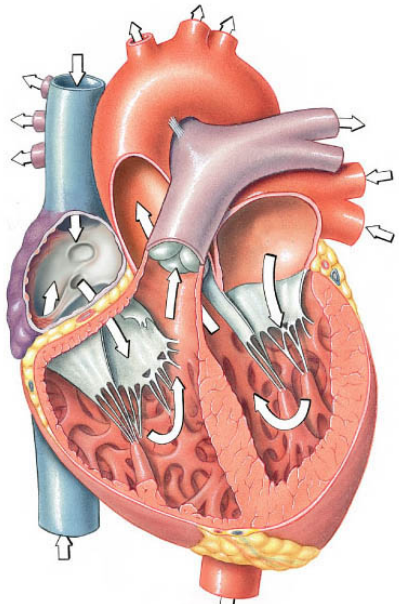
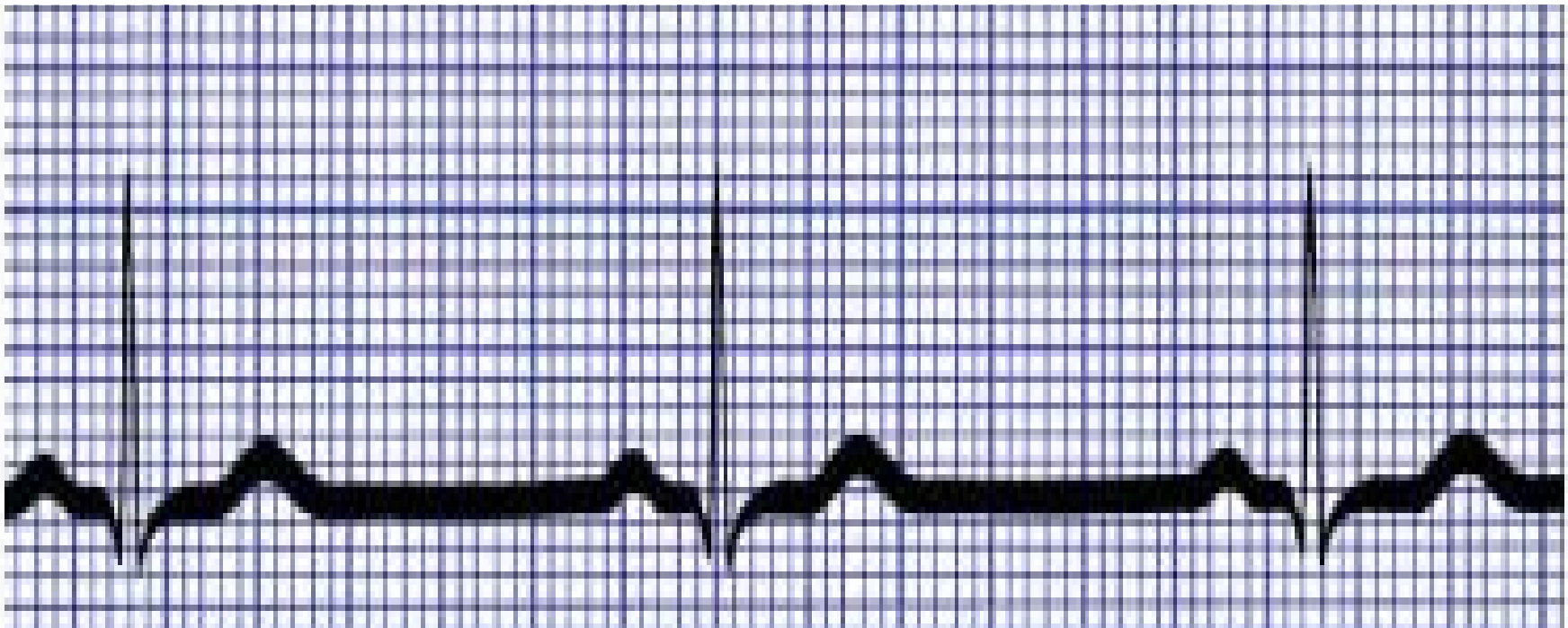
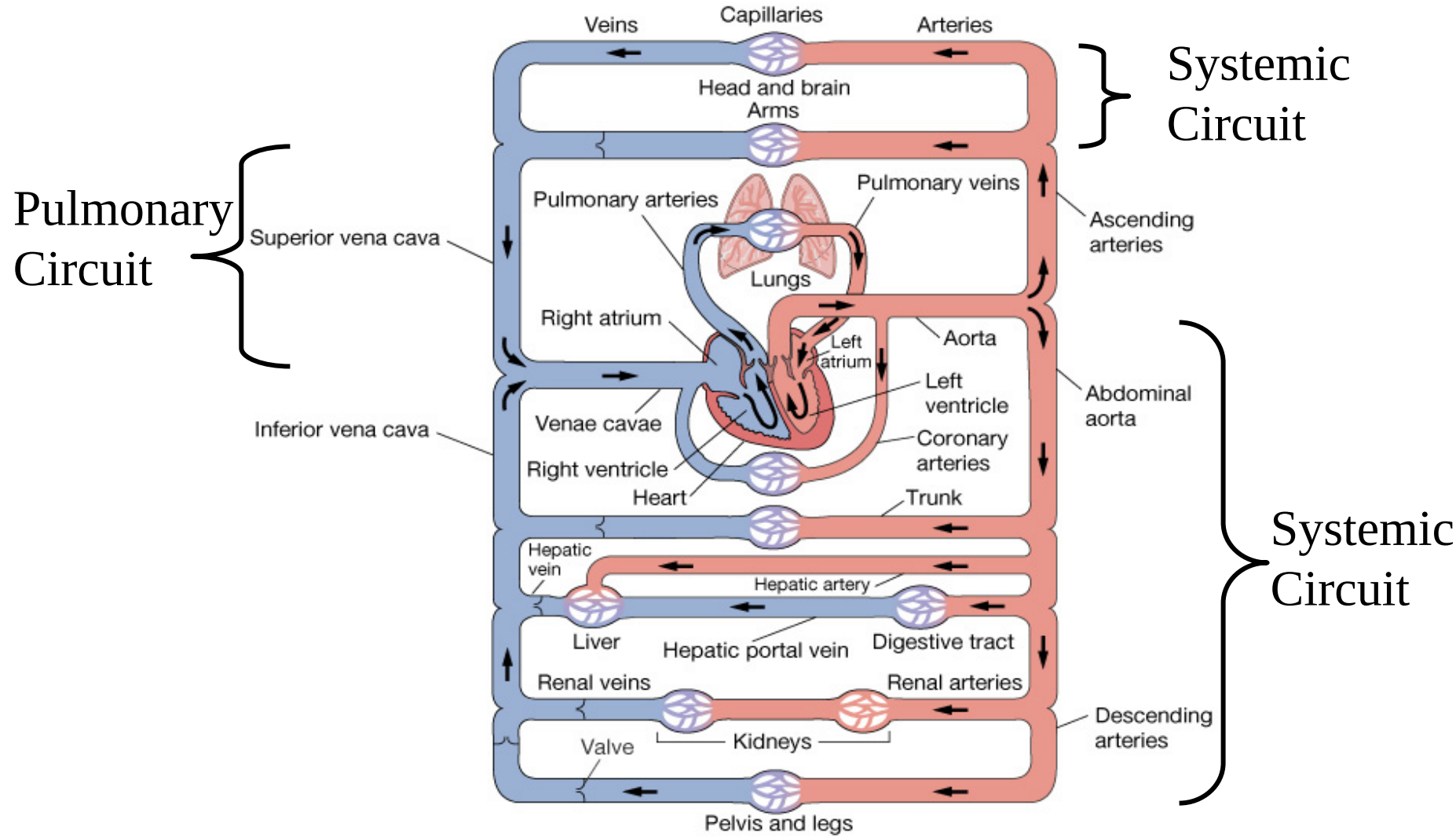


Cardiovascular System II



The Circulatory system is a "closed circulation"

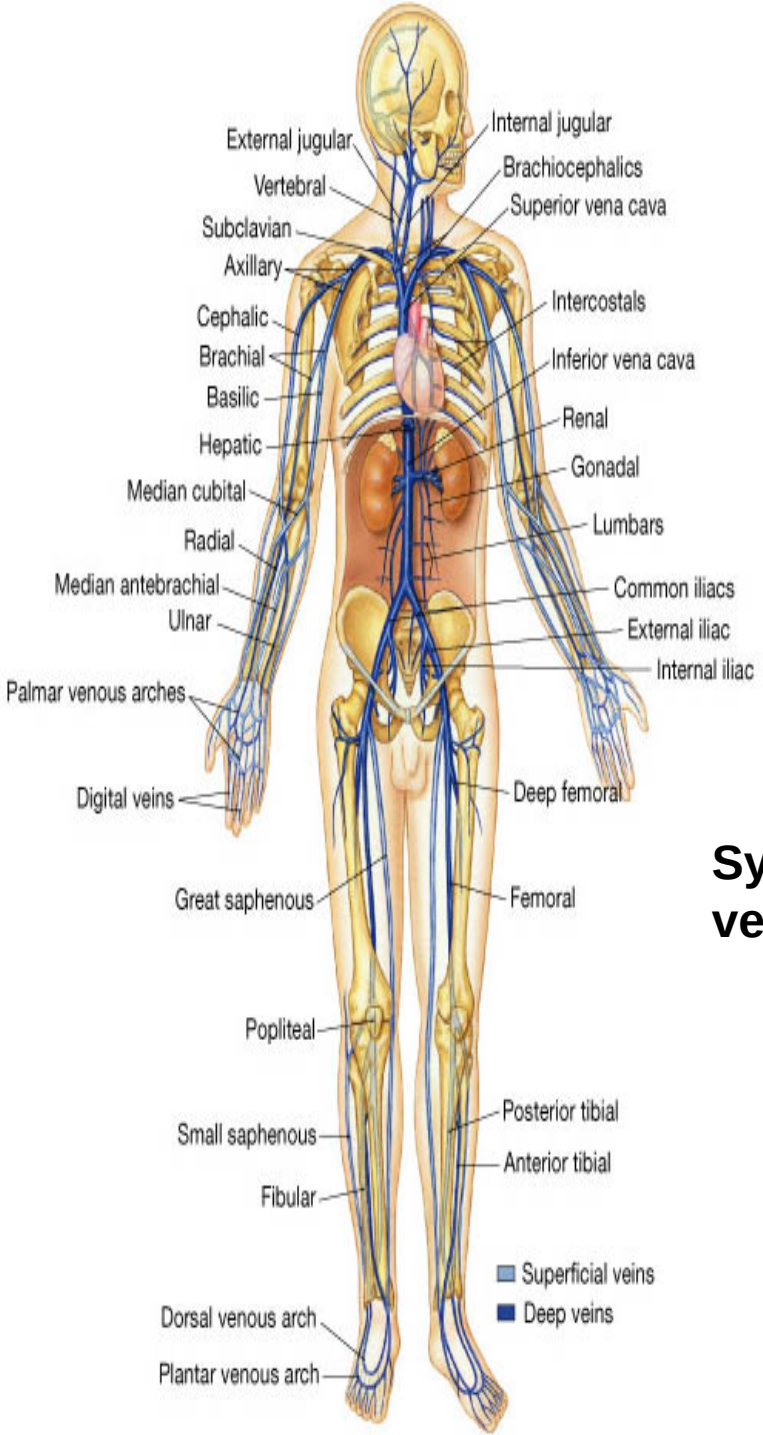


Arteries = vessels that carry blood away from the heart.

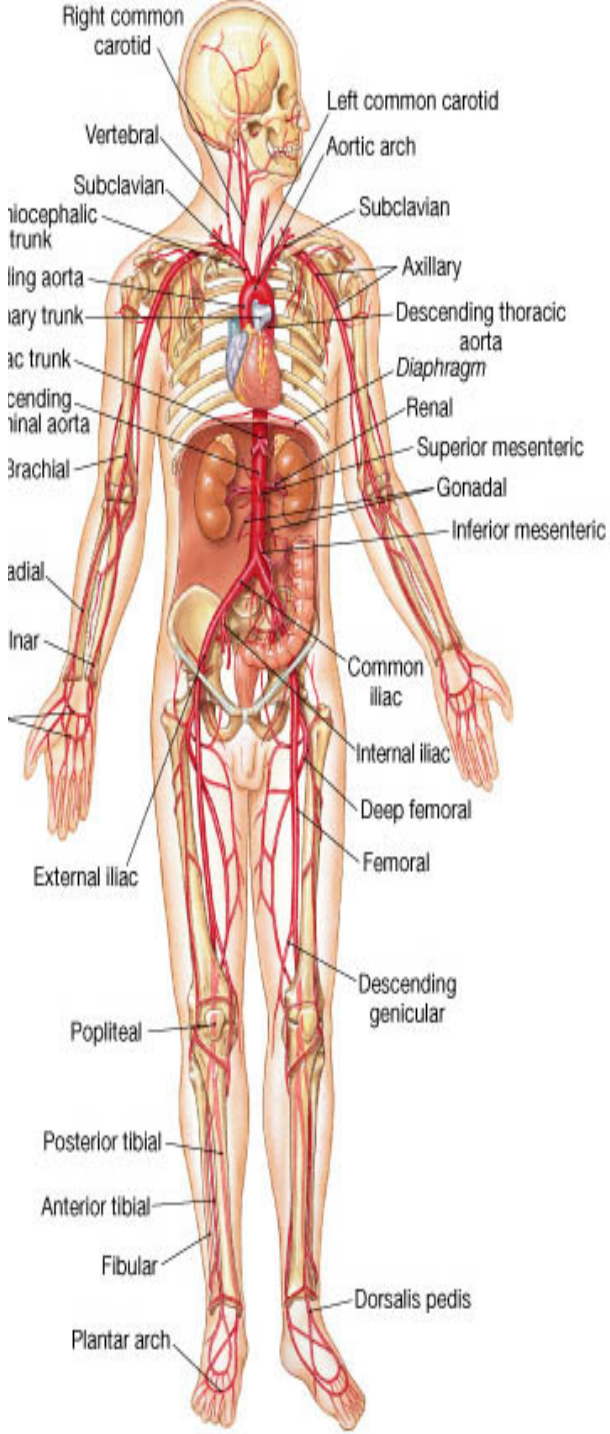
Veins = vessels that return blood to the heart.

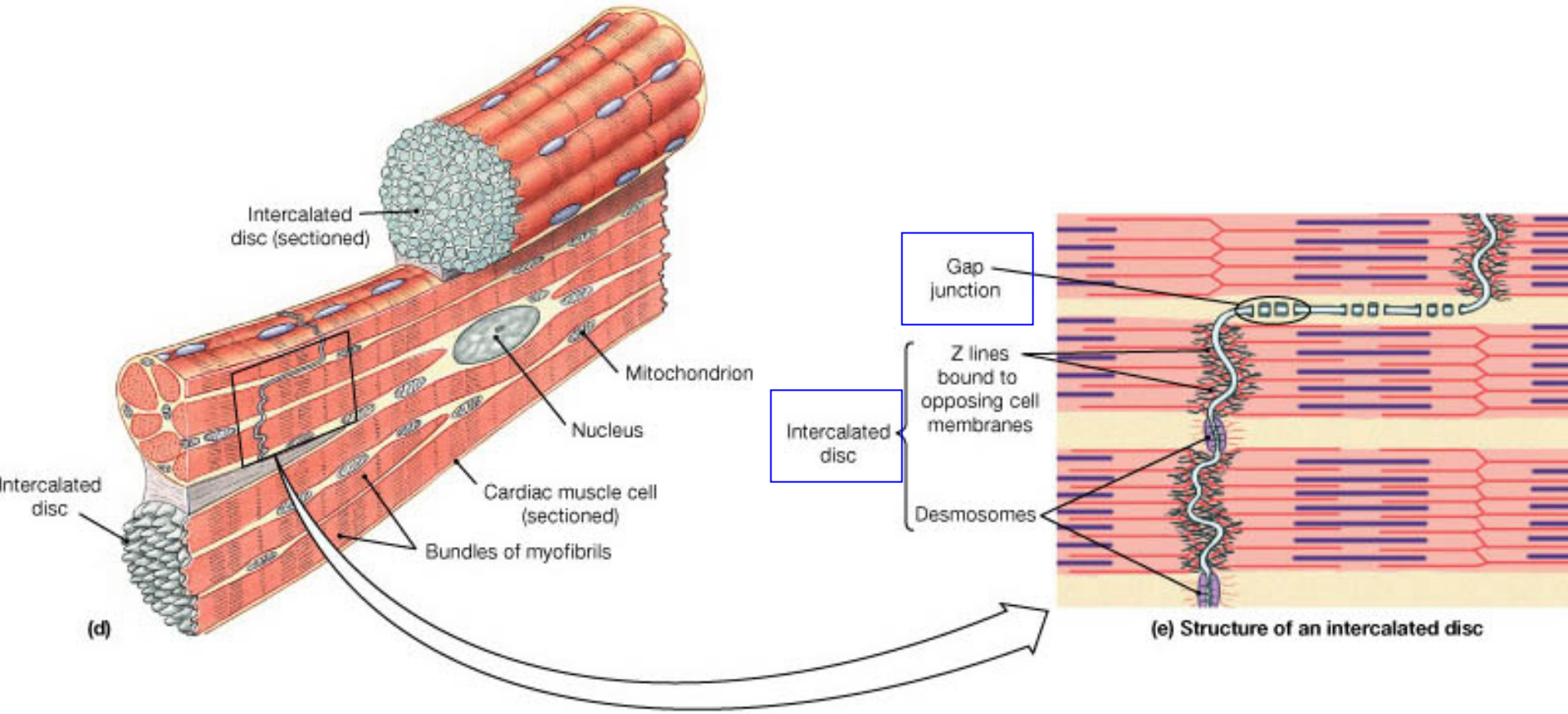
Capillaries = smallest vessels, found between smallest arteries and veins. These are the ***exchange vessels***.

- Veins→Heart→arteries→Arterioles→capillaries→venules→ Veins= CLOSED SYSTEM



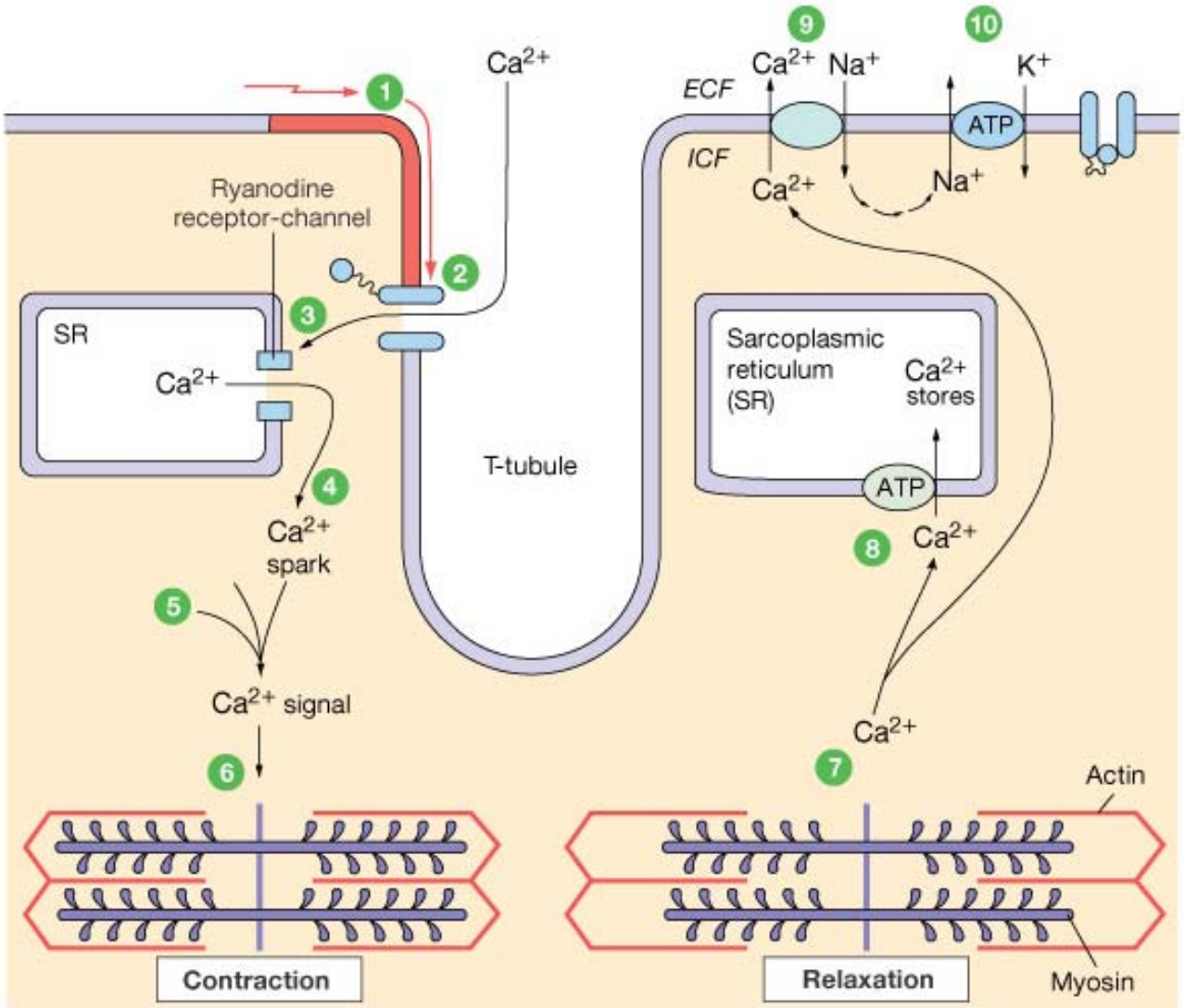
Systemic vessels




Intercalated disc (sectioned)
Mitochondrion
Nucleus
Intercalated disc
Cardiac muscle cell (sectioned)
Bundles of myofibrils
(d)
Gap junction
Intercalated disc
Z lines bound to opposing cell membranes
Desmosomes
(e) Structure of an intercalated disc

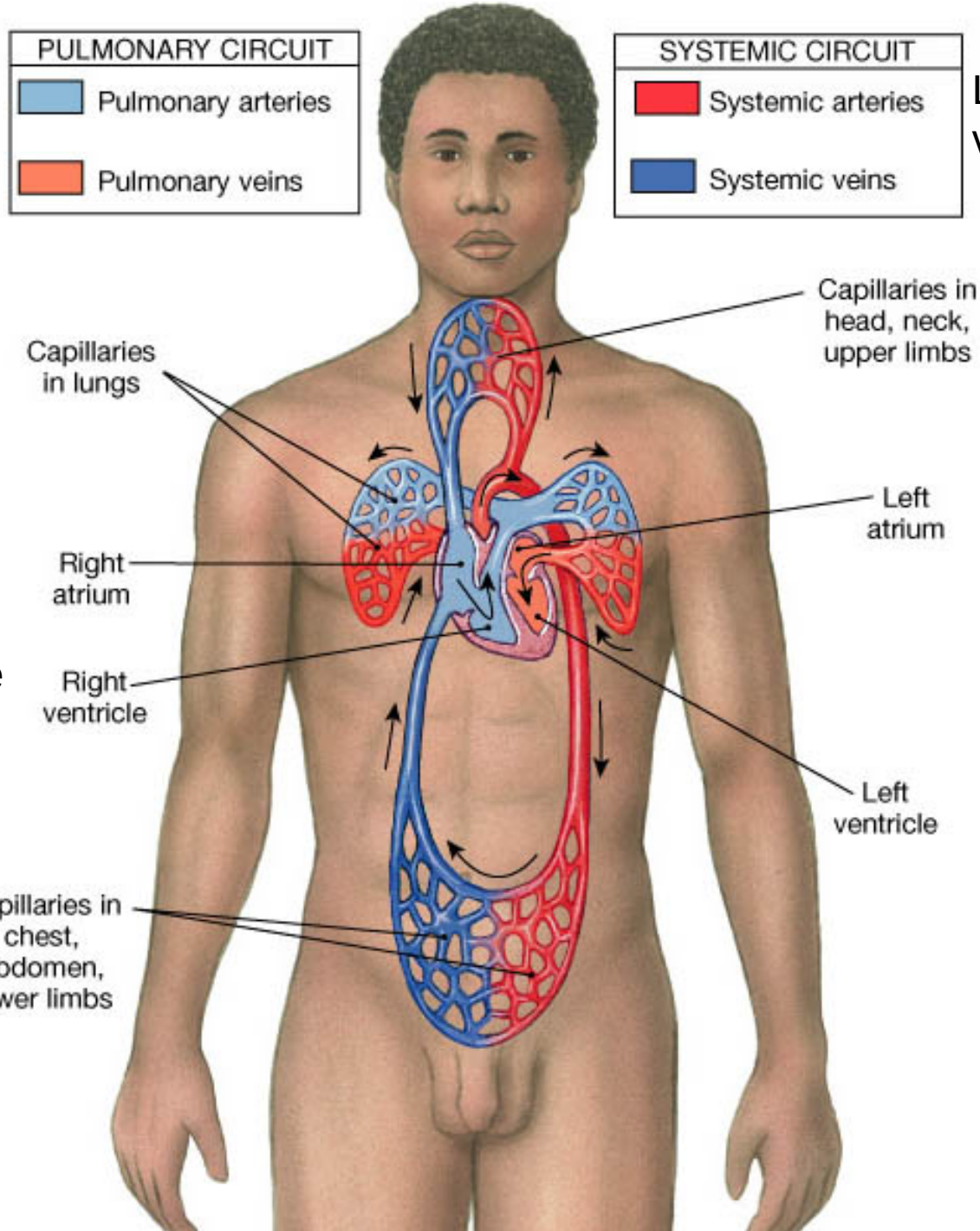
Fig

21.3



1 Action potential enters from adjacent cell.

Right ventricle



Left ventricle

Which ventricle does more work?

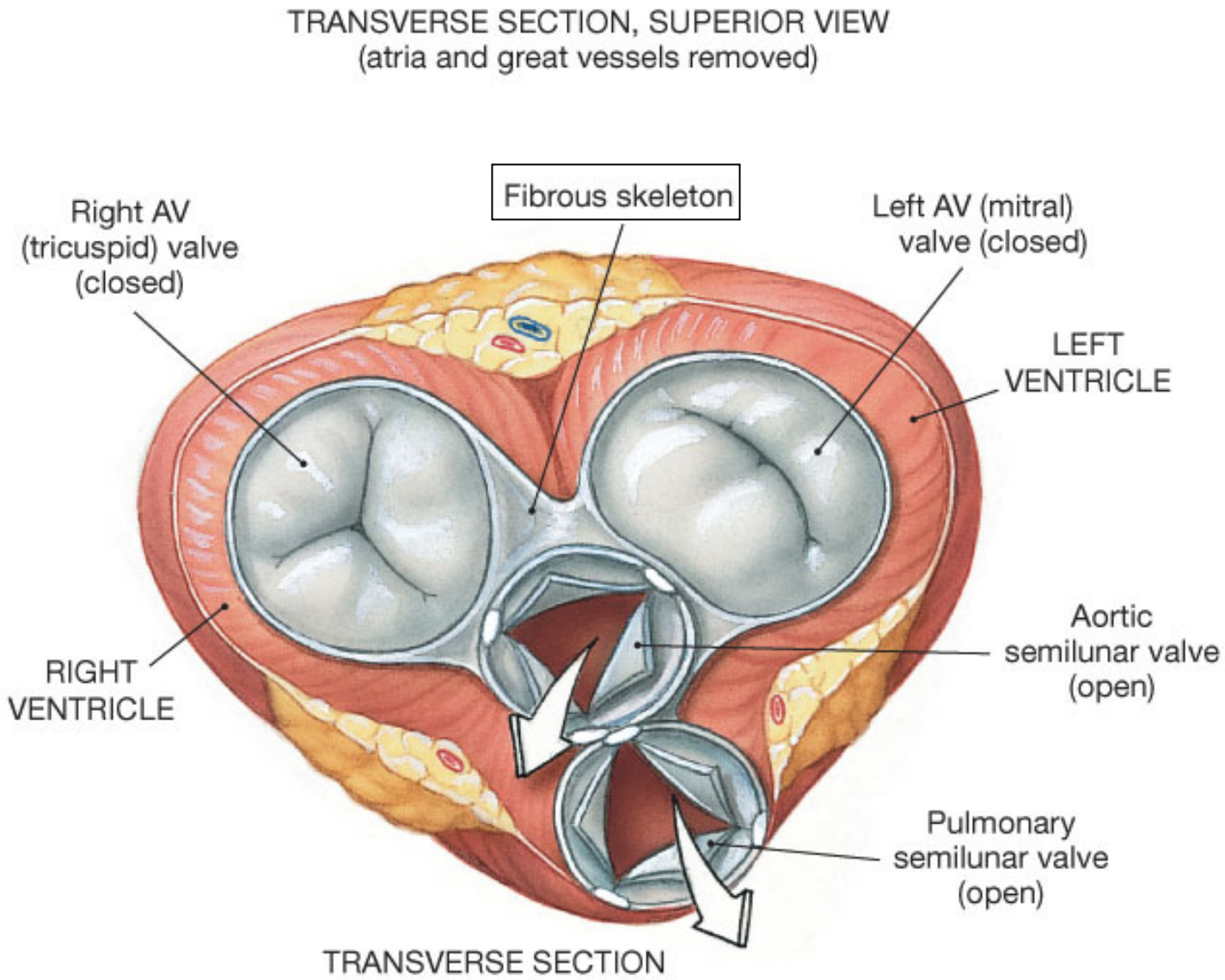
Heart valves

- Heart valves allow blood to flow only in one direction thru the heart
- Atrioventricular valves (AV)-between an atrium and ventricle

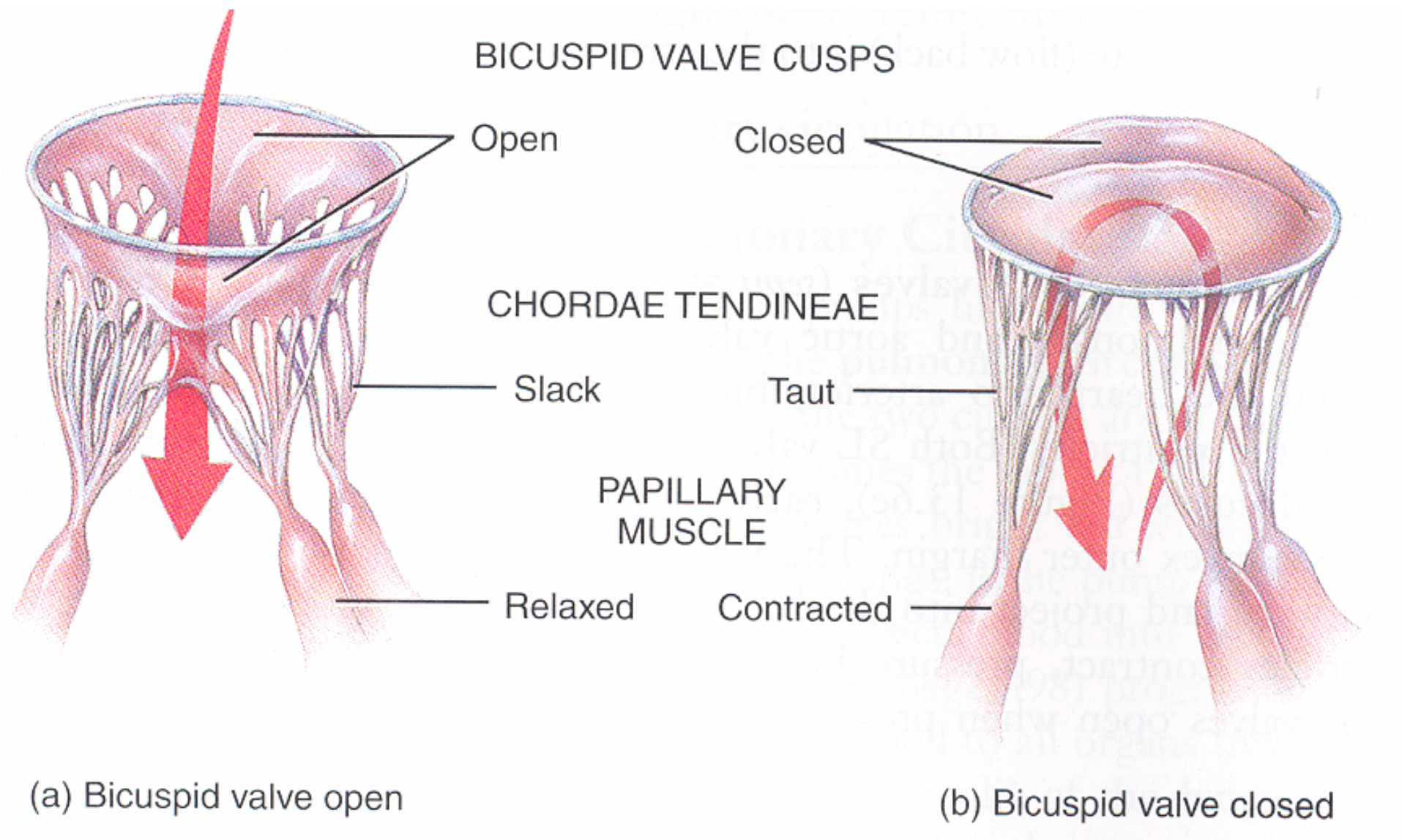
- rt. atrium>Rt. AV (tricuspid) valve>rt. ventricle
- lt. atrium>Lt. AV (bicuspid/mitral) valve>lt. ventricle

- Semilunar valves-between the ventricle & an artery

- lt. ventricle>Aortic semilunar valve>aorta
- rt. ventricle>Pulmonary semilunar valve>pulmonary artery



(b) Ventricular systole (contraction)



(a) Bicuspid valve open

(b) Bicuspid valve closed

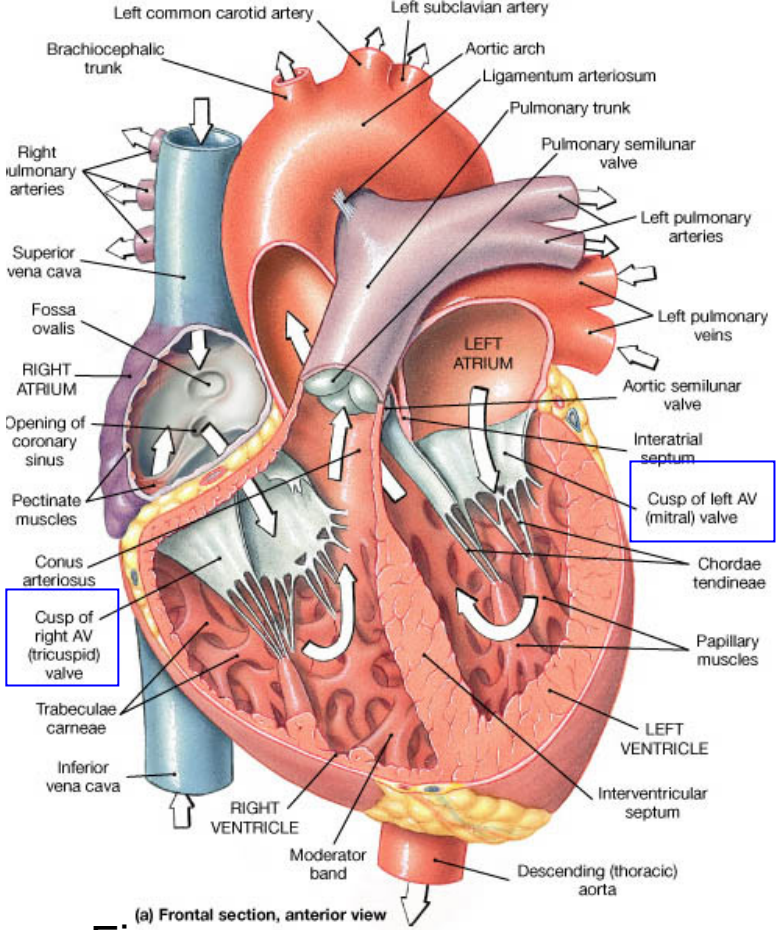


Fig 21.6

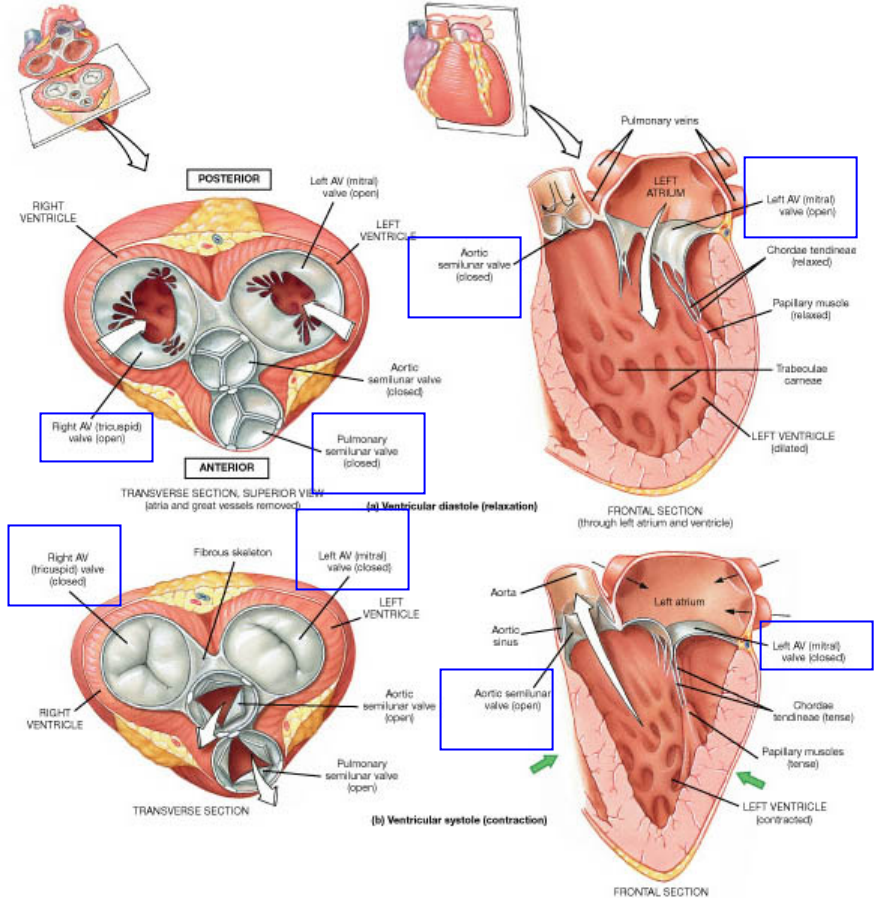
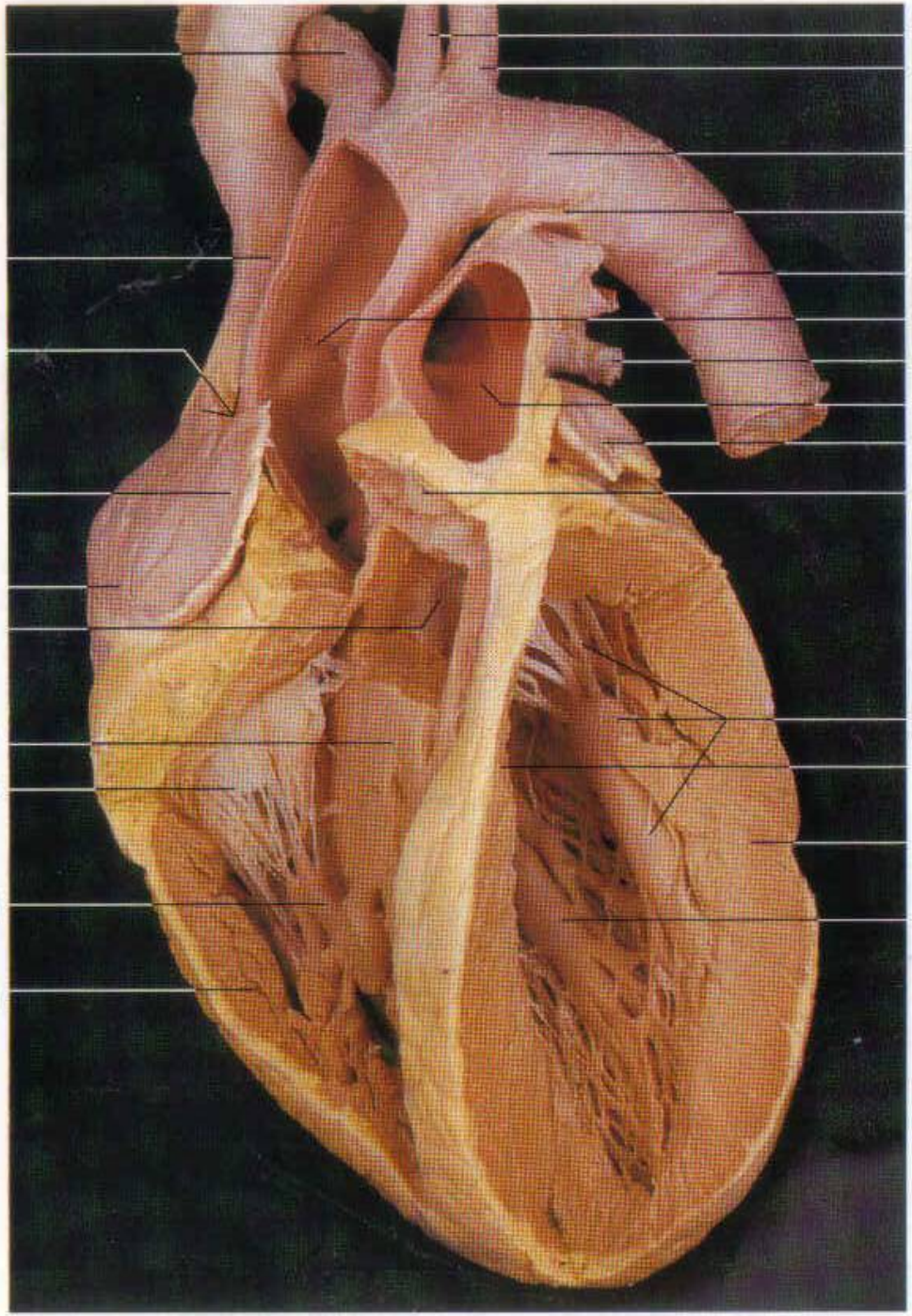


Fig 21.7



Heart valves

- heart valves demo

Heart sounds

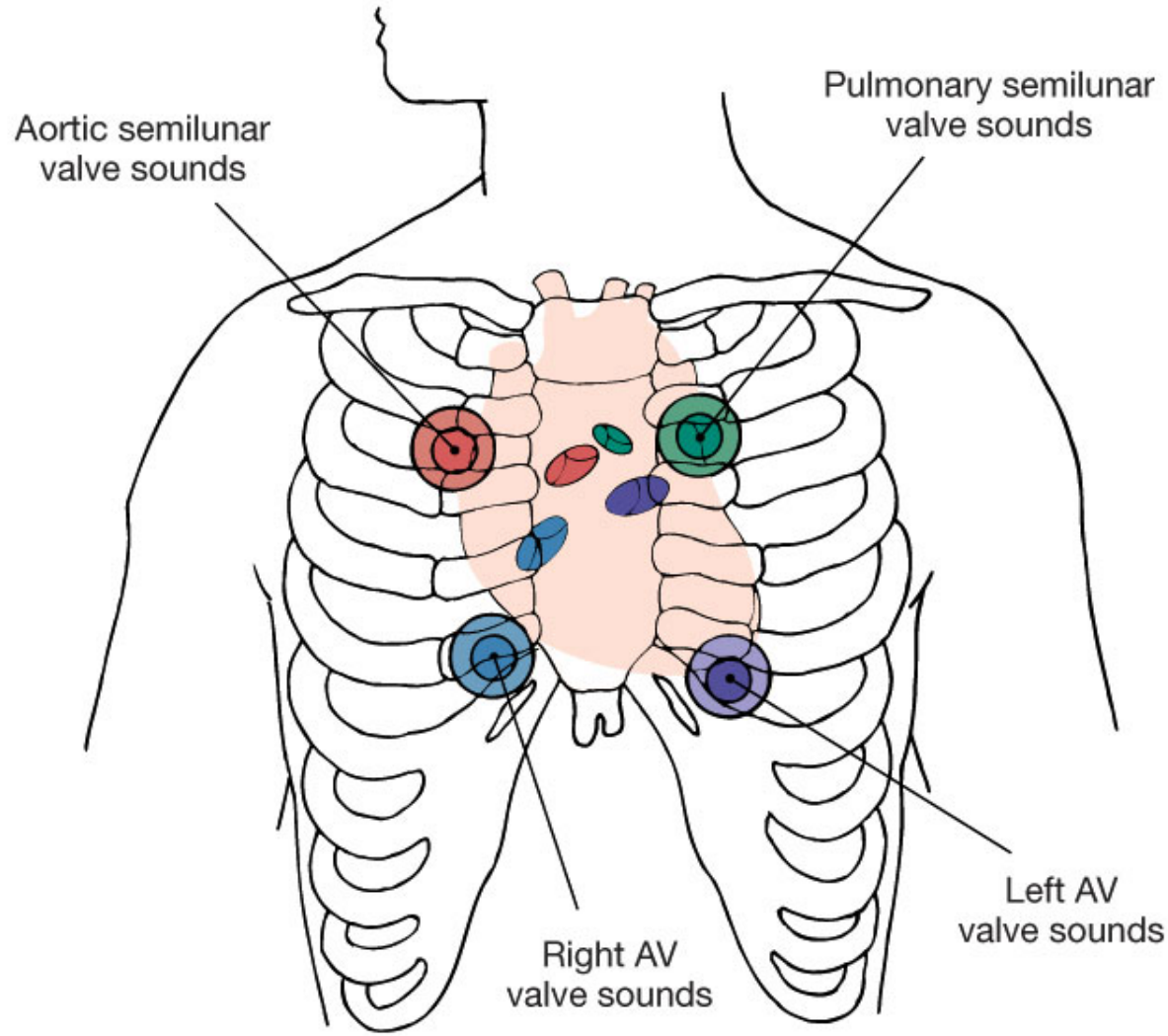
- The two heart sounds are
- “Lubb”-AV valves closing
- “Dupp”-semilunar valves closing

- Aortic-2nd intercostals space (Right side)
- Pulmonary- 2nd ICS (Left side)
- Right AV valve- 5th ICS (Right of sternum)
- Left AV valve- 5th ICS (inferior to left nipple)

- Heart sounds demo

Heart Valves and Heart Sounds

- Closure of the AV valves create the 1st heart sound (‘lubb’).
- Closure of the semilunar valves create the 2nd heart sound (‘dupp’).
- Placement of a stethoscope varies depending on which heart sounds and valves are of interest.



The cardiac cycle

- A chamber of the heart can be in one of two phases:
- Systole-contraction of the muscle, ejecting blood out of the chamber
- Diastole-relaxation of the muscle, the chamber fills with blood

- The heart pumps by using cycles of systole and diastole

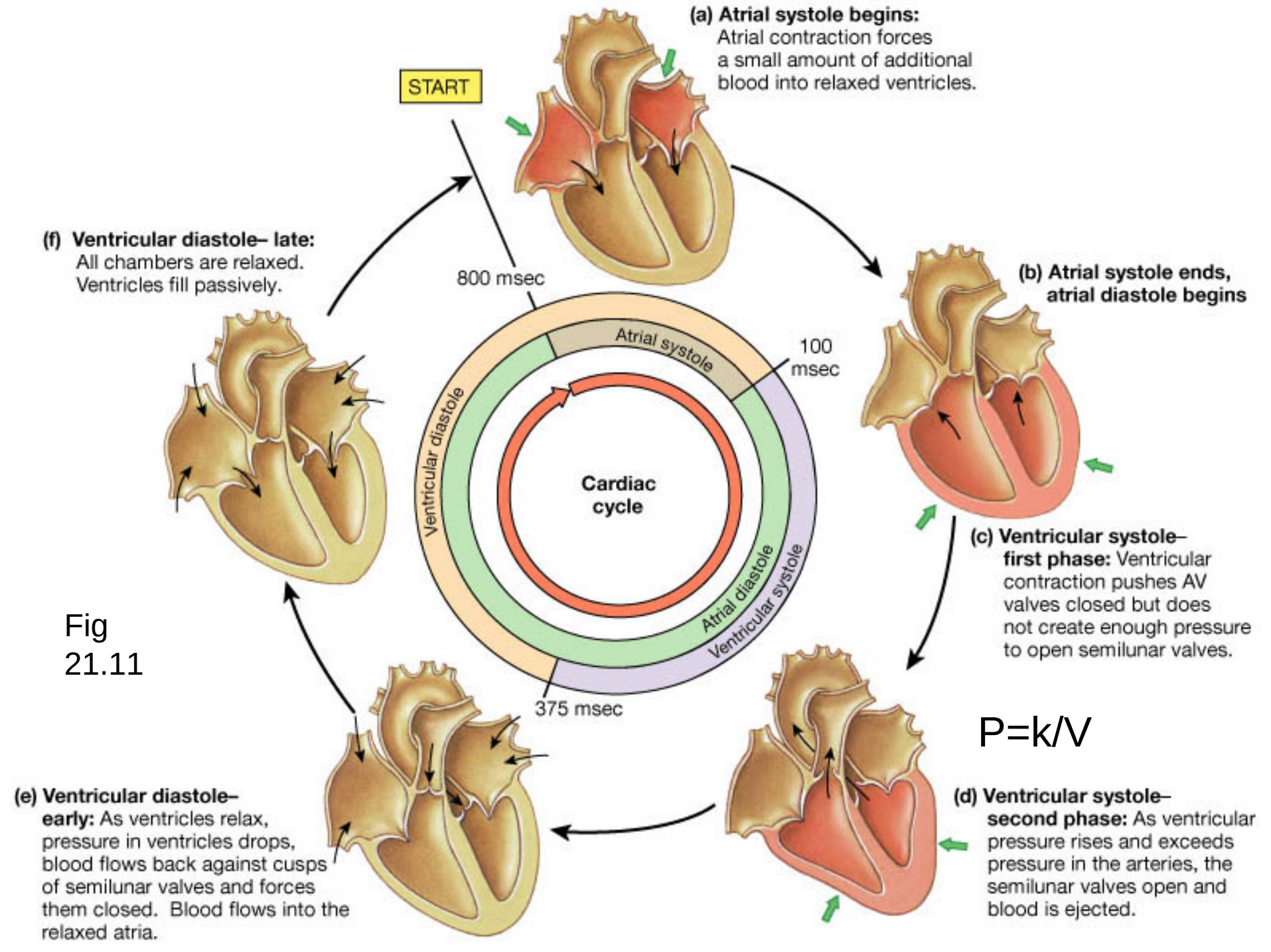
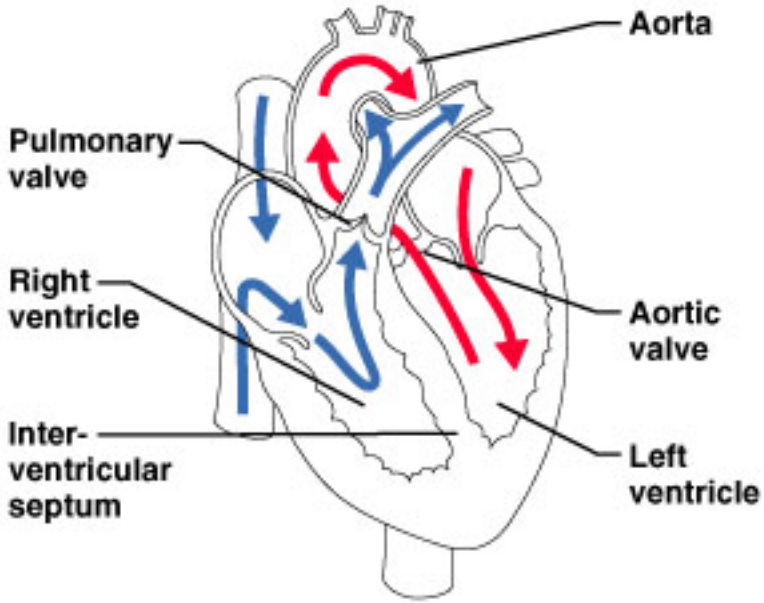

(a) Atrial systole begins:
Atrial contraction forces a small amount of additional blood into relaxed ventricles.
START
(b) Atrial systole ends, atrial diastole begins
(c) Ventricular systole– first phase: Ventricular contraction pushes AV valves closed but does not create enough pressure to open semilunar valves.
(d) Ventricular systole– second phase: As ventricular pressure rises and exceeds pressure in the arteries, the semilunar valves open and blood is ejected.
(e) Ventricular diastole– early: As ventricles relax, pressure in ventricles drops, blood flows back against cusps of semilunar valves and forces them closed. Blood flows into the relaxed atria.
(f) Ventricular diastole– late:
All chambers are relaxed.
Ventricles fill passively.
800 msec
100 msec
375 msec
Atrial systole
Ventricular diastole
Cardiac cycle
Atrial diastole
Ventricular systole

Fig 21.11

P=k/V

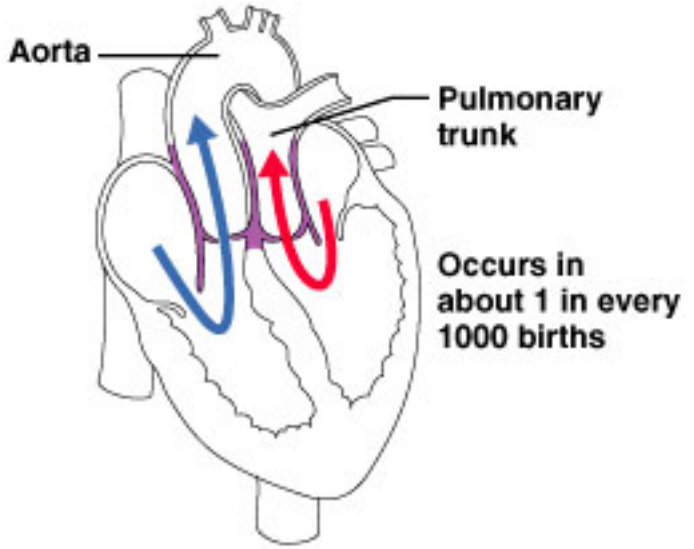
Normal Functional Heart Anatomy



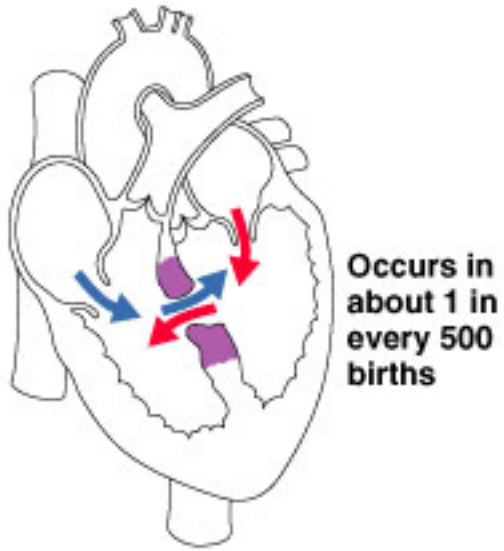
Normal heart. Arrows indicate the path of blood flow through the heart. Red = oxygen-rich blood; blue = oxygen-poor blood.

Congenital Heart Defects

FYI



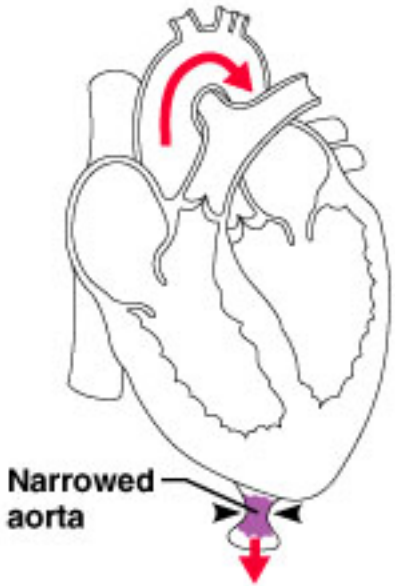
Transposition of the great vessels. Aorta comes from right ventricle, pulmonary trunk from left. Results when the bulbus cordis does not divide properly. Unoxygenated blood passes repeatedly around systemic circuit, while oxygenated blood recycles around the pulmonary circuit.



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

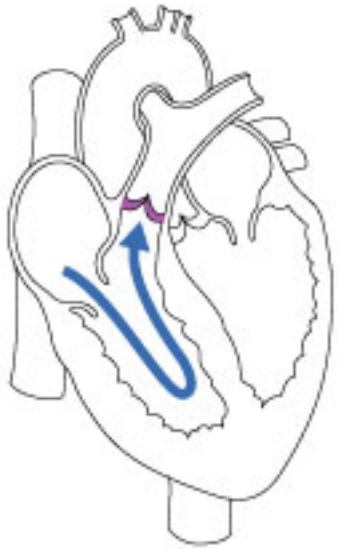
Congenital Heart Defects

FYI



Occurs in about 1 in every 1500 births

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

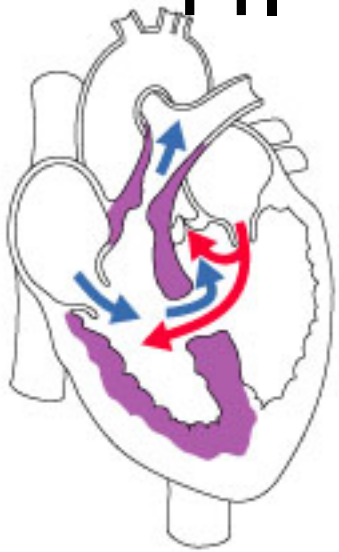


Occurs in about 1 in every 2800 births

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

Congenital Heart Defects

FYI



Occurs in about 1 in every 2000 births

(e) 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.

Intrinsic conduction system

- Pacemaker cells and conducting fibers coordinate contraction of the heart chambers

- Nodal cells establish the rate of cardiac contraction
- Conducting fibers distribute electrical stimulus throughout the myocardium

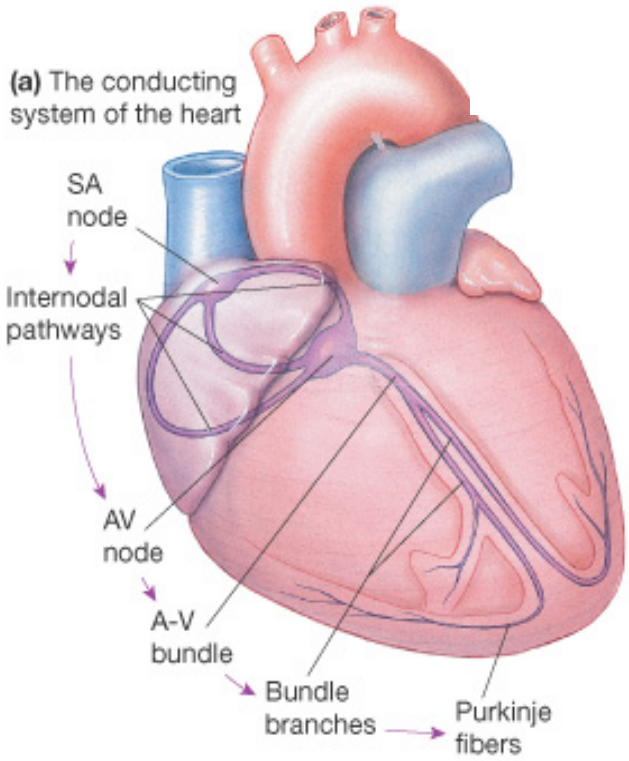
Nodal cells

- Nodal cells spontaneously depolarize causing an action potential
- Two groups of nodal cells:
  - Sinoatrial (SA) node-makes 80-100 AP/min
    - Primary pacemaker
    - Posterior wall of the rt. atrium
  - Atrioventricular AV node-slower than SA node
    - Secondary pacemeker
    - Inferior region of the rt. atrium wall

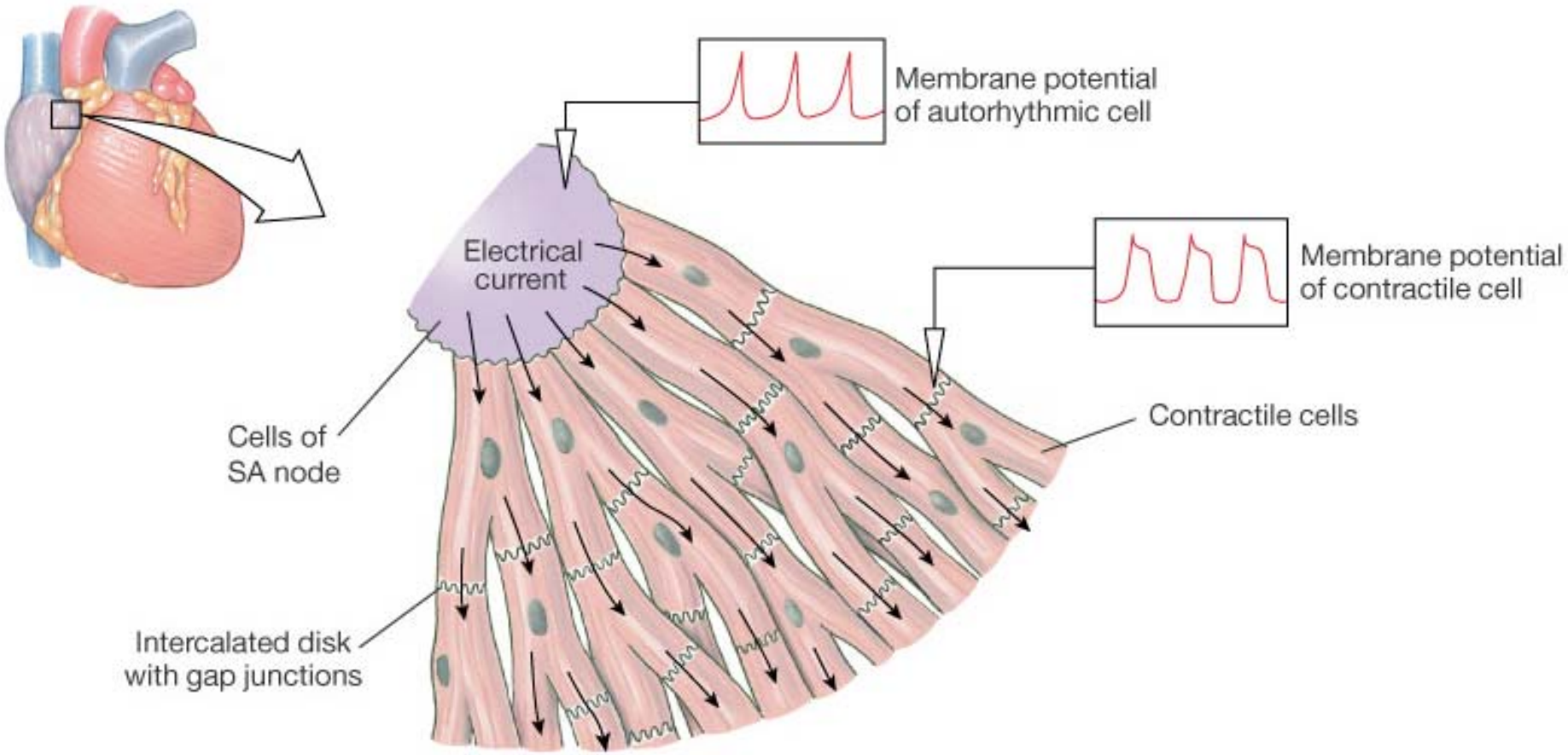
- The SA node sends action potential to the conducting fibers
- Conducting fibers>rt. & lt. atrium cardiac muscle (gap junctions & intercalated discs)

- Internodal pathway (conducting fibers) send AP from the SA node to the AV node

Electrical Conduction System



1. Sino Atrial (SA) Node
2. Internodal pathways
3. Atrial Ventricular (AV) Node
4. AV Bundle (Bundle of His)
5. L and R Bundle Branches
6. Purkinje Fibers



Depolarizations of autorhythmic cells rapidly spread to adjacent contractile cells through gap junctions.

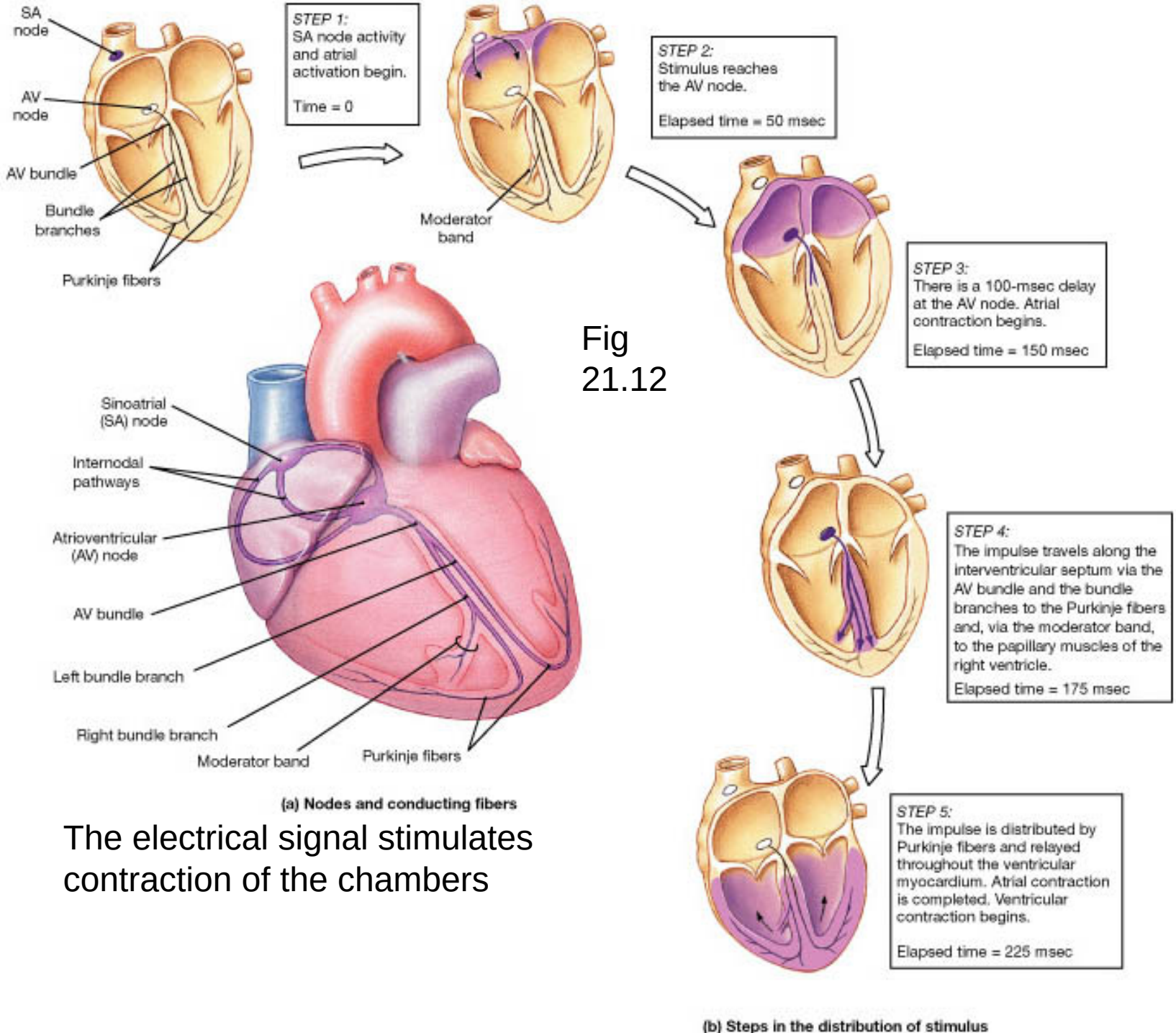


Fig 21.12

The electrical signal stimulates contraction of the chambers

EKG-electrocardiogram

- Surface electrodes can monitor the depolarization of the nodal and conducting fibers
- EKG graph gives electrical and mechanical diagnostic information

ECG rhythm strip

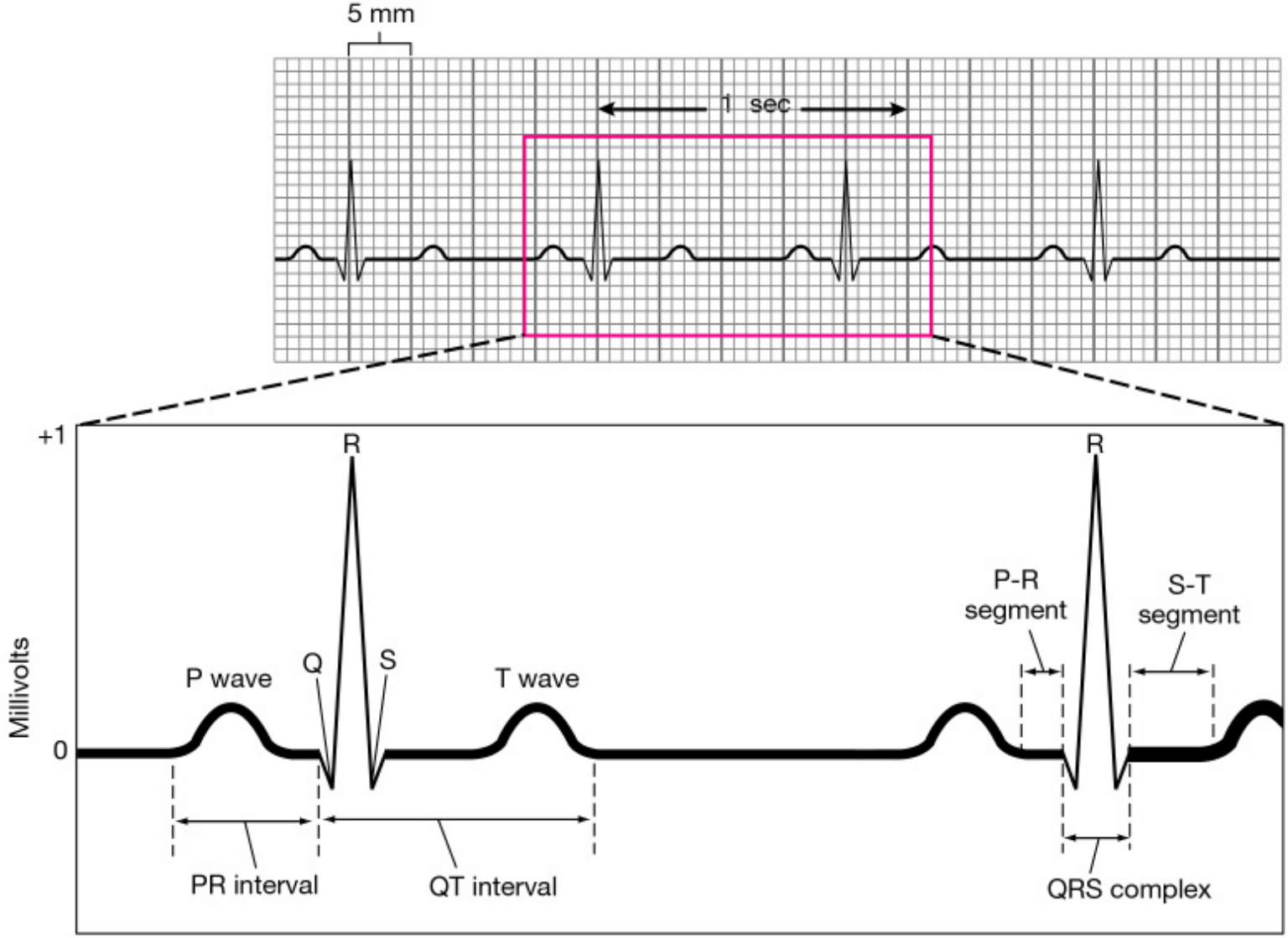
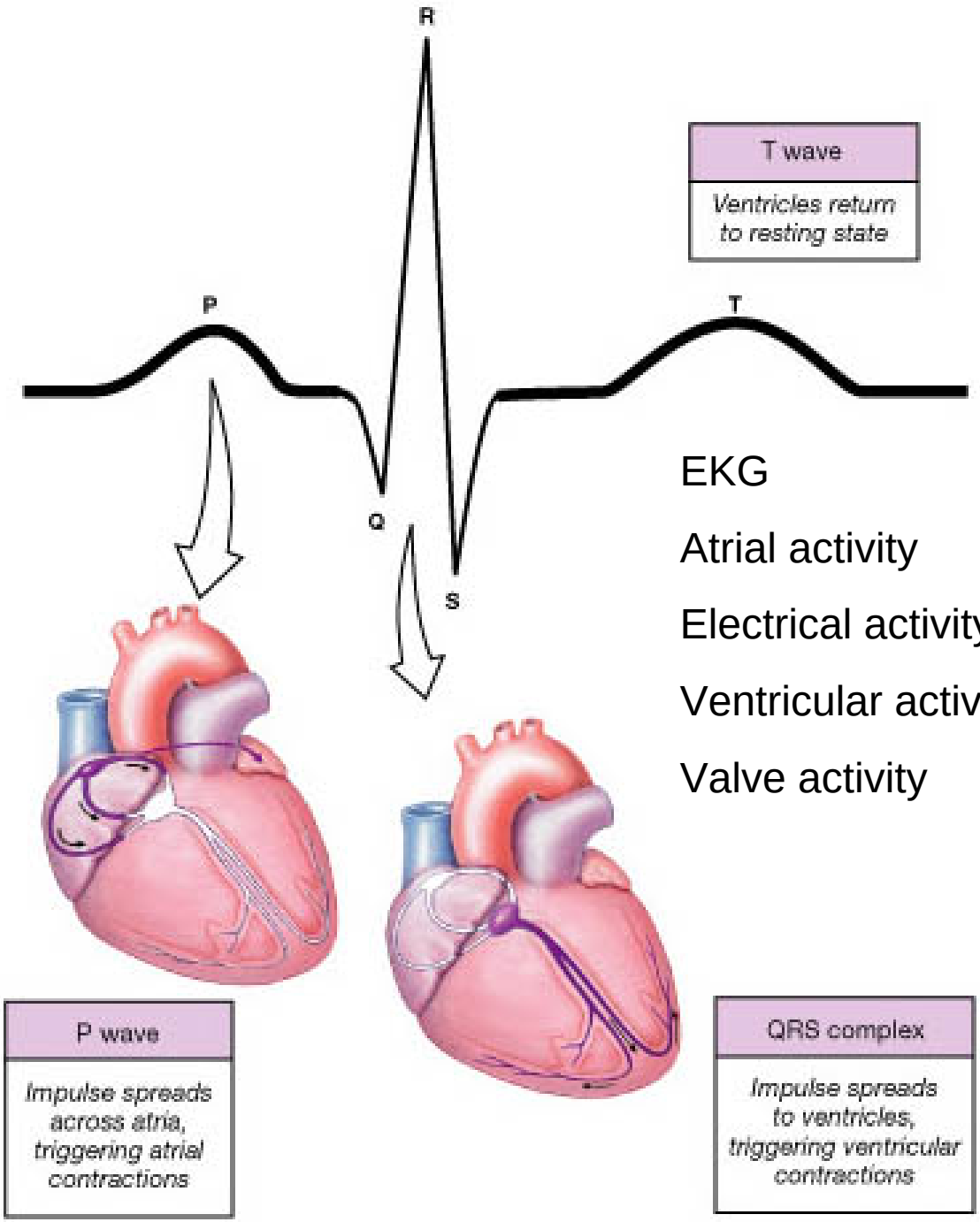

5 mm
1 sec
+1
0
Millivolts
R
R
P wave
Q
S
T wave
P-R segment
S-T segment
PR interval
QT interval
QRS complex

Fig 21.13



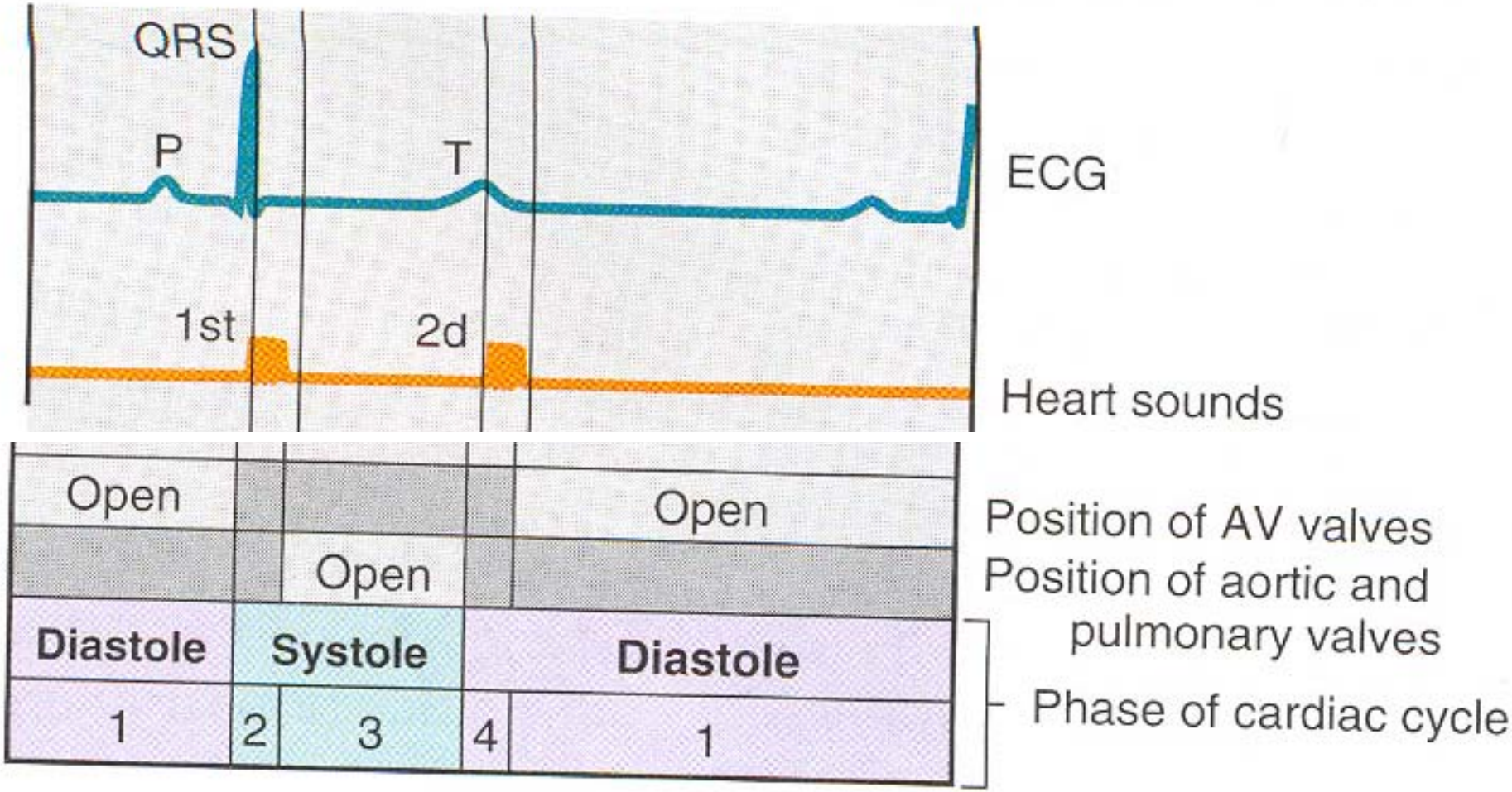
EKG

Atrial activity

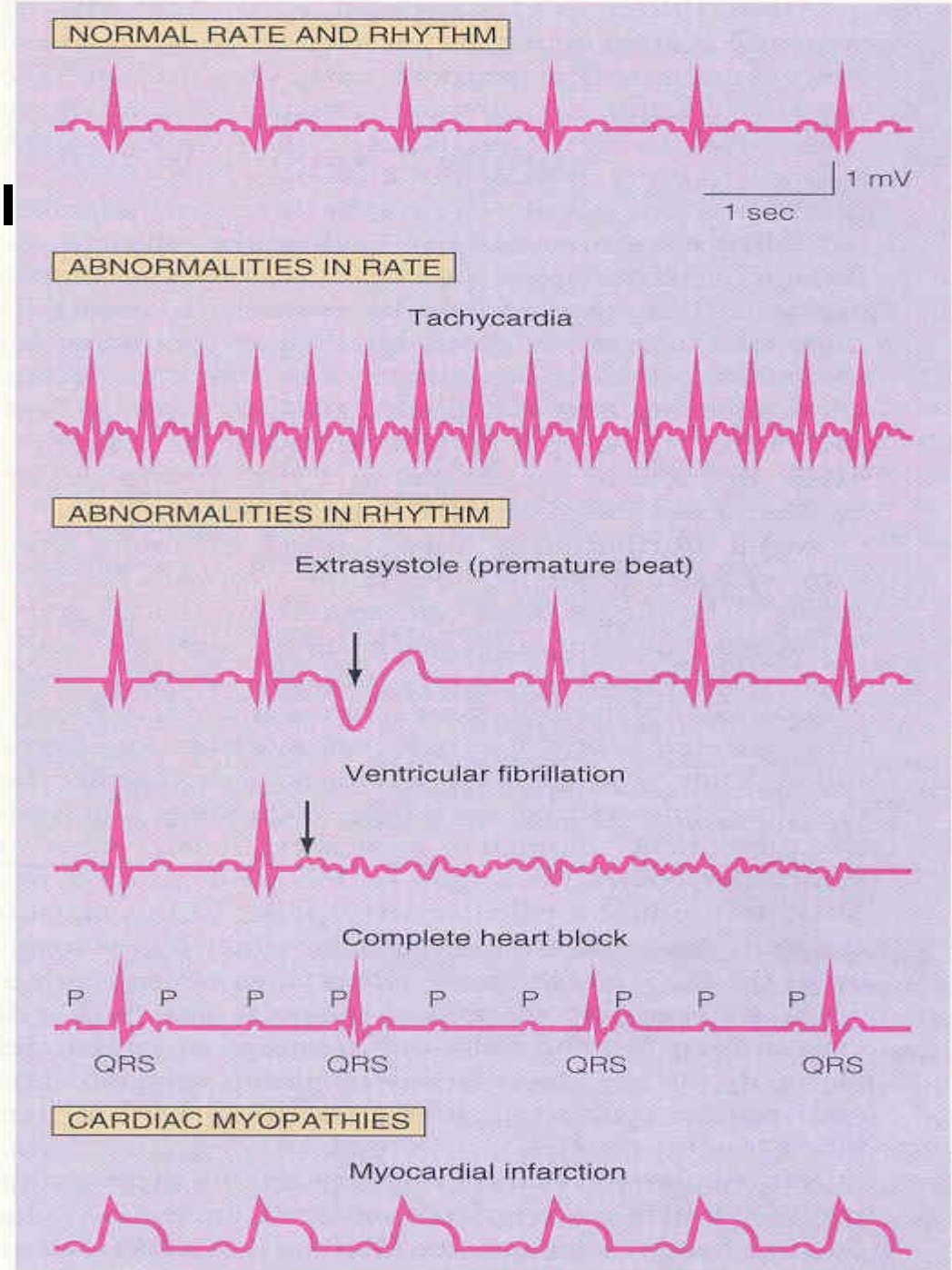
Electrical activity

Ventricular activity

Valve activity


QRS
P
T
ECG
1st
2d
Heart sounds
Open
Open
Open
Position of AV valves
Position of aortic and pulmonary valves
Diastole
Systole
Diastole
1
2
3
4
1
Phase of cardiac cycle

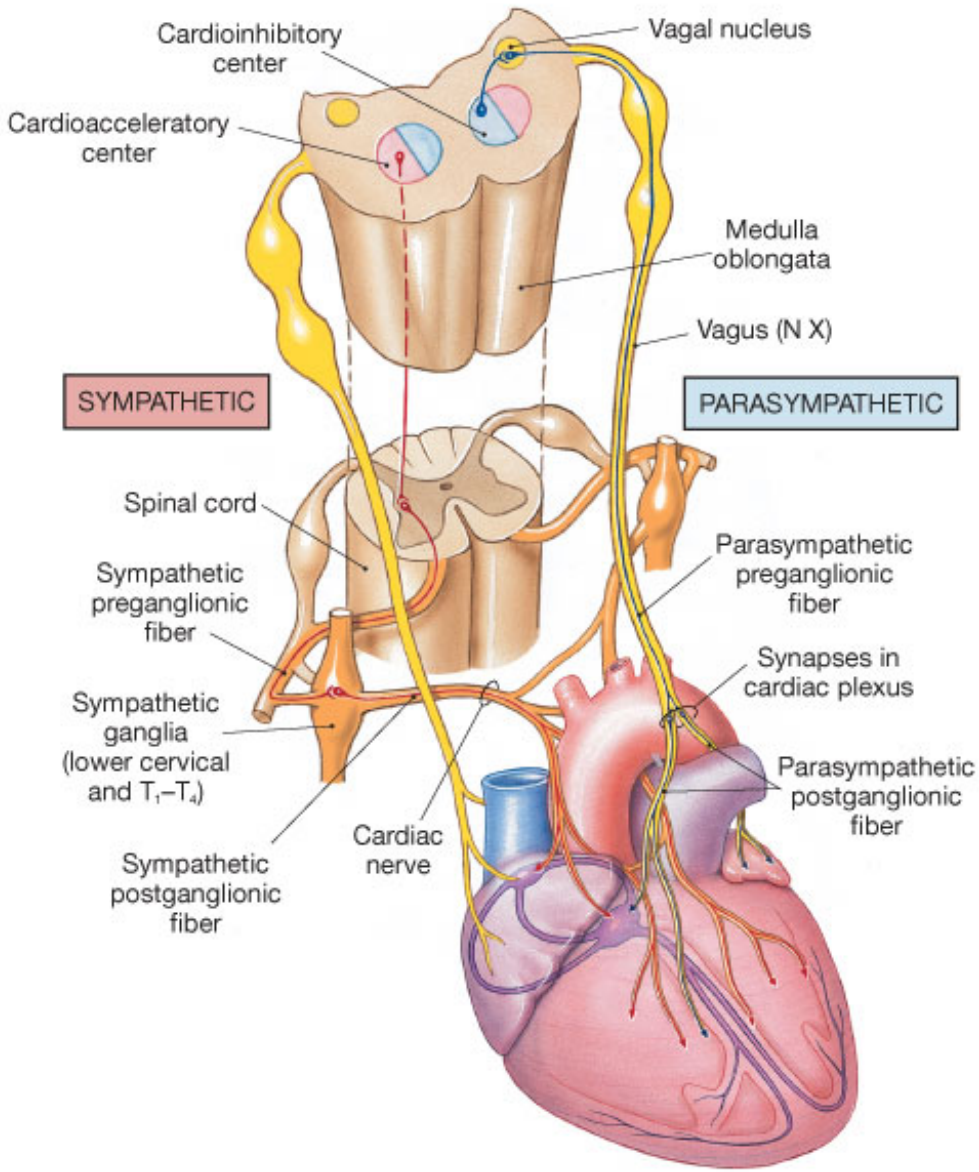
FYI


NORMAL RATE AND RHYTHM
1 mV
1 sec
ABNORMALITIES IN RATE
Tachycardia
ABNORMALITIES IN RHYTHM
Extrasystole (premature beat)
Ventricular fibrillation
Complete heart block
P P P P P P P P P
QRS QRS QRS QRS
CARDIAC MYOPATHIES
Myocardial infarction

The Autonomic Innervation of the Heart

- The stimulus for contraction is generated by pacemaker cells of the SA node.
  - Modified by the Autonomic Nervous System
  - Modified by Hormones

FYI



Autonomic Control of Heart Rate

- Basic rate established by pacemaker cells inside the heart (myocardium)
- Modified by ANS
  - Para: ACh decreases rate and contraction force.
  - Sym: NE increases heart rate and force of contraction.

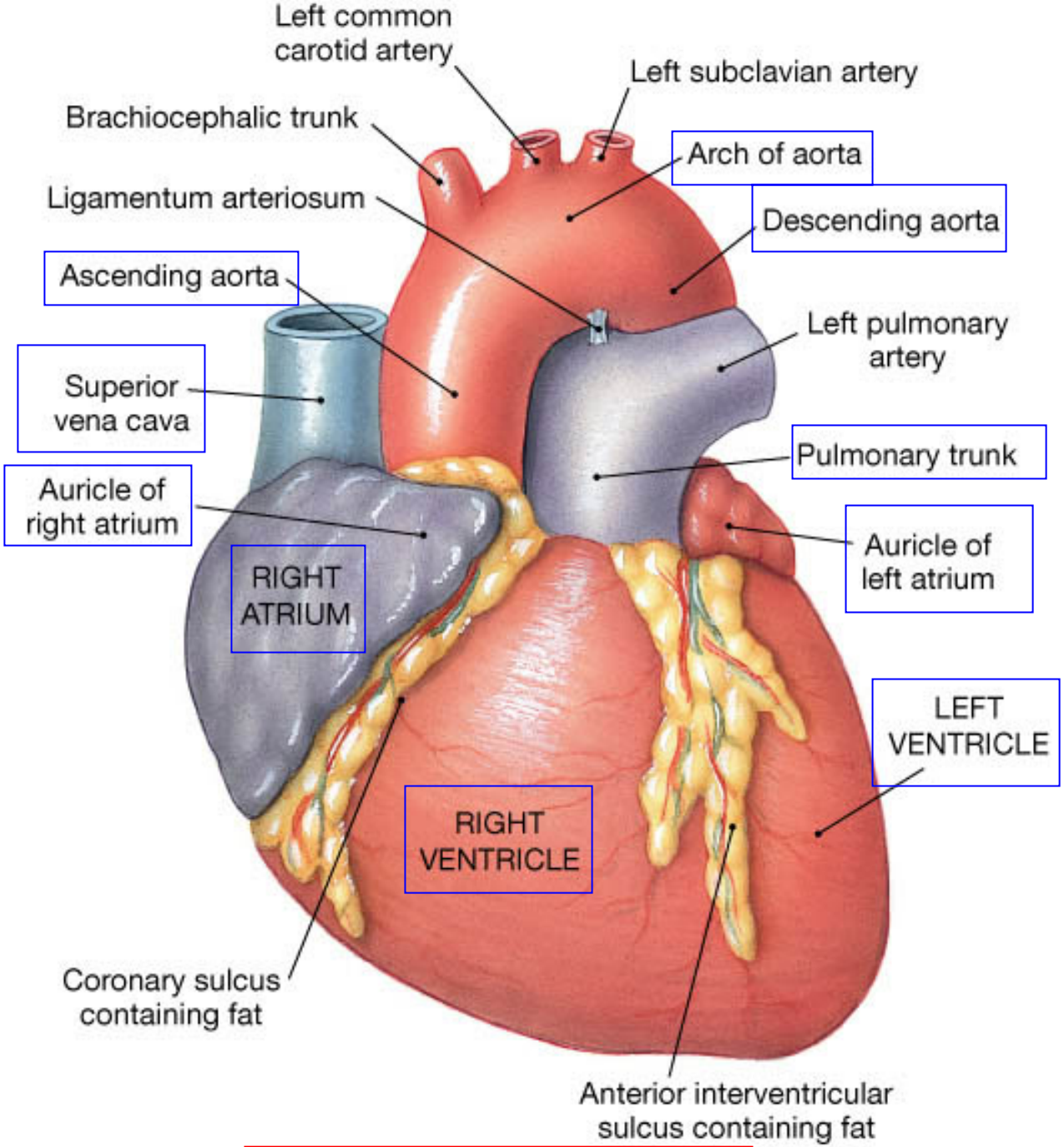
Cardiac Centers in CNS **FYI**

- Cardioaccelatory center
  - Medulla oblongata (Activates sympathetic neurons)
- Cardioinhibitory center
  - Medulla oblongata (Parasympathetic neurons)

Centers receive input from

- Higher centers (cerebrum)
- Receptors monitoring blood pressure
- Receptors monitoring dissolved gases

Fig 21.5



(a) Anterior (sternocostal) surface

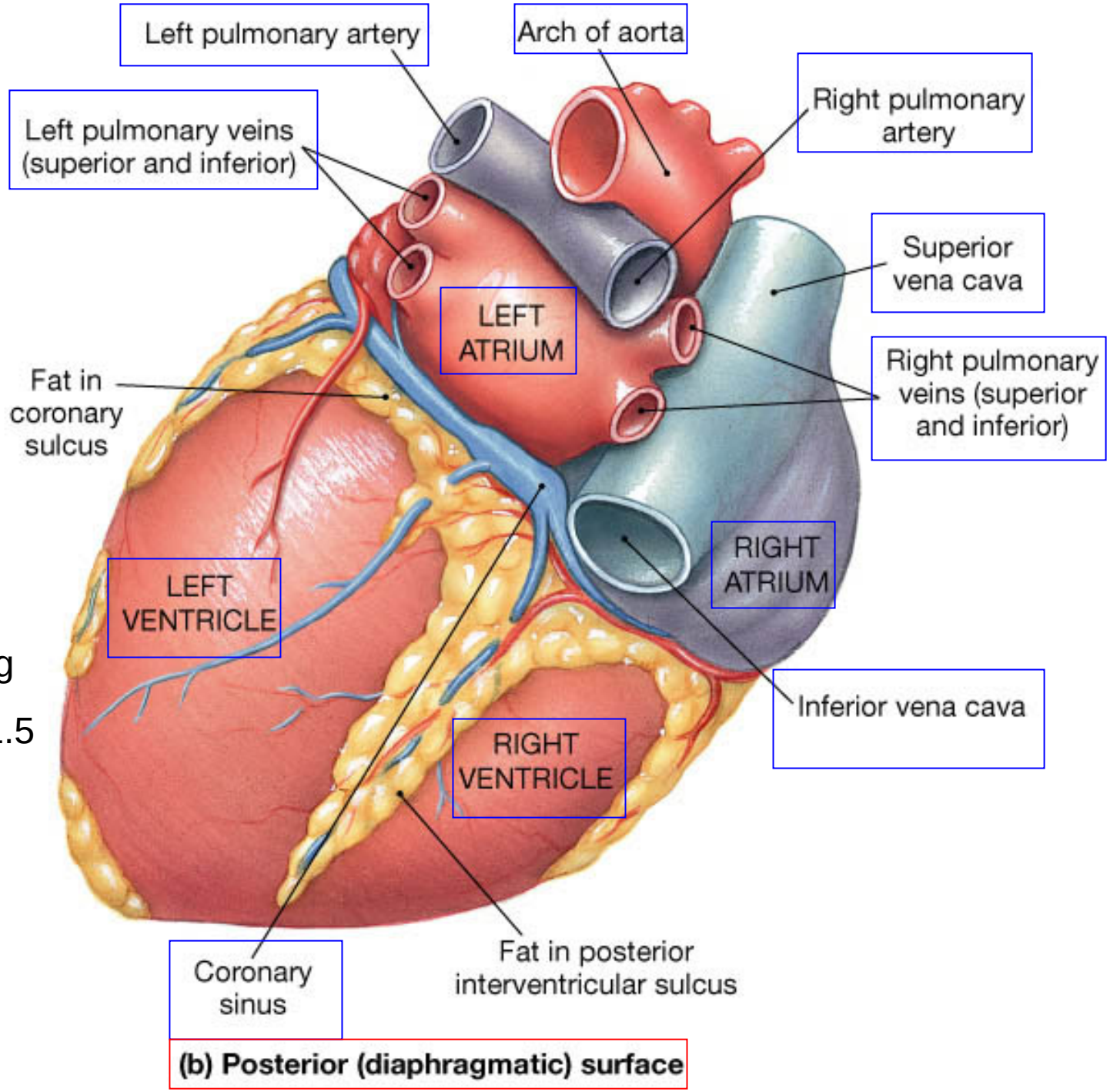
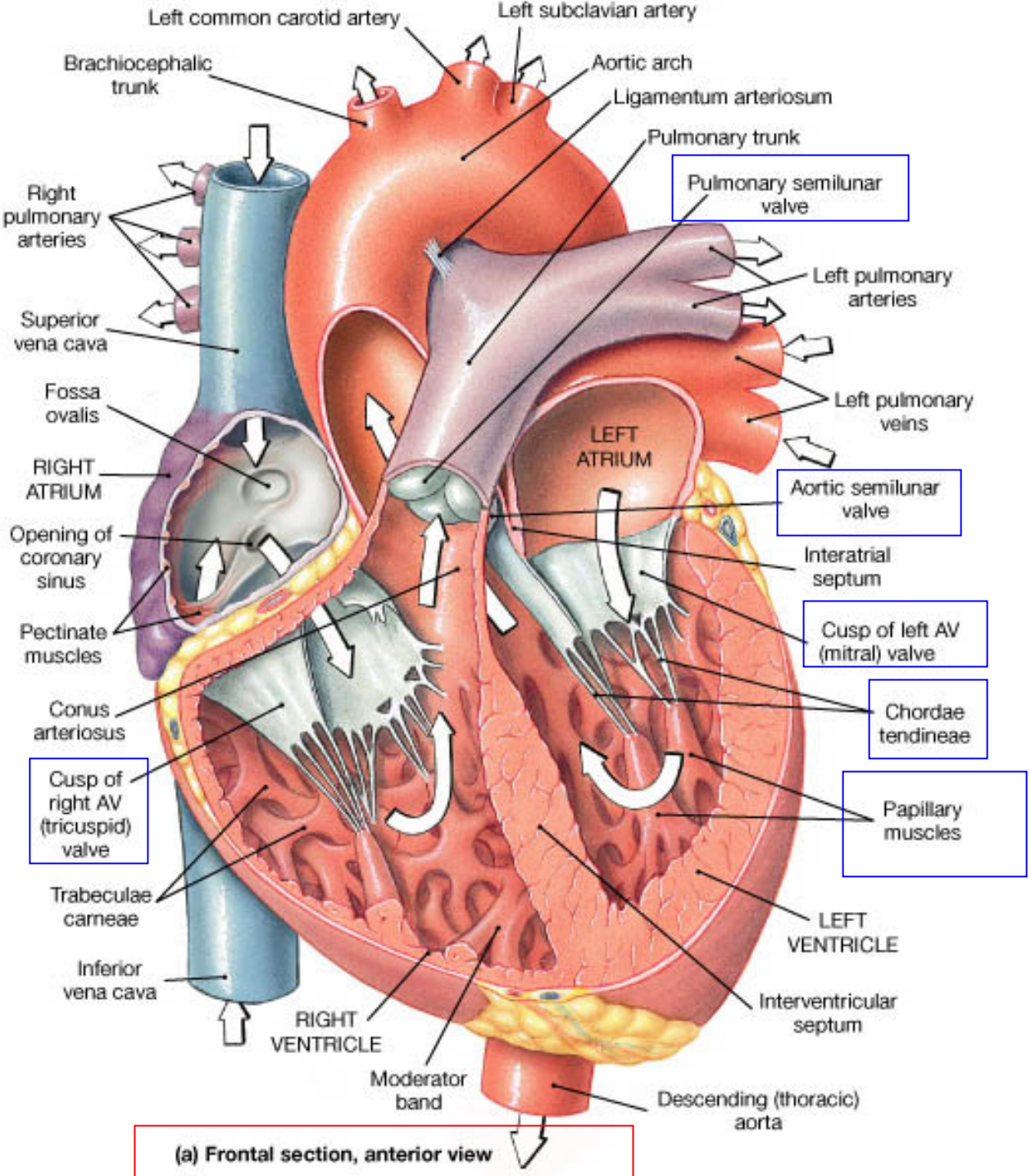
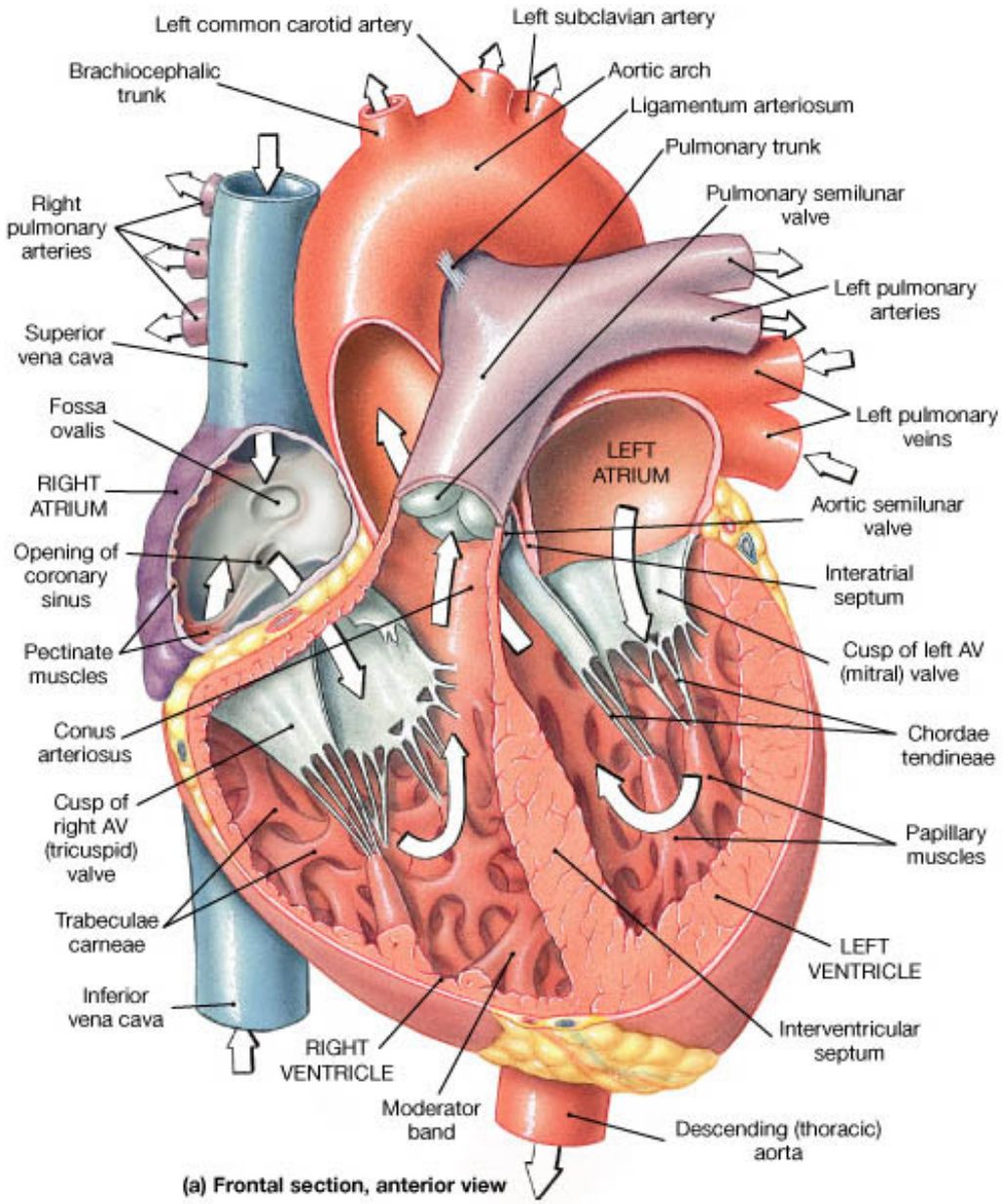

Left pulmonary artery
Arch of aorta
Right pulmonary artery
Left pulmonary veins (superior and inferior)
Superior vena cava
LEFT ATRIUM
Right pulmonary veins (superior and inferior)
Fat in coronary sulcus
RIGHT ATRIUM
LEFT VENTRICLE
Inferior vena cava
RIGHT VENTRICLE
Coronary sinus
Fat in posterior interventricular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

Fig 21.5

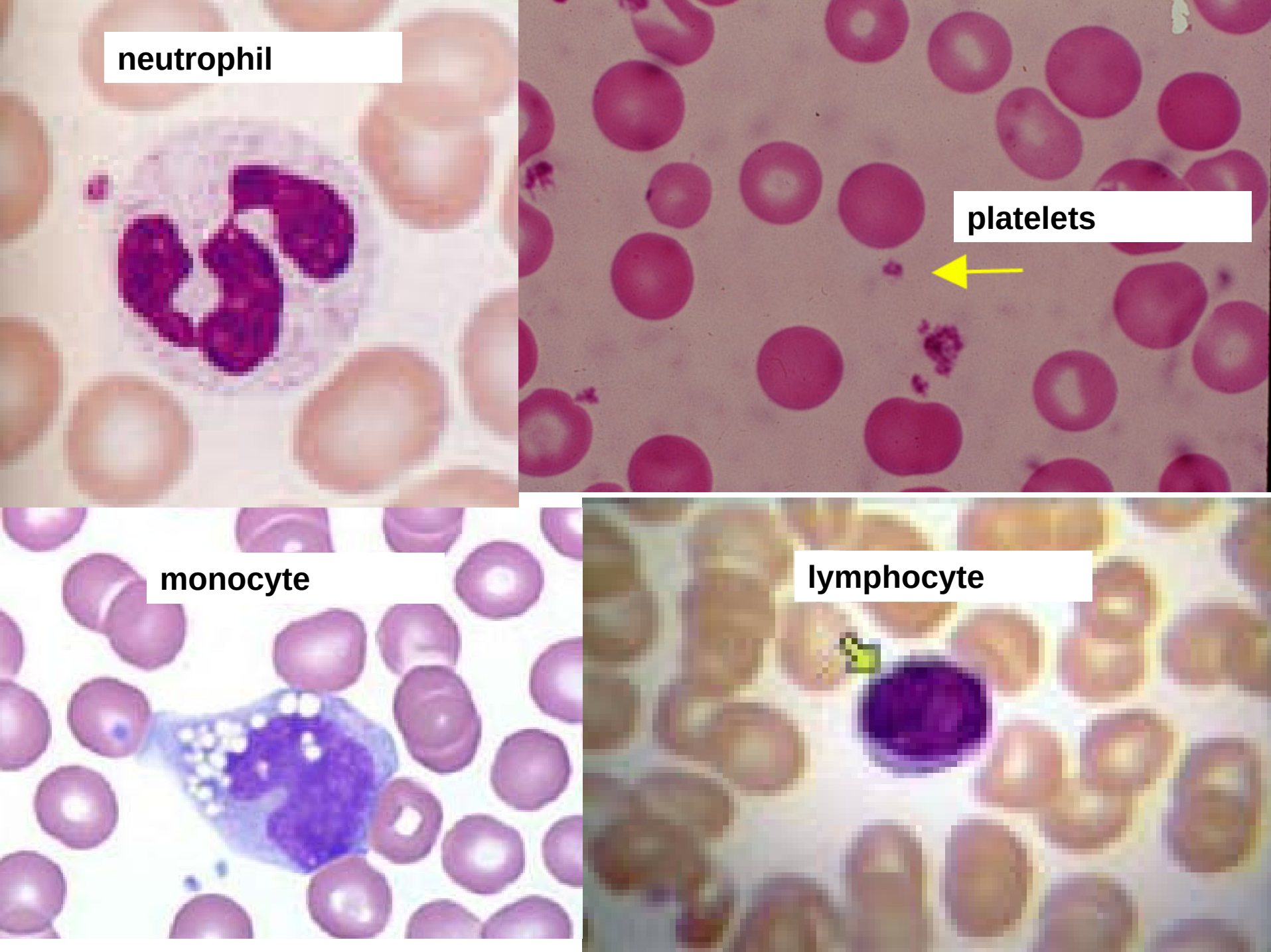
Fig 21.6

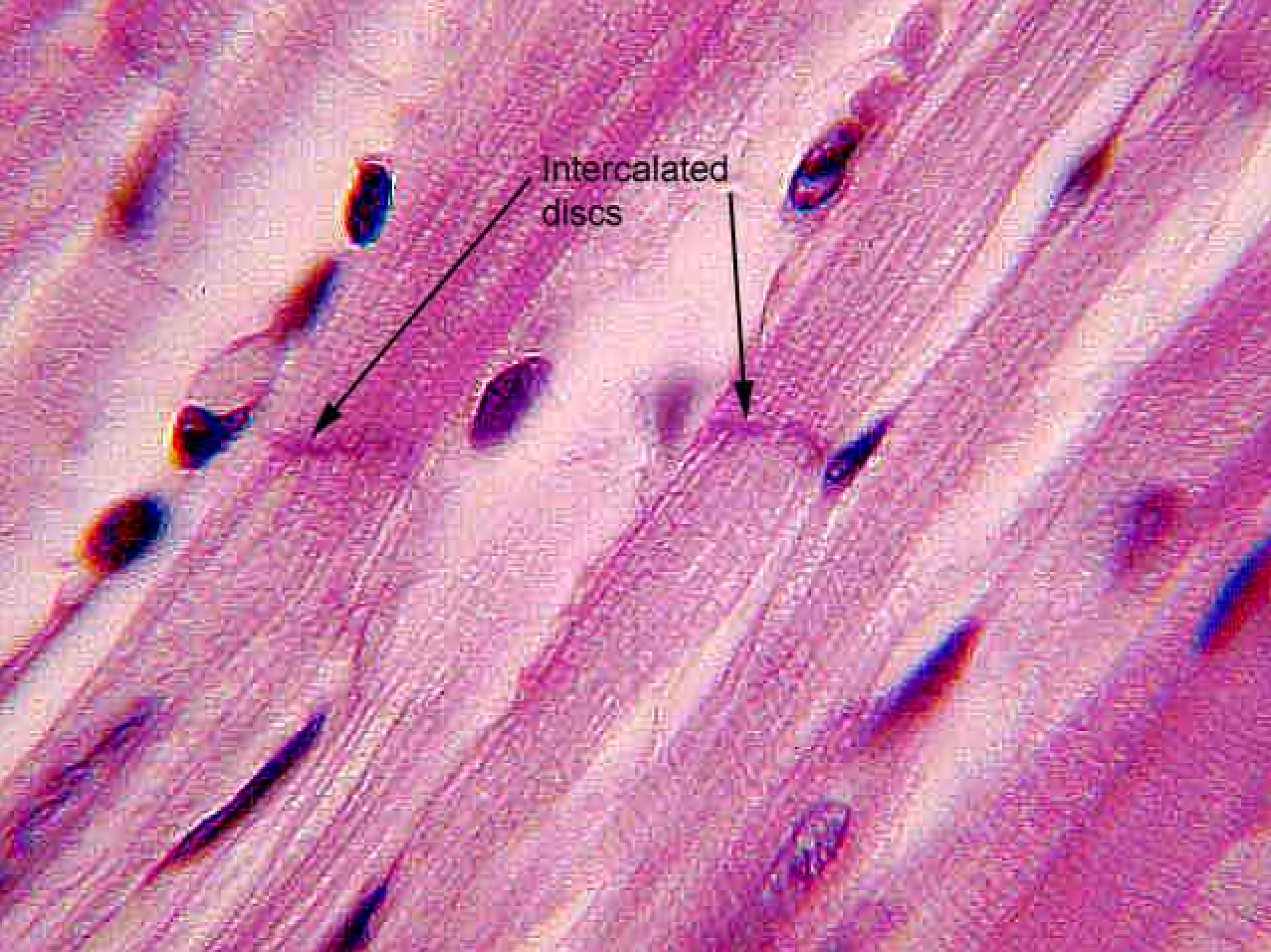

Left common carotid artery
Left subclavian artery
Brachiocephalic trunk
Aortic arch
Ligamentum arteriosum
Pulmonary trunk
Pulmonary semilunar valve
Right pulmonary arteries
Left pulmonary arteries
Superior vena cava
Fossa ovalis
Left pulmonary veins
LEFT ATRIUM
RIGHT ATRIUM
Aortic semilunar valve
Opening of coronary sinus
Interatrial septum
Pectinate muscles
Cusp of left AV (mitral) valve
Conus arteriosus
Chordae tendineae
Cusp of right AV (tricuspid) valve
Papillary muscles
Trabeculae carneae
LEFT VENTRICLE
Inferior vena cava
Interventricular septum
RIGHT VENTRICLE
Moderator band
Descending (thoracic) aorta
(a) Frontal section, anterior view

- Superior/Inferior Vena Cava
- Rt. Atrium
- Rt. Atrioventricular valve
- Rt. Ventricle
- Pulmonary Semilunar valve
- Pulmonary Arteries
- Lungs
- Pulmonary Veins
- Lt. Atrium
- Lt. Atrioventricular valve
- Lt. Ventricle
- Aortic Semilunar valve
- Ascending Aorta

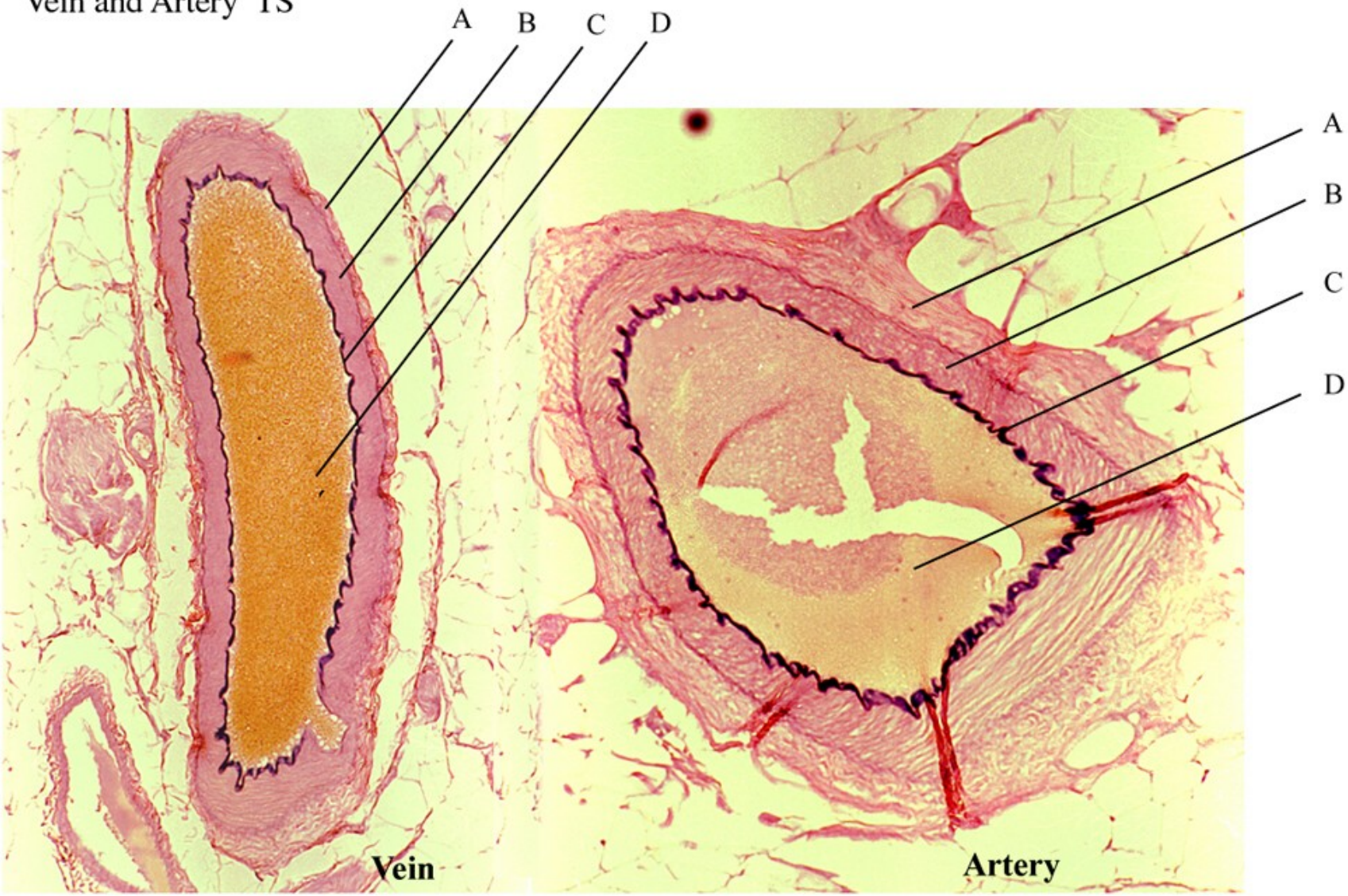


Interactive physiology CD
Histology CD


neutrophil
platelets
monocyte
lymphocyte


Intercalated
discs

Vein and Artery TS



A - layer of elastic fibres (tunica adventitia)
B - layer of smooth muscles and elastic fibres (tunica media)
C - endothelium and elastin (tunica intima)
D - blood