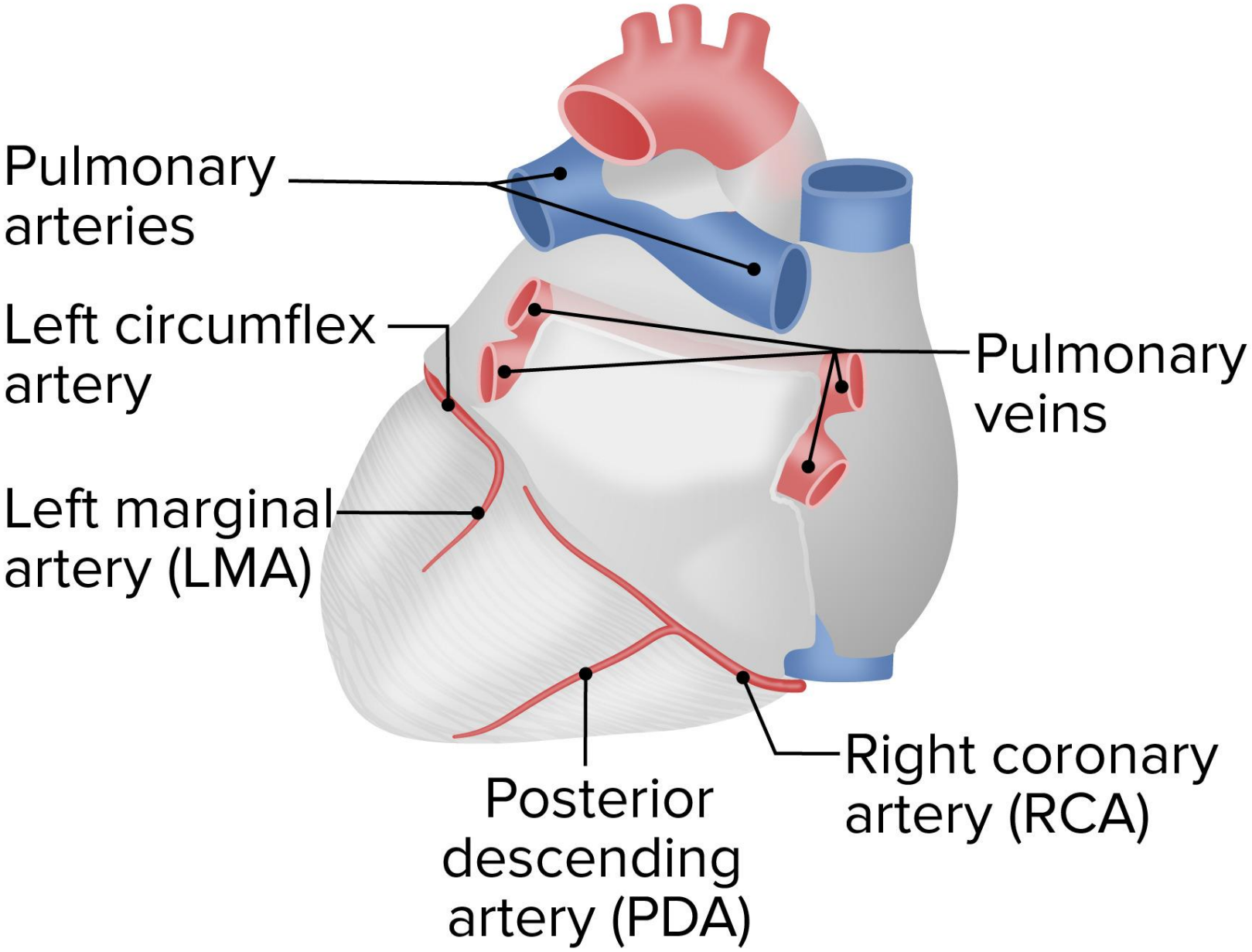
- Right atrium
- Parts of both ventricles
- Conduction system (clinical relevance: occlusion of the RCA is associated with arrhythmias)

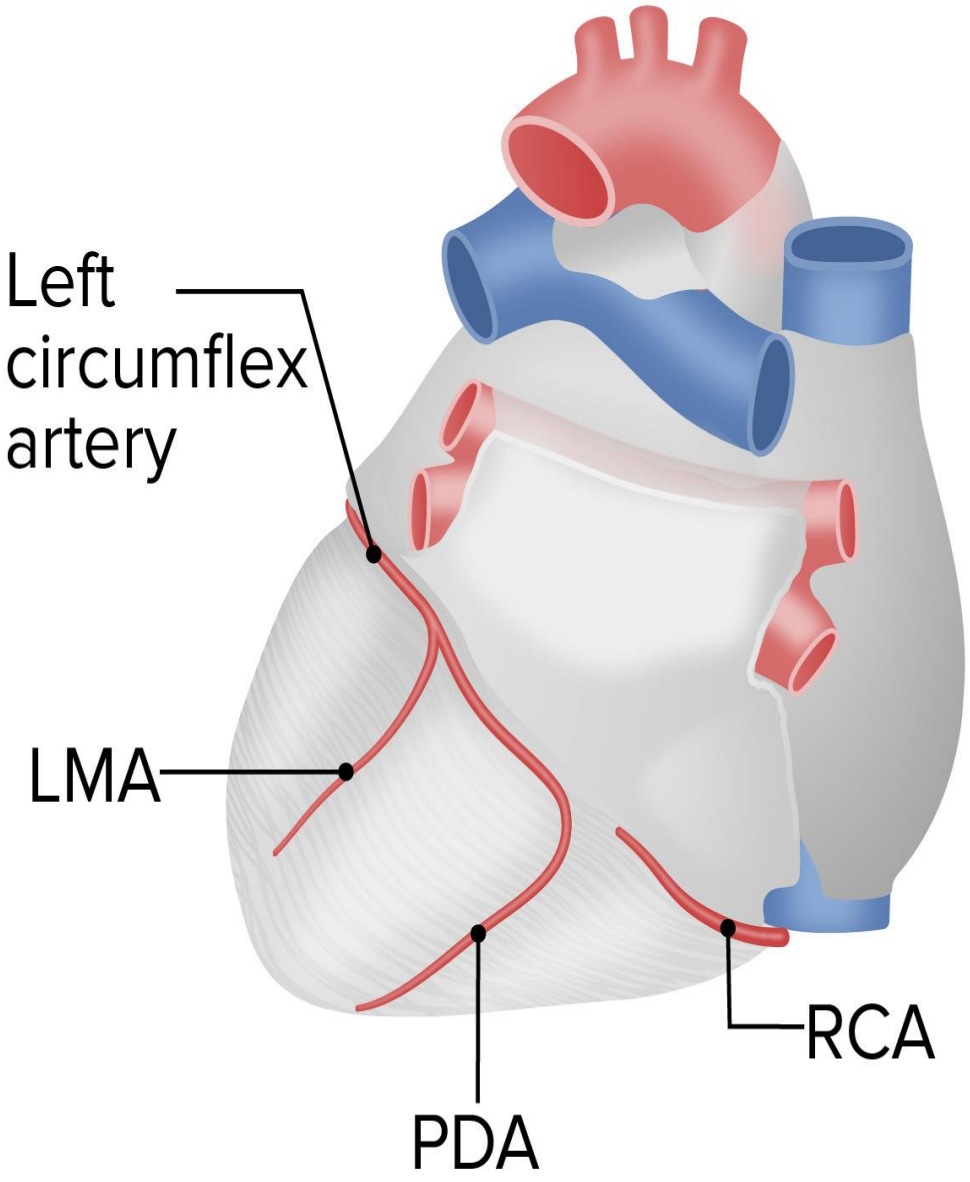
Branches into:
Posterior interventricular artery:
Commonly referred to as the posterior descending artery (PDA)
Travels down the posterior interventricular sulcus toward the apex
Supplies the posterior wall of both ventricles
Right marginal artery: supplies the lateral aspect of the RA and RV

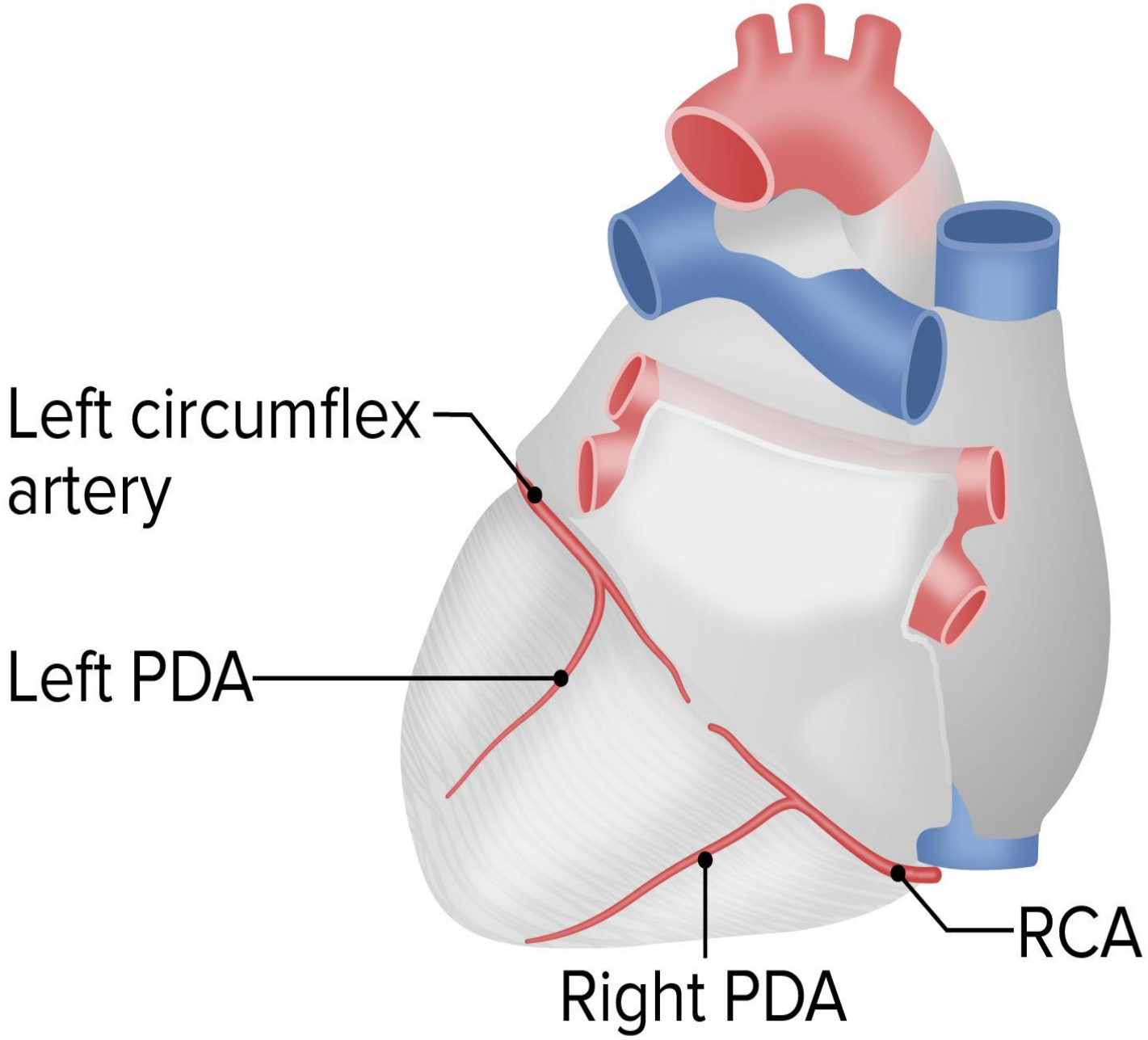

Aortic arch
Ascending aorta
Pulmonary trunk
Right atrium
Atrial arteries
Right coronary artery
Anterior cardiac veins
Small cardiac vein
Left coronary artery
Circumflex artery
Anterior interventricular artery
Great cardiac vein


Aorta
Sinoatrial nodal branch of right coronary artery
Right coronary artery
Right anterior ventricular arteries
Anterior interventricular branch of left coronary artery
Right marginal branch of right coronary artery
Right ventricle


Great cardiac vein
Circumflex branch of left coronary artery
Left marginal artery
Posterior cardiac vein
Coronary sinus
Small cardiac vein
Right coronary artery
Posterior interventricular artery
Middle cardiac vein


Pulmonary arteries
Left circumflex artery
Left marginal artery (LMA)
Pulmonary veins
Right coronary artery (RCA)
Posterior descending artery (PDA)


Left
circumflex
artery
LMA
PDA
RCA


Left circumflex artery
Left PDA
Right PDA
RCA

Coronary veins

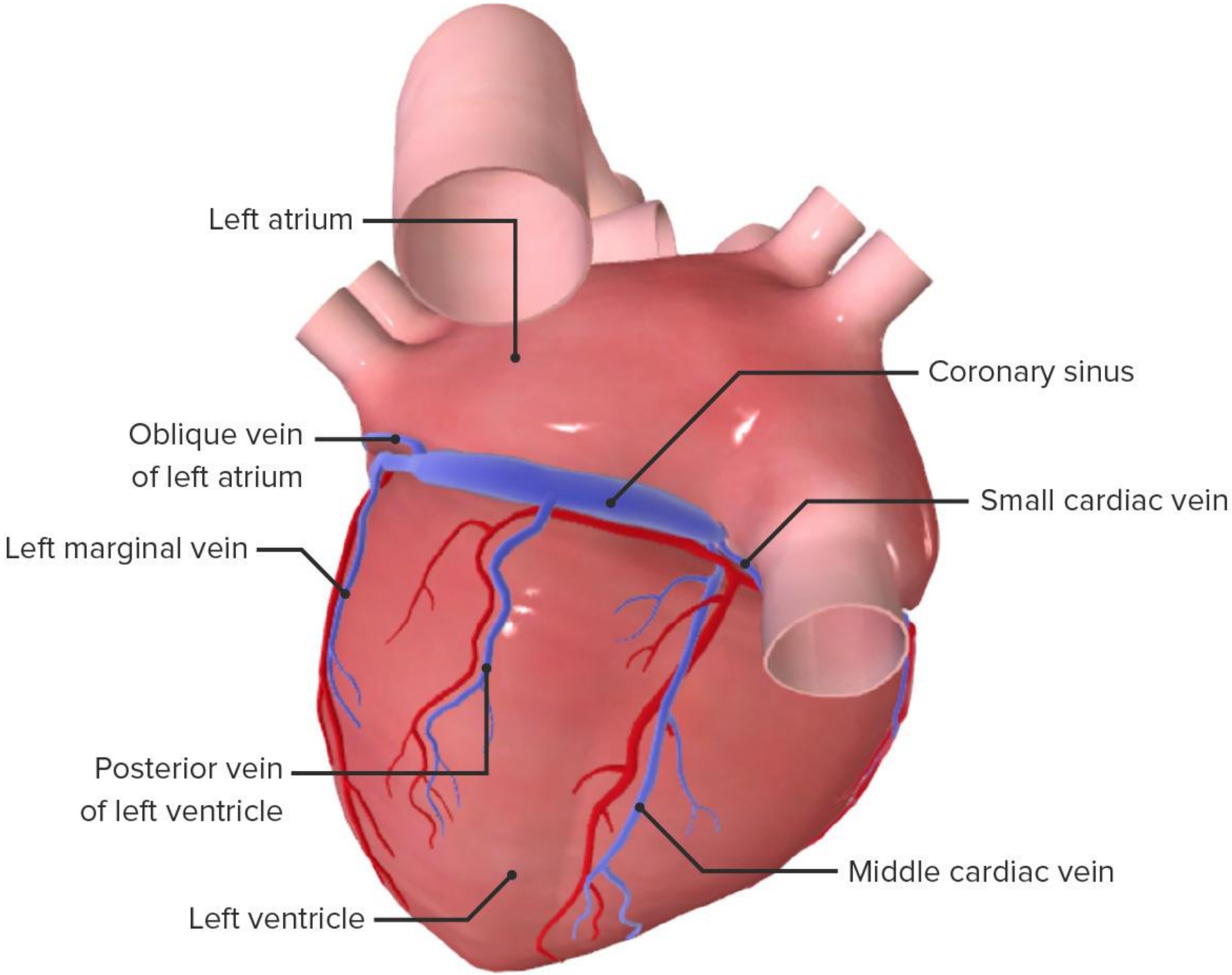
Great cardiac vein:

- Drains the anterior side of the heart
- Travels with the LAD in the anterior IV sulcus

Middle cardiac vein:

- Drains the posterior side of the heart
- Travels with the PDA in the posterior IV sulcus

The great and middle cardiac veins
drain into the coronary sinus, which:
Lies in the left posterior AV sulcus
Drains directly into the RA
Approximately 20% of the coronary circulation
drains directly into the right ventricle via small vessels


Left atrium
Coronary sinus
Oblique vein
of left atrium
Small cardiac vein
Left marginal vein
Posterior vein
of left ventricle
Middle cardiac vein
Left ventricle

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