

Cardiovascular system

AND

Respirator system

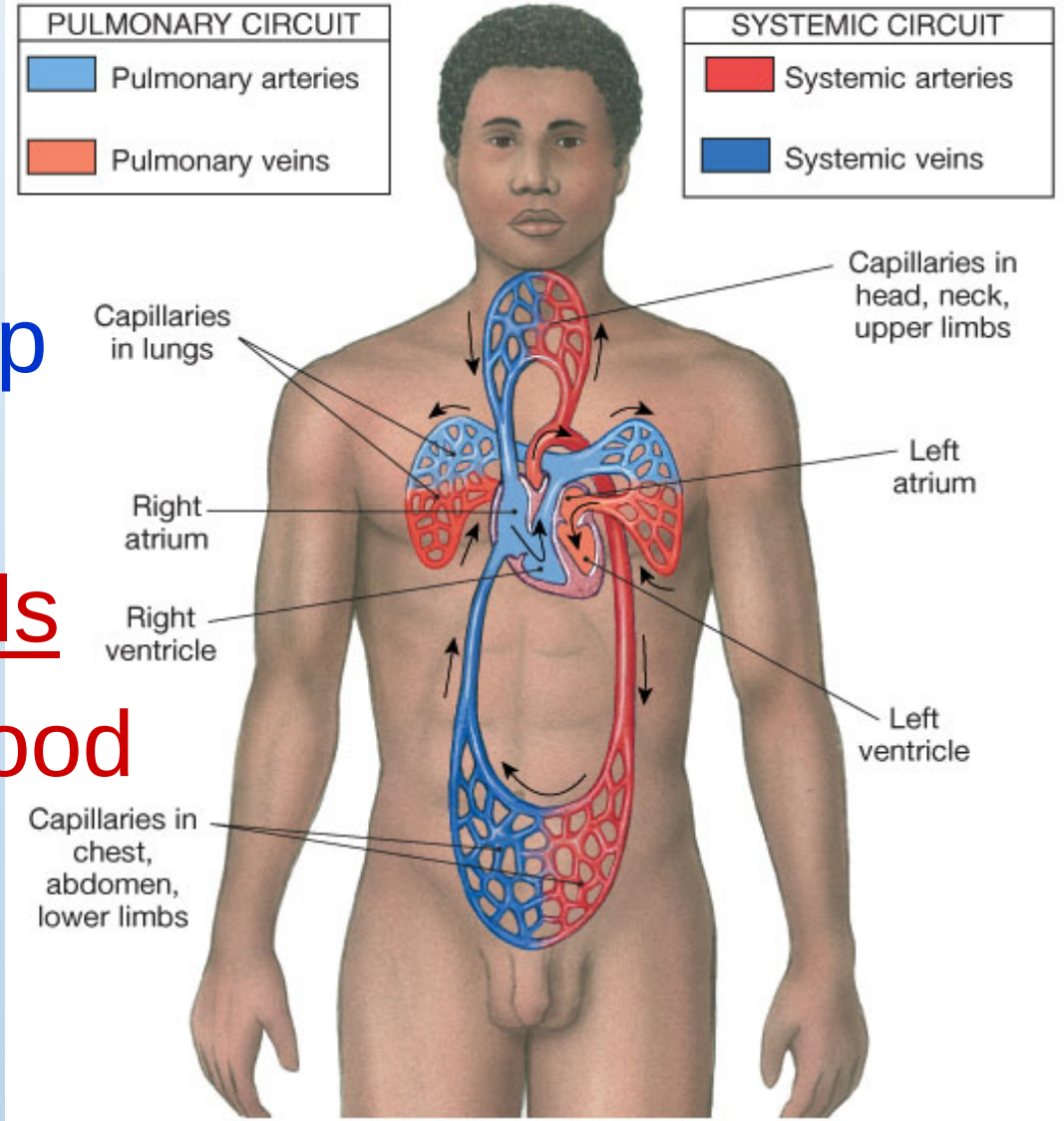
The Cardiovascular System

Heart

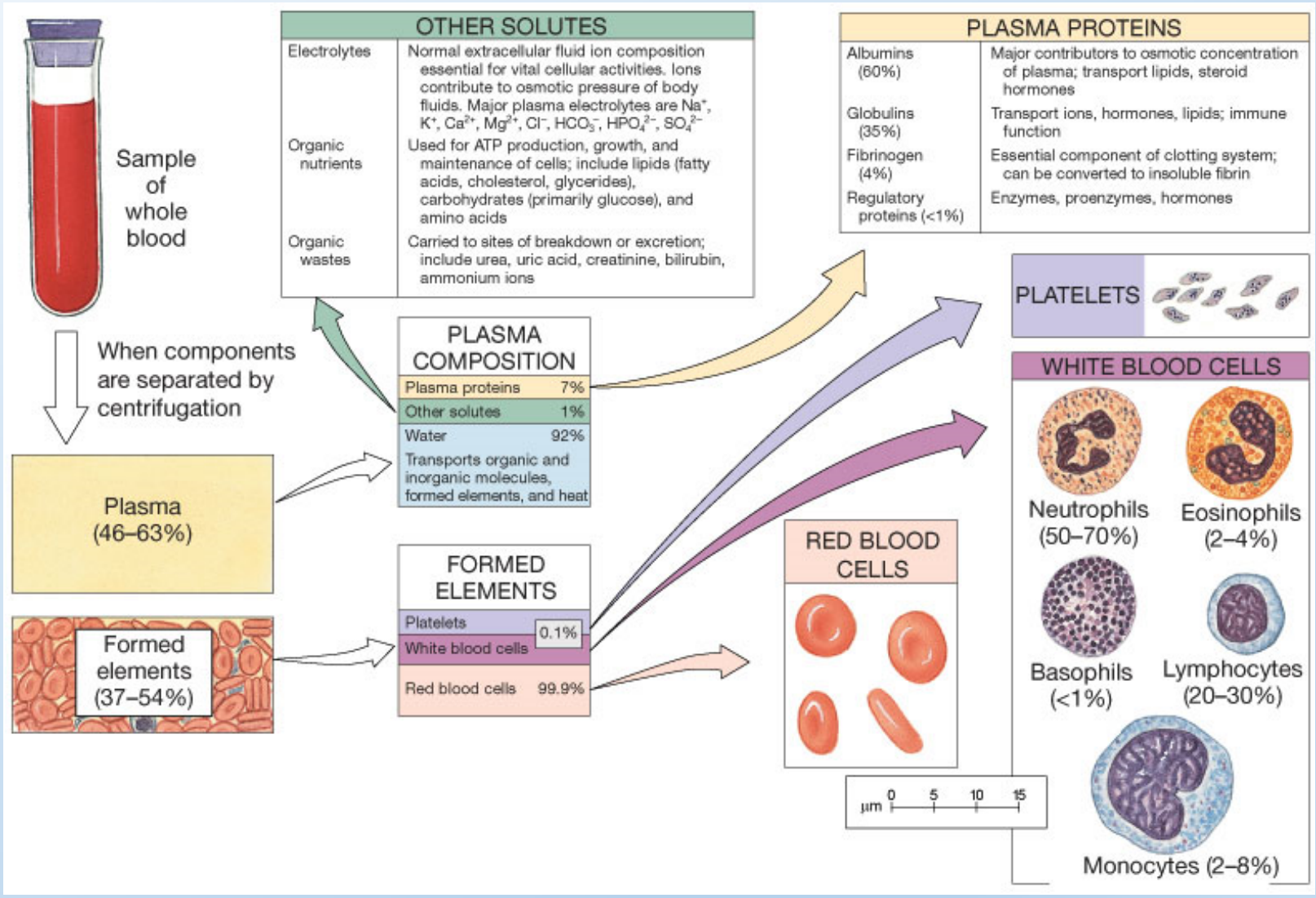
Central Pump

Blood Vessels

Transport Blood



Blood


Sample of whole blood
When components are separated by centrifugation
Plasma (46–63%)
Formed elements (37–54%)
OTHER SOLUTES
Electrolytes
Normal extracellular fluid ion composition essential for vital cellular activities. Ions contribute to osmotic pressure of body fluids. Major plasma electrolytes are Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, HPO_4^{2-}, SO_4^{2-}
Organic nutrients
Used for ATP production, growth, and maintenance of cells; include lipids (fatty acids, cholesterol, glycerides), carbohydrates (primarily glucose), and amino acids
Organic wastes
Carried to sites of breakdown or excretion; include urea, uric acid, creatinine, bilirubin, ammonium ions
PLASMA COMPOSITION
Plasma proteins 7%
Other solutes 1%
Water 92%
Transports organic and inorganic molecules, formed elements, and heat
FORMED ELEMENTS
Platelets
White blood cells
0.1%
Red blood cells 99.9%
PLASMA PROTEINS
Albumins (60%)
Major contributors to osmotic concentration of plasma; transport lipids, steroid hormones
Globulins (35%)
Transport ions, hormones, lipids; immune function
Fibrinogen (4%)
Essential component of clotting system; can be converted to insoluble fibrin
Regulatory proteins (<1%)
Enzymes, proenzymes, hormones
PLATELETS
WHITE BLOOD CELLS
Neutrophils (50–70%)
Eosinophils (2–4%)
Basophils (<1%)
Lymphocytes (20–30%)
Monocytes (2–8%)
RED BLOOD CELLS
µm 0 5 10 15

Blood = Plasma + Formed (Cellular) Elements

Plasma

- ~ 55% blood volume
- ~ 92% of plasma is water

- High dissolved O_2 content
- Dissolved proteins
- Minerals, glucose, ions.

Cells

- ~ 45% blood volume
- RBCs (~ 99% of cells)
- WBCs (~ 1% of cells)

The Proteins in Plasma

- **Albumins**
 - 60% of plasma proteins.
- **Globulins**
 - 35% of plasma proteins.
- **Fibrinogen**
 - For clotting reaction, forms *Fibrin*.

* serum = plasma without clotting proteins

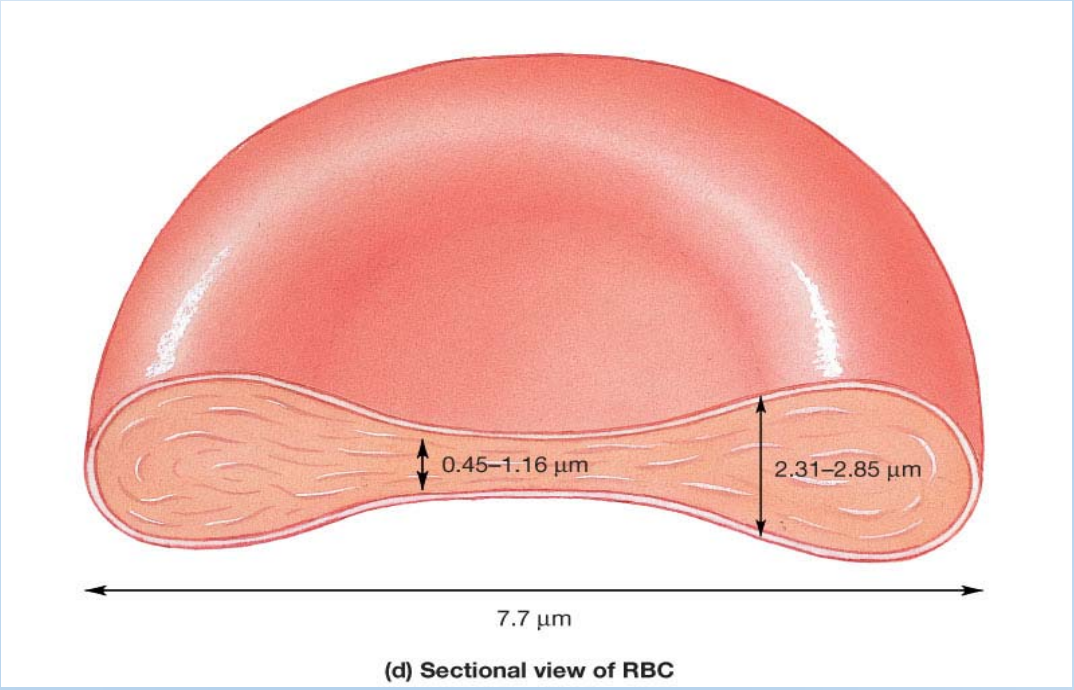
Cellular Components

RBCs (erythrocytes) ~ 99% of all cells.

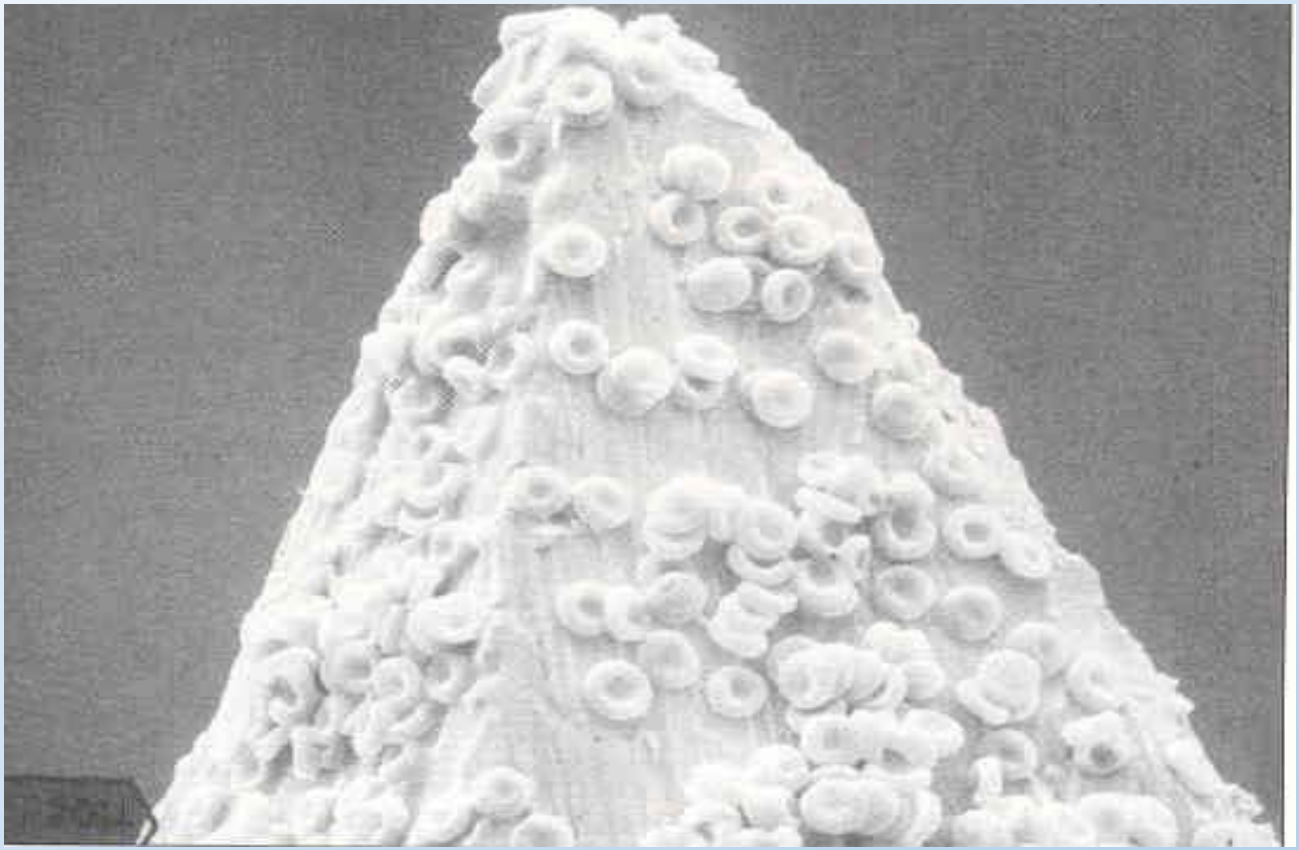
***Hematocrit* = % of blood occupied by cellular components.**
(packed RBC volume)

Lacks: nuclei,
mitochondria
and ribosomes.

Anaerobic metabolism
Life span = ~120 days

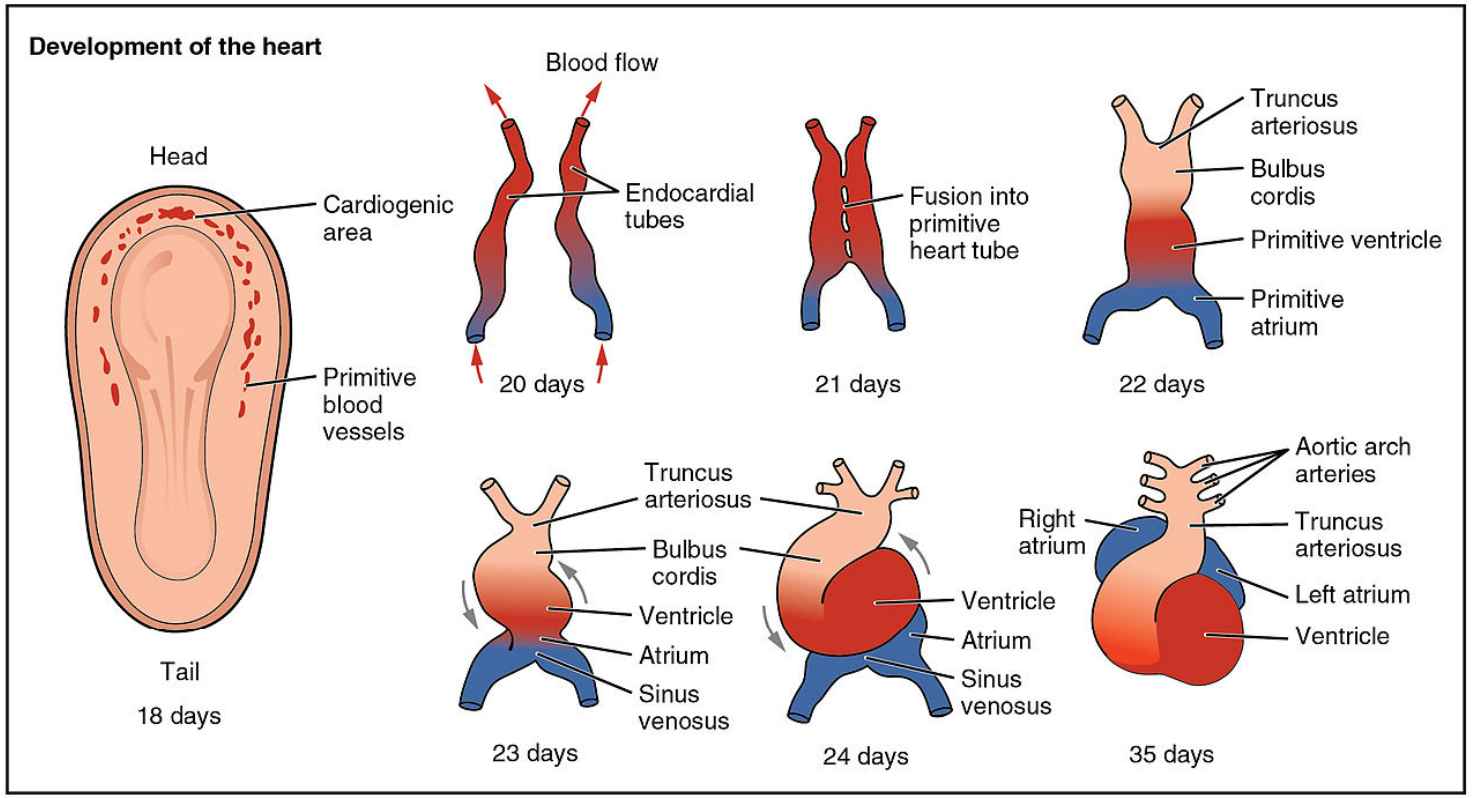


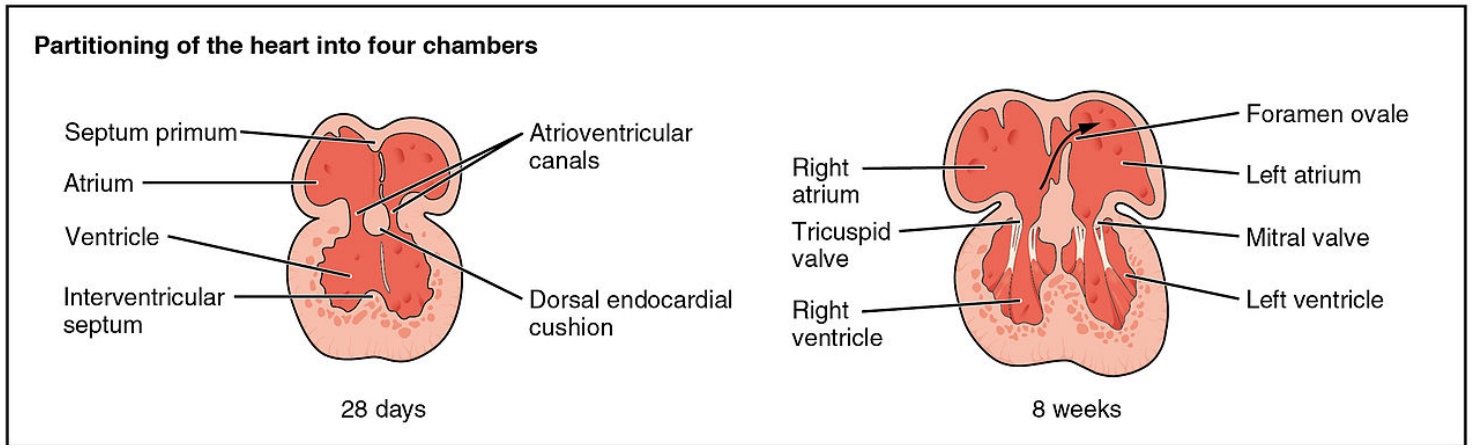
(d) Sectional view of RBC



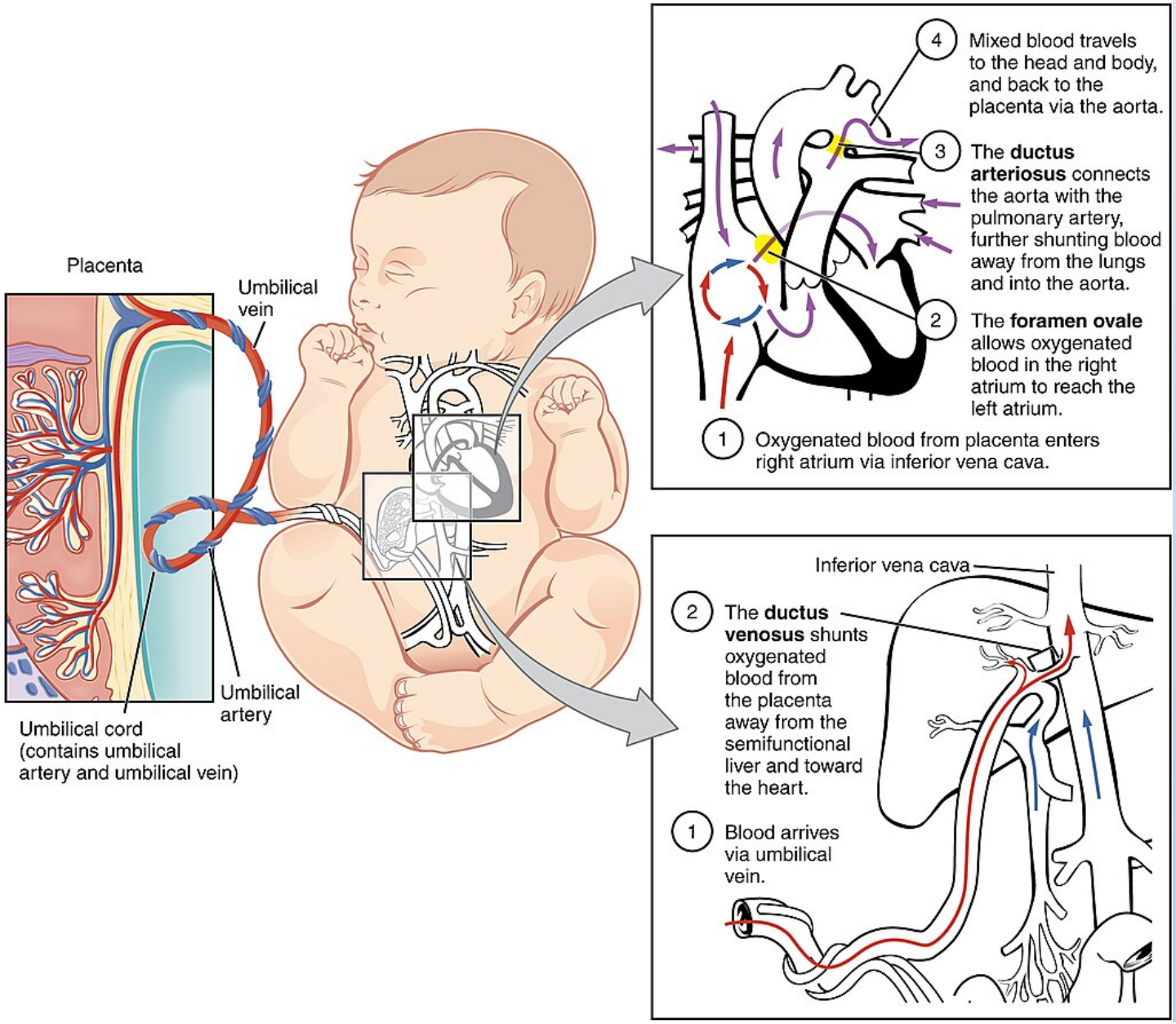
Scanning Electron Micrograph (SEM) of Erythrocytes or Red Blood Cells (RBCs) on the tip of a hypodermic needle.

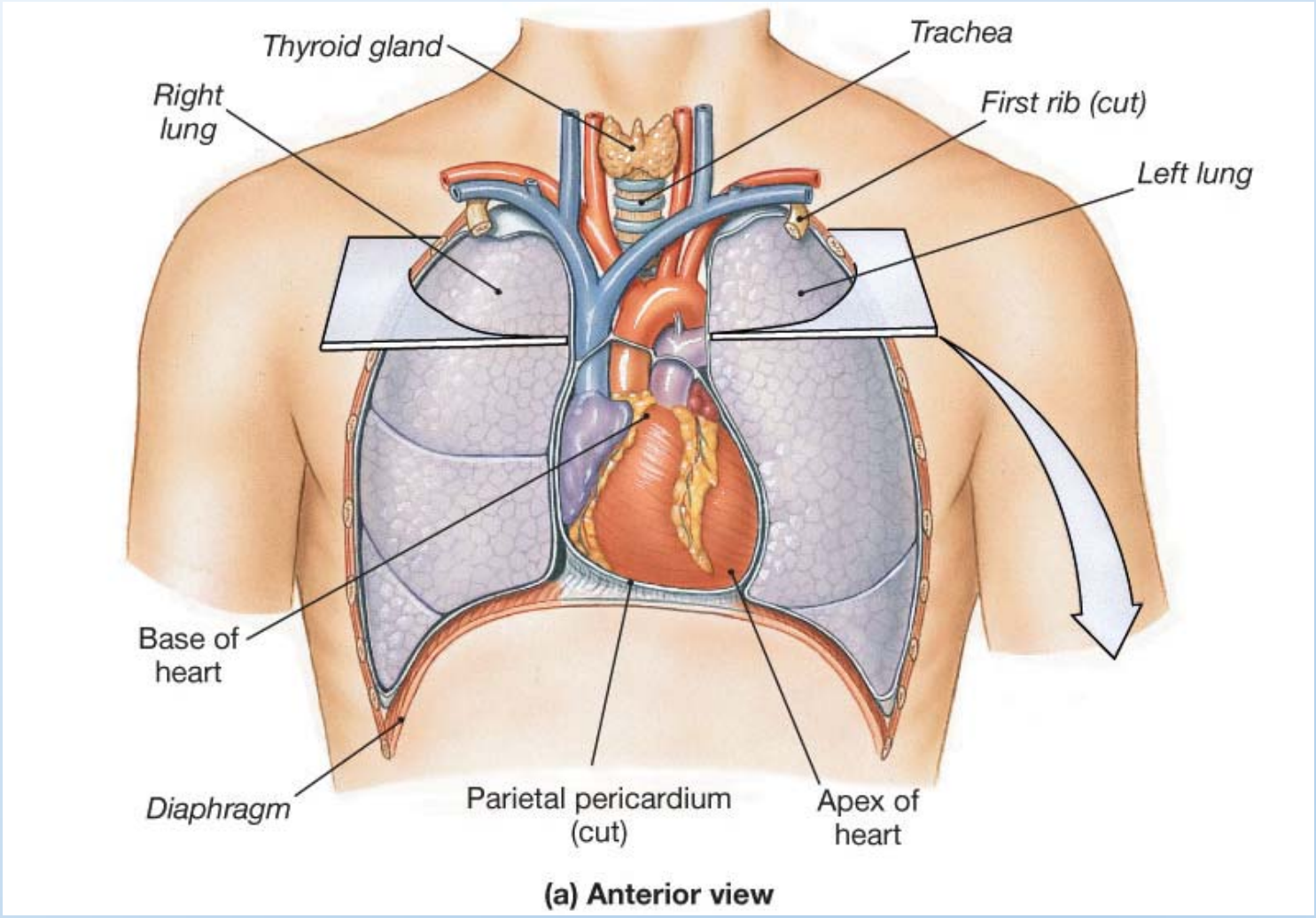
Development



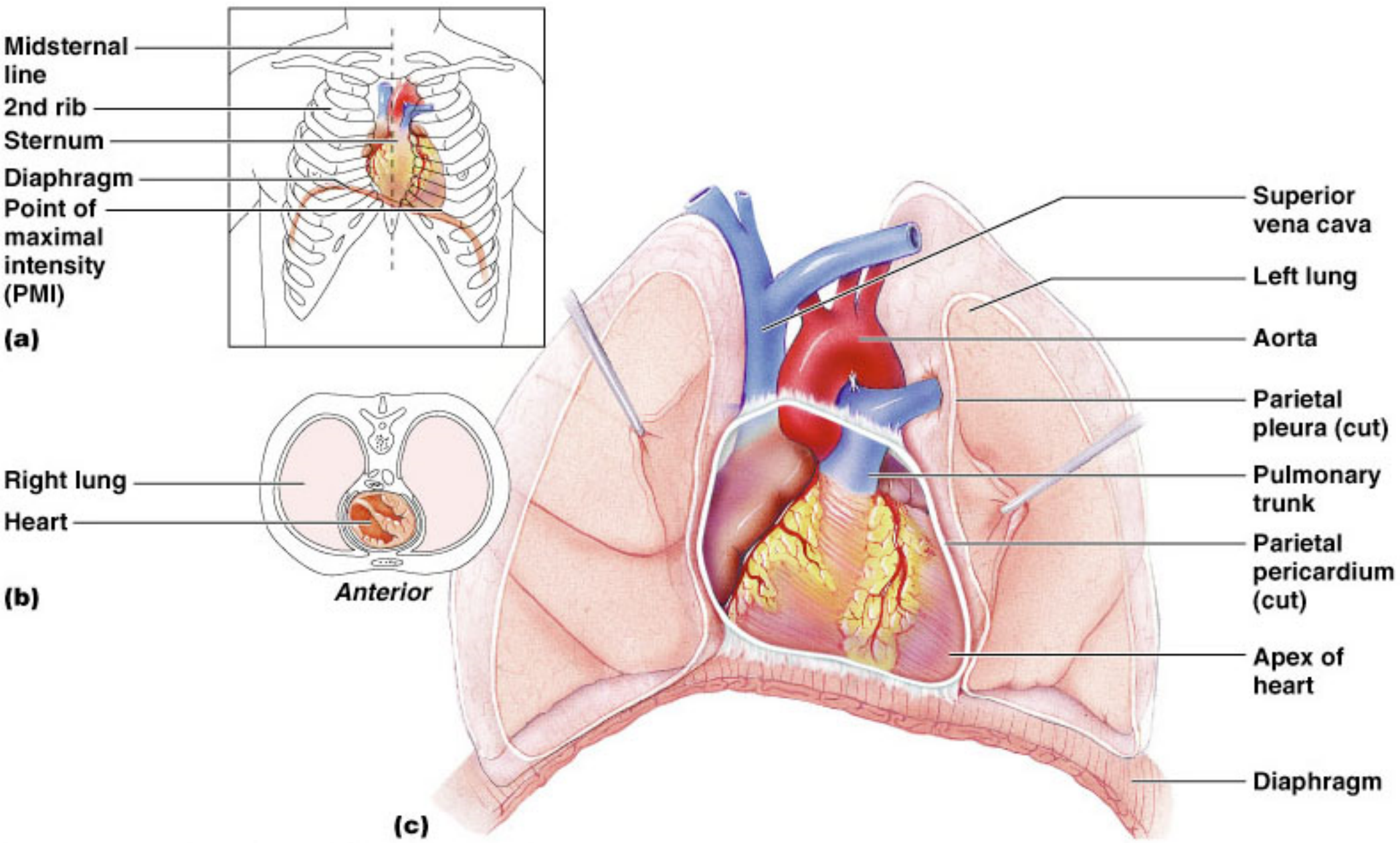


Fetal

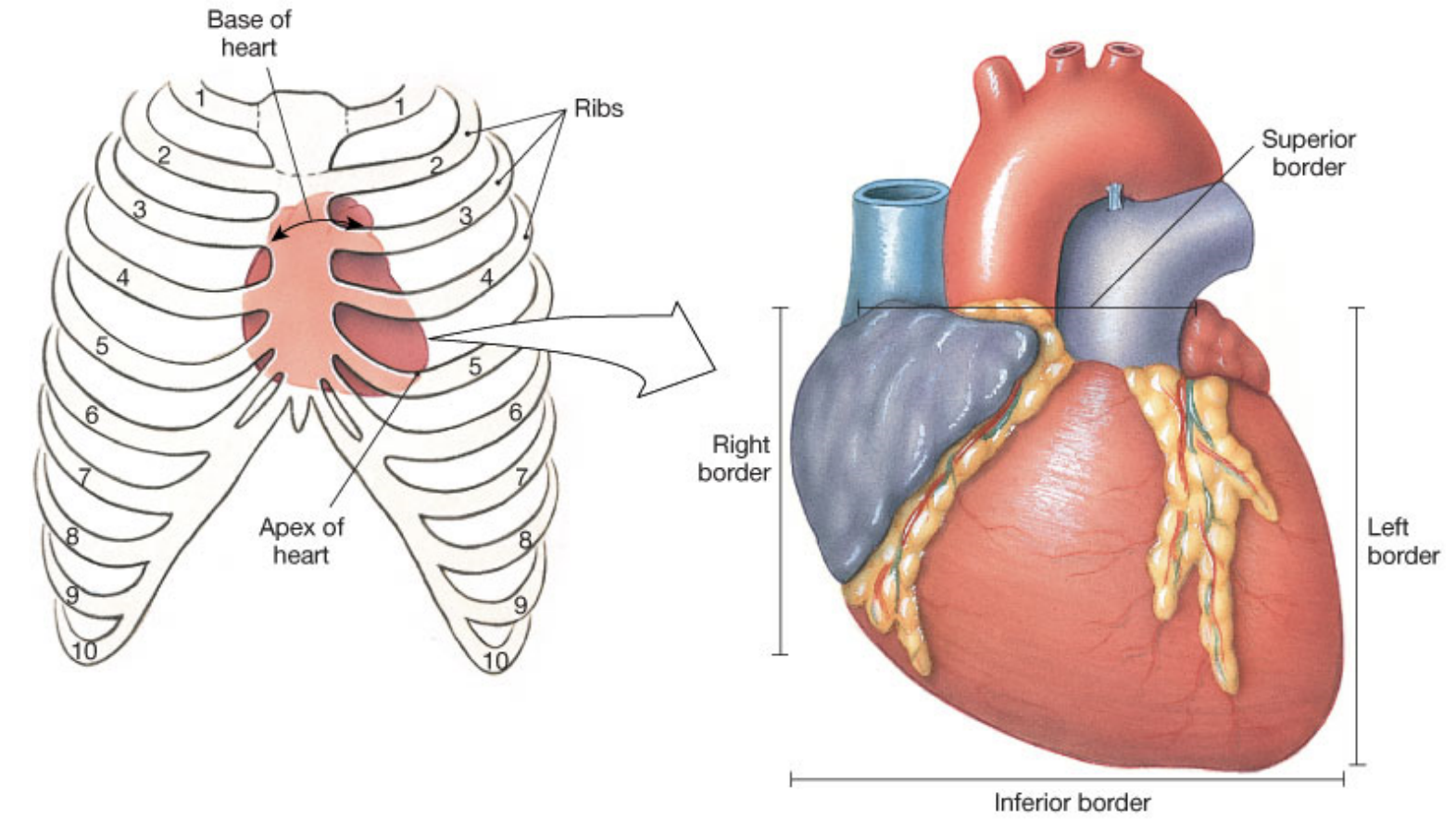

Placenta
Umbilical vein
Umbilical artery
Umbilical cord (contains umbilical artery and umbilical vein)
4 Mixed blood travels to the head and body, and back to the placenta via the aorta.
3 The ductus arteriosus connects the aorta with the pulmonary artery, further shunting blood away from the lungs and into the aorta.
2 The foramen ovale allows oxygenated blood in the right atrium to reach the left atrium.
1 Oxygenated blood from placenta enters right atrium via inferior vena cava.
Inferior vena cava
2 The ductus venosus shunts oxygenated blood from the placenta away from the semifunctional liver and toward the heart.
1 Blood arrives via umbilical vein.



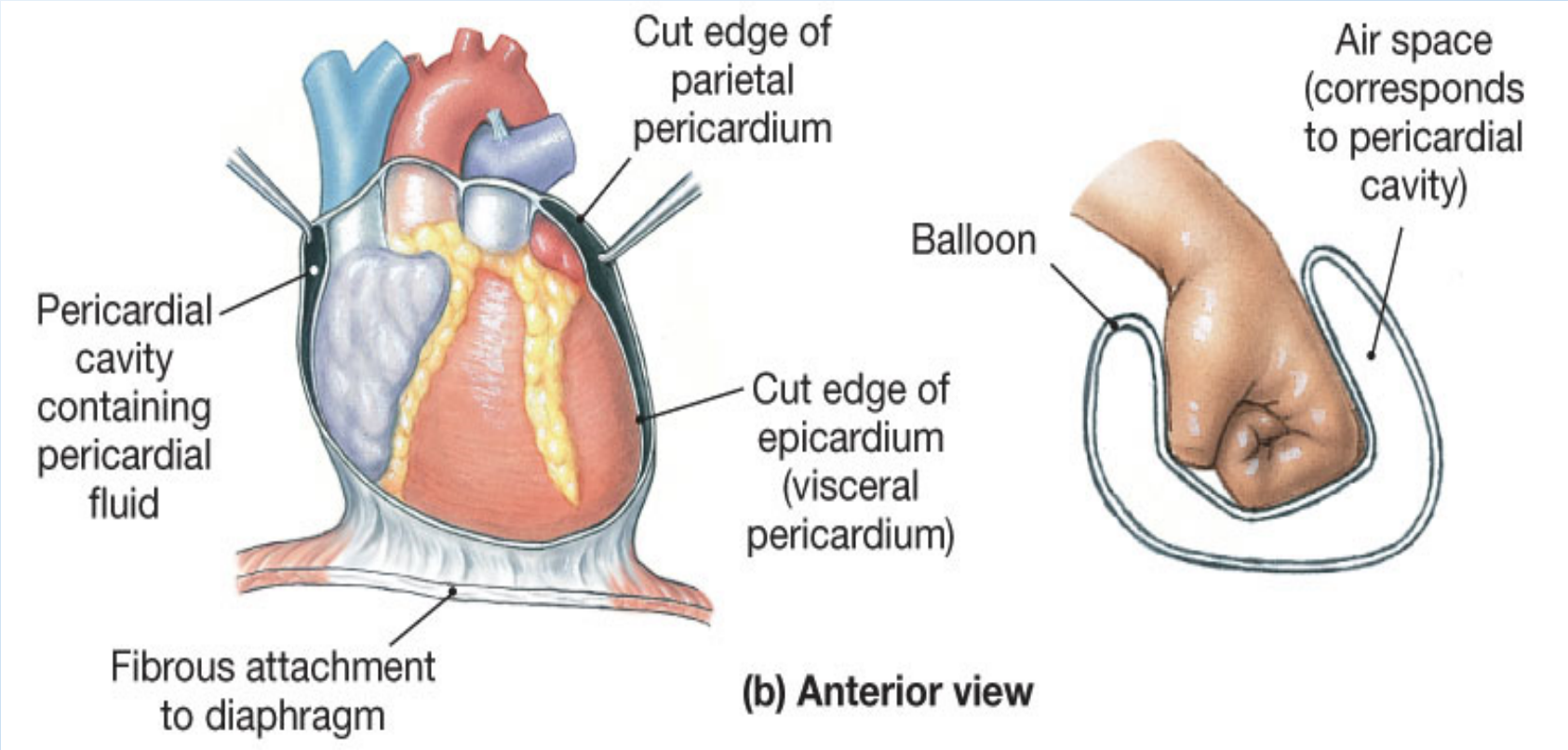
(a) Anterior view


Midsternal line
2nd rib
Sternum
Diaphragm
Point of maximal intensity (PMI)
(a)
Right lung
Heart
(b)
Anterior
Superior vena cava
Left lung
Aorta
Parietal pleura (cut)
Pulmonary trunk
Parietal pericardium (cut)
Apex of heart
Diaphragm
(c)

Position and Orientation of the Heart

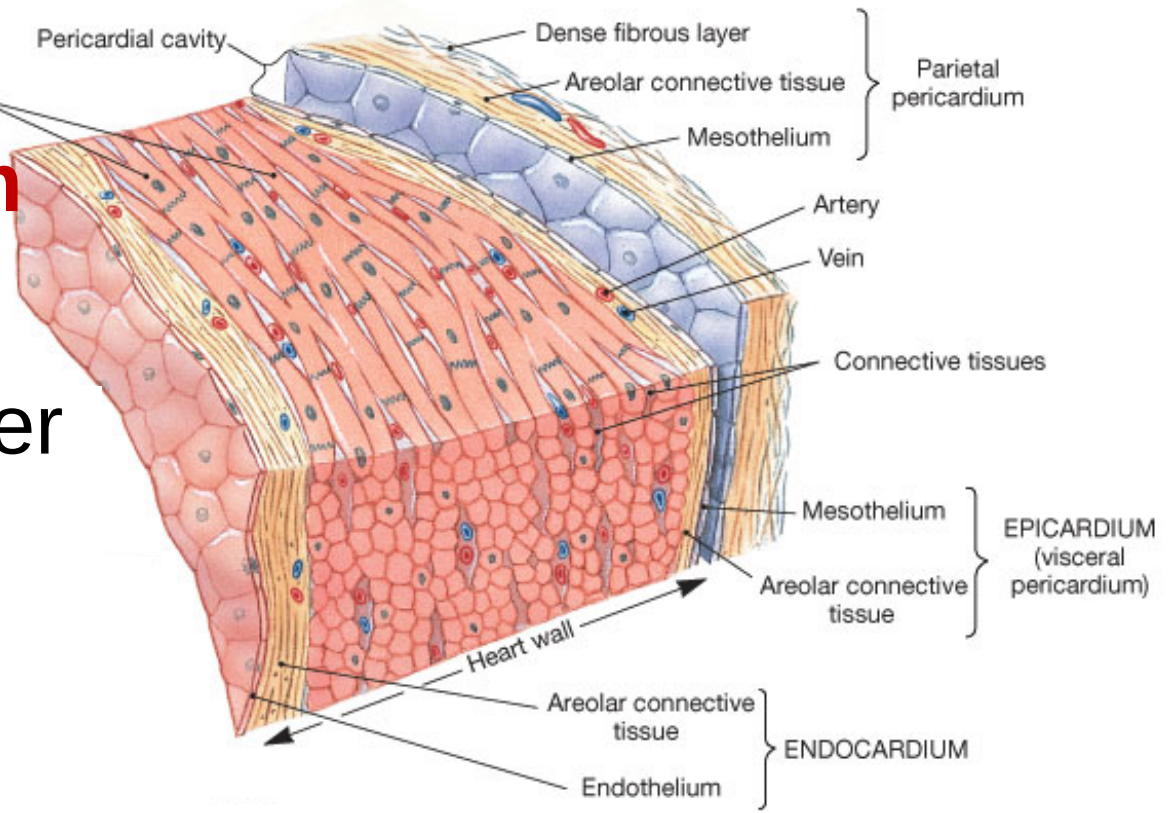


Pericardial Sac and Location of the Heart in the Thoracic Cavity



Endocardium

Endothelium and CT of inner surface

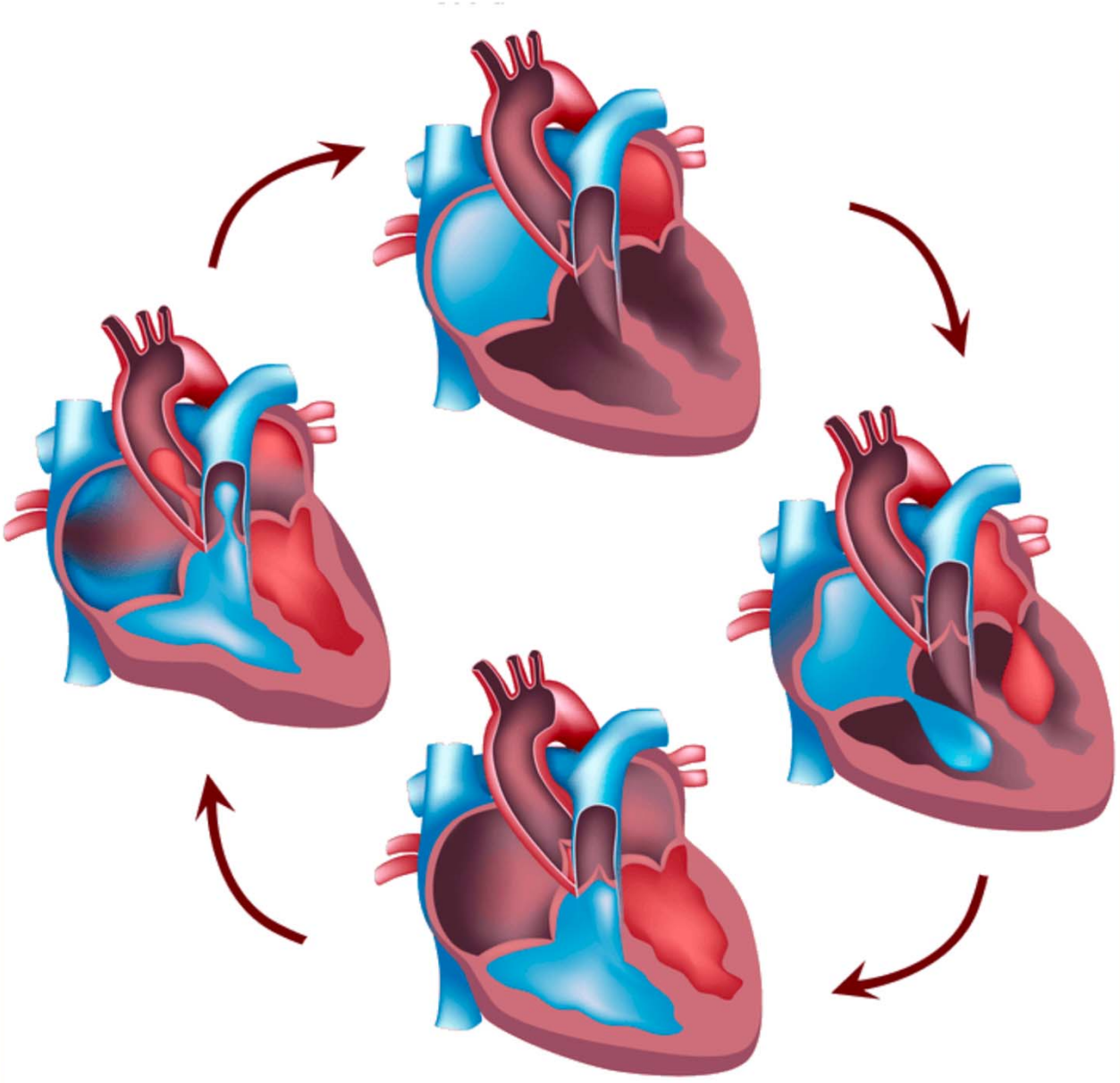


Myocardium

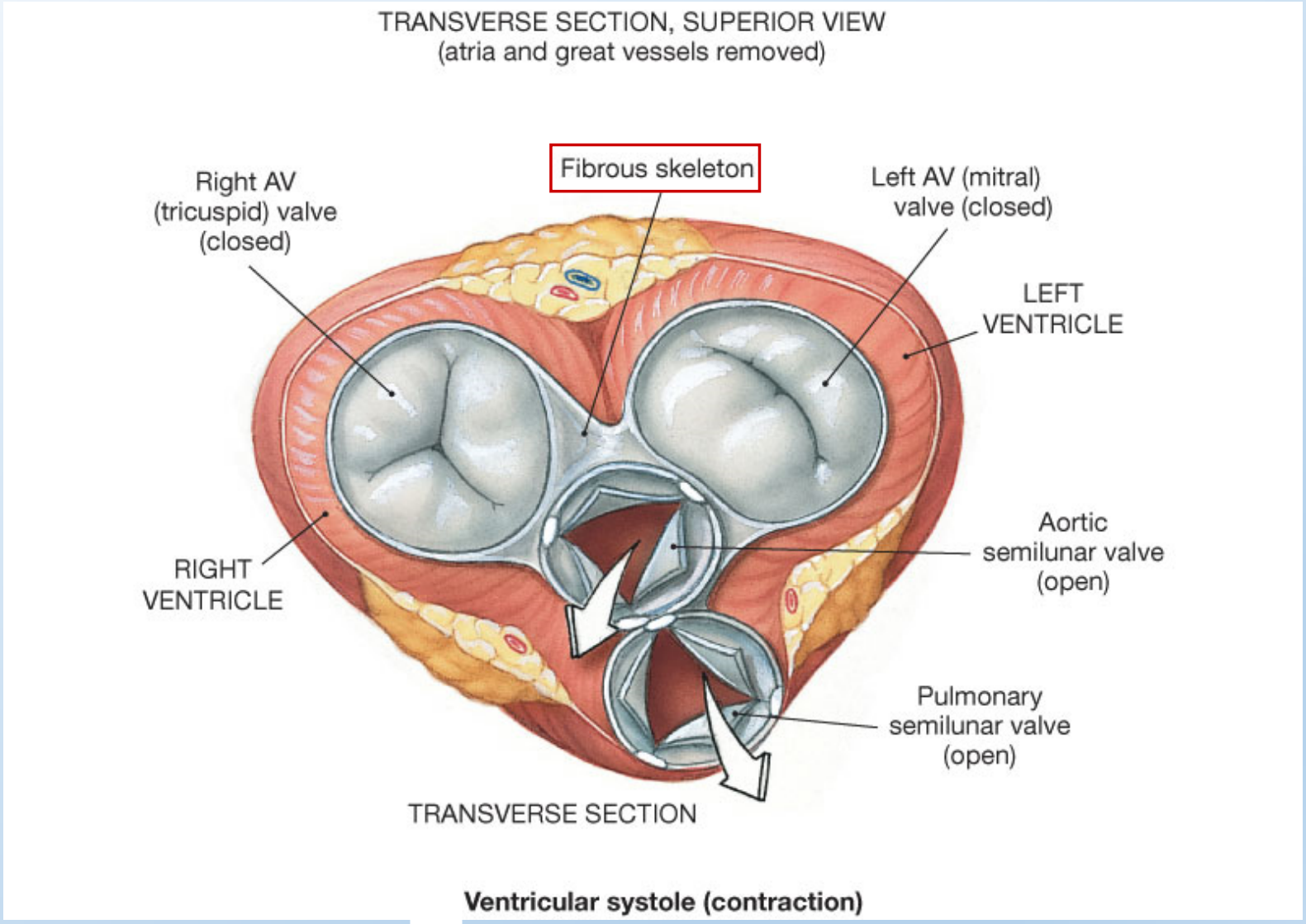
Cardiac Muscle (thickest layer of heart)

Epicardium

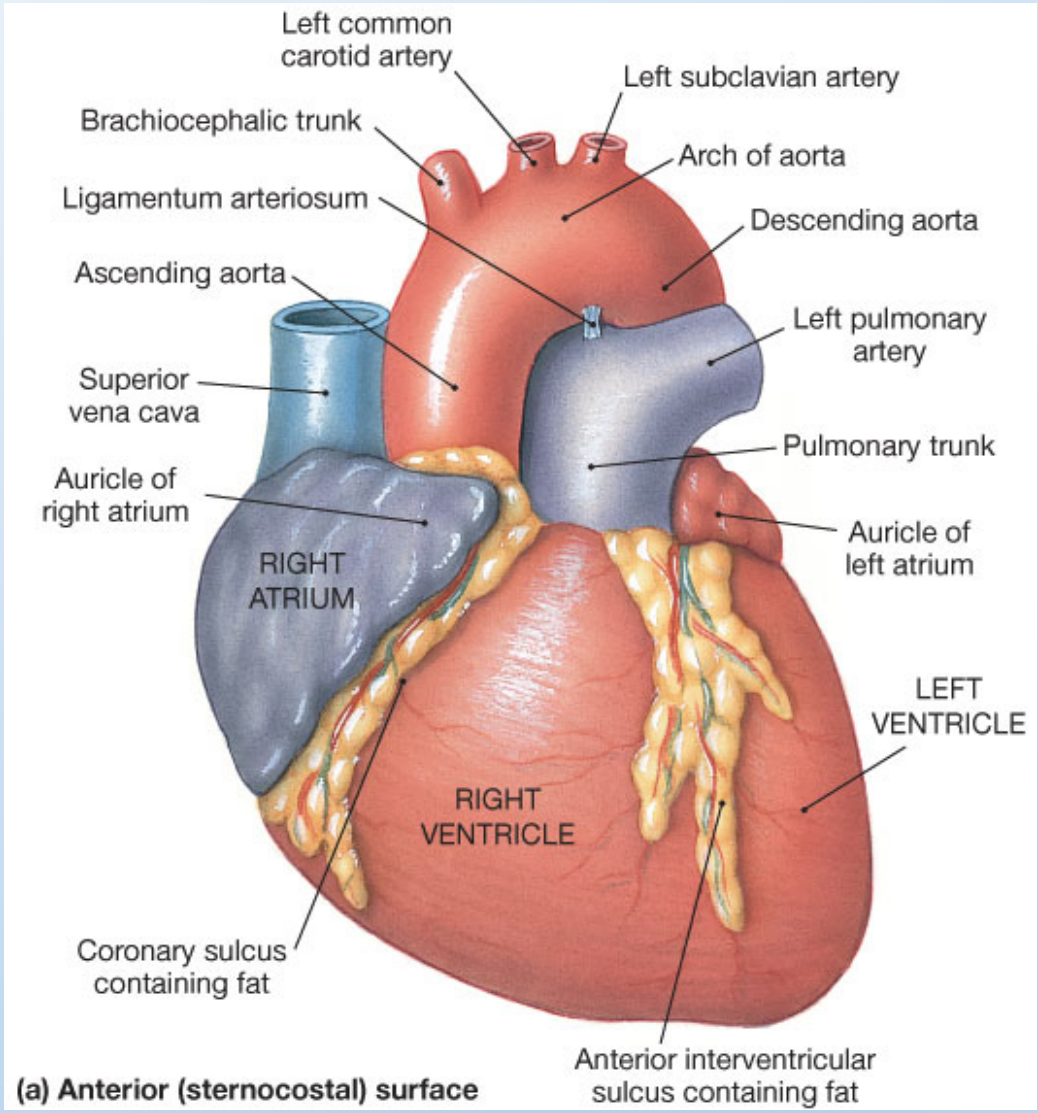
Visceral pericardium (a serous membrane)

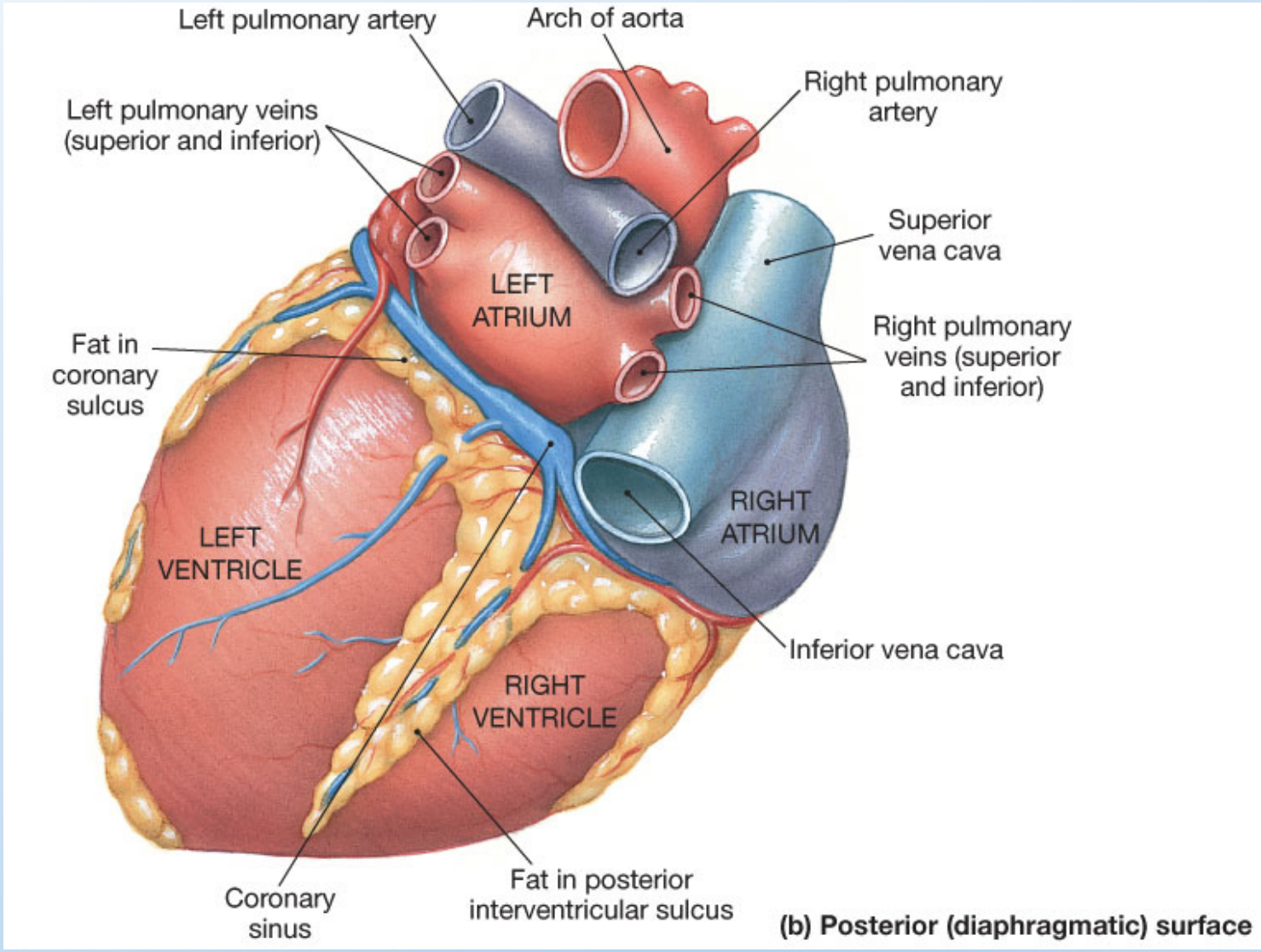


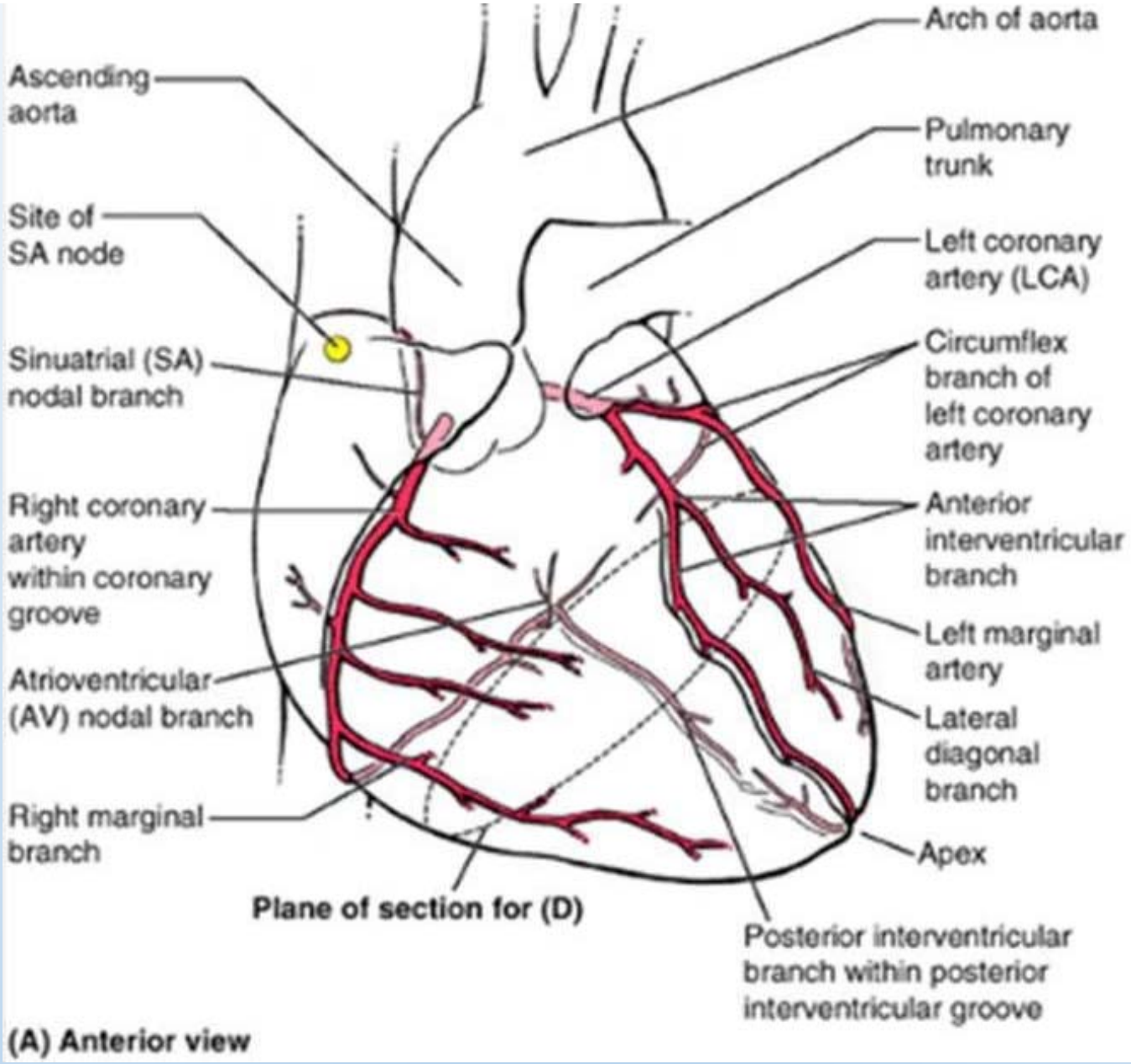
How the heart functions

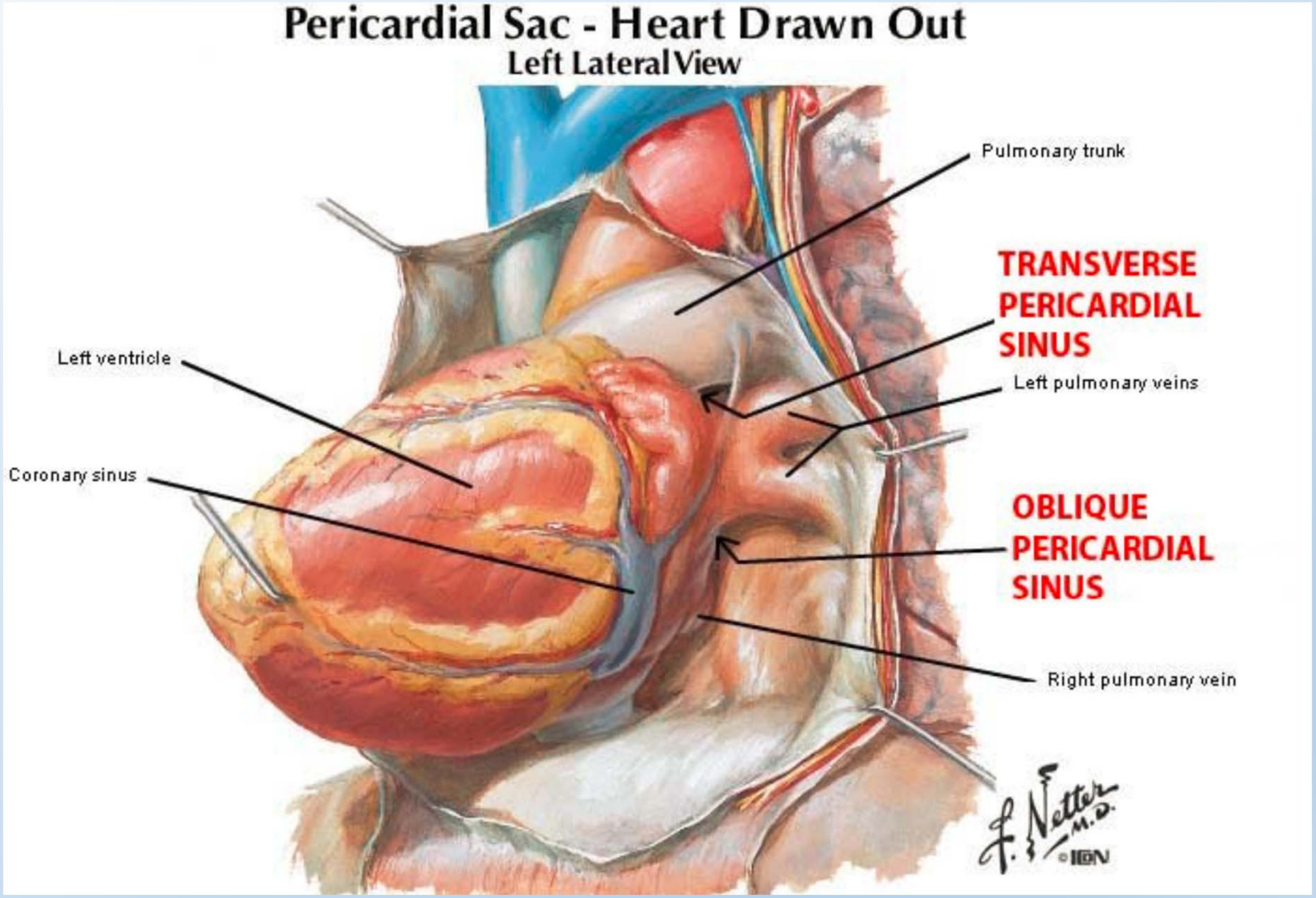

TRANSVERSE SECTION, SUPERIOR VIEW
(atria and great vessels removed)
Fibrous skeleton
Right AV
(tricuspid) valve
(closed)
Left AV (mitral)
valve (closed)
LEFT
VENTRICLE
Aortic
semilunar valve
(open)
RIGHT
VENTRICLE
Pulmonary
semilunar valve
(open)
TRANSVERSE SECTION
Ventricular systole (contraction)

Surface Anatomy of the Heart

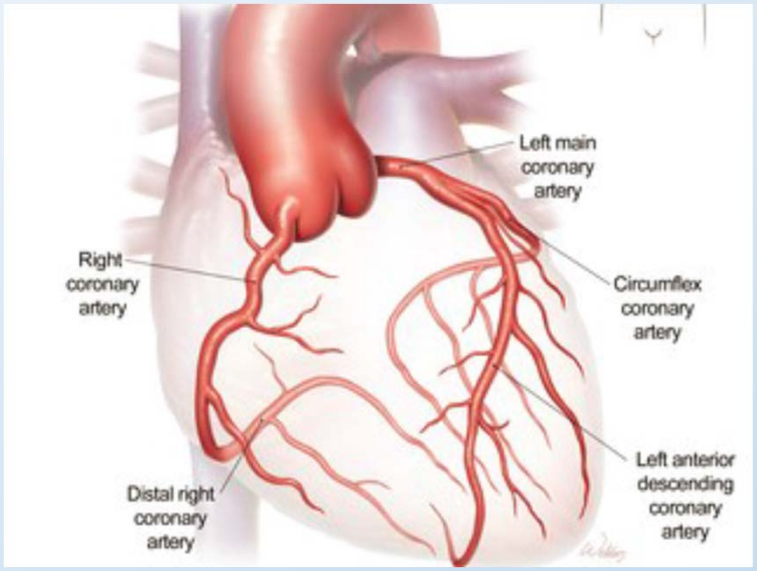


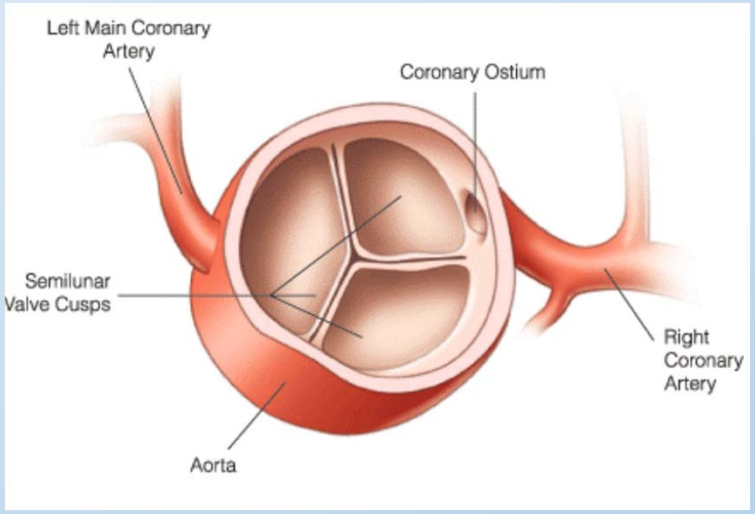

Left pulmonary artery
Arch of aorta
Right pulmonary artery
Left pulmonary veins (superior and inferior)
Superior vena cava
LEFT ATRIUM
Right pulmonary veins (superior and inferior)
Fat in coronary sulcus
RIGHT ATRIUM
LEFT VENTRICLE
Inferior vena cava
RIGHT VENTRICLE
Coronary sinus
Fat in posterior interventricular sulcus
(b) Posterior (diaphragmatic) surface

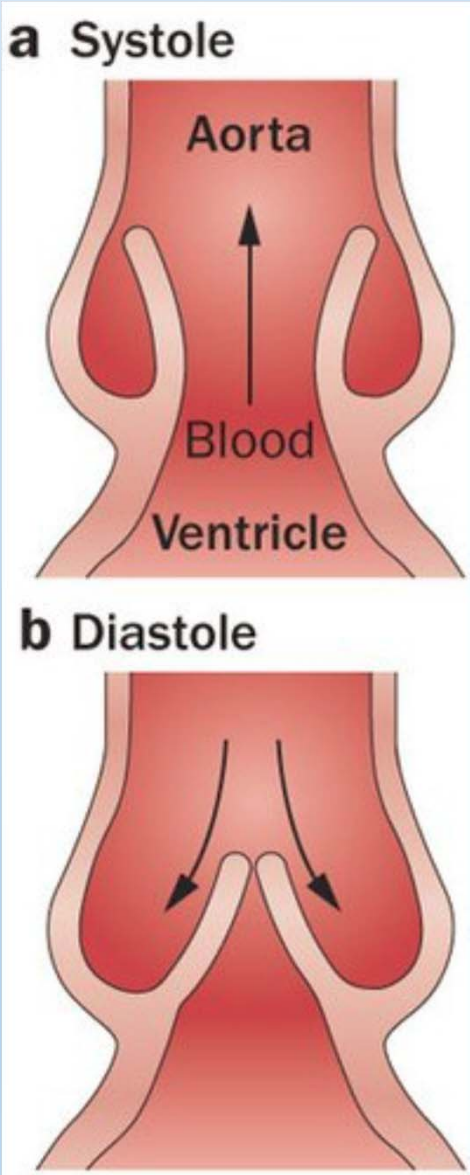

Arch of aorta
Ascending aorta
Pulmonary trunk
Site of SA node
Left coronary artery (LCA)
Sinuatrial (SA) nodal branch
Circumflex branch of left coronary artery
Right coronary artery within coronary groove
Anterior interventricular branch
Left marginal artery
Atrioventricular (AV) nodal branch
Lateral diagonal branch
Right marginal branch
Apex
Plane of section for (D)
Posterior interventricular branch within posterior interventricular groove
(A) Anterior view


Pericardial Sac - Heart Drawn Out
Left Lateral View
Pulmonary trunk
TRANSVERSE PERICARDIAL SINUS
Left pulmonary veins
Left ventricle
Coronary sinus
OBLIQUE PERICARDIAL SINUS
Right pulmonary vein
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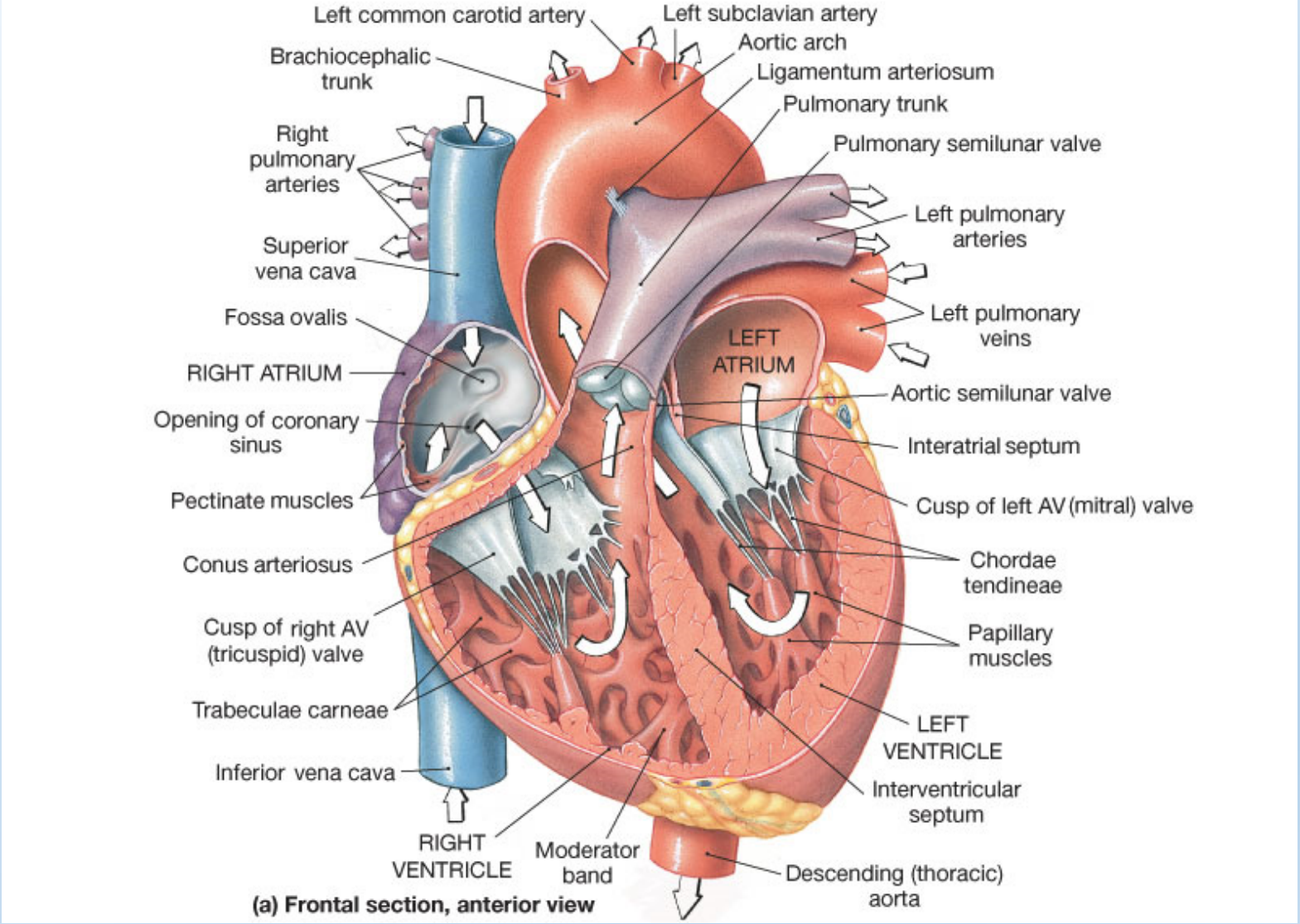
The heart receives blood supply during diastole!



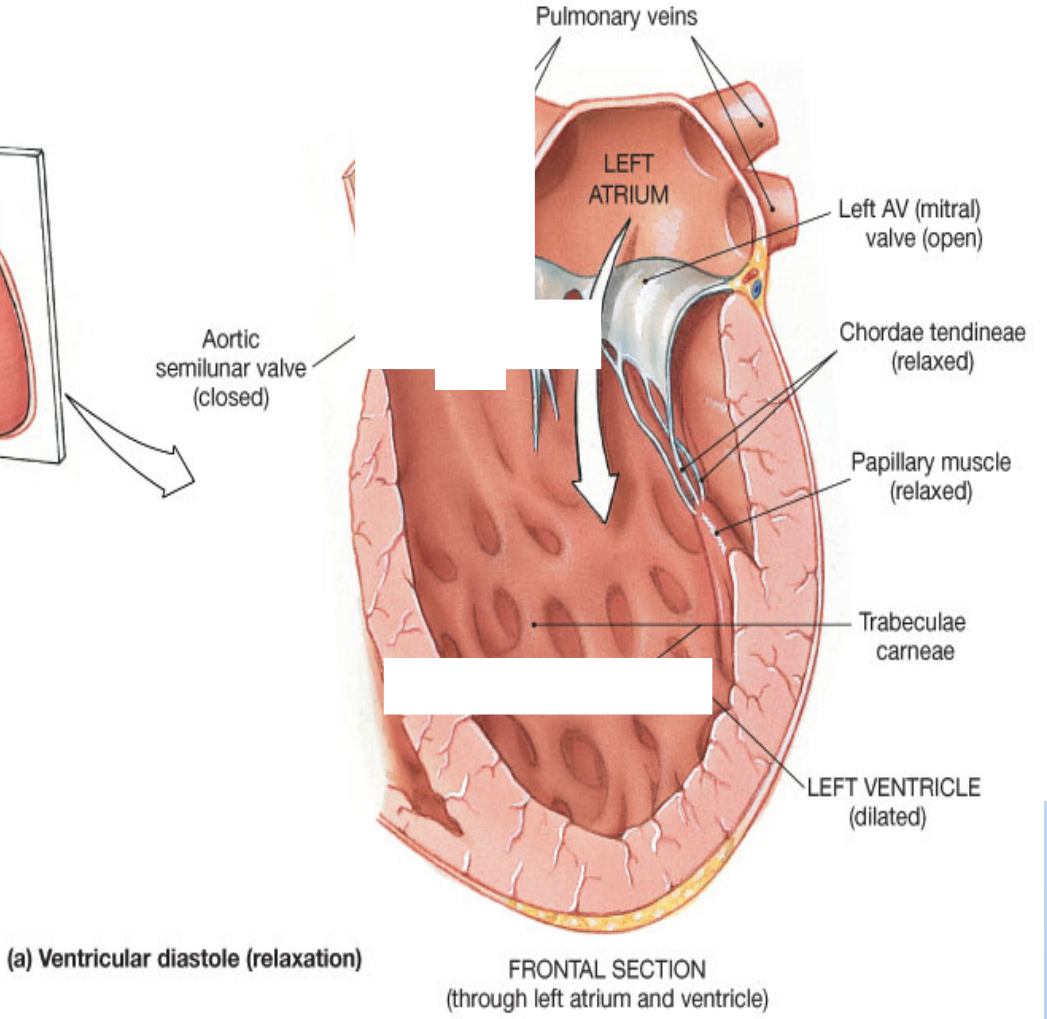


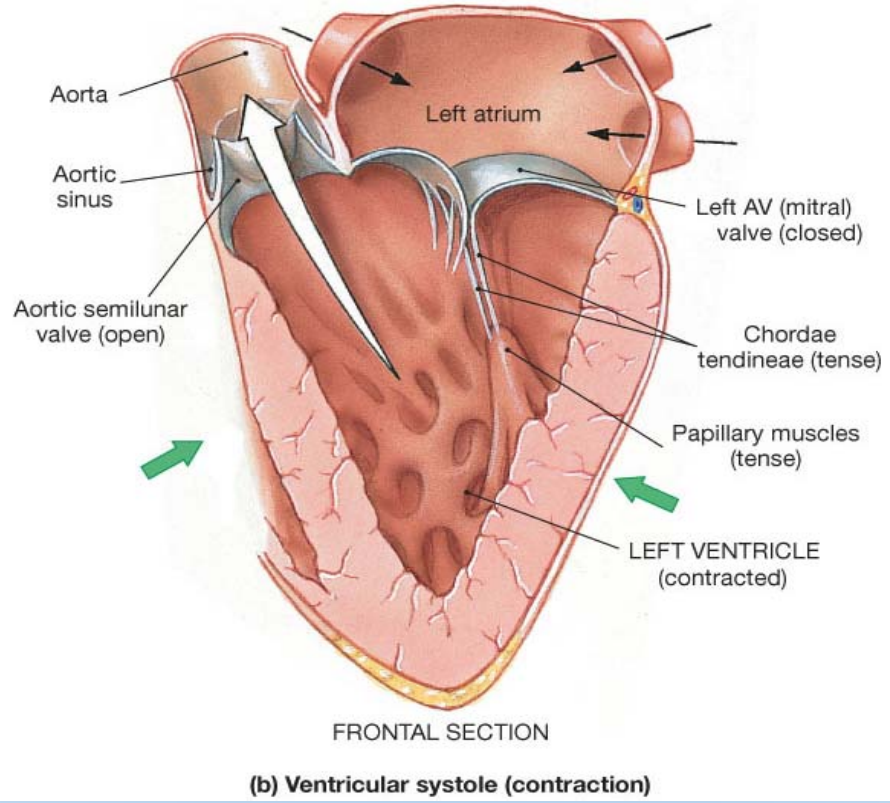


Sectional Anatomy of the Heart

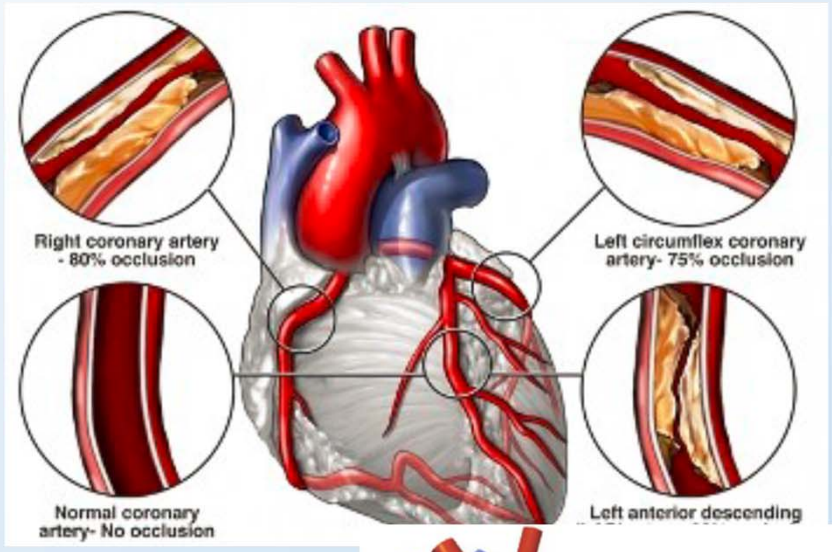


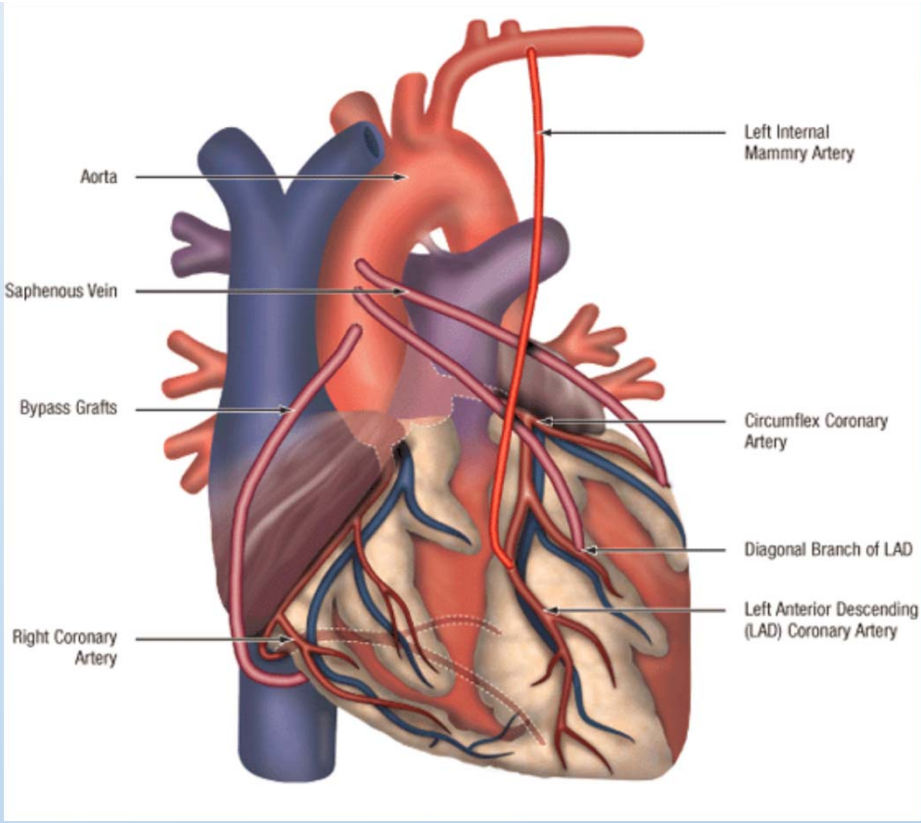
Valves of the Heart

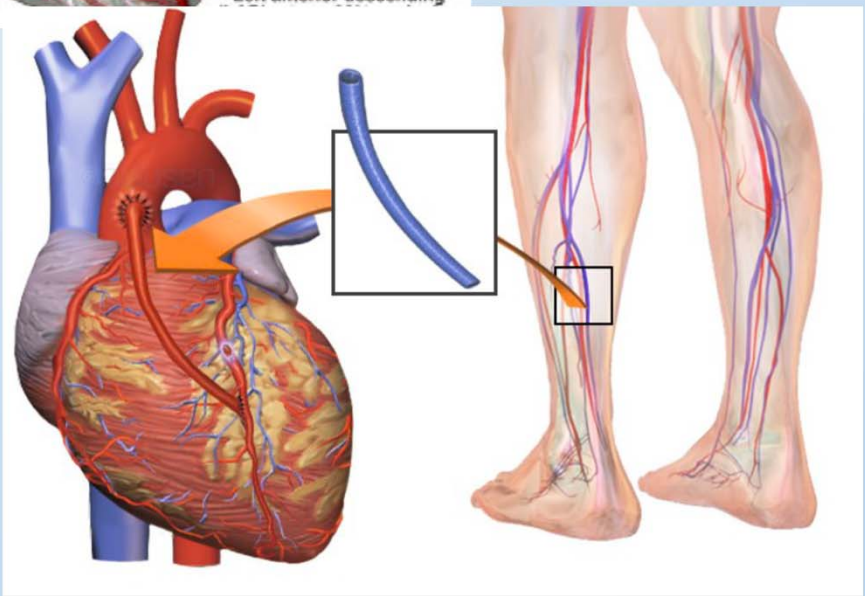


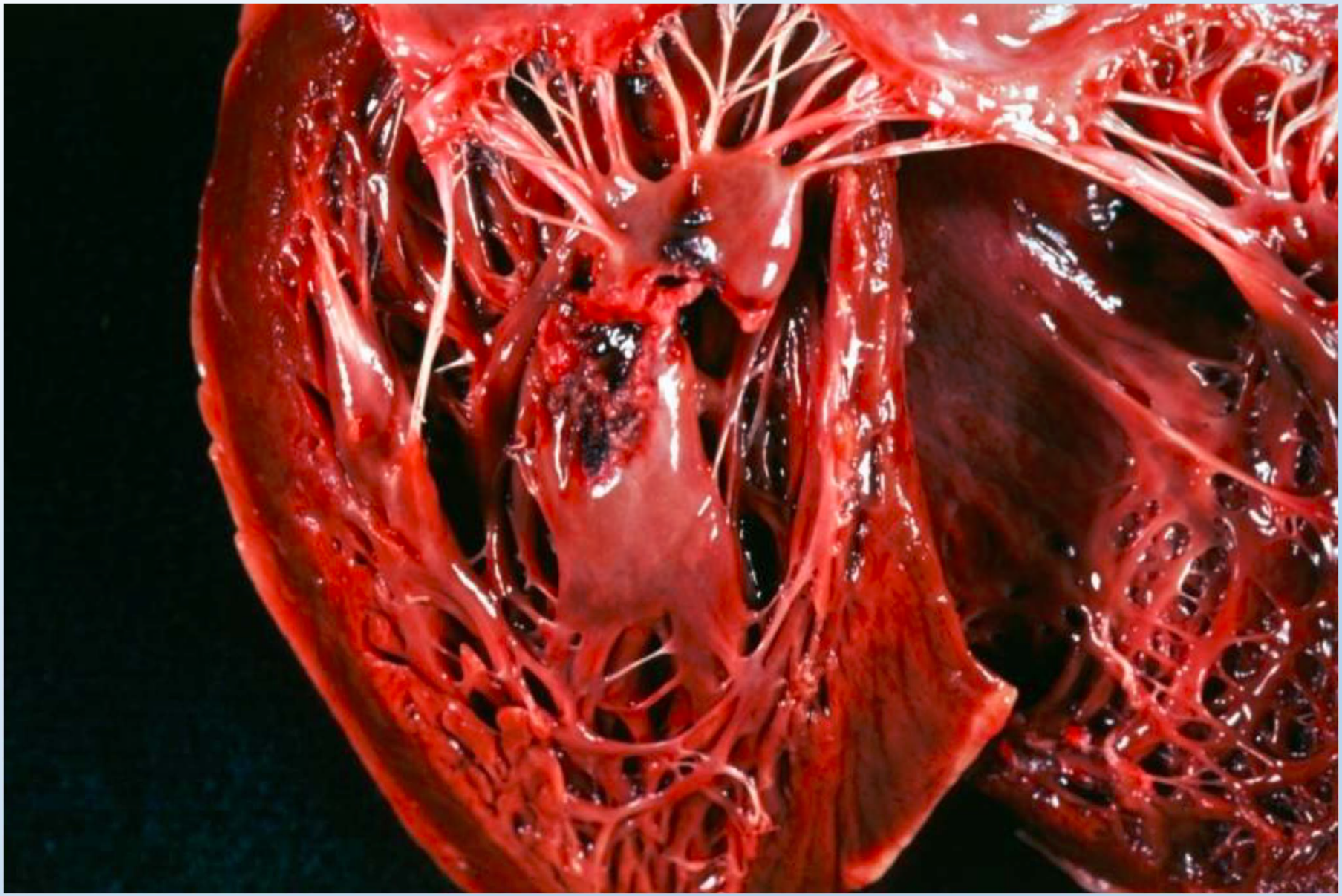


Coronary artery bypass grafting (CABG)

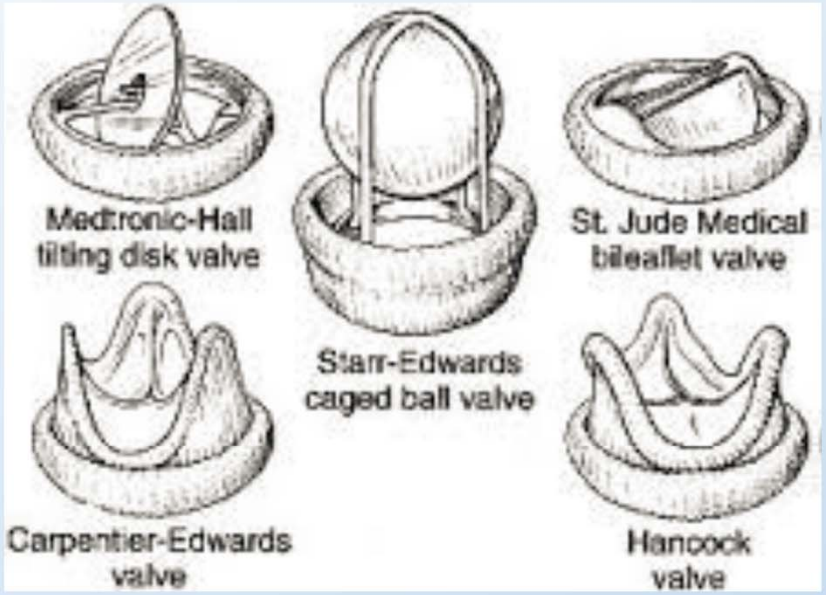


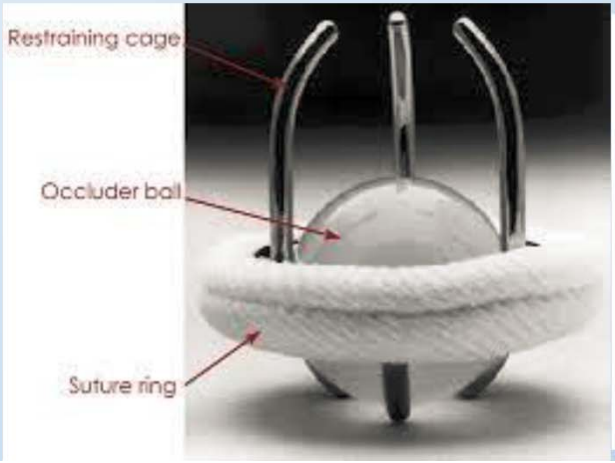




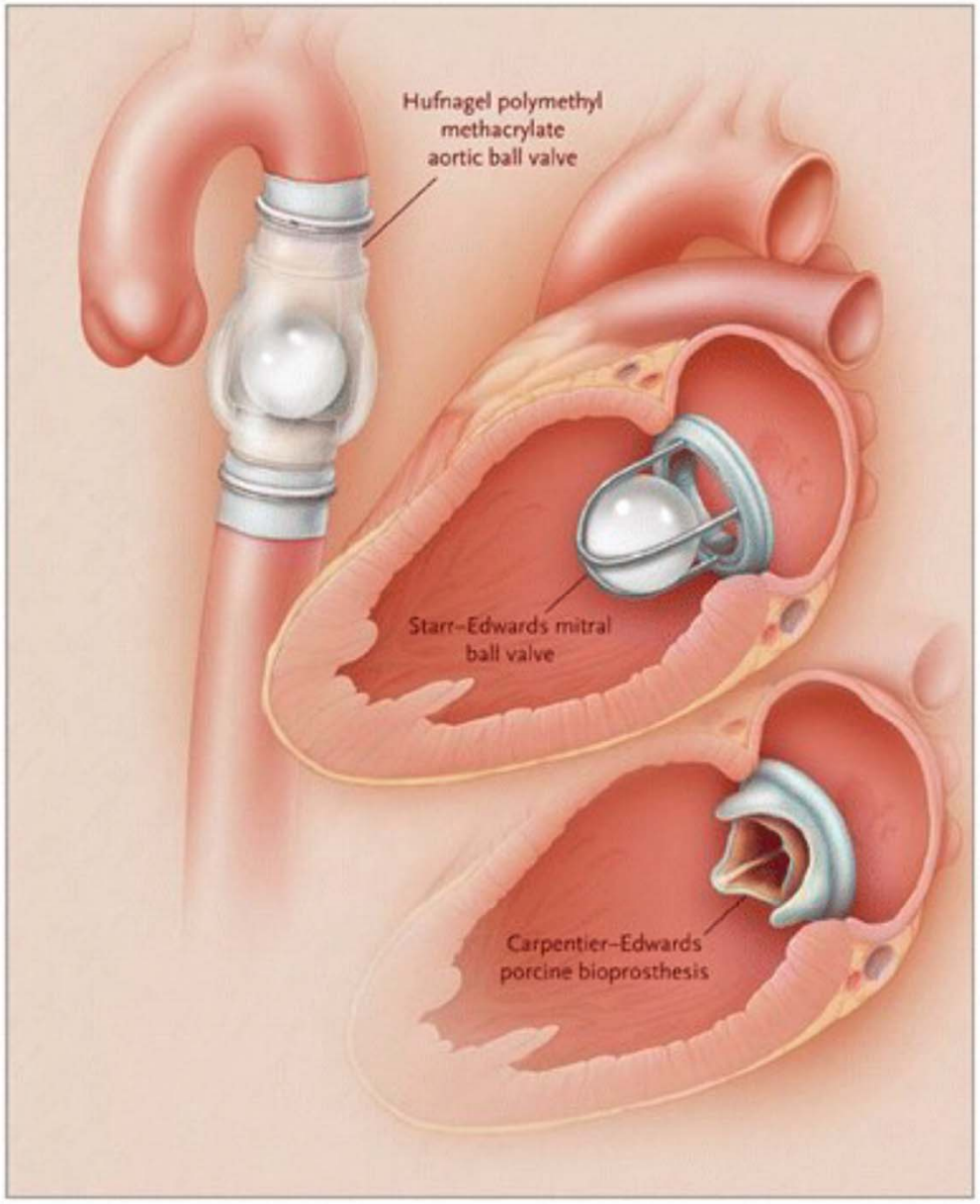


Cusp prosthetics

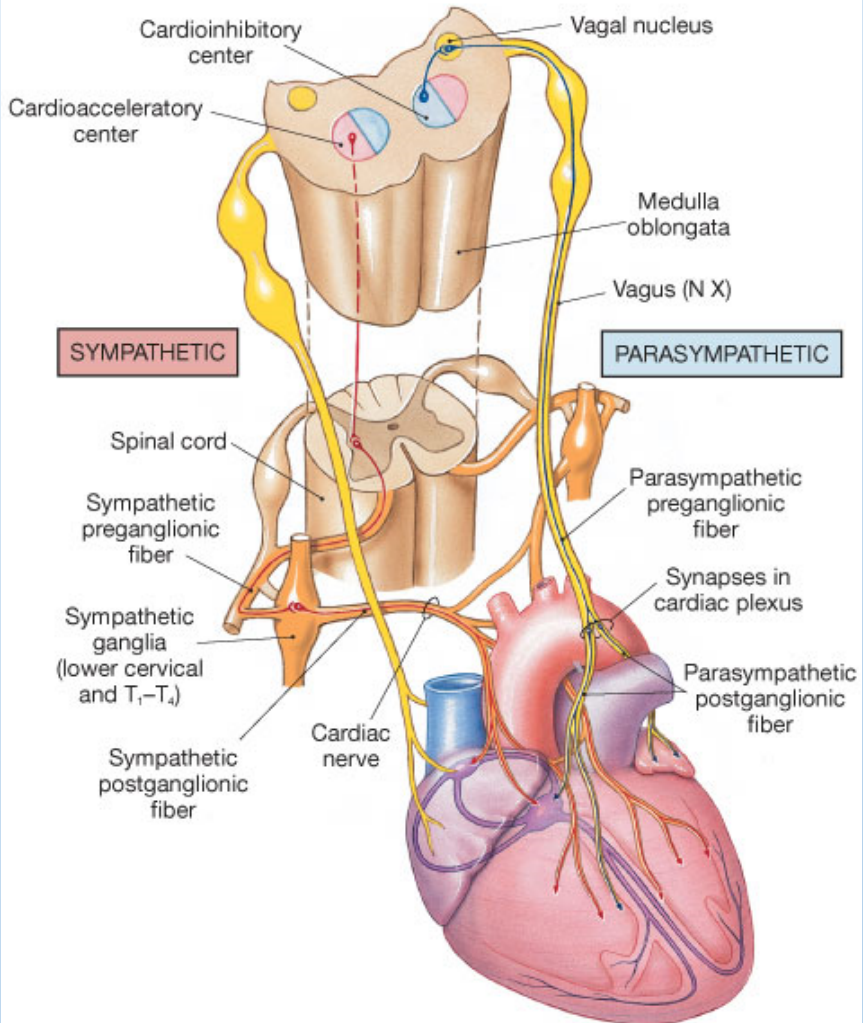




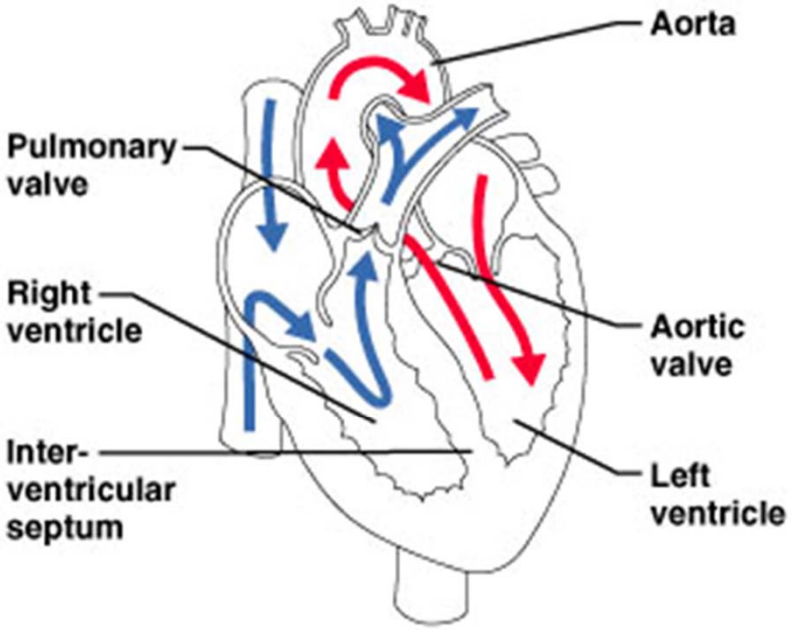




The Autonomic Innervation of the Heart

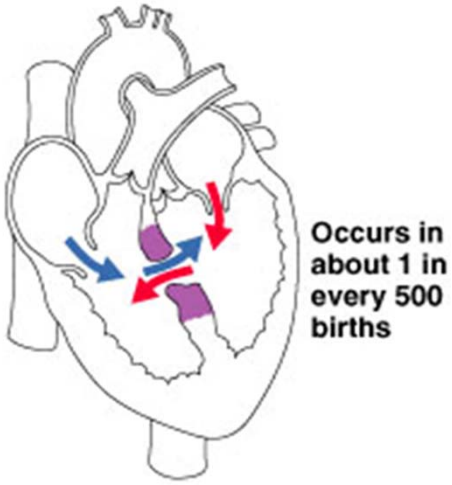


Circulation

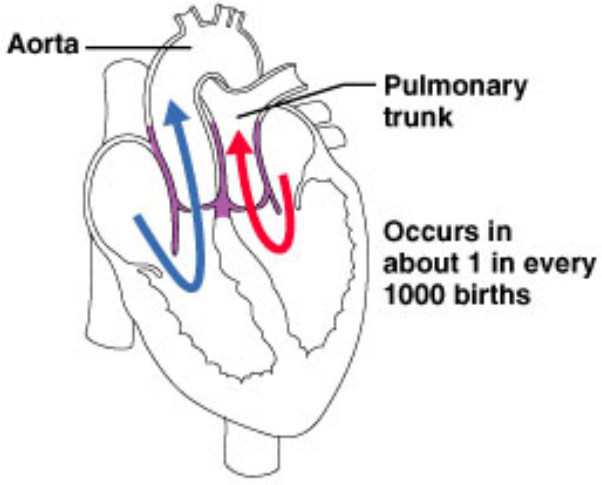


(a) Normal heart. Arrows indicate the path of blood flow through the heart. Red = oxygen-rich blood; blue = oxygen-poor blood.

Congenital Heart Defects

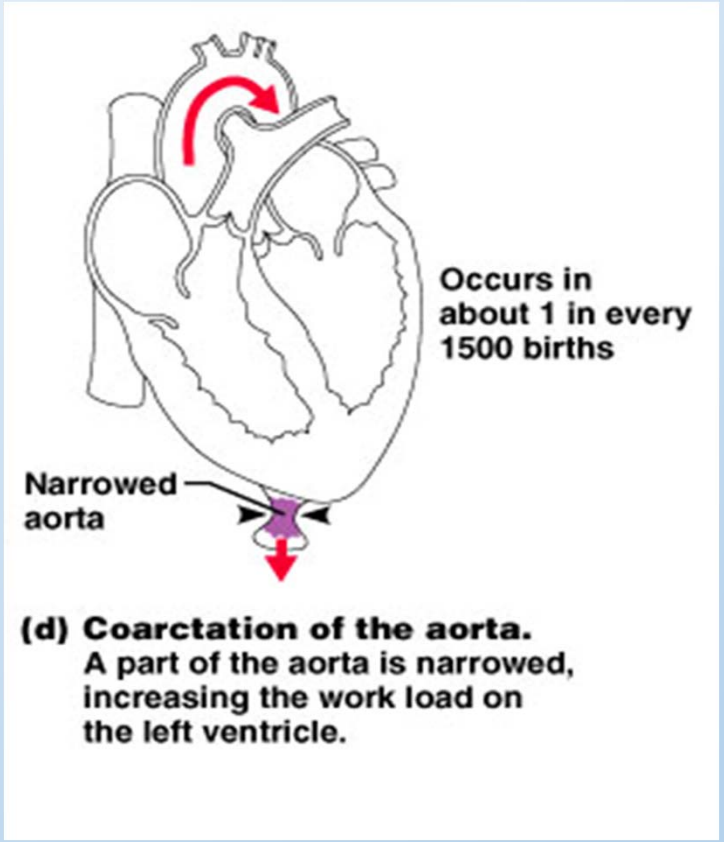


(b) Ventricular septal defect. The superior part of the interventricular septum fails to form; thus, blood mixes between the two ventricles.



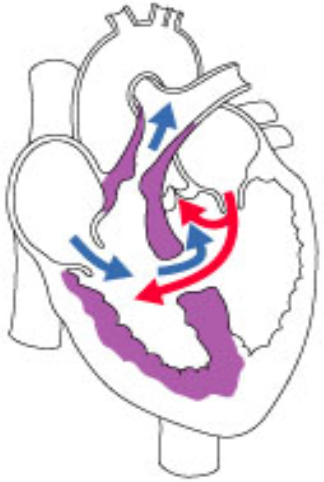
Transposition of the great vessels. Aorta comes from right ventricle, pulmonary trunk from left. Results when the bulbus cordis does not divide properly. Unoxygenated blood passes repeatedly around systemic circuit, while oxygenated blood recycles around the pulmonary circuit.

Congenital Heart Defects



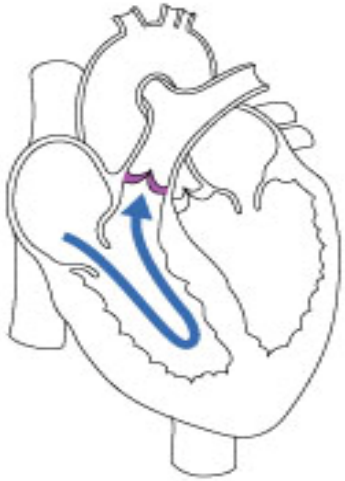
(d) Coarctation of the aorta. A part of the aorta is narrowed, increasing the work load on the left ventricle.

Congenital Heart Defects



Occurs in about 1 in every 2000 births

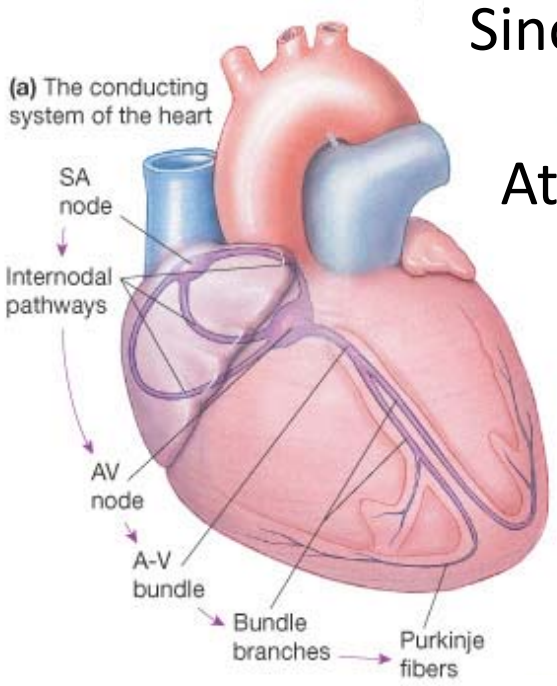
Tetralogy of Fallot. Multiple defects (tetra=four): Pulmonary trunk too narrow and pulmonary valve stenosed; ventricular septal defect; aorta opens from both ventricles; wall of right ventricle thickened from overwork.



Occurs in about 1 in every 2800 births

Pulmonary stenosis. The pulmonary semilunar valve is narrowed, lessening the flow of blood to the lungs.

Electrical Conduction System



Sino Atrial (SA) Node – sup/post rt atrium

↘

Atrial Ventricular (AV) Node – inf rt atrium

↘

AV Bundle (of His) – sup IV septum

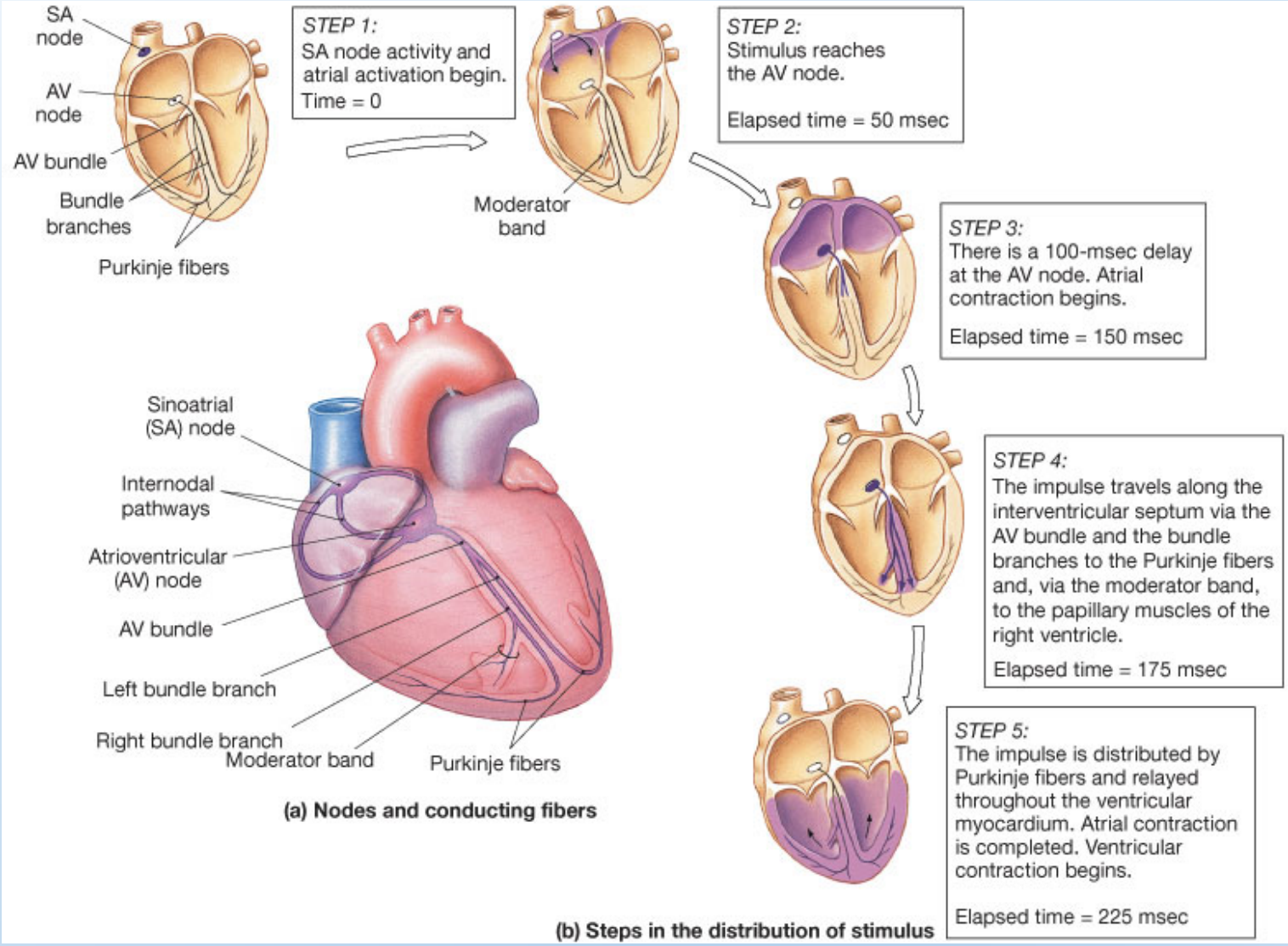
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L and R Bundle Branches – IV septum

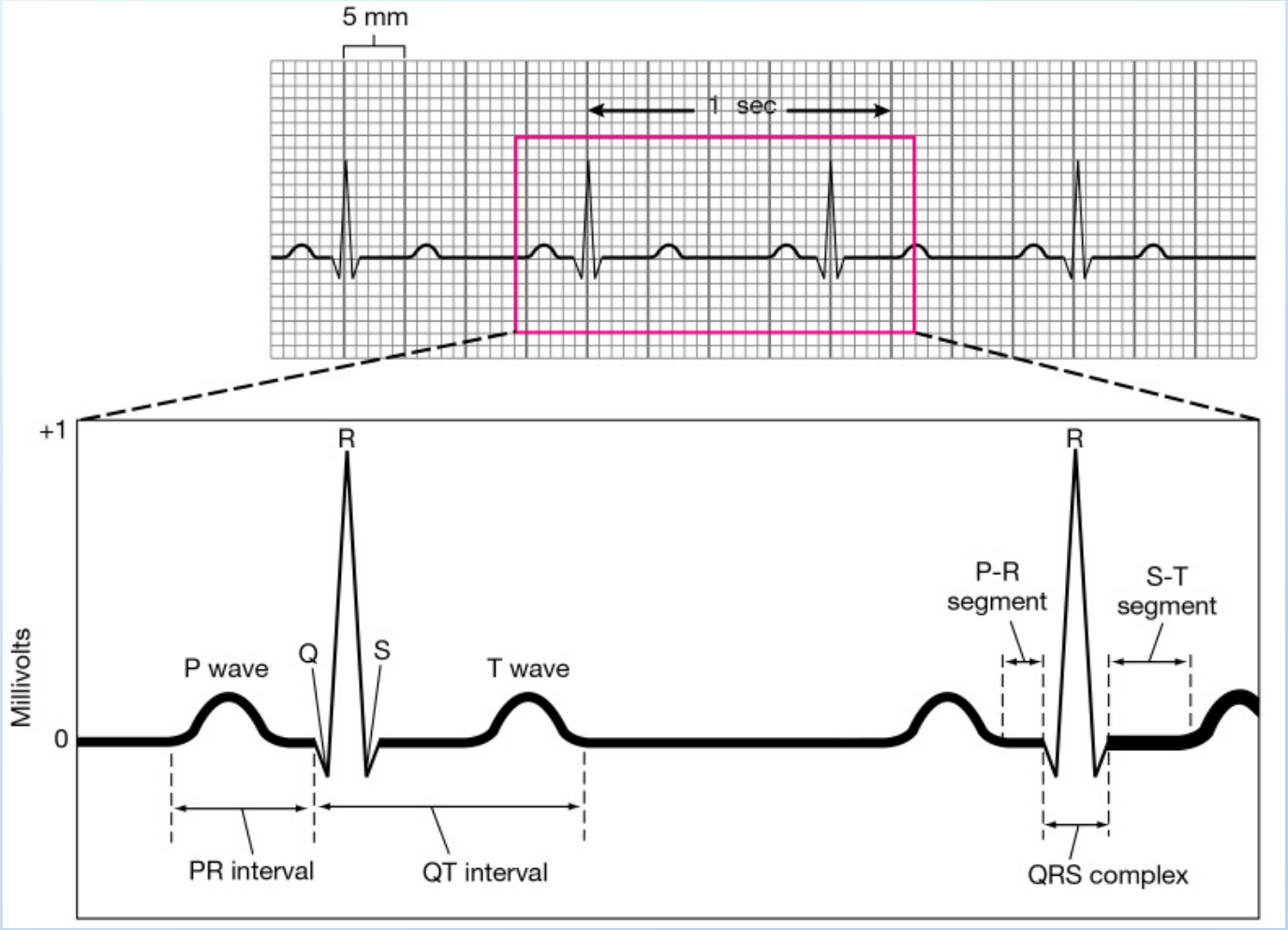
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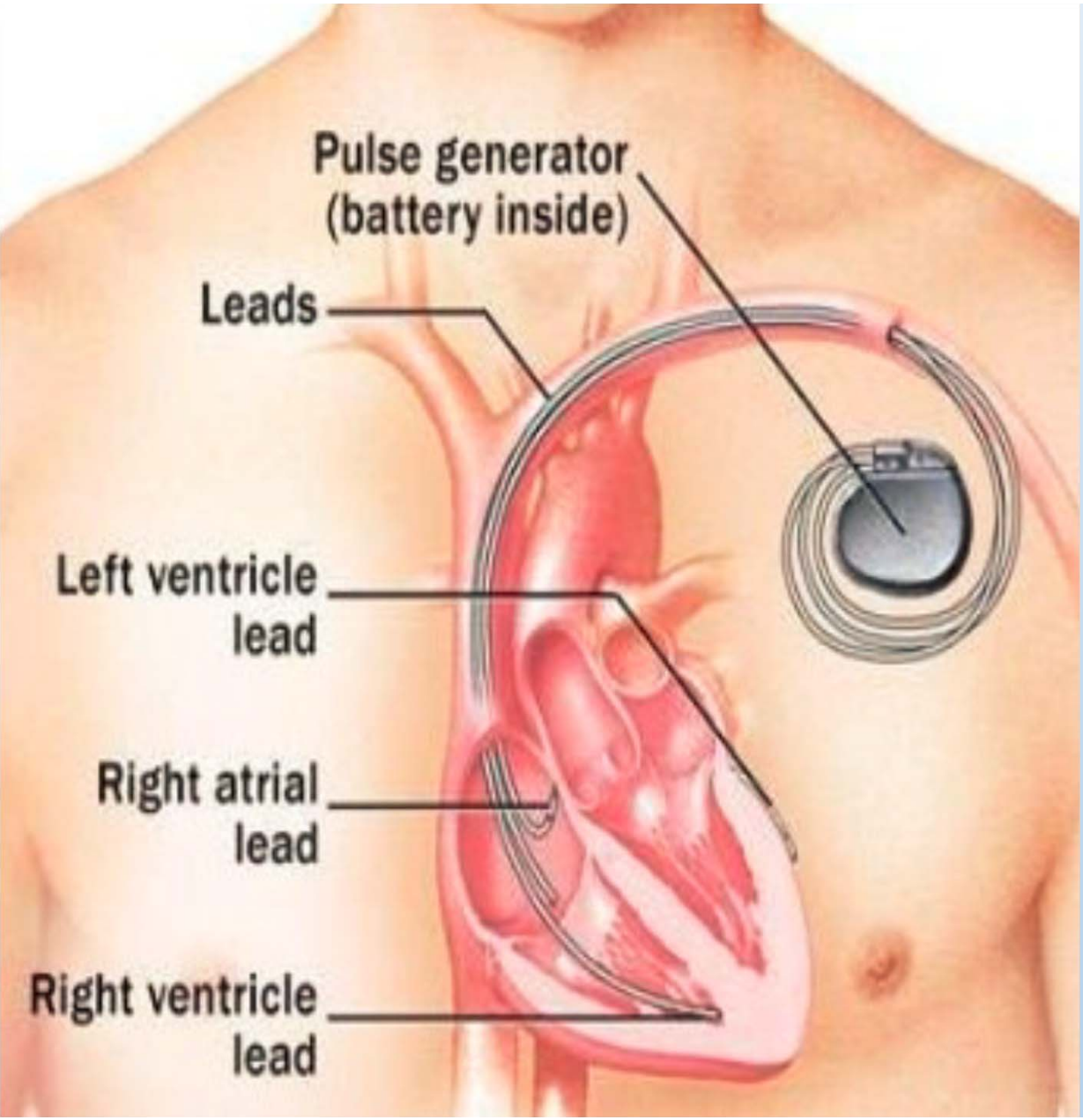
Purkinje Fibers – both ventricles

The Conducting System of the Heart

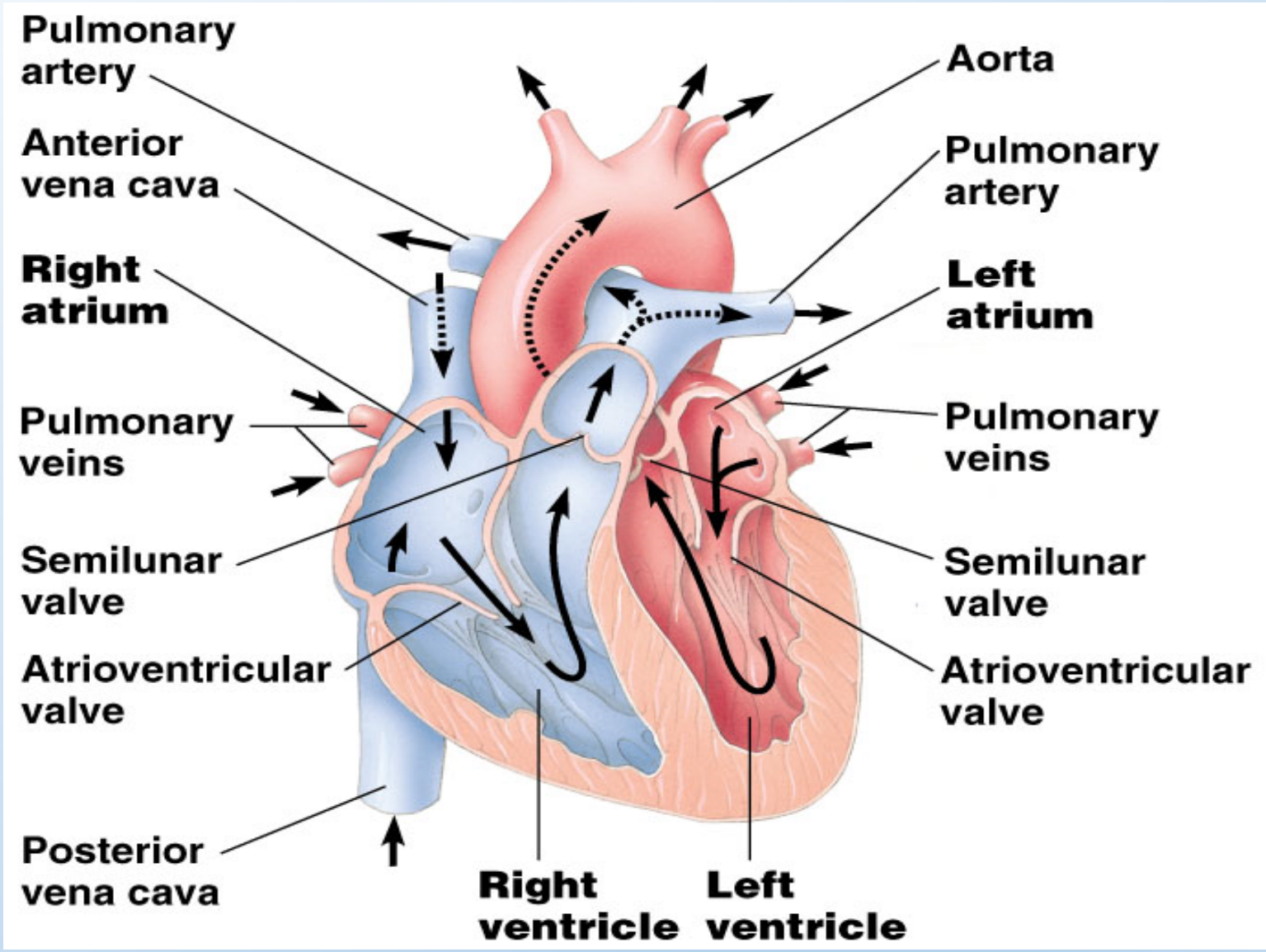


An Electrocardiogram (ECG) trace



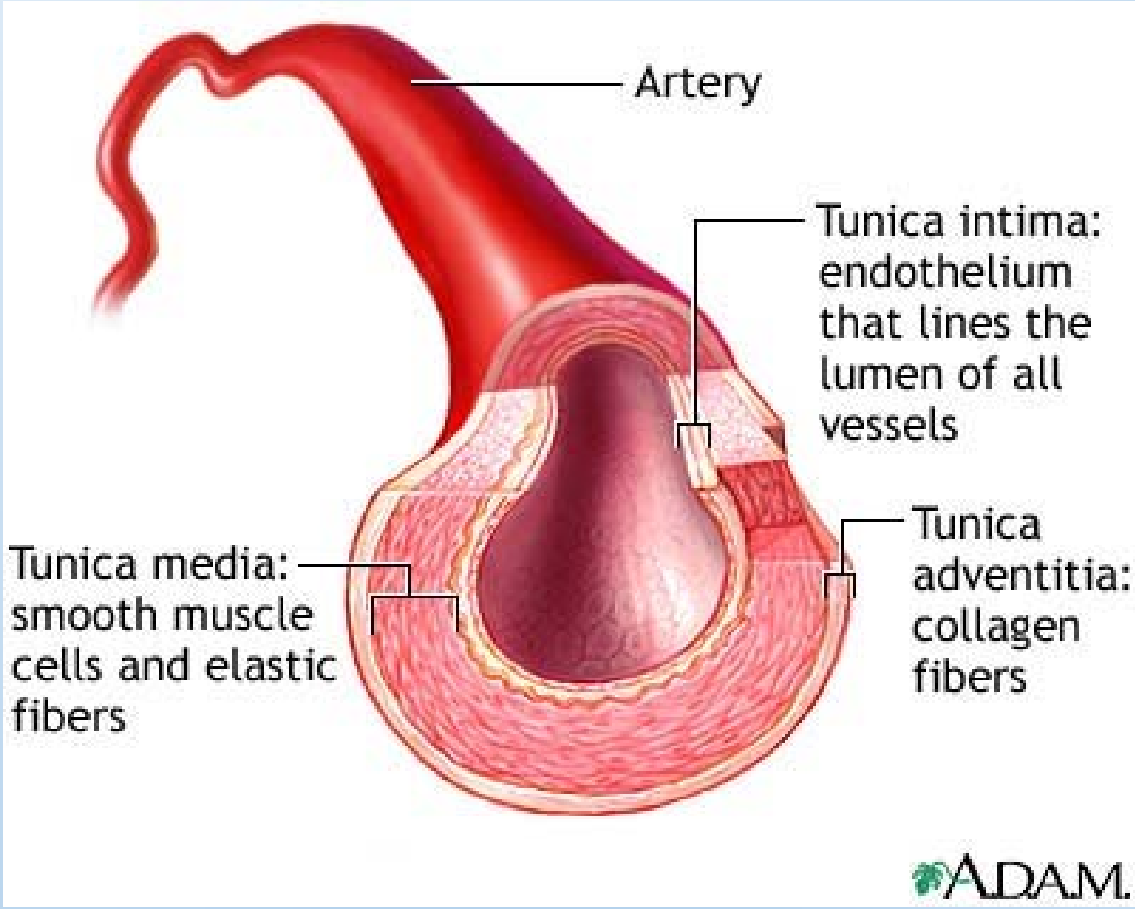


Artificial pacemaker
(pulse generator)


Pulmonary artery
Anterior vena cava
Right atrium
Pulmonary veins
Semilunar valve
Atrioventricular valve
Posterior vena cava
Right ventricle
Left ventricle
Aorta
Pulmonary artery
Left atrium
Pulmonary veins
Semilunar valve
Atrioventricular valve

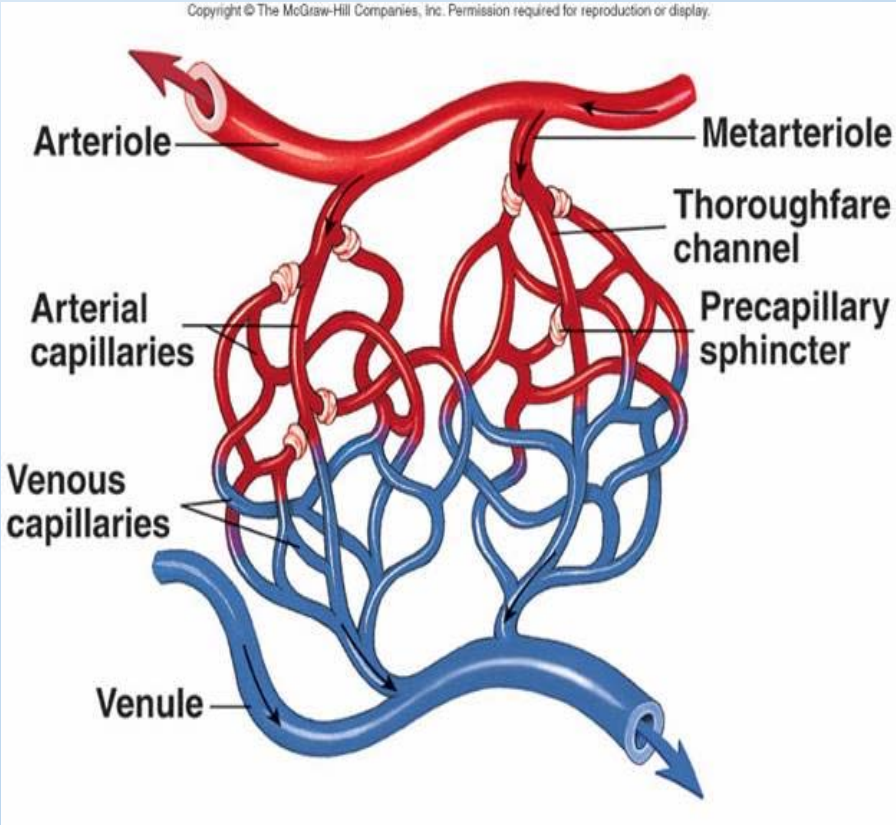
ARTERIES

- **Blood vessels that carry blood away from the heart are called arteries.**
- **They are the thickest blood vessels and they carry blood high in oxygen known as oxygenated blood (oxygen rich blood).**



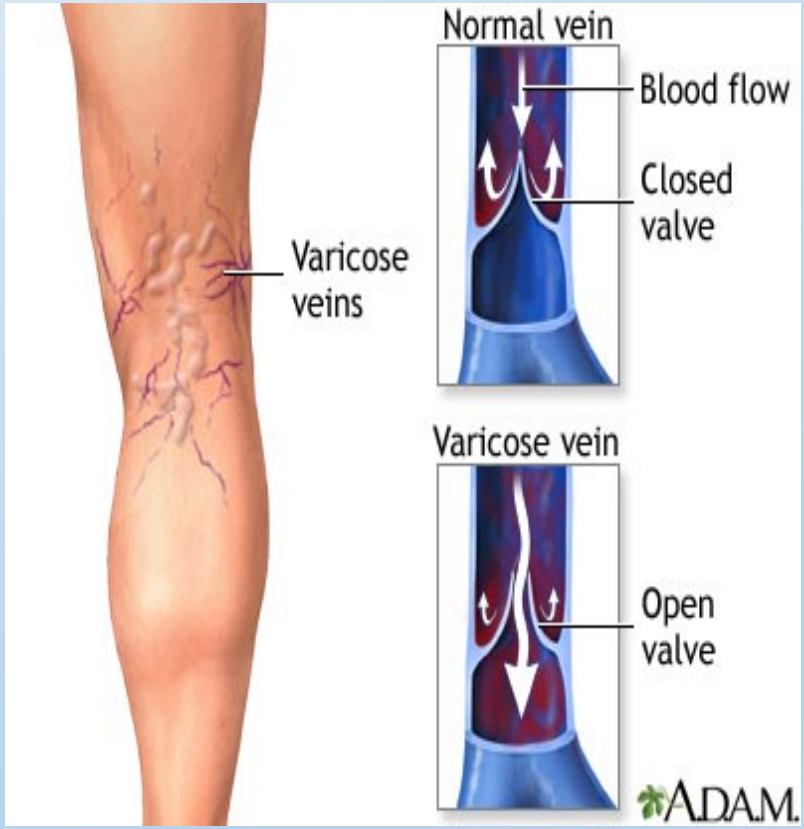
CAPILLARIES (5-8 micron)

- **The smallest blood vessels are capillaries and they connect the arteries and veins.**
- **This is where the exchange of nutrients and gases occurs.**



VEINS

- **Blood vessels that carry blood back to the heart are called veins.**
- **They have one-way valves which prevent blood from flowing backwards.**
- **They carry blood that is high in carbon dioxide known as deoxygenated blood (oxygen poor blood).**



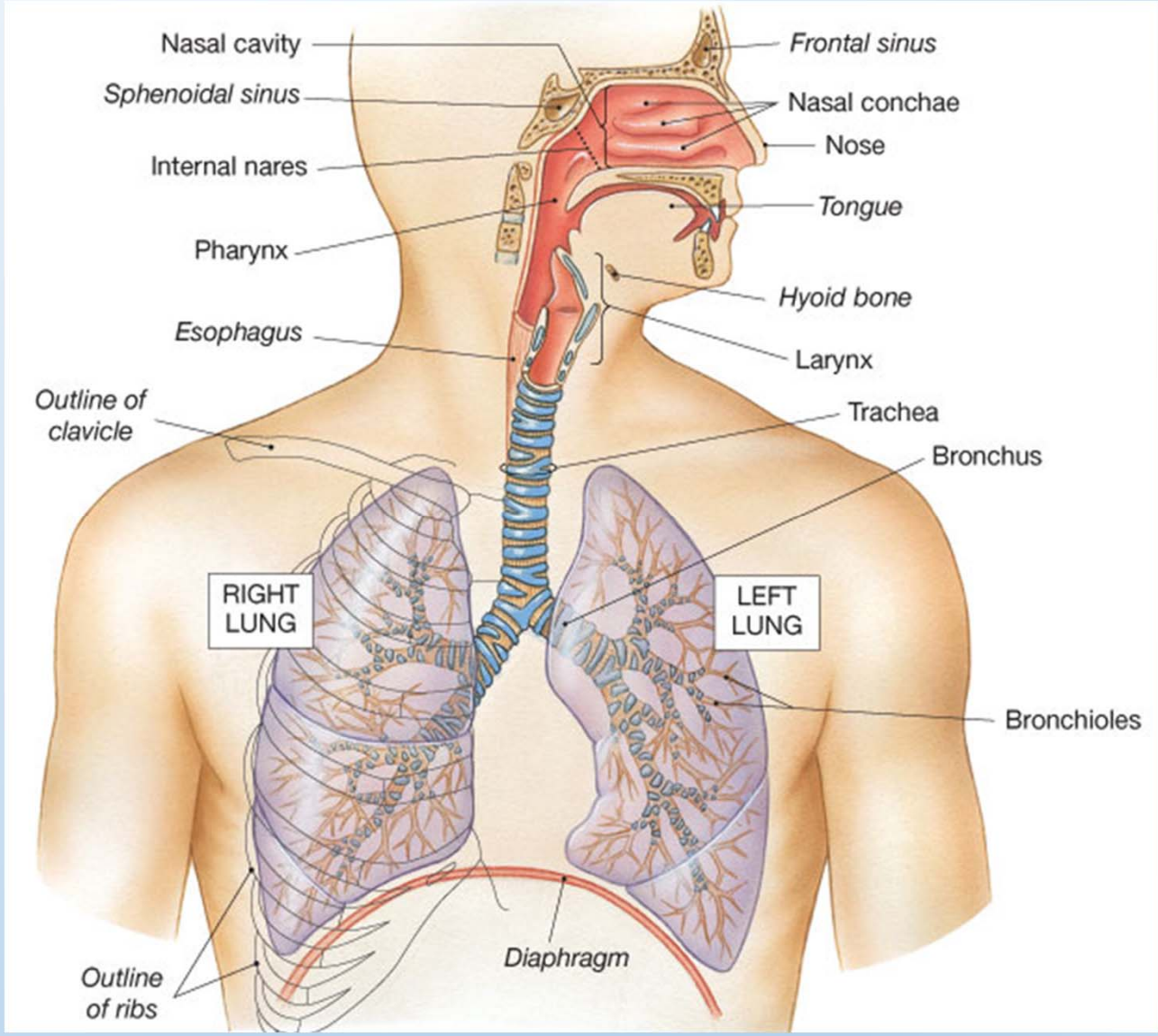
Superficial veins

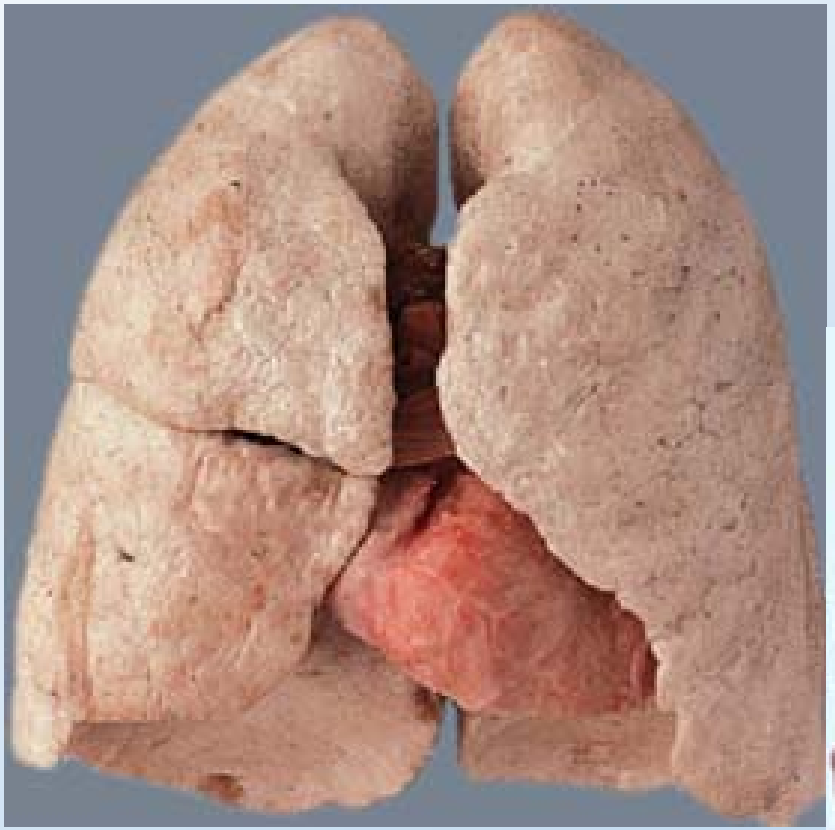
-provide convenient sites for venipuncture



Respiratory Tract:

From nose to alveoli

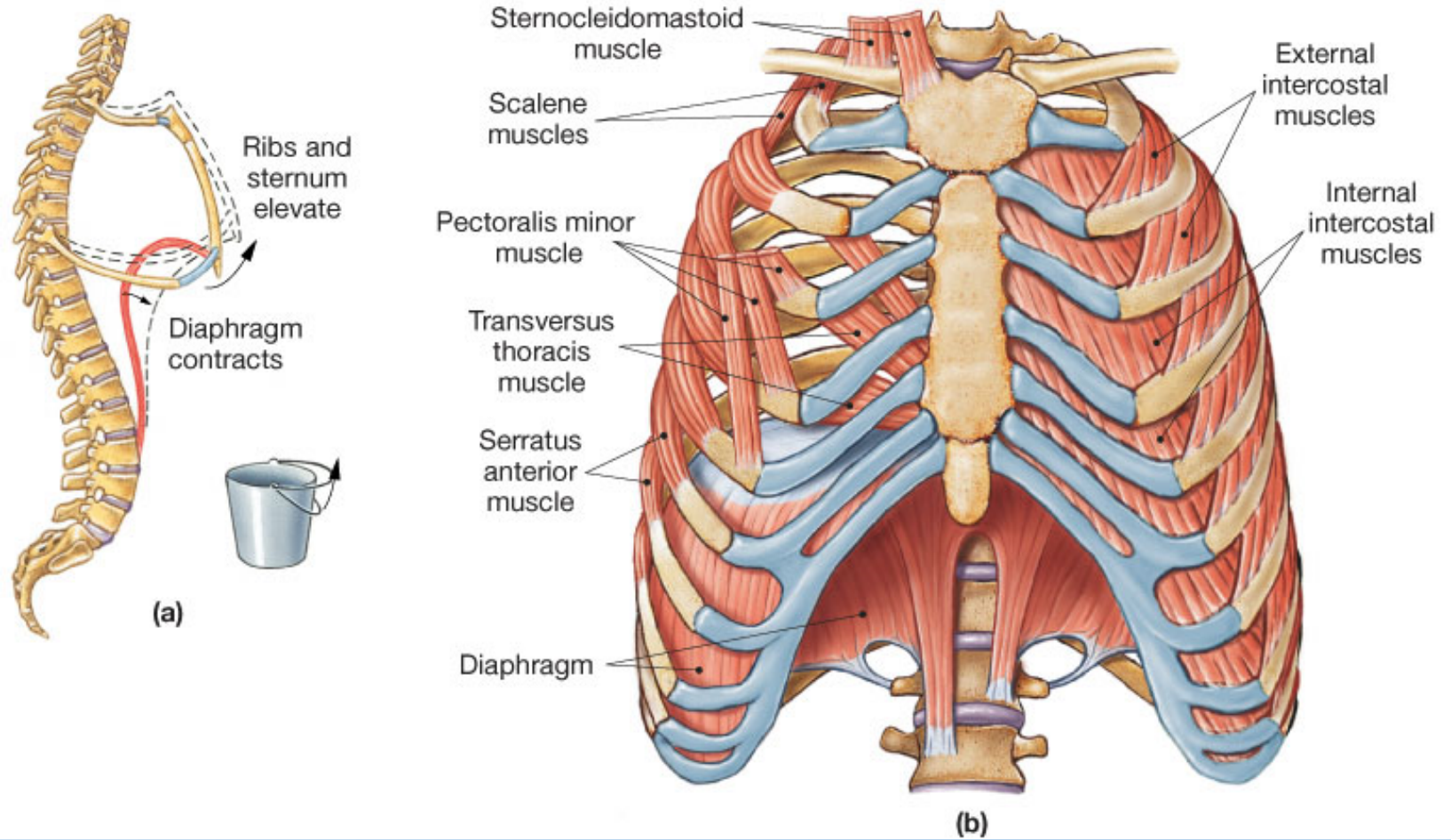




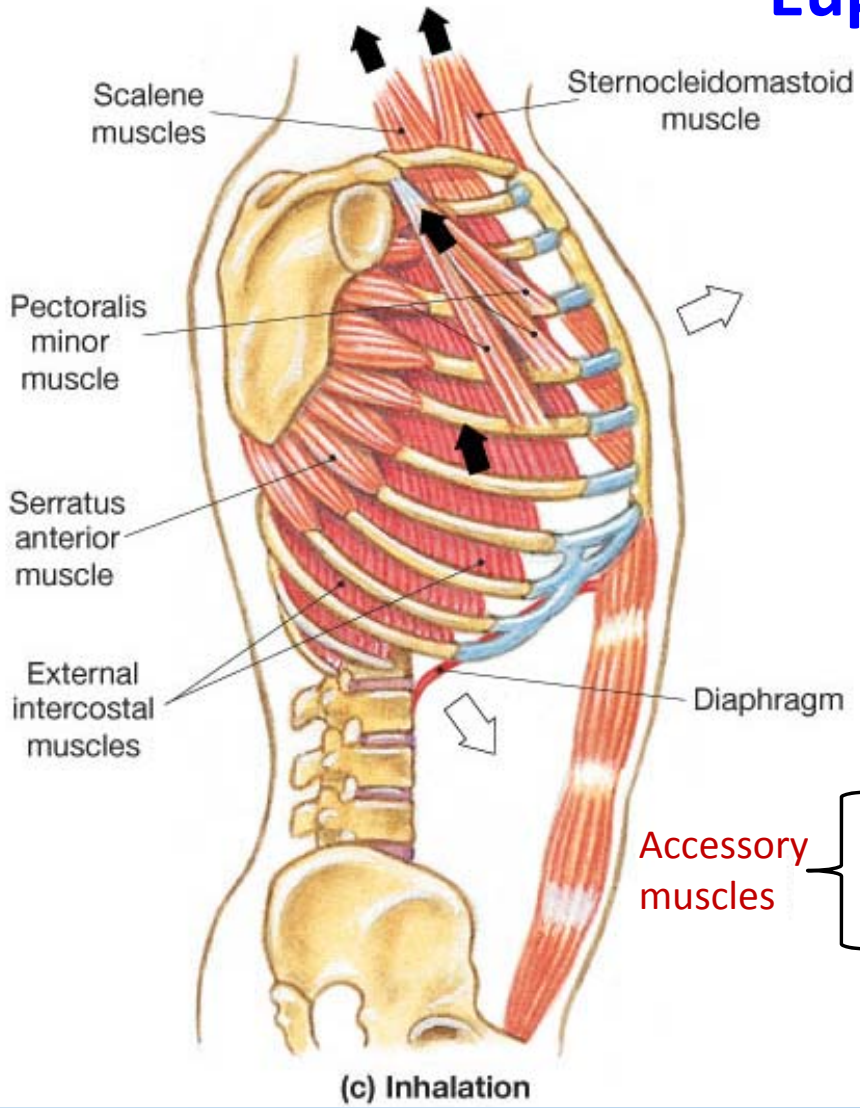




Respiratory Muscles



Ventilation - movement of air into and out of lungs.



Eupnea = normal quite breathing at rest.

For Inspiration

Muscle activity required:

Diaphragm

External Intercostals

Accessory muscles
- ***Sternocleidomastoid***
- ***Scalenes***

Forceful breathing

(hypereupnea):

Same muscles required as in Eupnea.

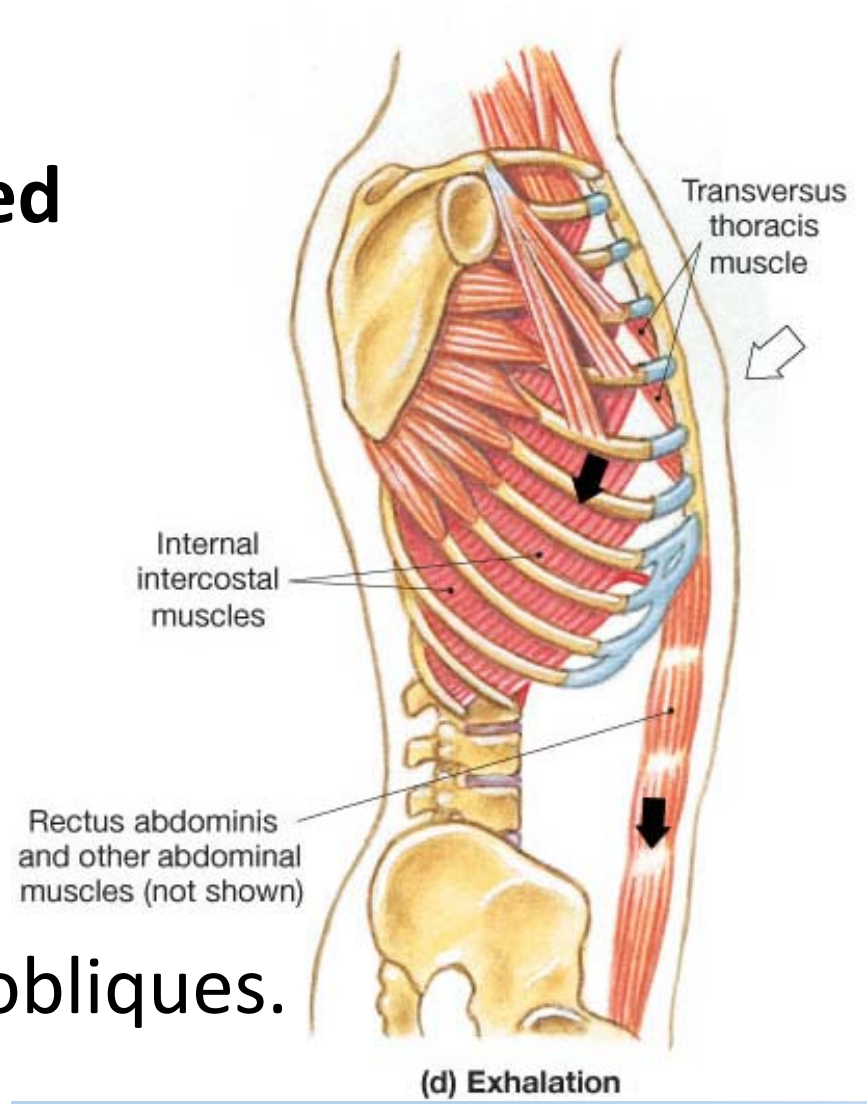
Expiration requires:

Internal Intercostals

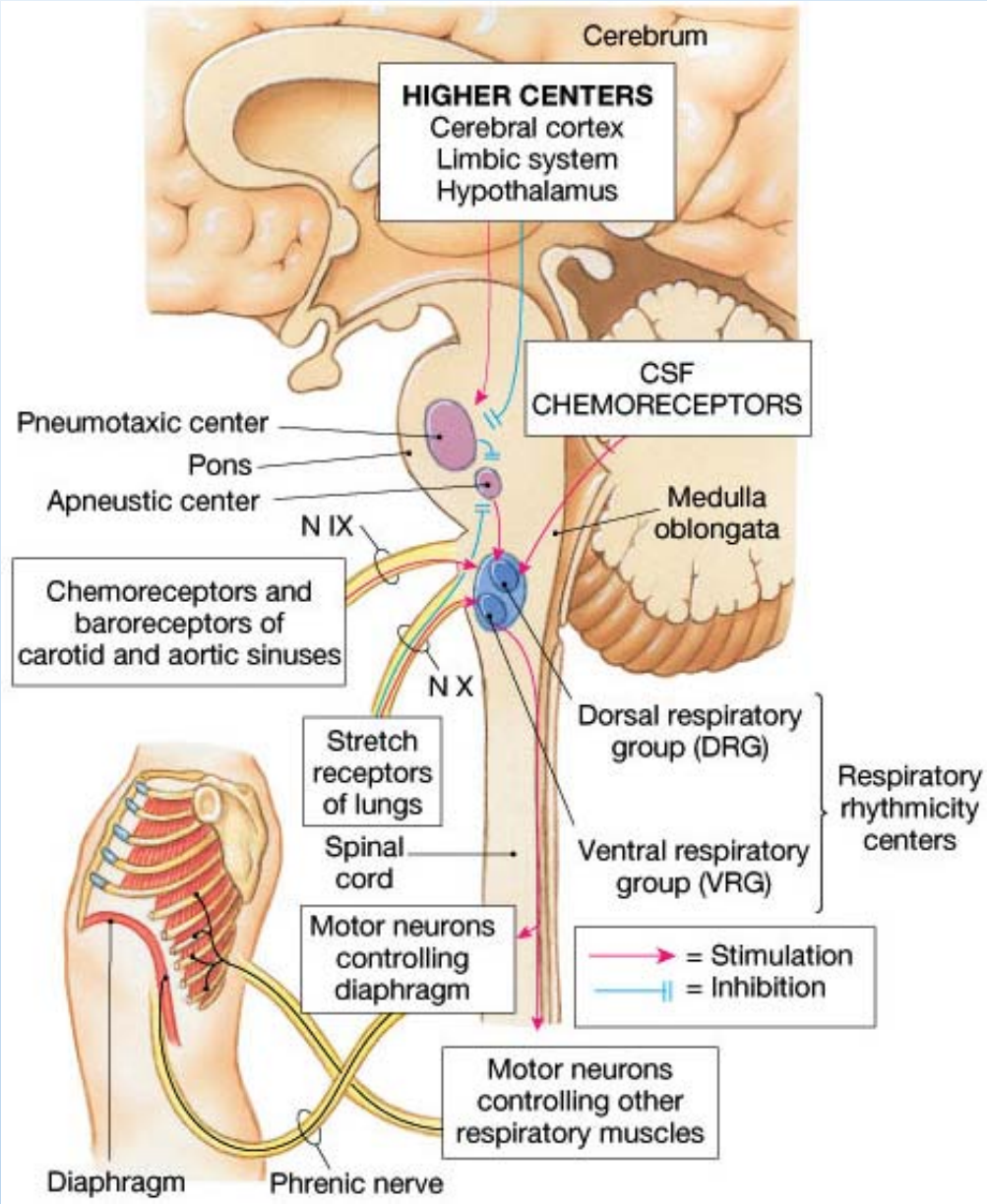
Rectus abdominis

Transverse abdominis,

Internal and External obliques.



Locations of these centers in the brain

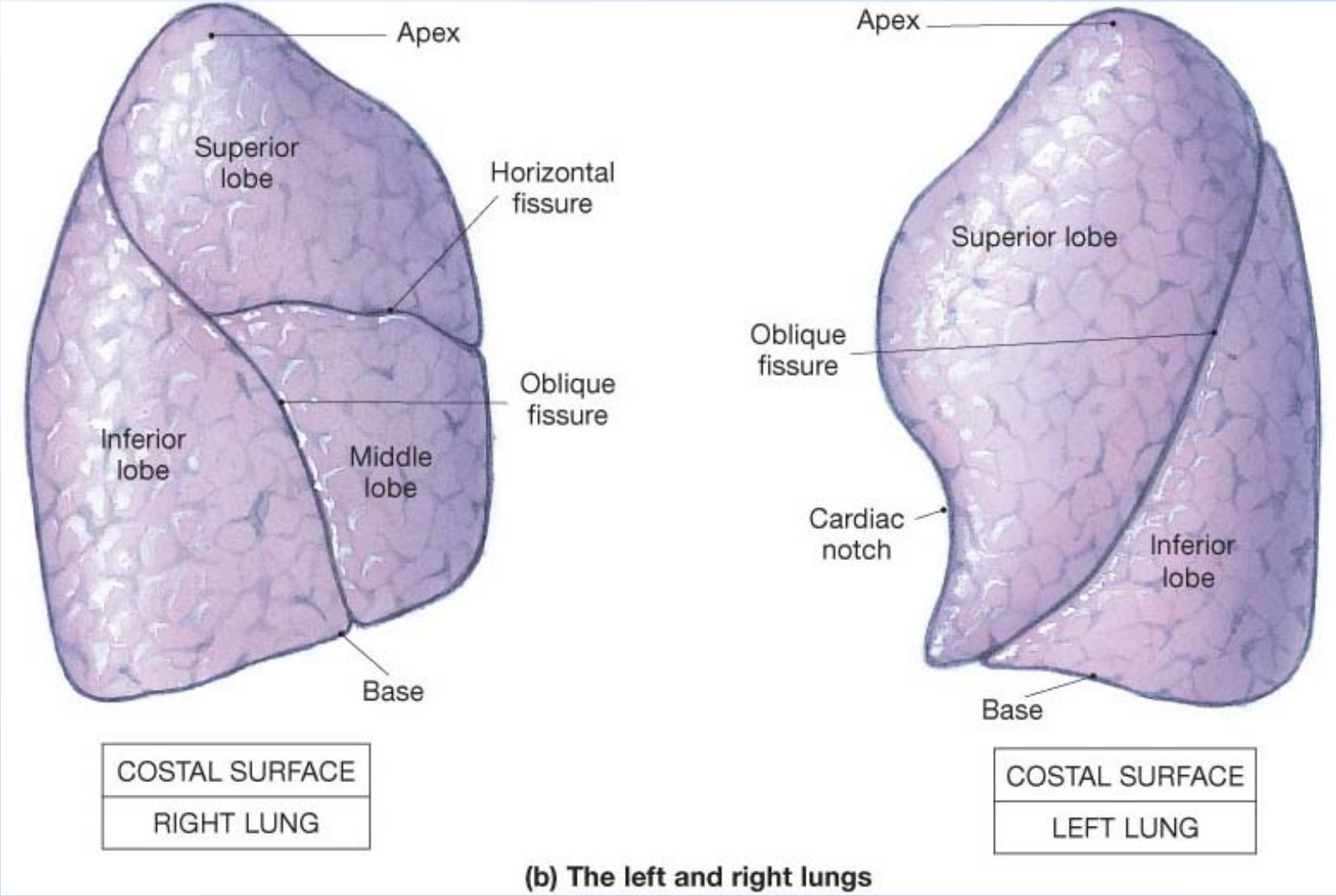


The Lungs

- Separated by fissures
 - Right lung has three lobes.
 - Left lung has two lobes.
- Costal surface
 - Anterior surface
 - Follows inner contours of rib cage
- Mediastinal surface
 - Contains hilus
 - Costal notch - Left lung

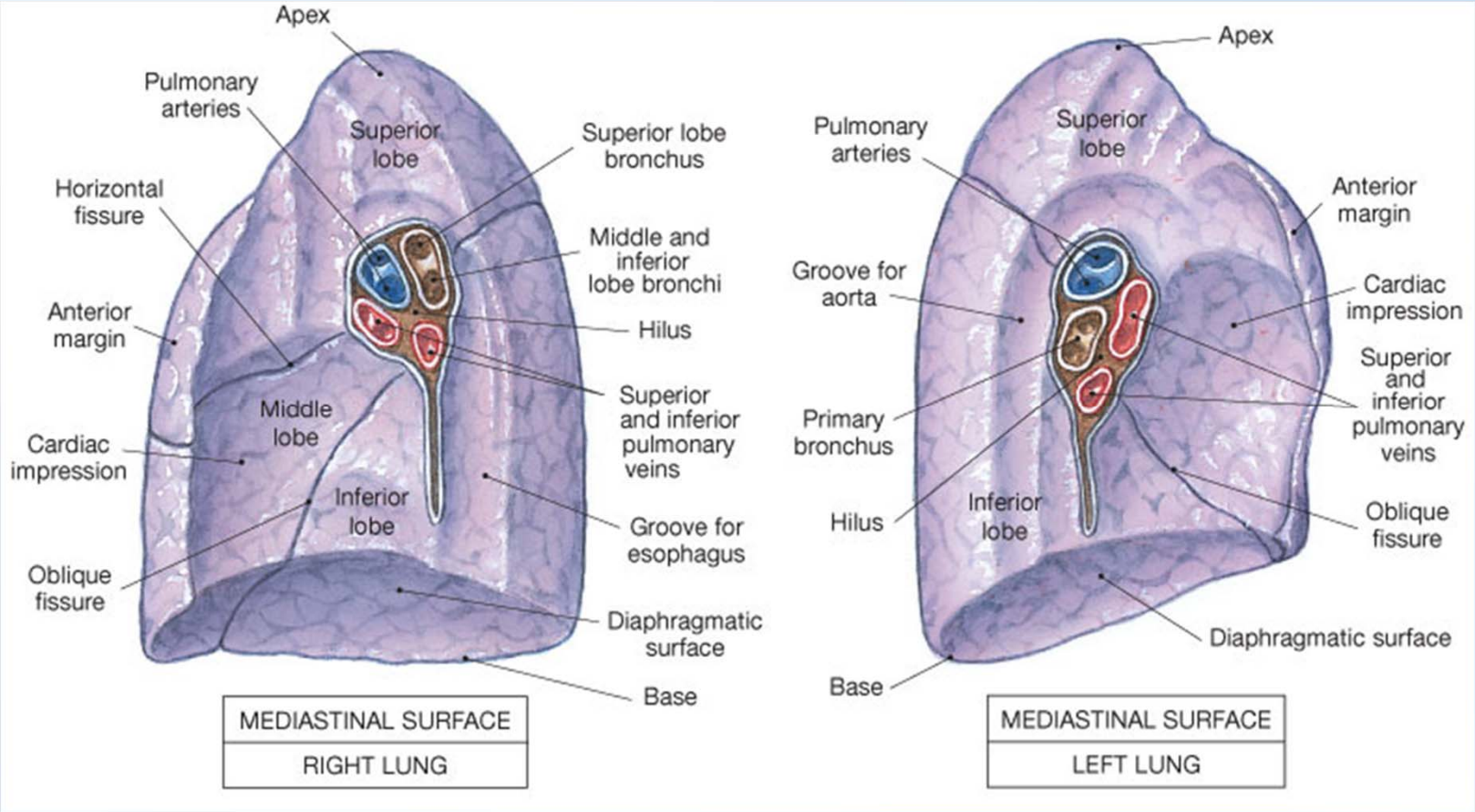
Right Lung

Left Lung

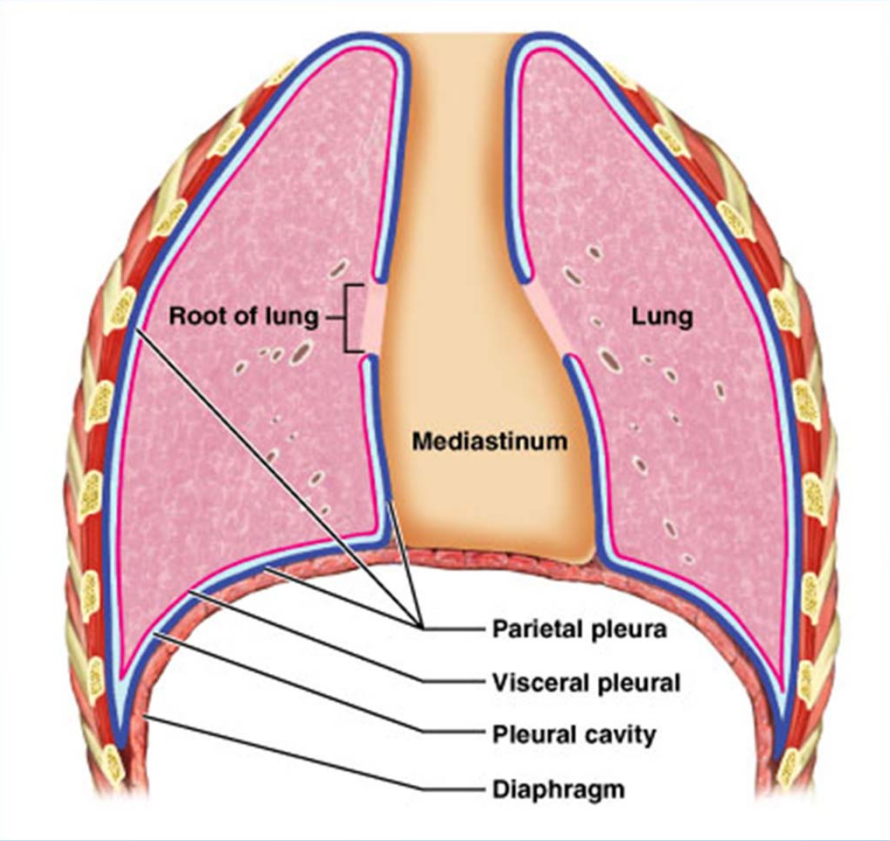


(b) The left and right lungs

Medial aspect of each Lung



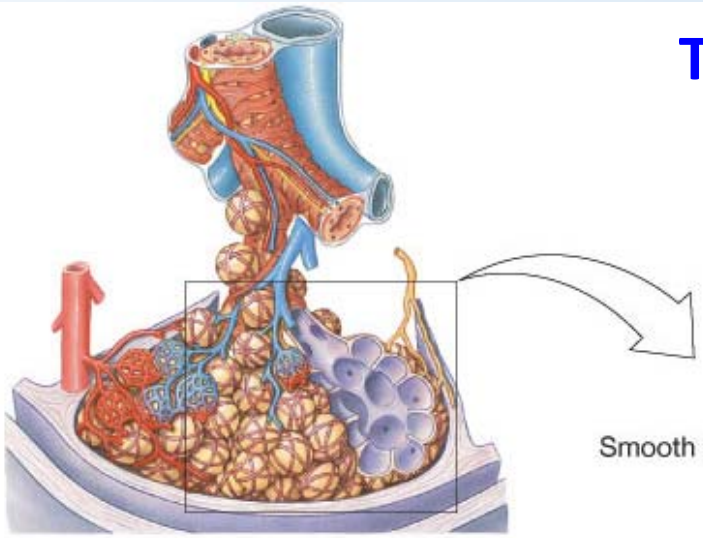
Each Lung is in a ‘Bag’

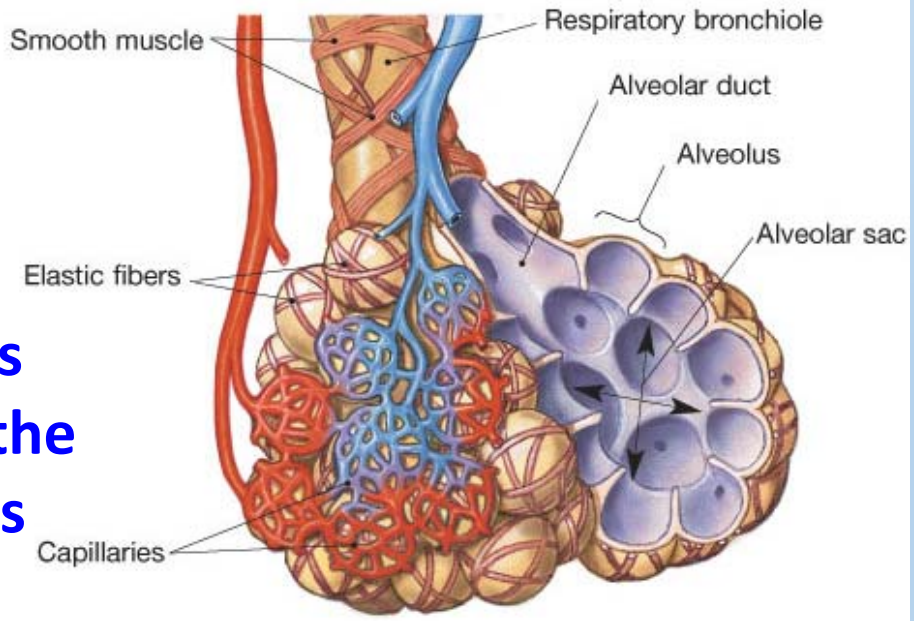


Visceral pleura

Parietal pleura

There are about 150 million alveoli in each Lung

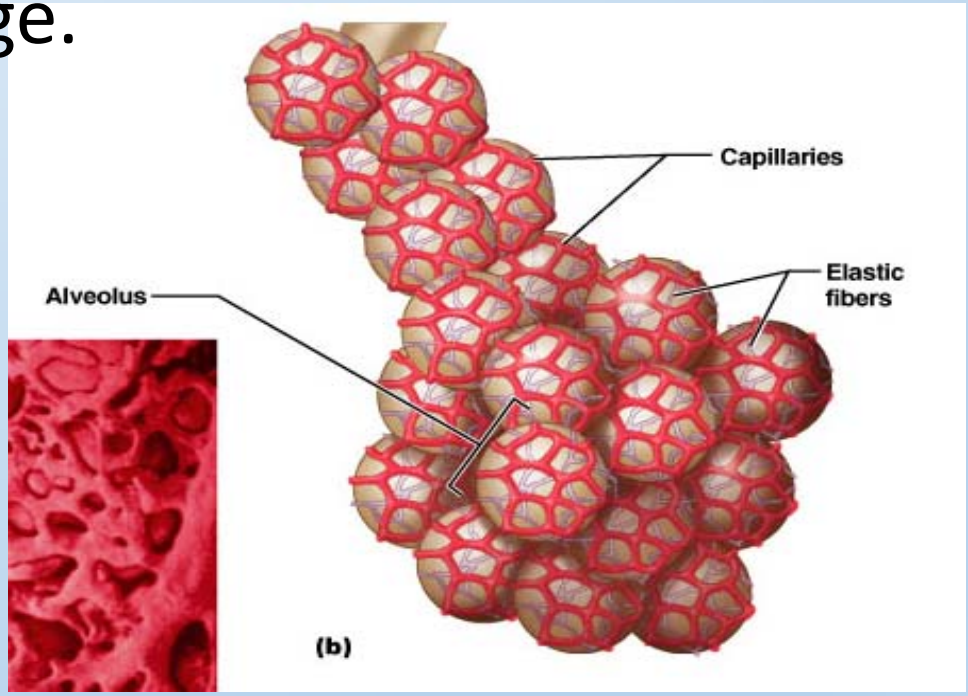


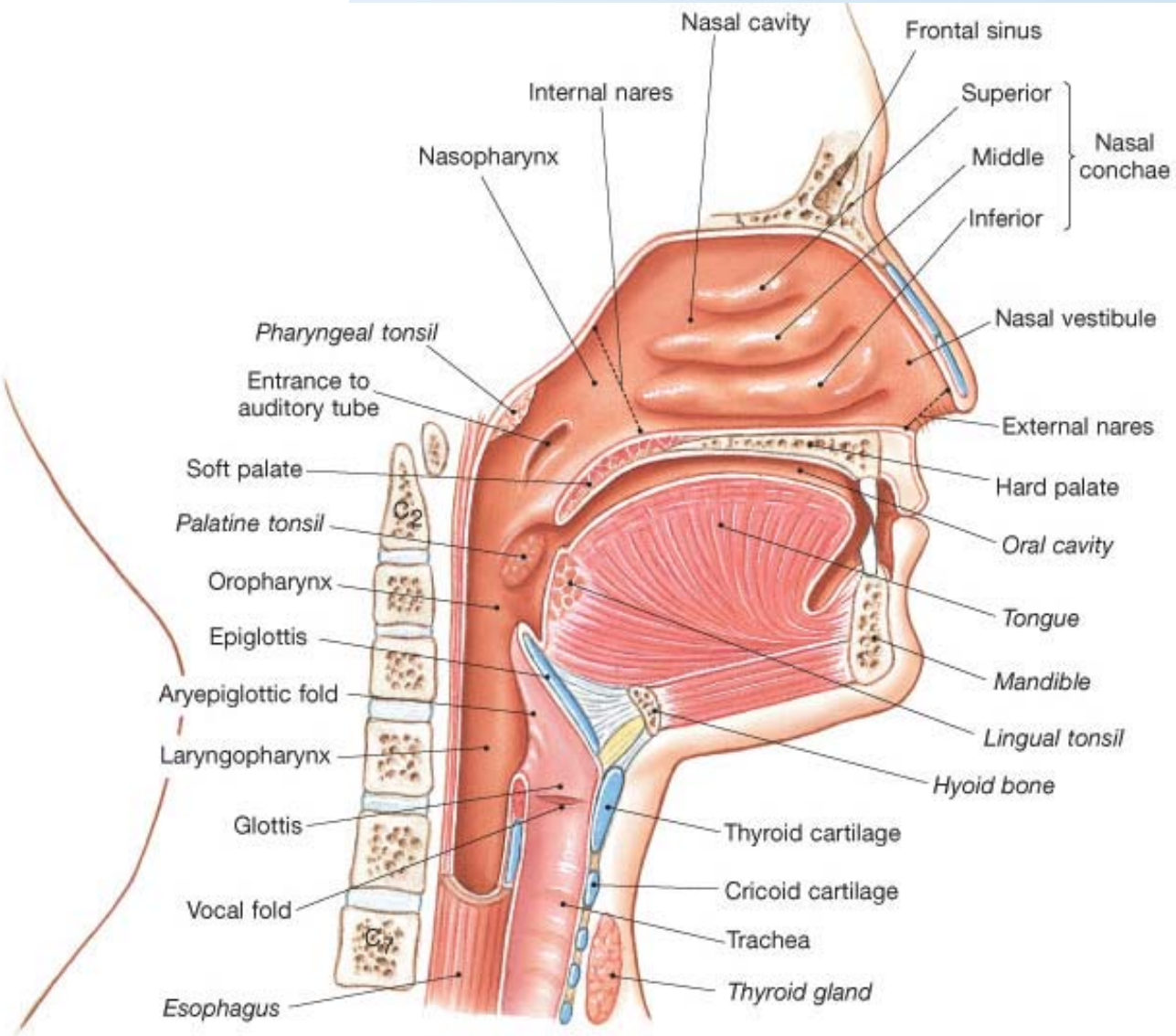


The alveoli is where gas exchange occurs with the pulmonary capillaries

An alveolus consist of 3 Types of cells

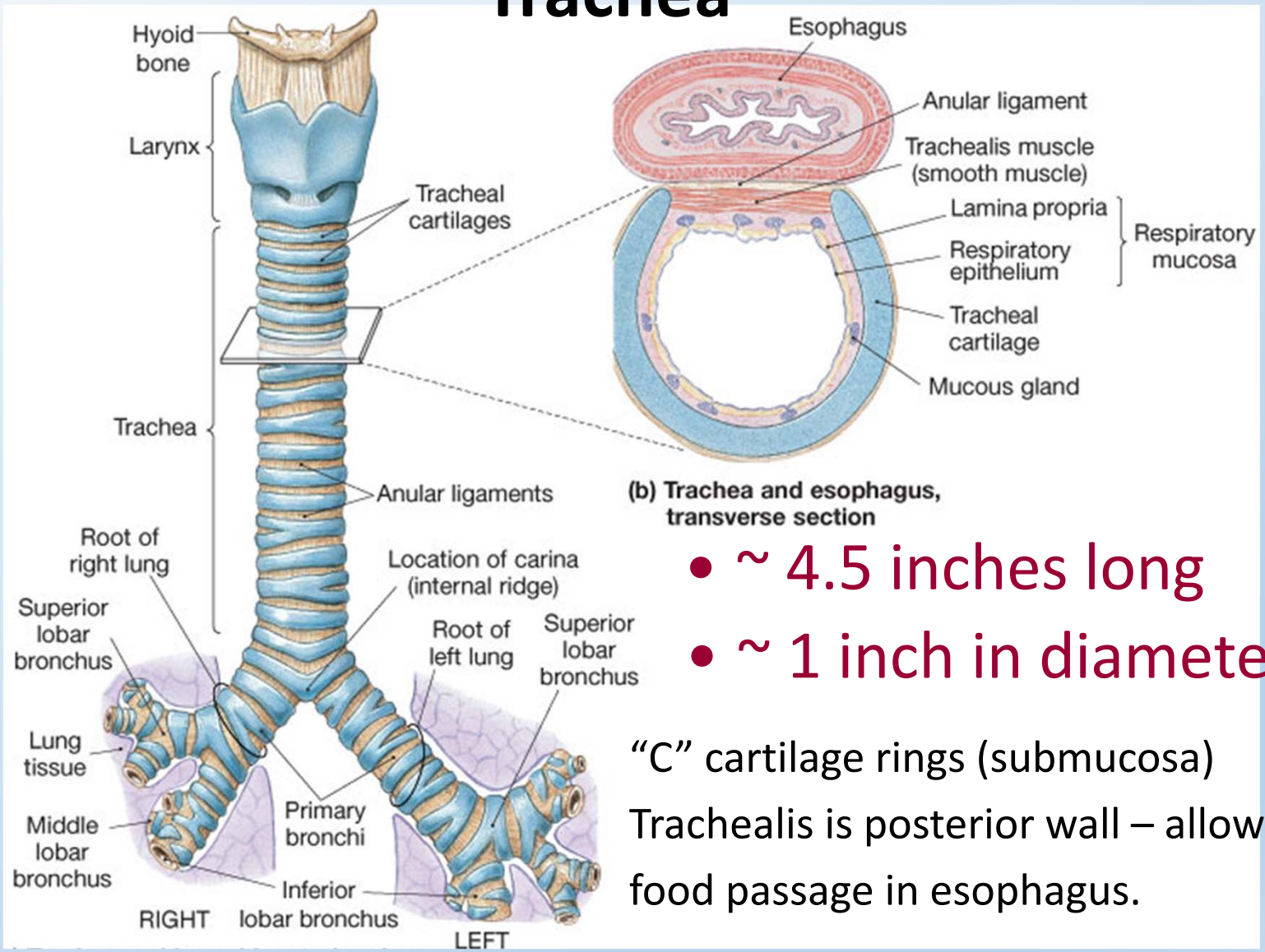
1) Alveolar Type I cells – thin (simple squamous epithelium); makes 'walls' of alveoli, provides surface area for gas exchange.





(d) Sagittal section

Trachea

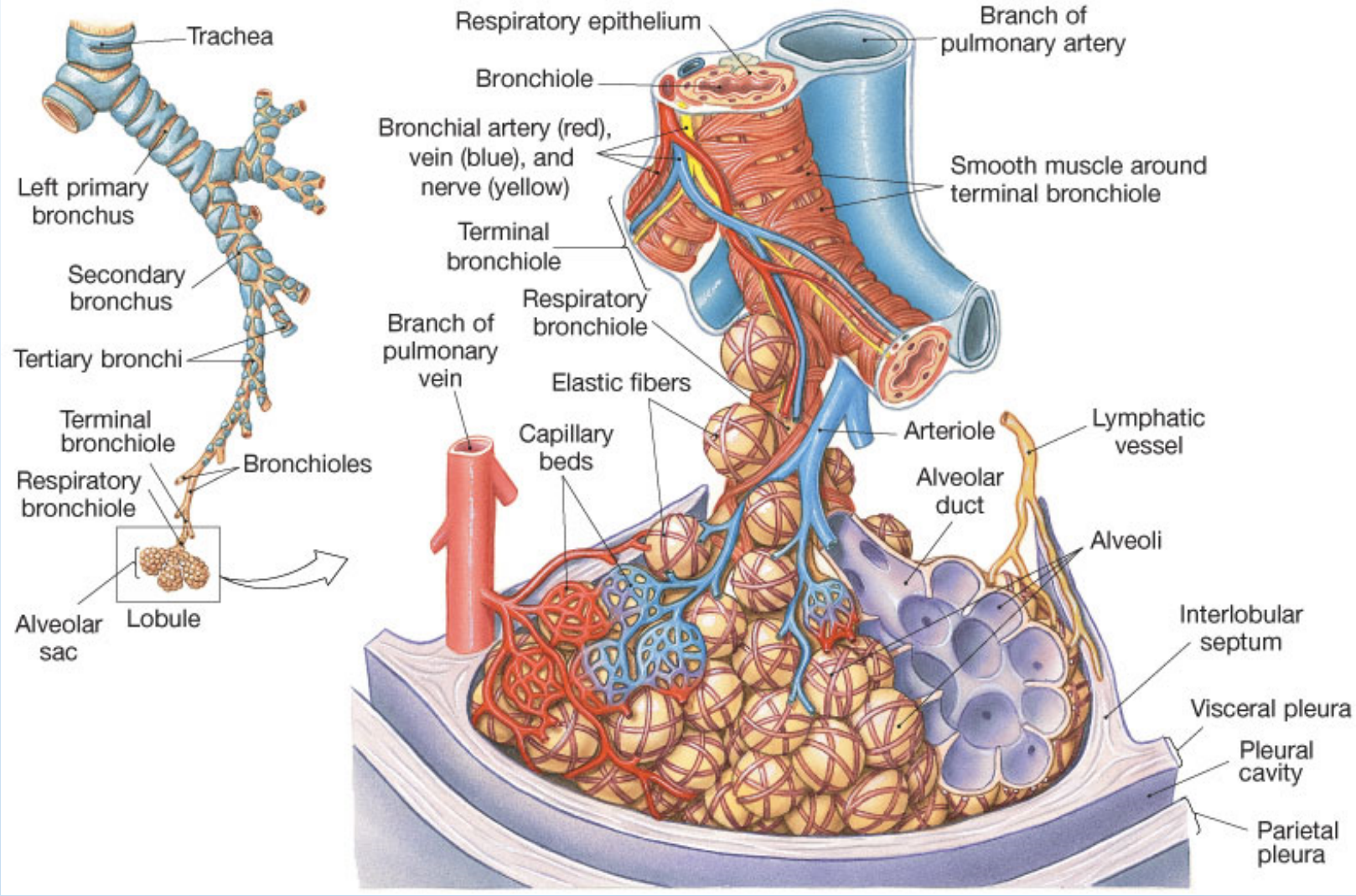


- ~ 4.5 inches long
- ~ 1 inch in diameter

"C" cartilage rings (submucosa)

Trachealis is posterior wall – allows food passage in esophagus.

Bronchi and Bronchioles

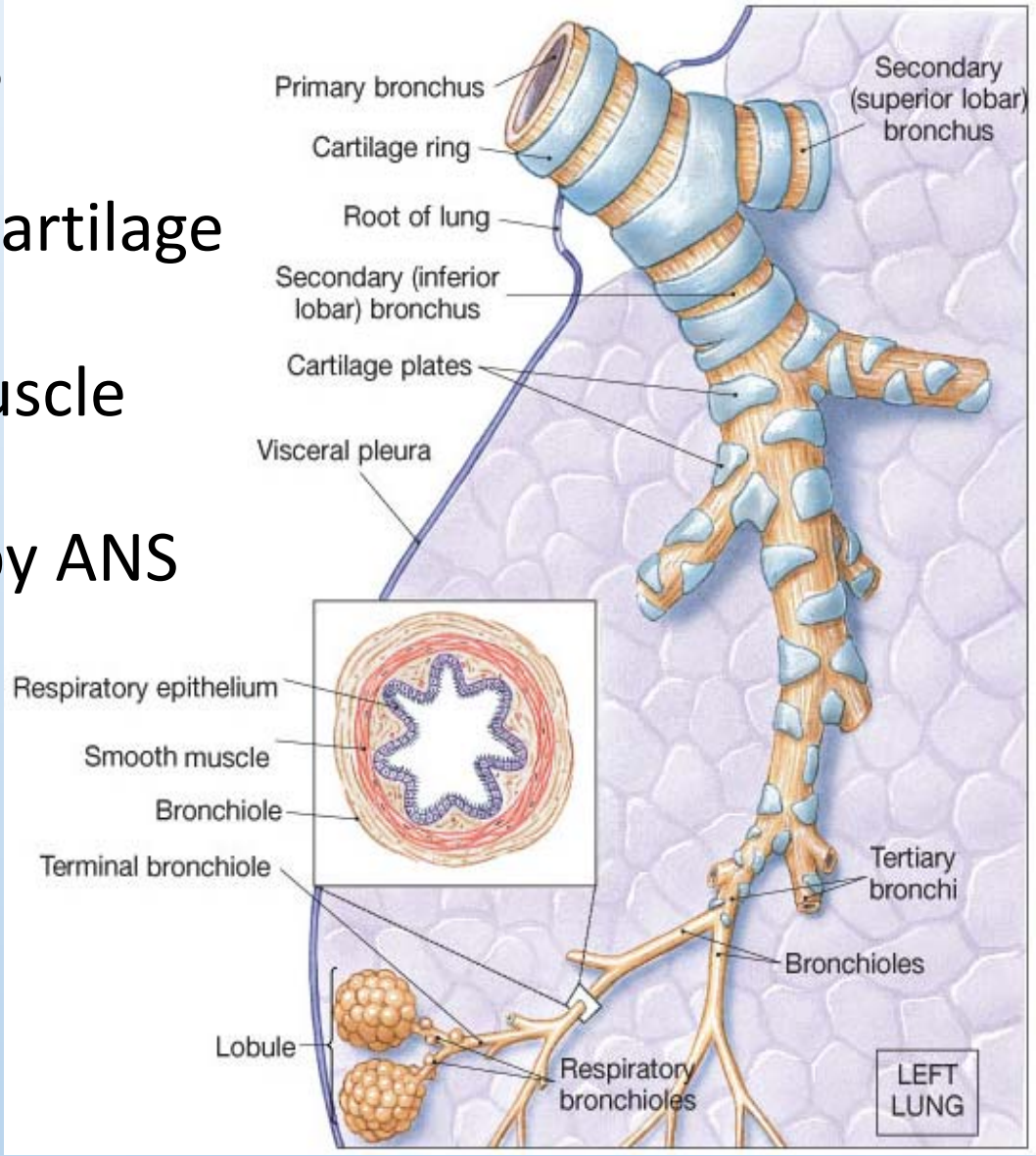


Bronchioles

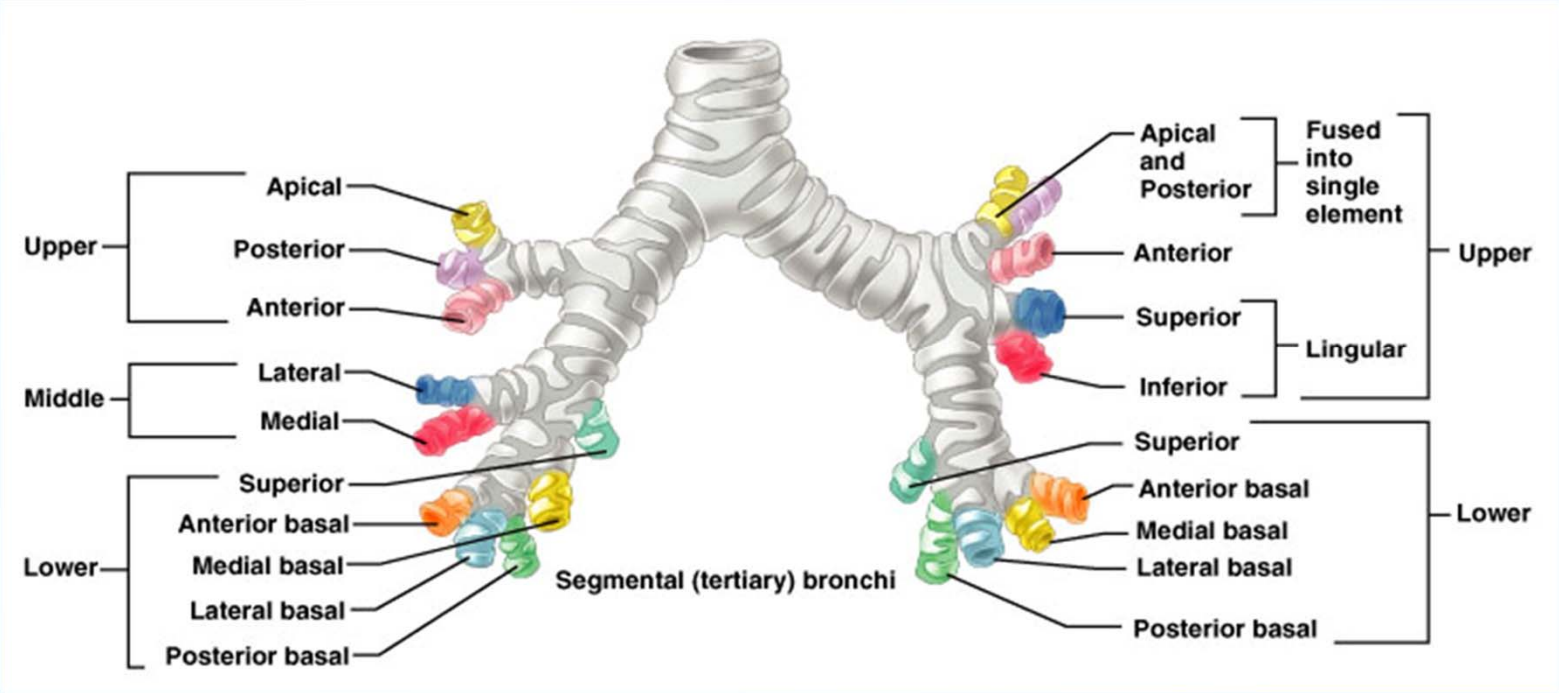
- Do not contain cartilage
- Have smooth muscle
- Are Innervated by ANS

<u>Parasympathetic</u>
– constrict airways

<u>Sympathetic</u>
– dilate airways

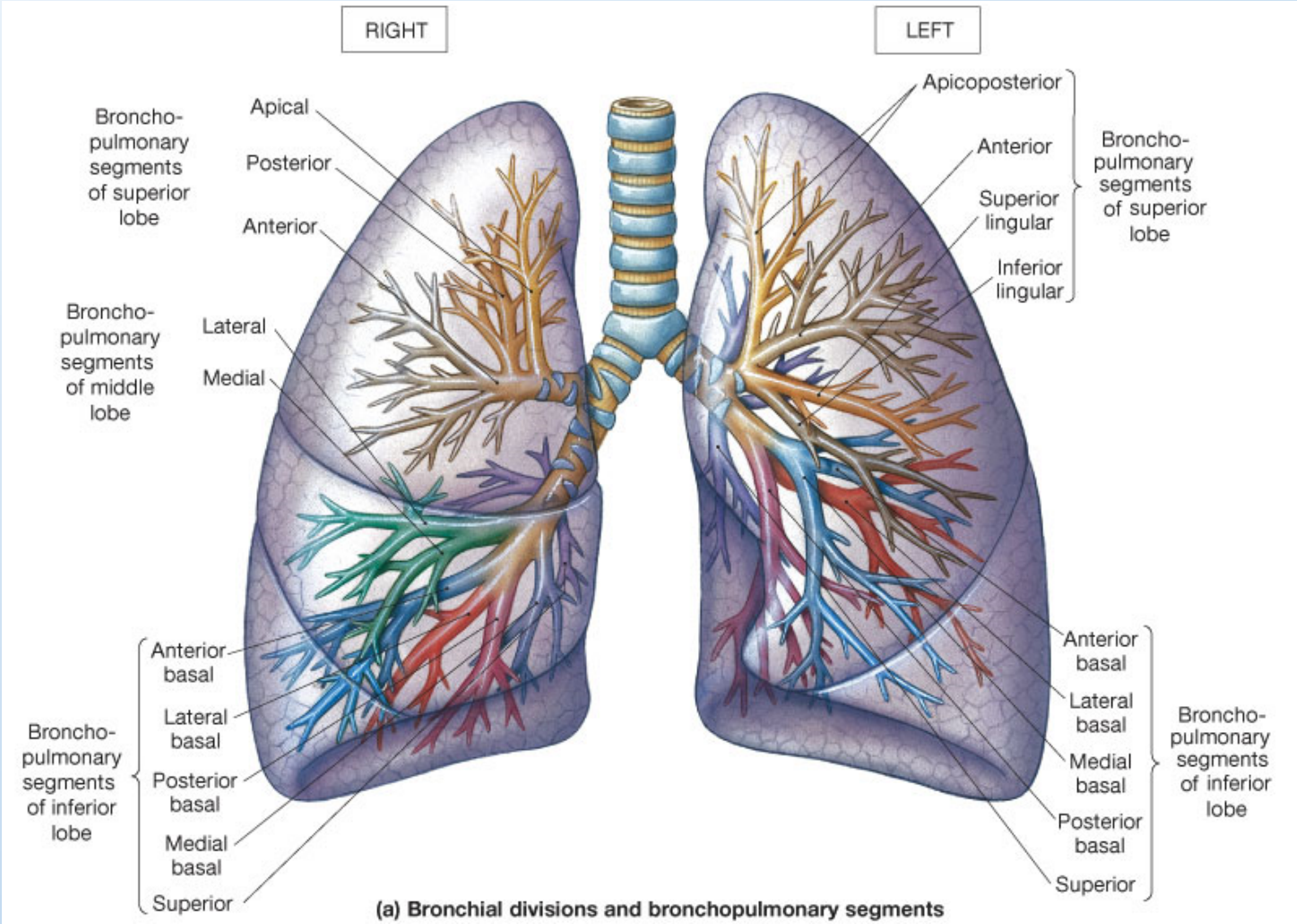


The Bronchiole Tree



Right Lung **Left Lung**

Bronchopulmonary Segments



(a) Bronchial divisions and bronchopulmonary segments