#Anatomy

HEART

Table 14-1

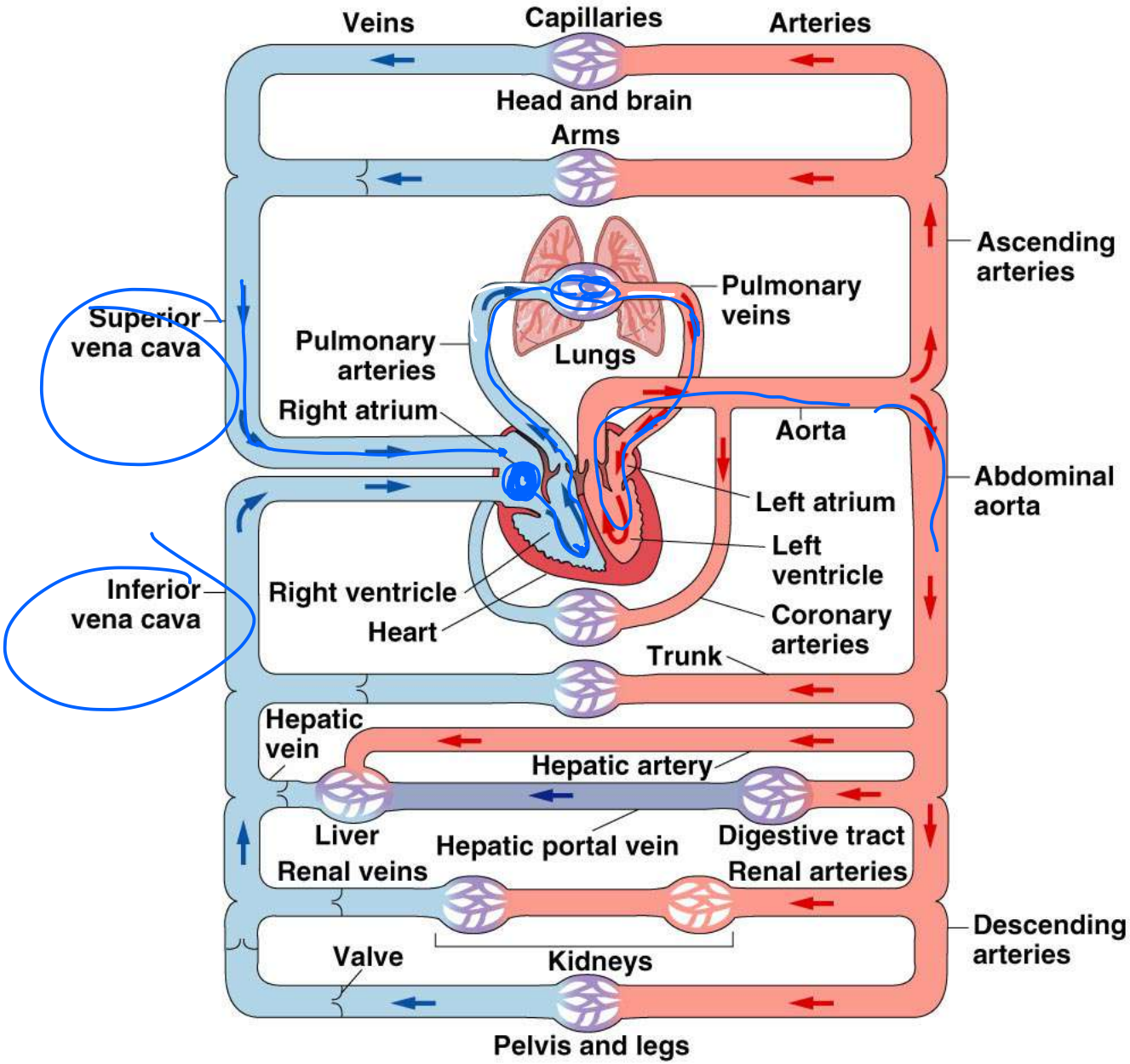


Figure 14-1

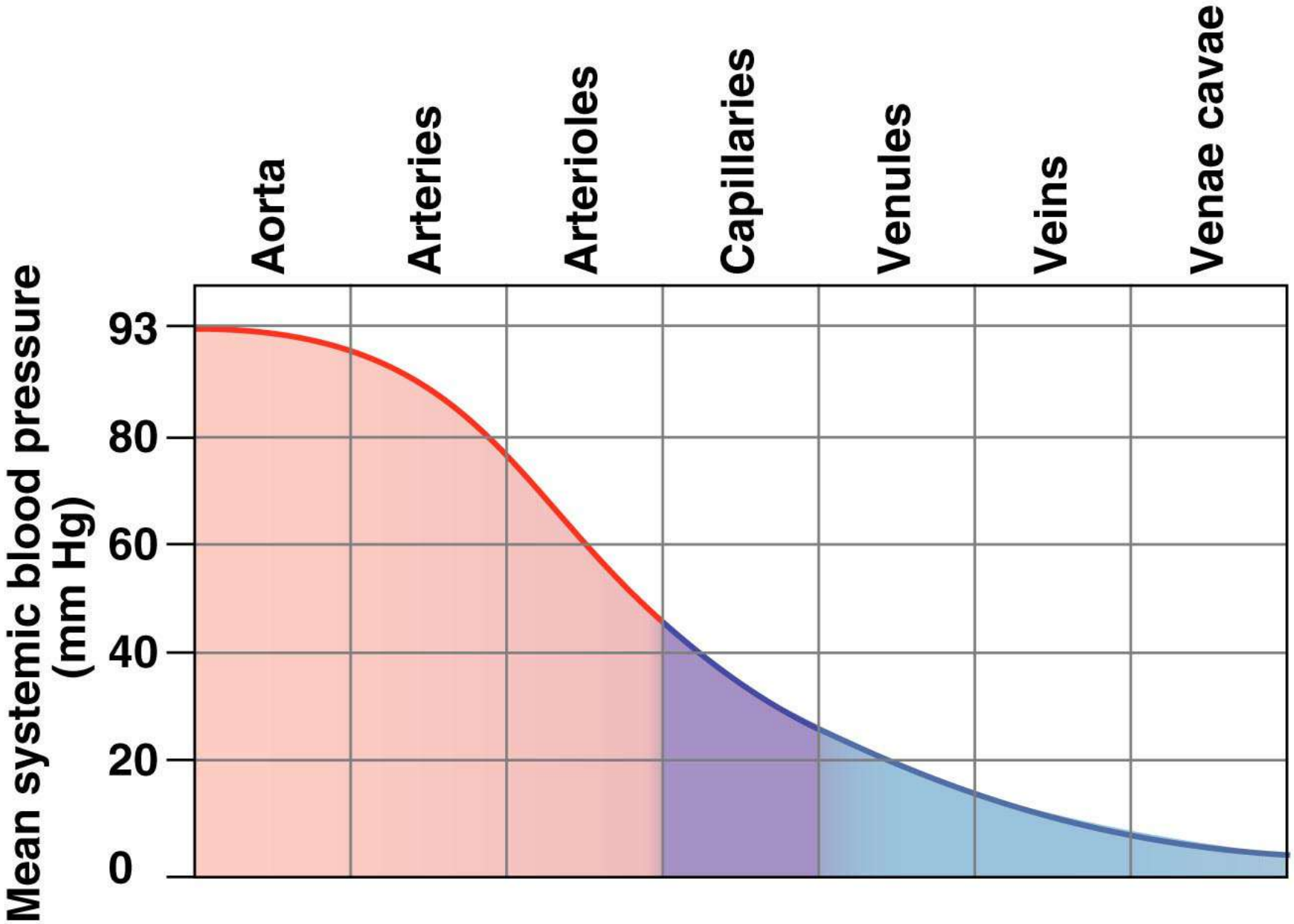


Figure 14-2

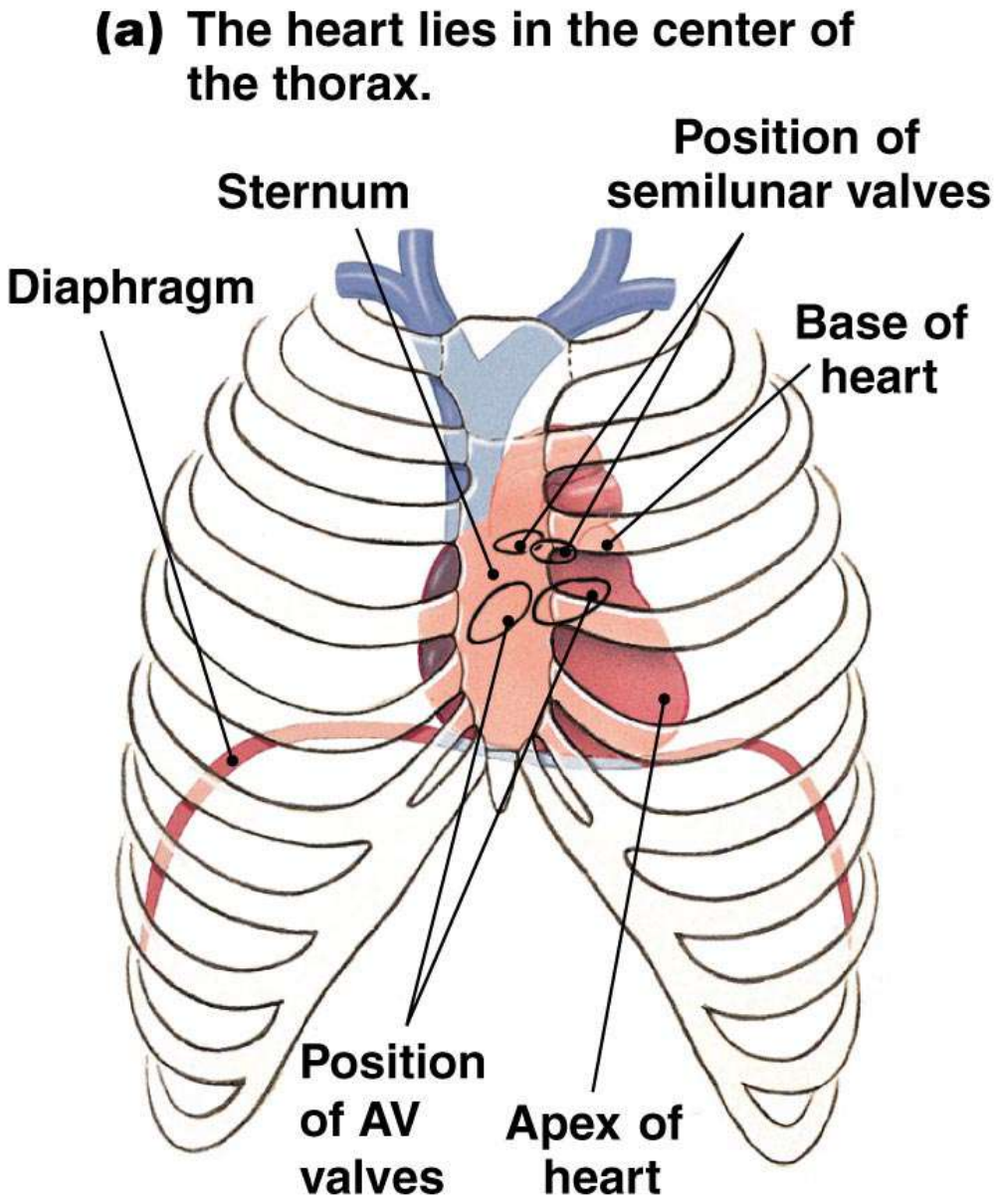
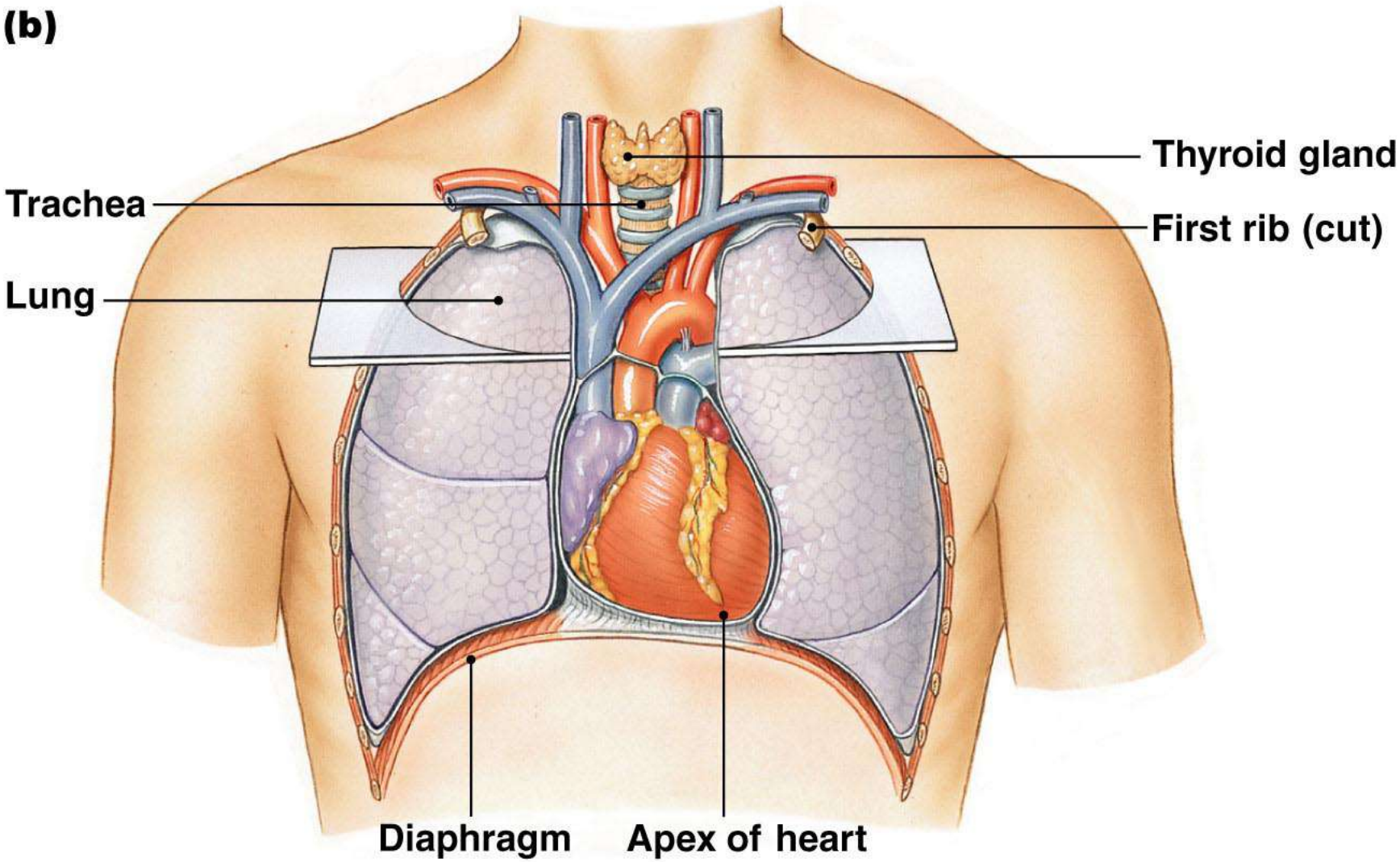
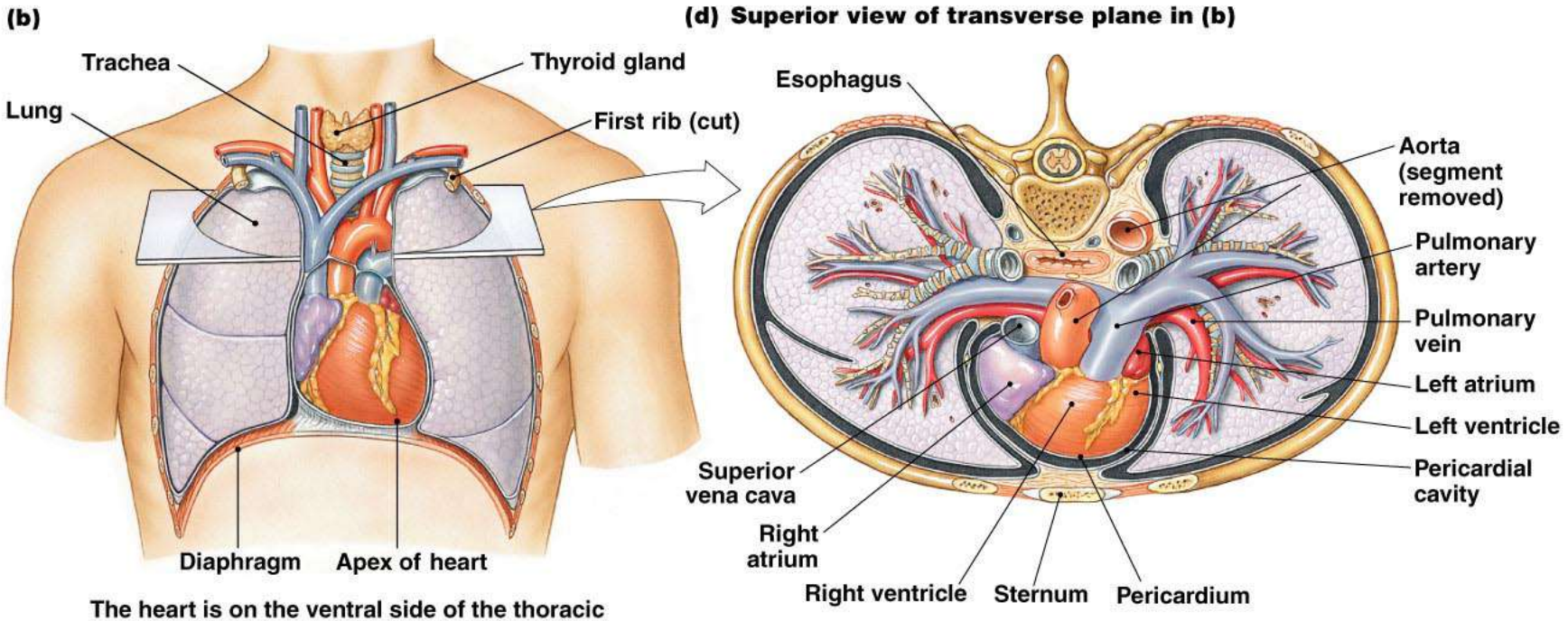


Figure 14-7a



The heart is on the ventral side of the thoracic cavity, sandwiched between the lungs.

Figure 14-7b



The heart is on the ventral side of the thoracic cavity, sandwiched between the lungs.

Figure 14-7b,d

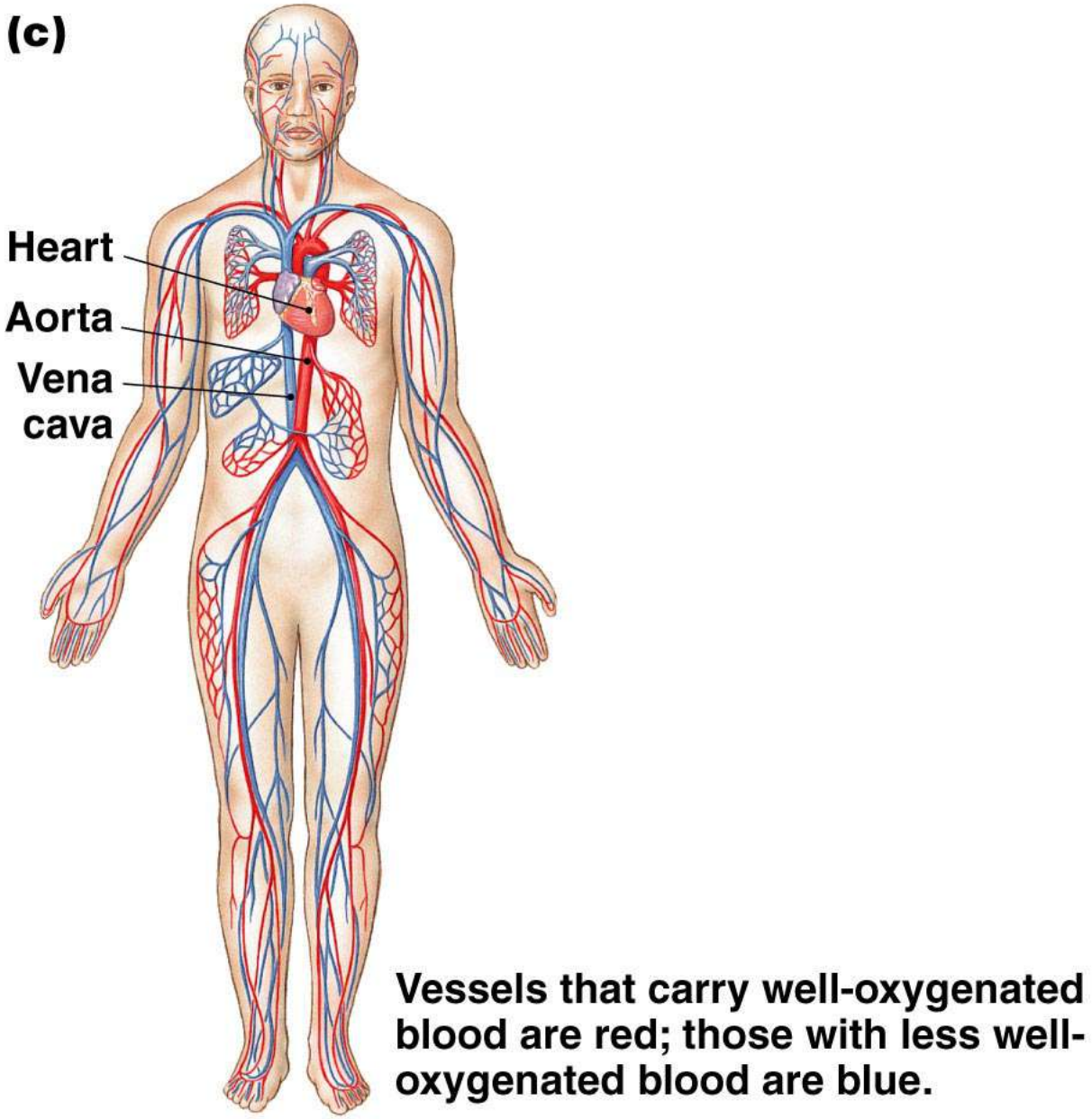


Figure 14-7c

(d) Superior view of transverse plane in (b)

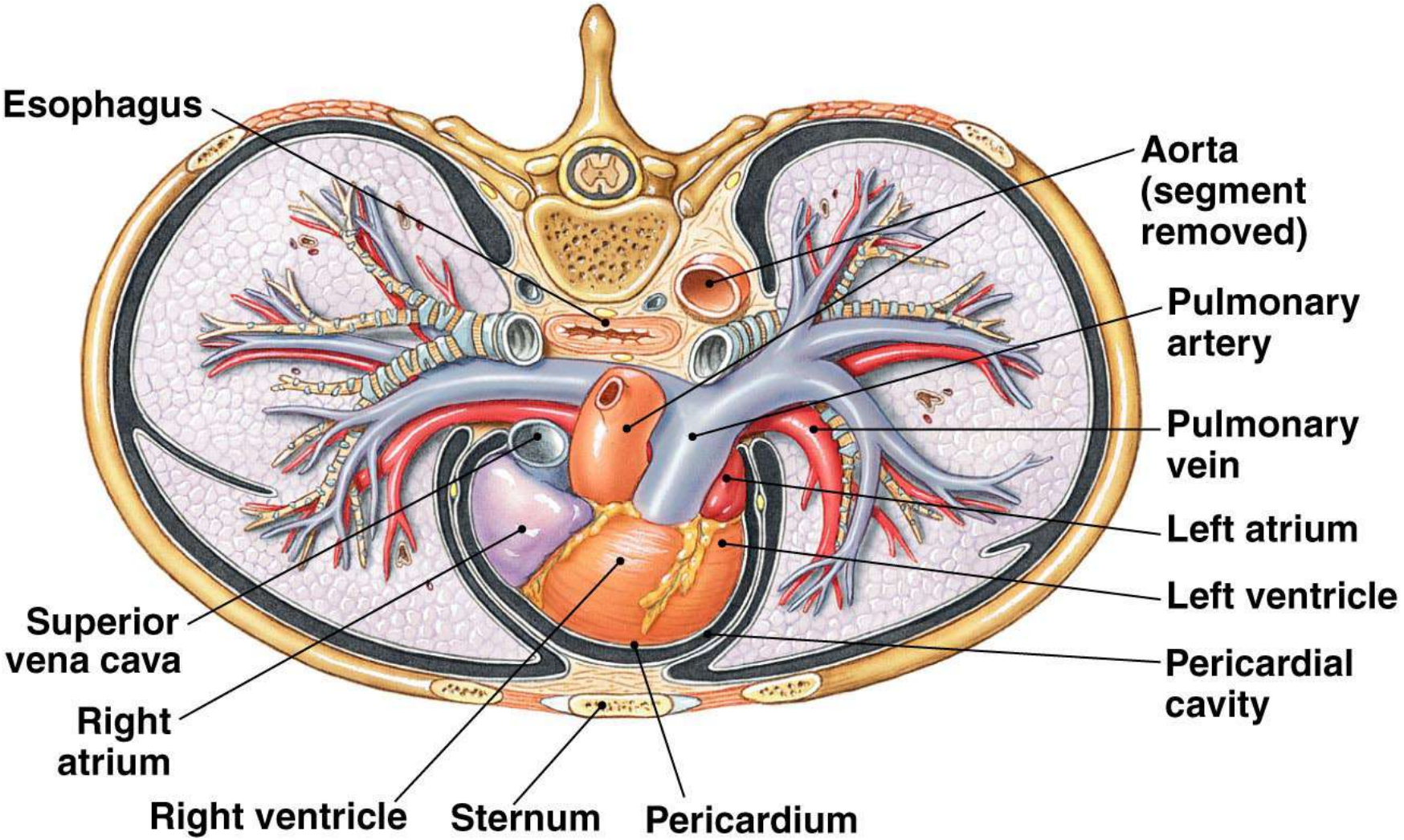
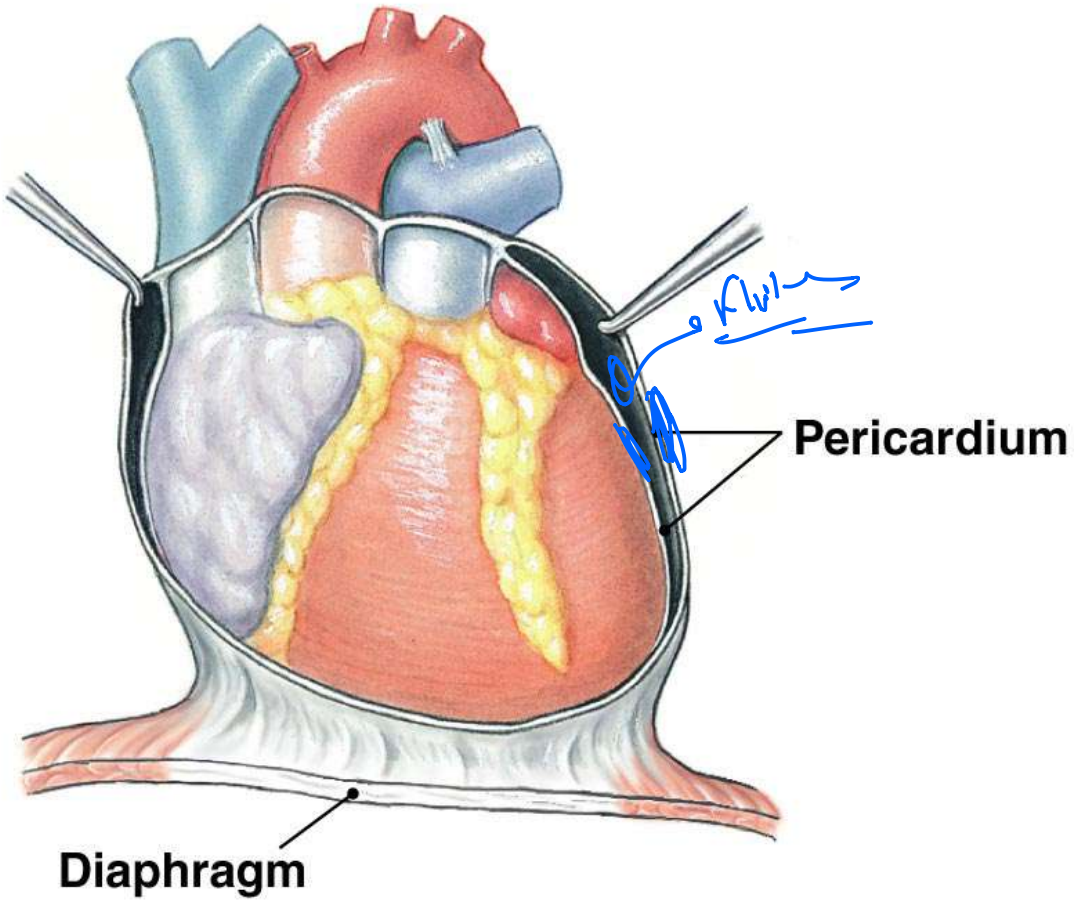


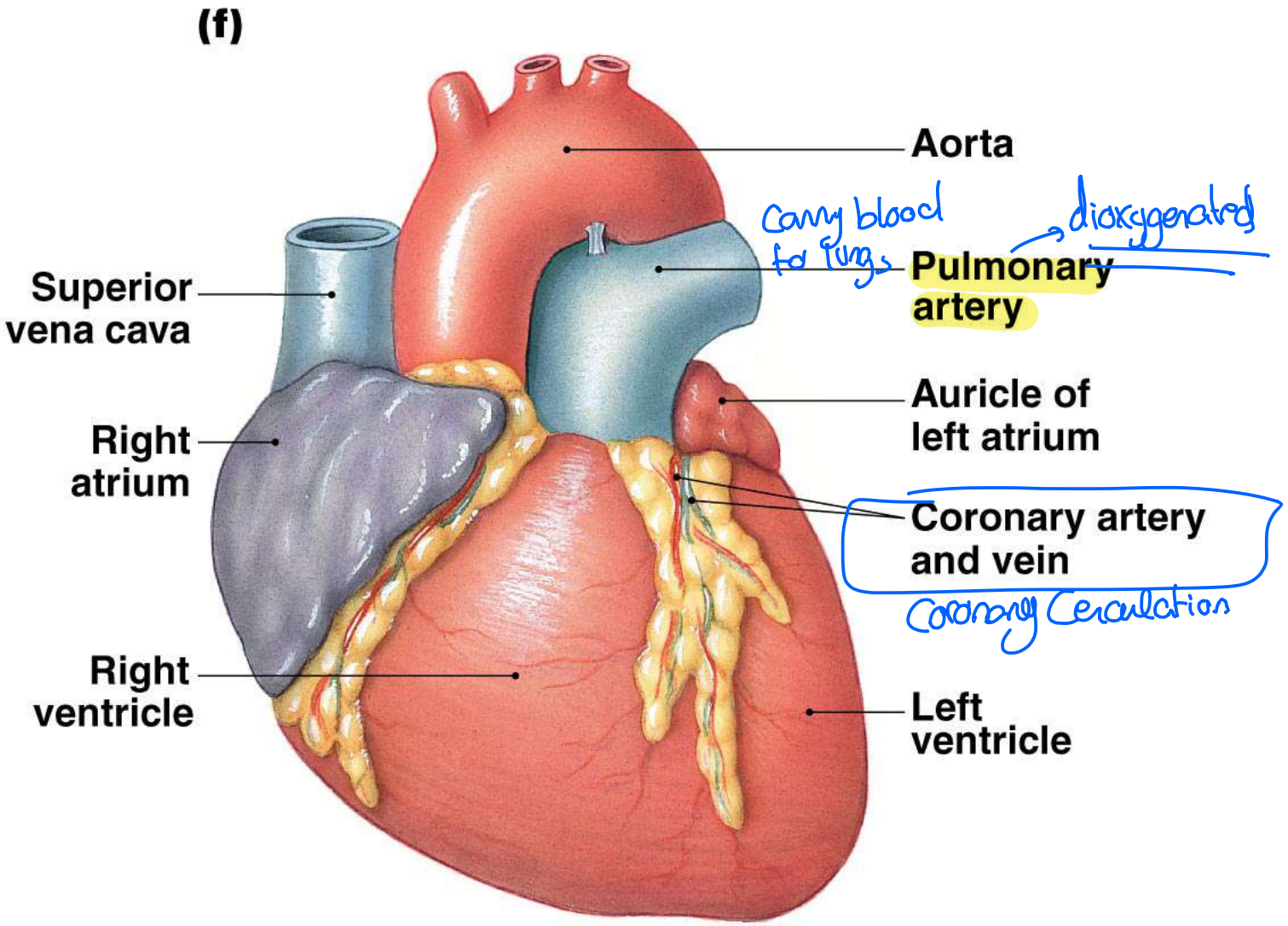
Figure 14-7d

(e)



The heart is encased within a membranous fluid-filled sac, the pericardium.

Figure 14-7e



The ventricles occupy the bulk of the heart. The arteries and veins all attach to the base of the heart.

Figure 14-7f

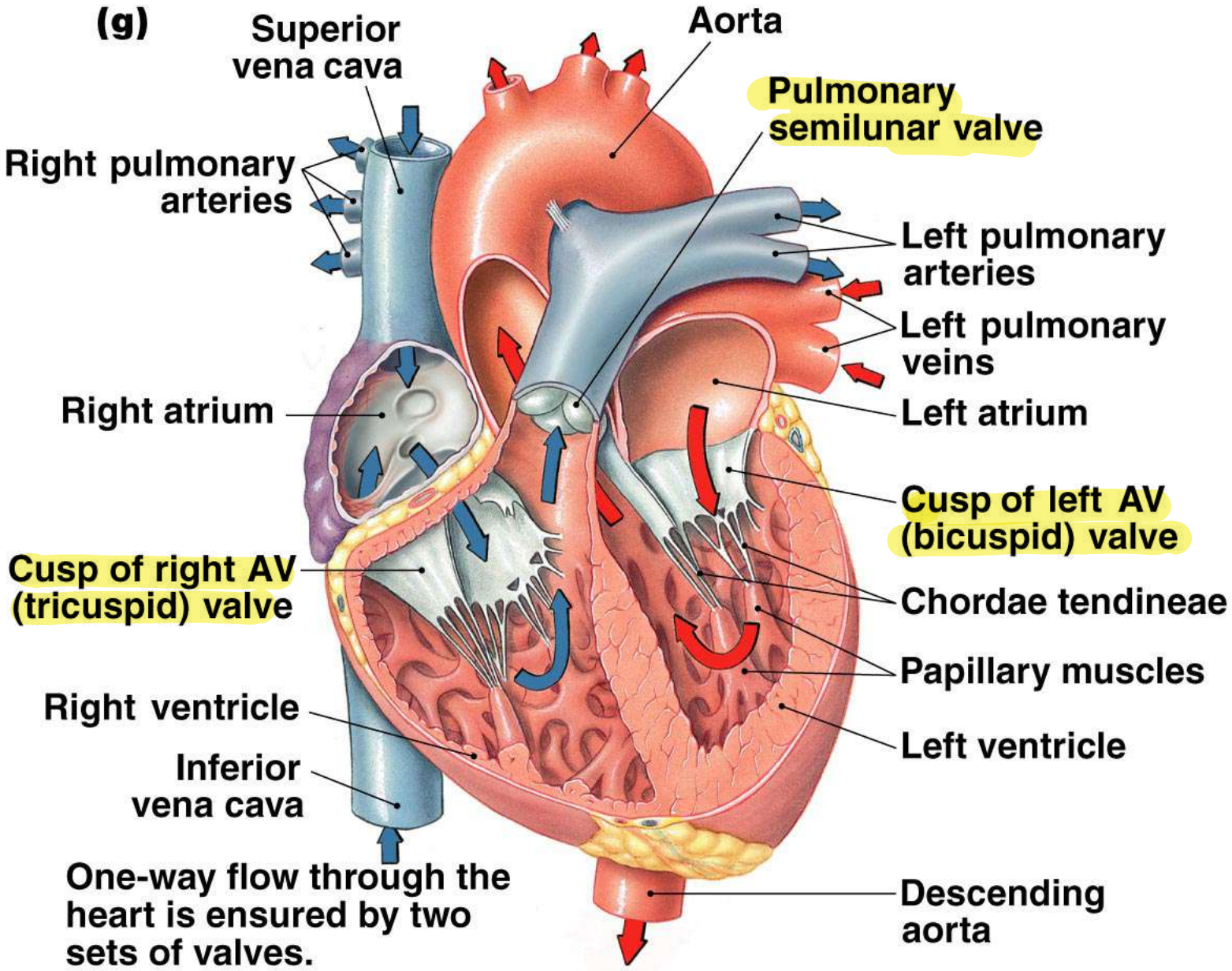


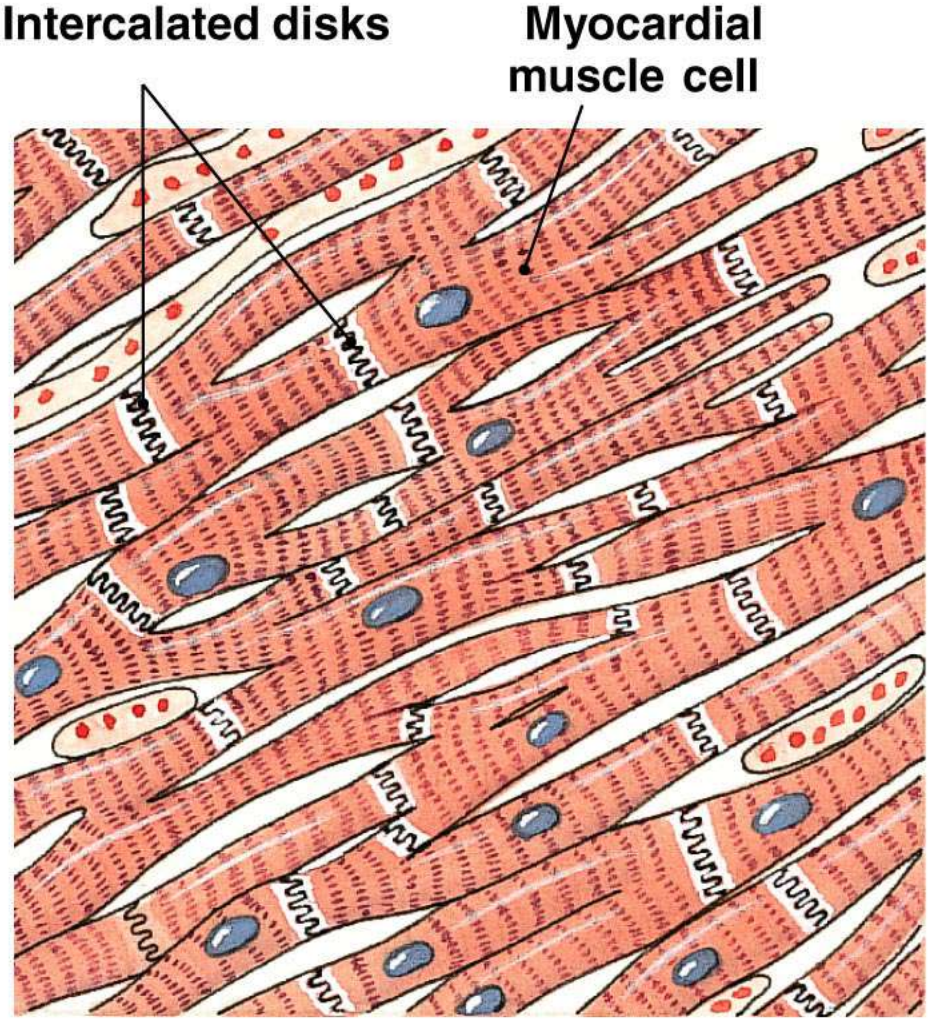
Figure 14-7g

Heart cardiac muscle

within Ventricals

From from Button to up

Skeletal — Smooth



Myocardial muscle cells are branched, have a single nucleus, and are attached to each other by specialized junctions known as intercalated disks.

Figure 14-7h

TABLE 14-2 The Heart and Major Blood Vessels

Blue type indicates structures containing blood with lower oxygen content; red type indicates well-oxygenated blood.

	RECEIVES BLOOD FROM	SENDS BLOOD TO
Heart		
Right atrium	Venae cavae	Right ventricle
Right ventricle	Right atrium	Lungs
Left atrium	Pulmonary veins	Left ventricle
Left ventricle	Left atrium	Body except for lungs
Vessels		
Venae cavae	Systemic veins	Right atrium
Pulmonary trunk (artery)	Right ventricle	Lungs
Pulmonary vein	Veins of the lungs	Left atrium
Aorta	Left ventricle	Systemic arteries

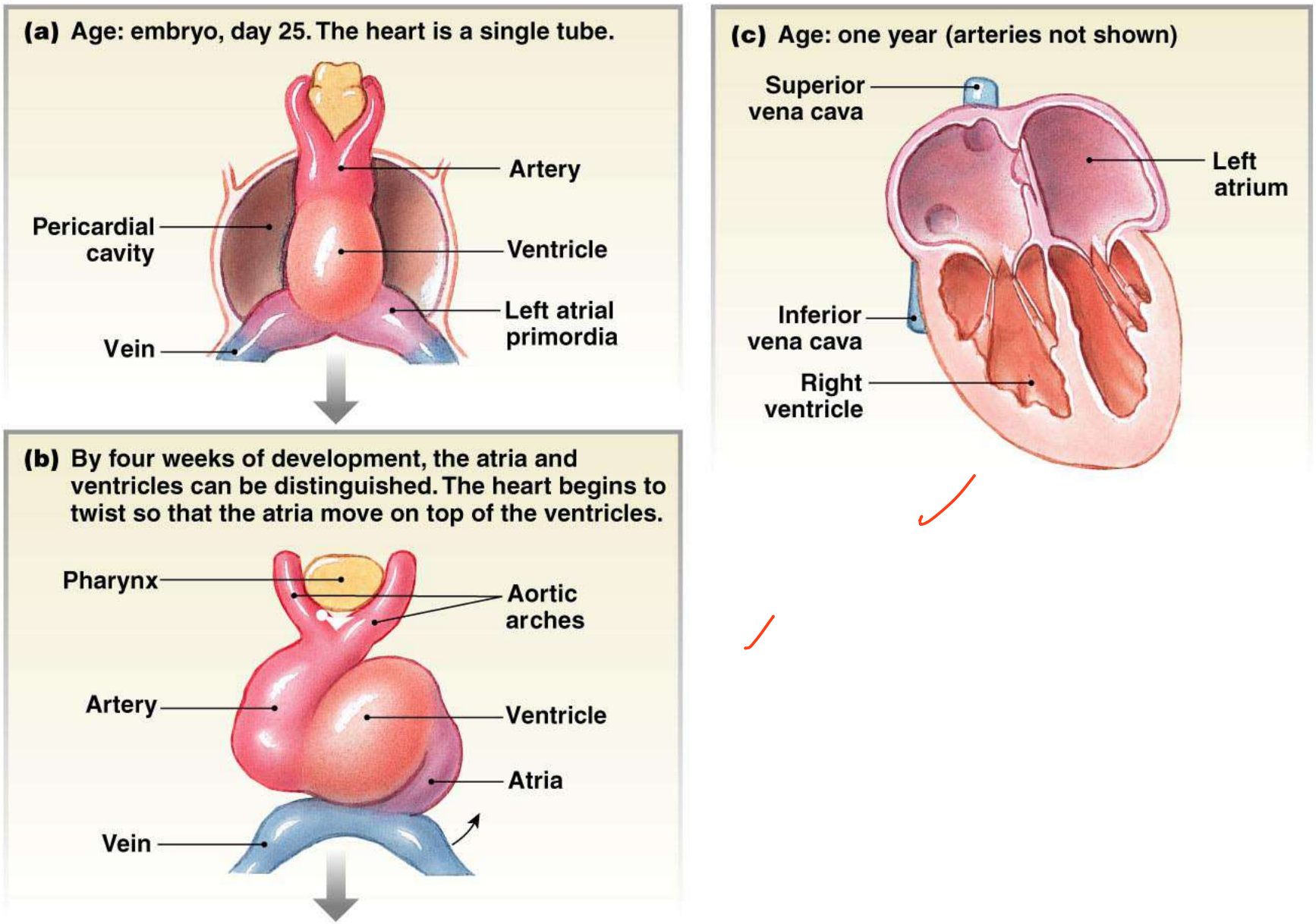


Figure 14-8 - Overview

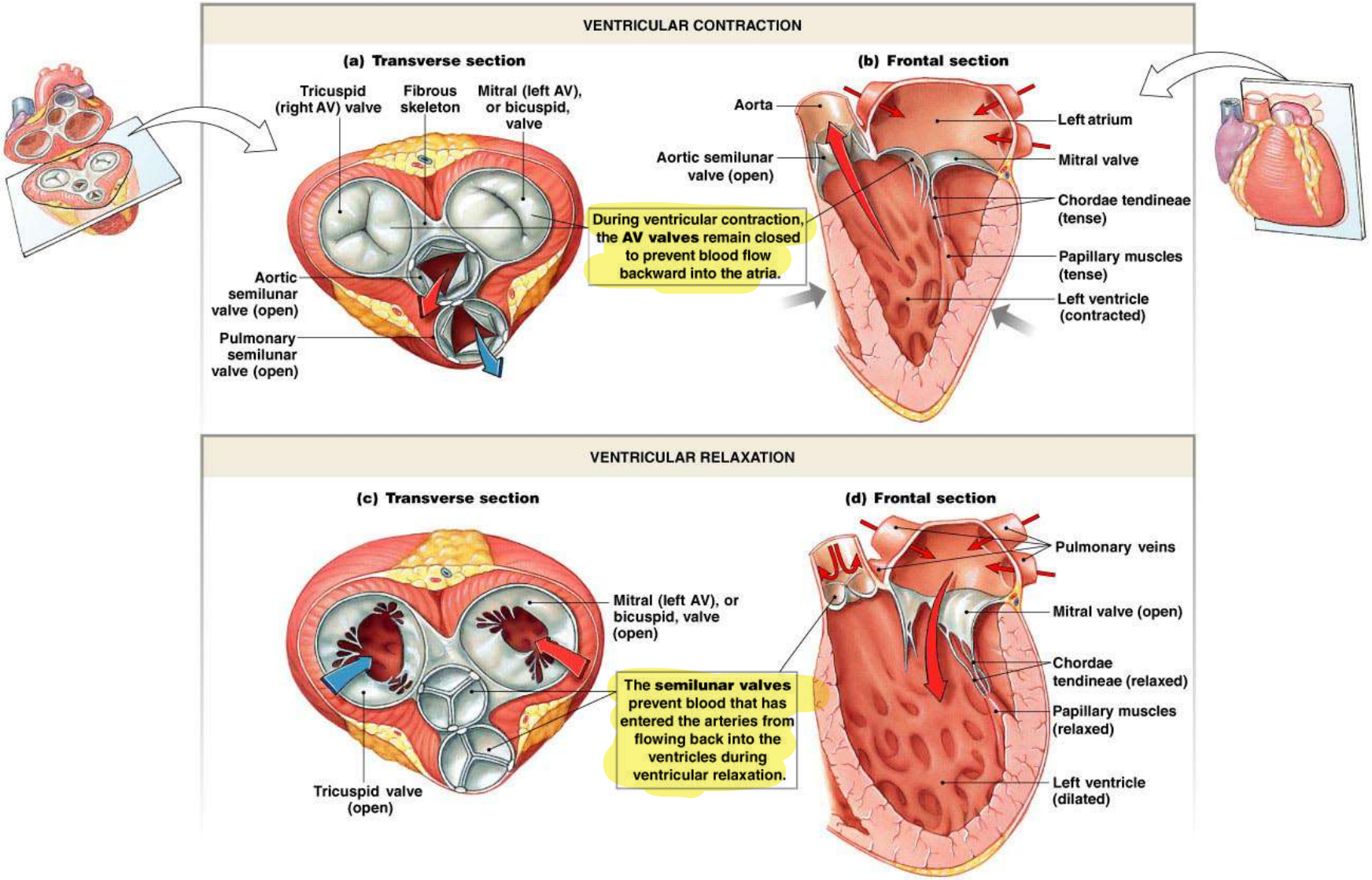


Figure 14-9 - Overview

(a) The spiral arrangement of ventricular muscle allows ventricular contraction to squeeze the blood upward from the apex of the heart.

autoRethmic cells

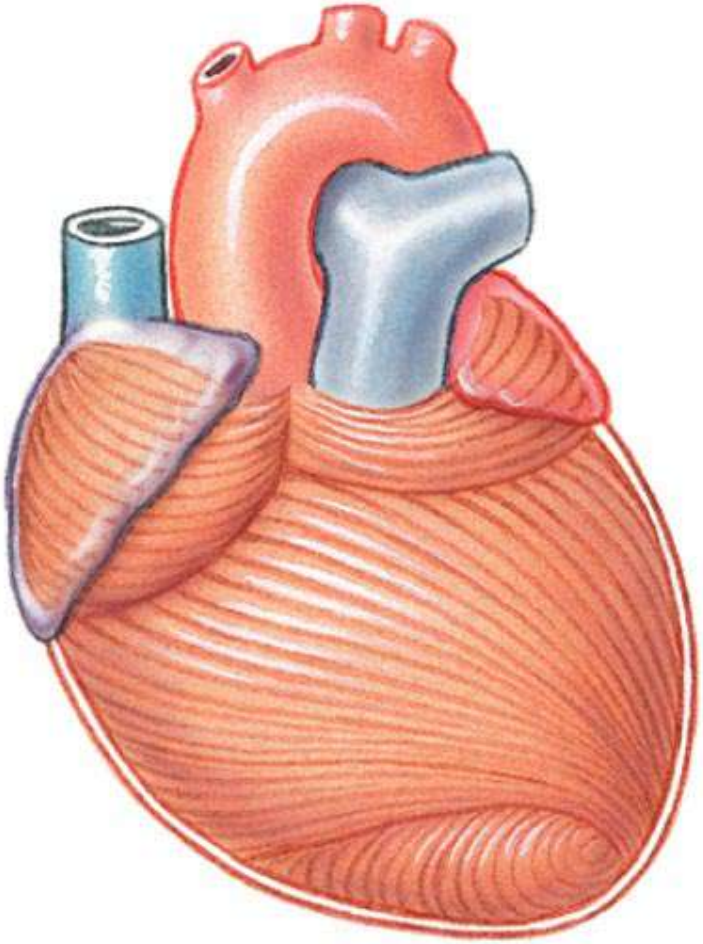


Figure 14-10a

(b) Intercalated disks contain desmosomes that transfer force from cell to cell and gap junctions that allow electrical signals to pass rapidly from cell to cell.

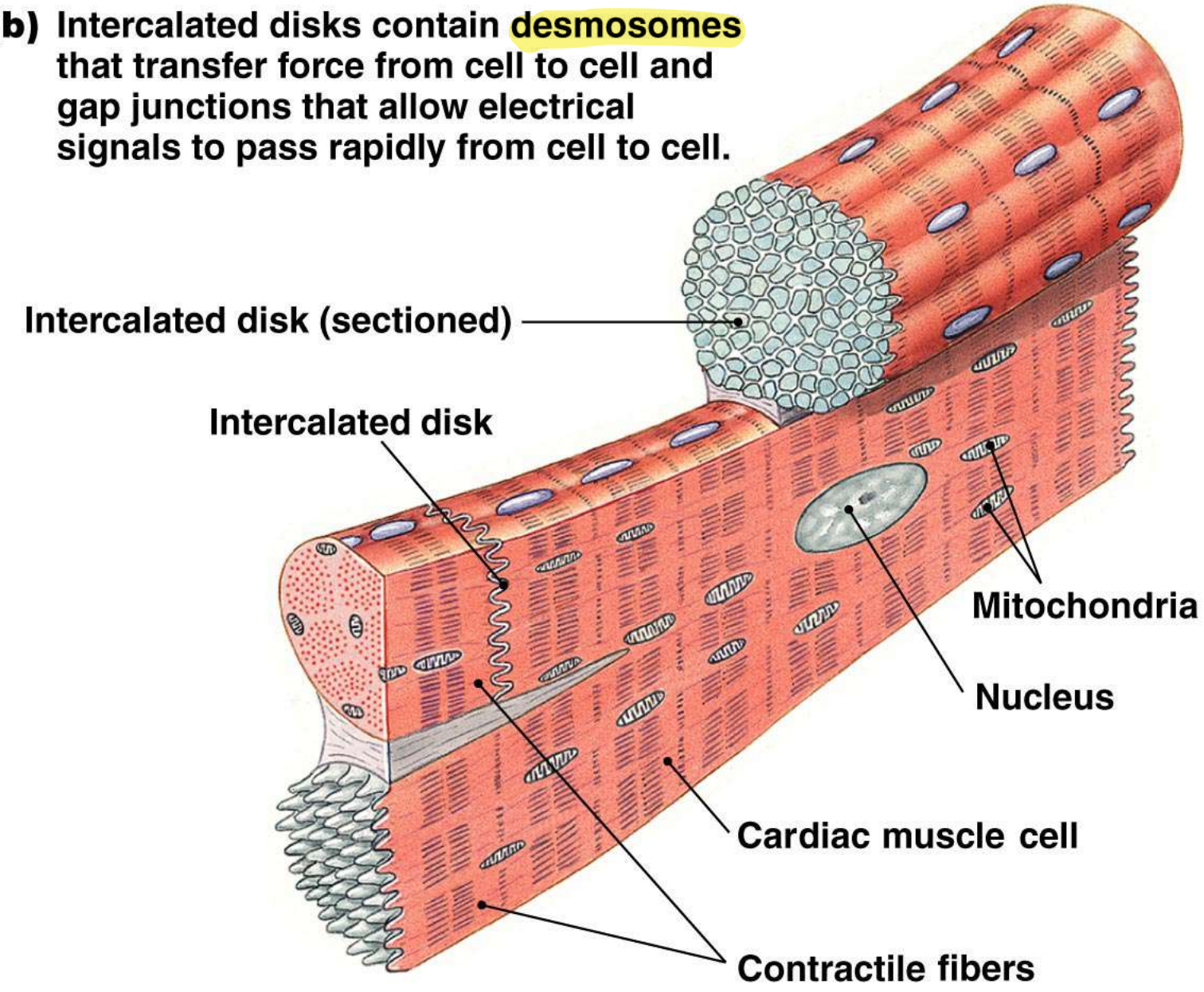


Figure 14-10b

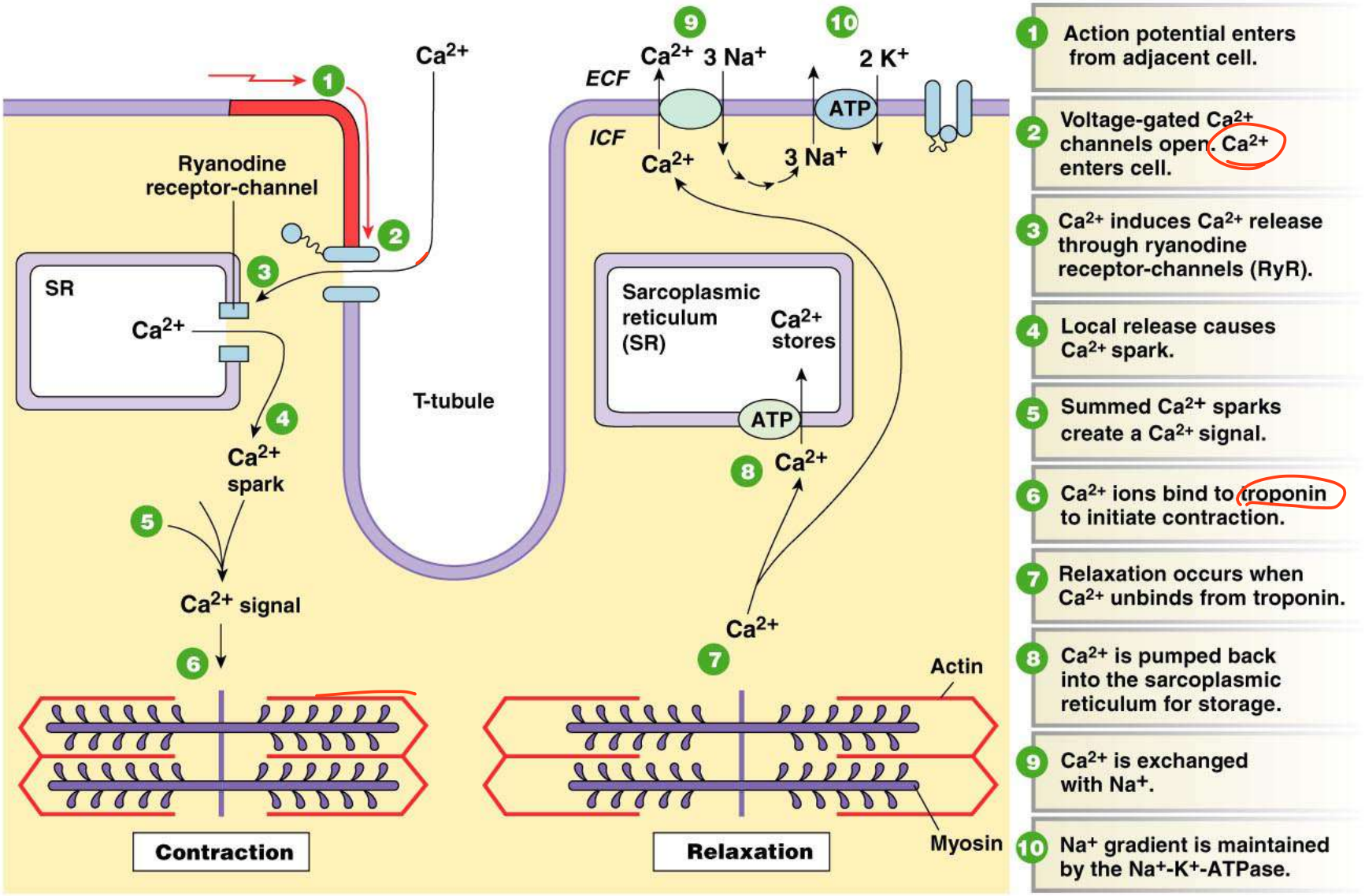
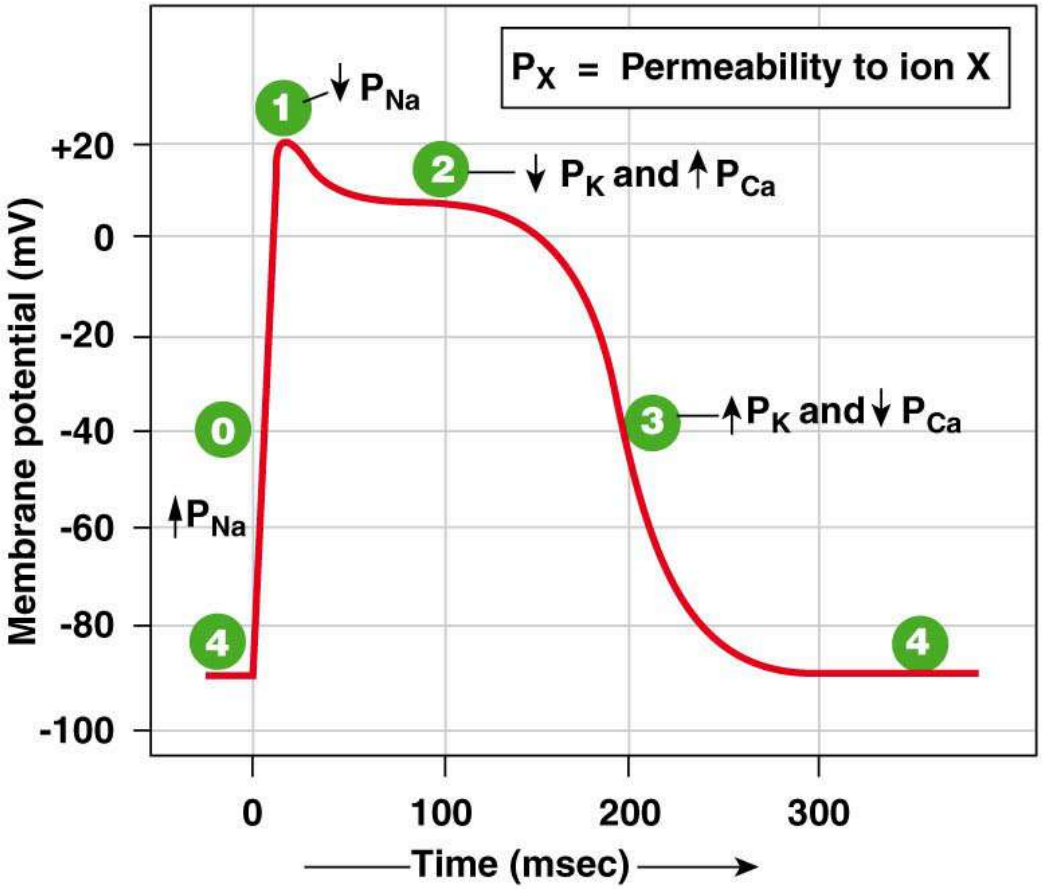


Figure 14-11 - Overview



Phase	Membrane channels
0	Na^+ channels open
1	Na^+ channels close
2	Ca^{2+} channels open; fast K^+ channels close
3	Ca^{2+} channels close; slow K^+ channels open
4	Resting potential

Figure 14-13

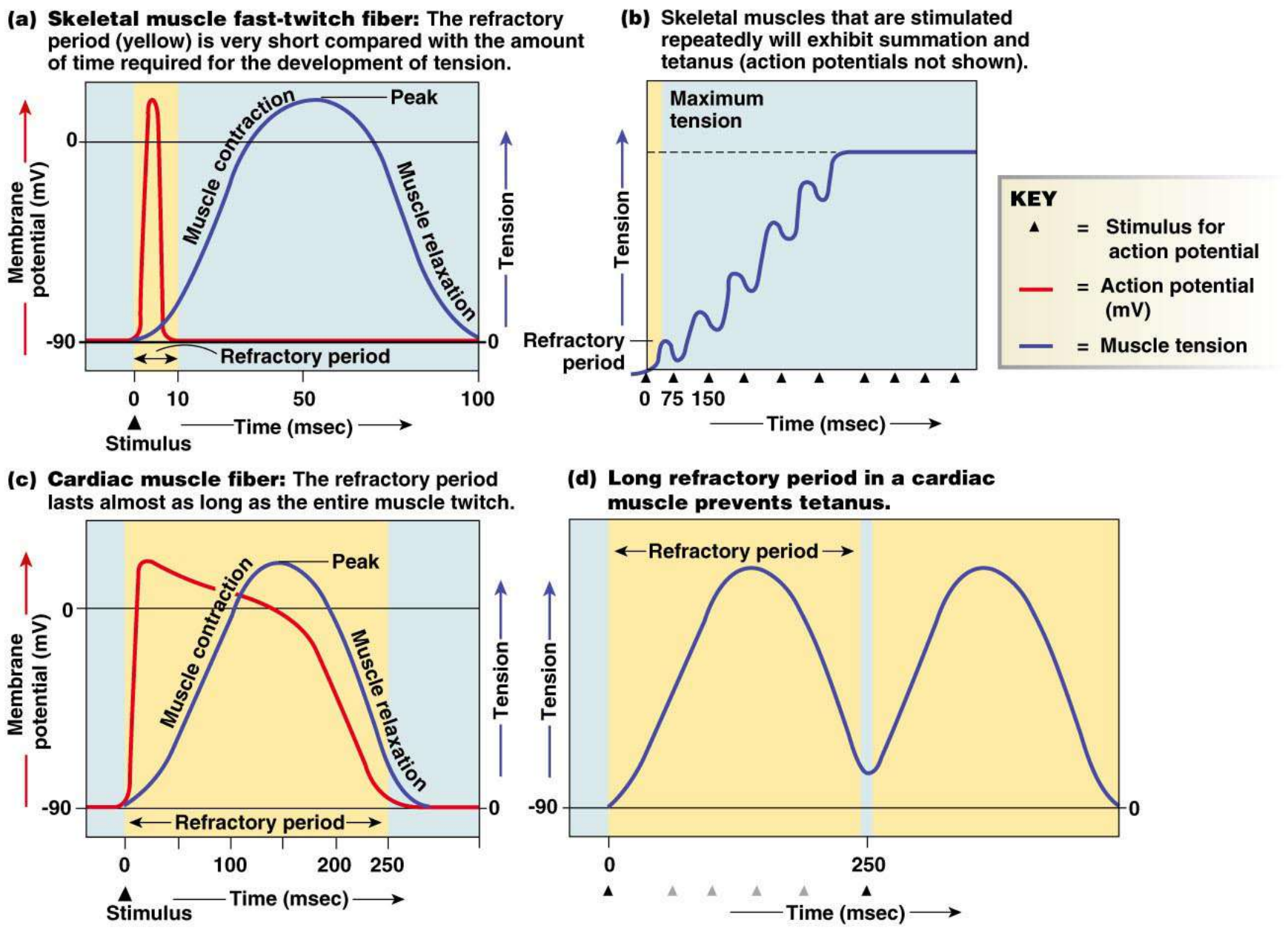


Figure 14-14 - Overview

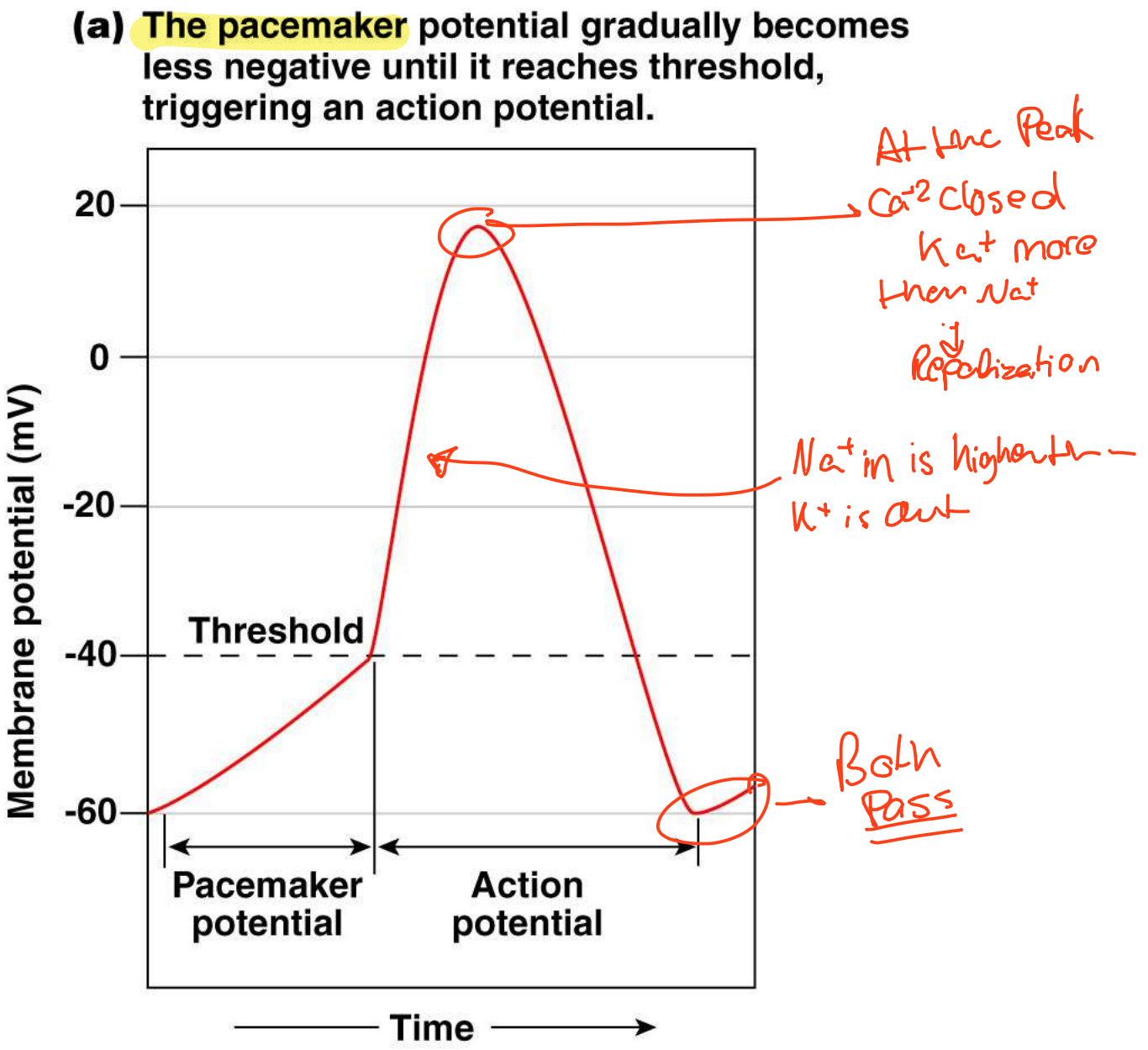


Figure 14-15a

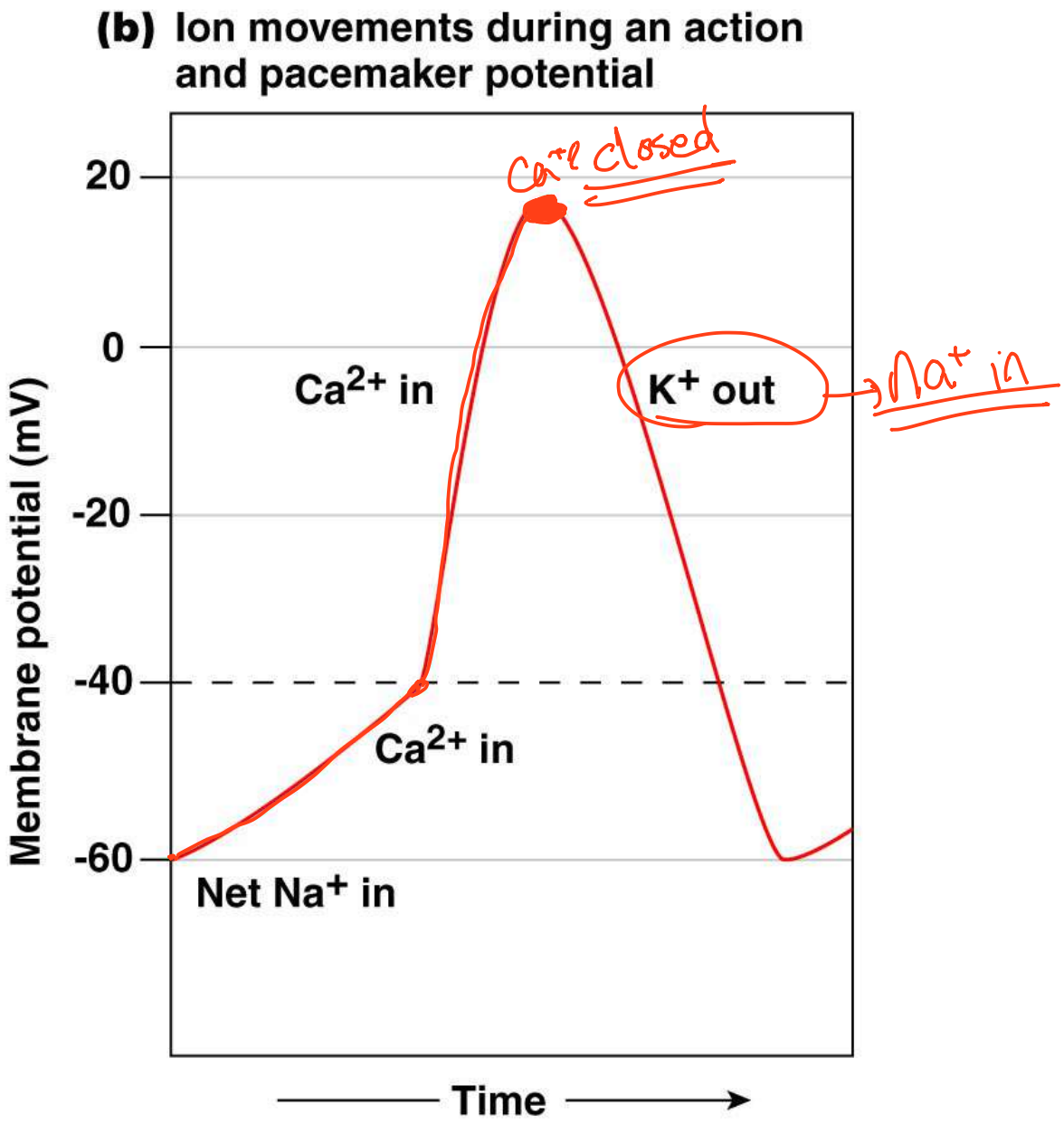


Figure 14-15b

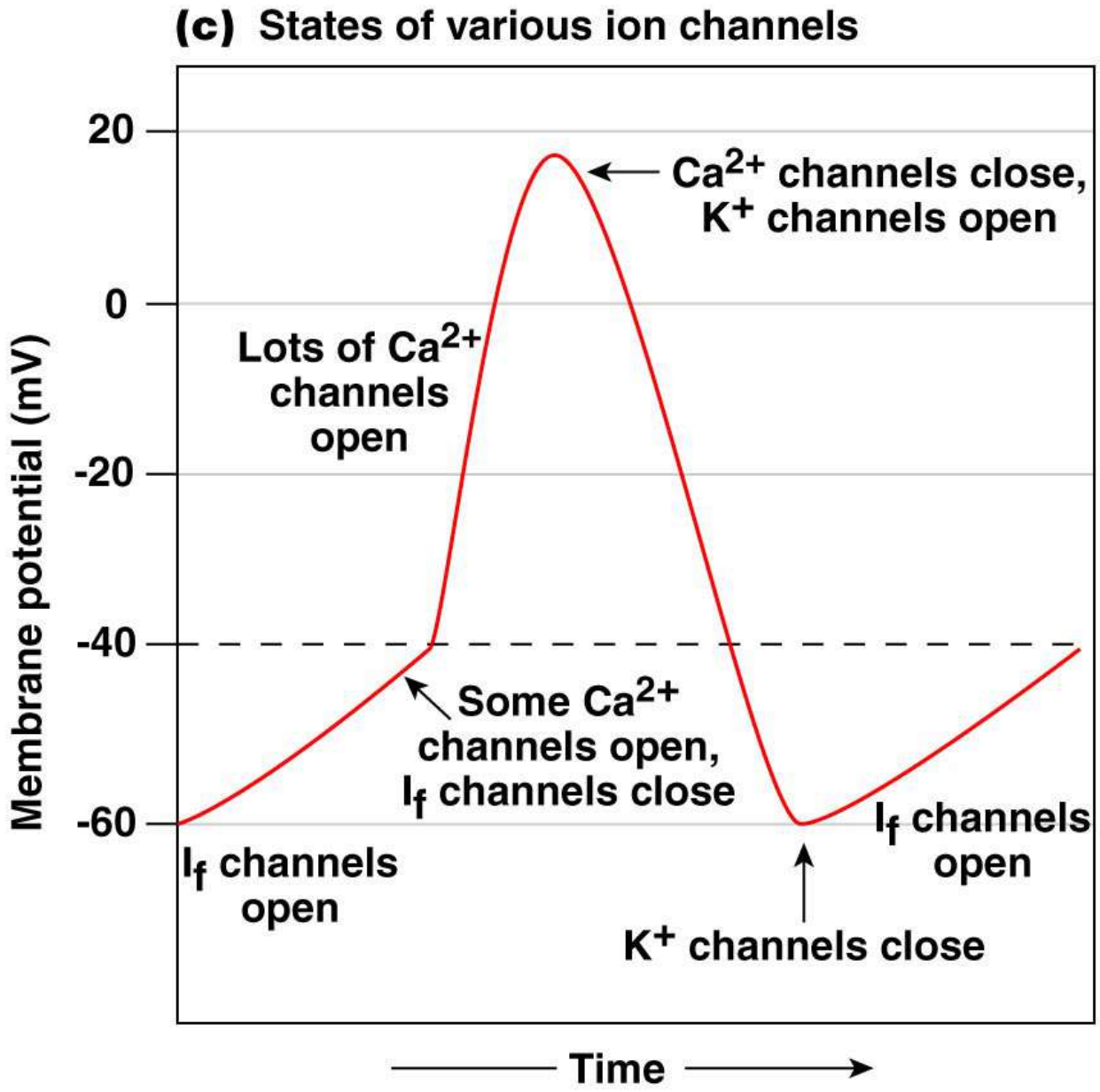


Figure 14-15c

(a) Sympathetic stimulation and epinephrine depolarize the autorhythmic cell and speed up the depolarization rate, increasing the heart rate.

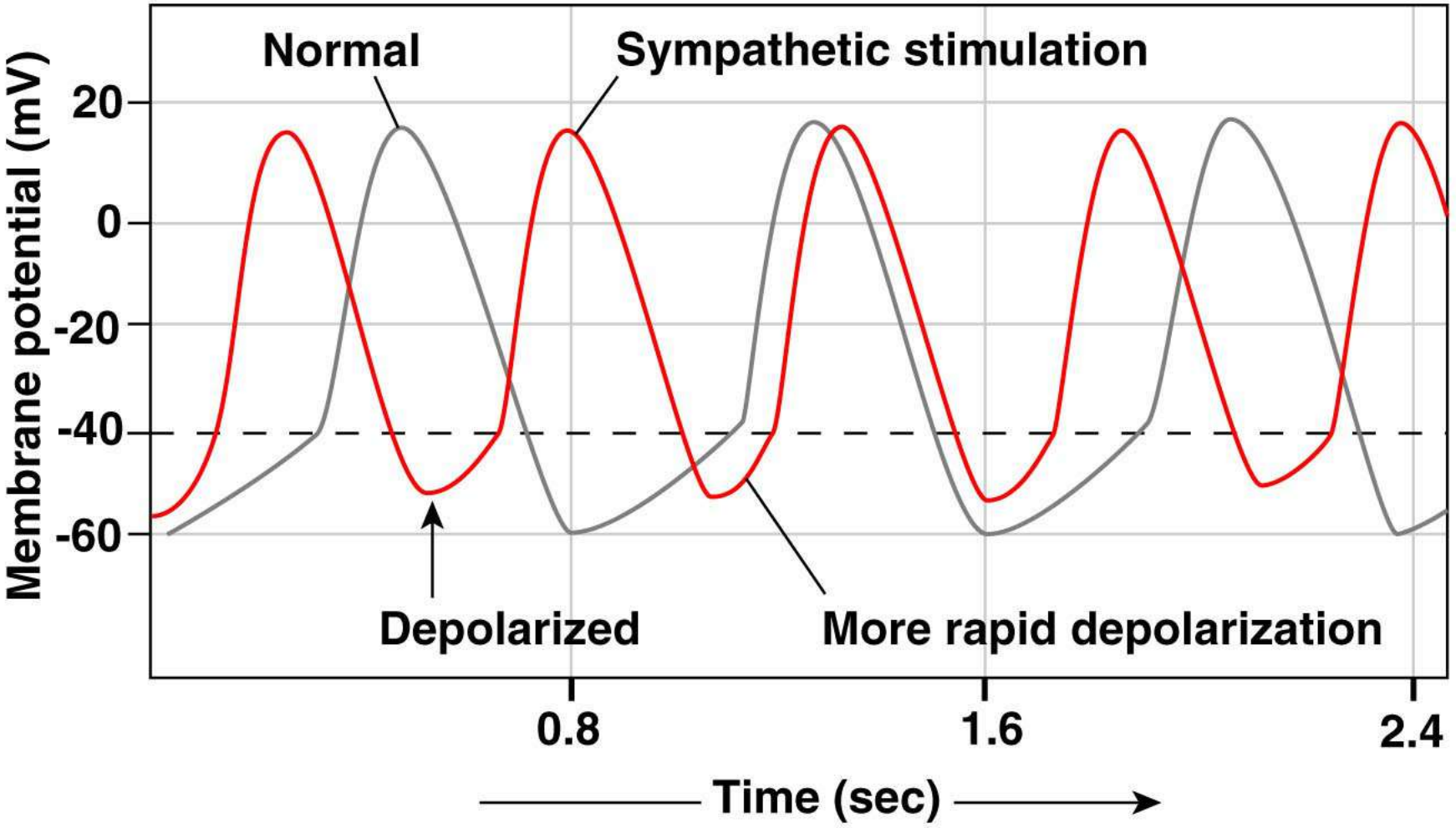


Figure 14-16a

(b) Parasympathetic stimulation hyperpolarizes the membrane potential of the autorhythmic cell and slows depolarization, decreasing the heart rate.

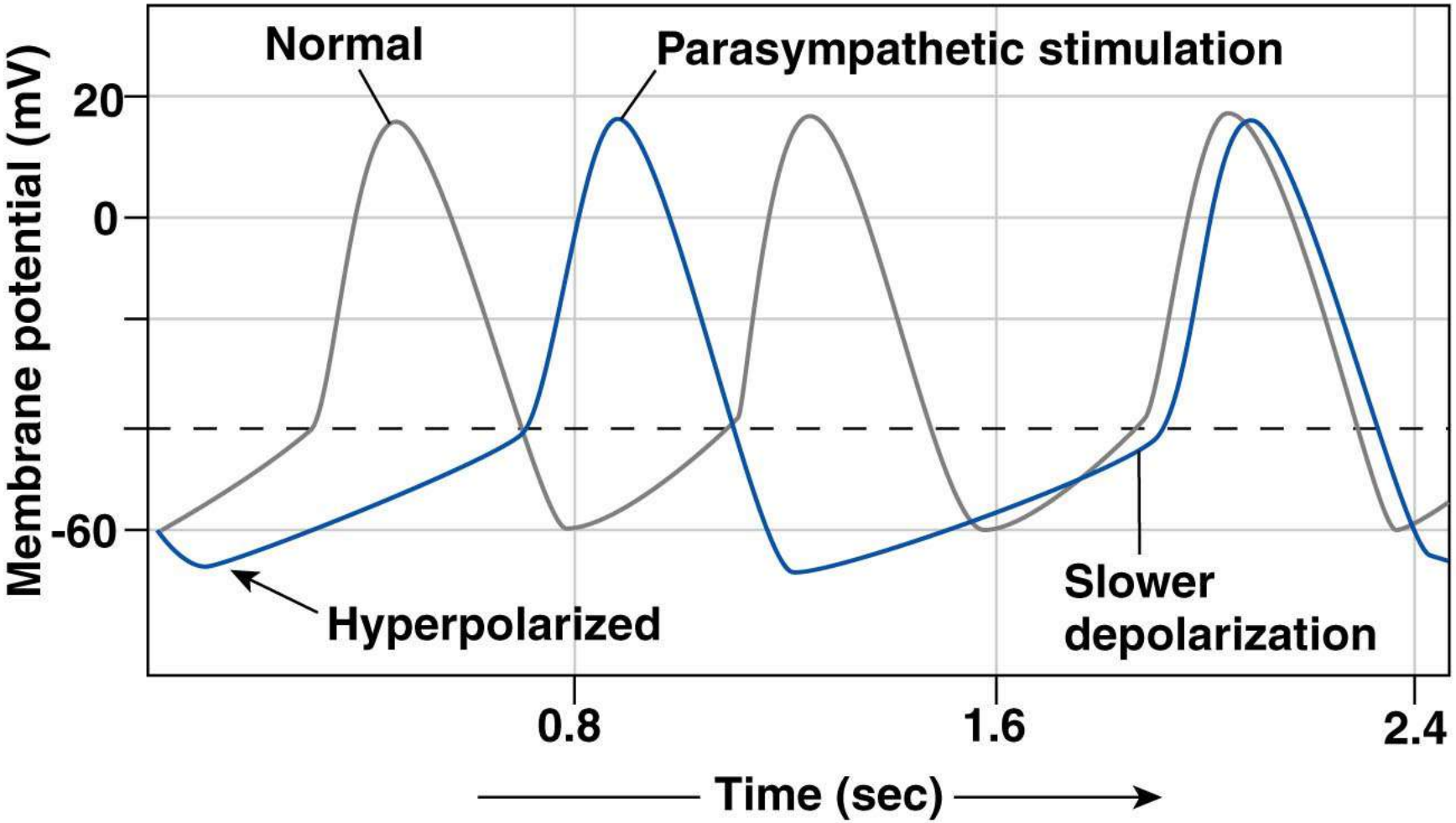


Figure 14-16b

TABLE 14-3 Comparison of Action Potentials in Cardiac and Skeletal Muscle

	SKELETAL MUSCLE	CONTRACTILE MYOCARDIUM	AUTORHYTHMIC MYOCARDIUM
Membrane potential	Stable at −70 mV	Stable at −90 mV	Unstable pacemaker potential; usually starts at −60 mV
Events leading to threshold potential	Net Na^+ entry through ACh-operated channels	Depolarization enters via gap junctions	Net Na^+ entry through I_f channels; reinforced by Ca^{2+} entry
Rising phase of action potential	Na^+ entry	Na^+ entry	Ca^{2+} entry
Repolarization phase	Rapid; caused by K^+ efflux	Extended plateau caused by Ca^{2+} entry; rapid phase caused by K^+ efflux	Rapid; caused by K^+ efflux
Hyperpolarization	Due to excessive K^+ efflux at high K^+ permeability when K^+ channels close; leak of K^+ and Na^+ restores potential to resting state	None; resting potential is −90 mV, the equilibrium potential for K^+	None; when repolarization hits −60 mV, the I_f channels open again
Duration of action potential	Short: 1–2 msec	Extended: 200+ msec	Variable; generally 150+ msec
Refractory period	Generally brief	Long because resetting of Na^+ channel gates delayed until end of action potential	None

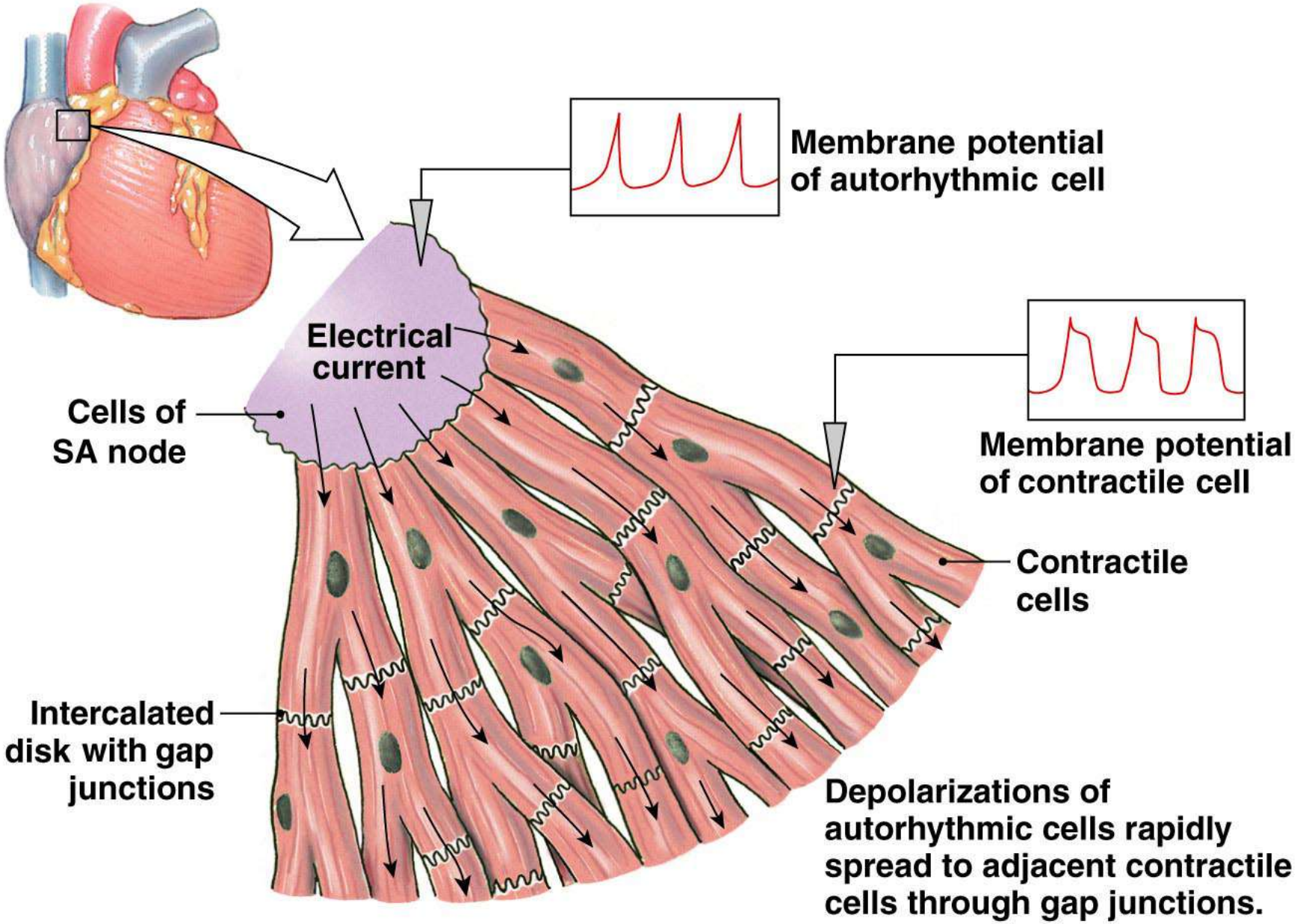


Figure 14-17

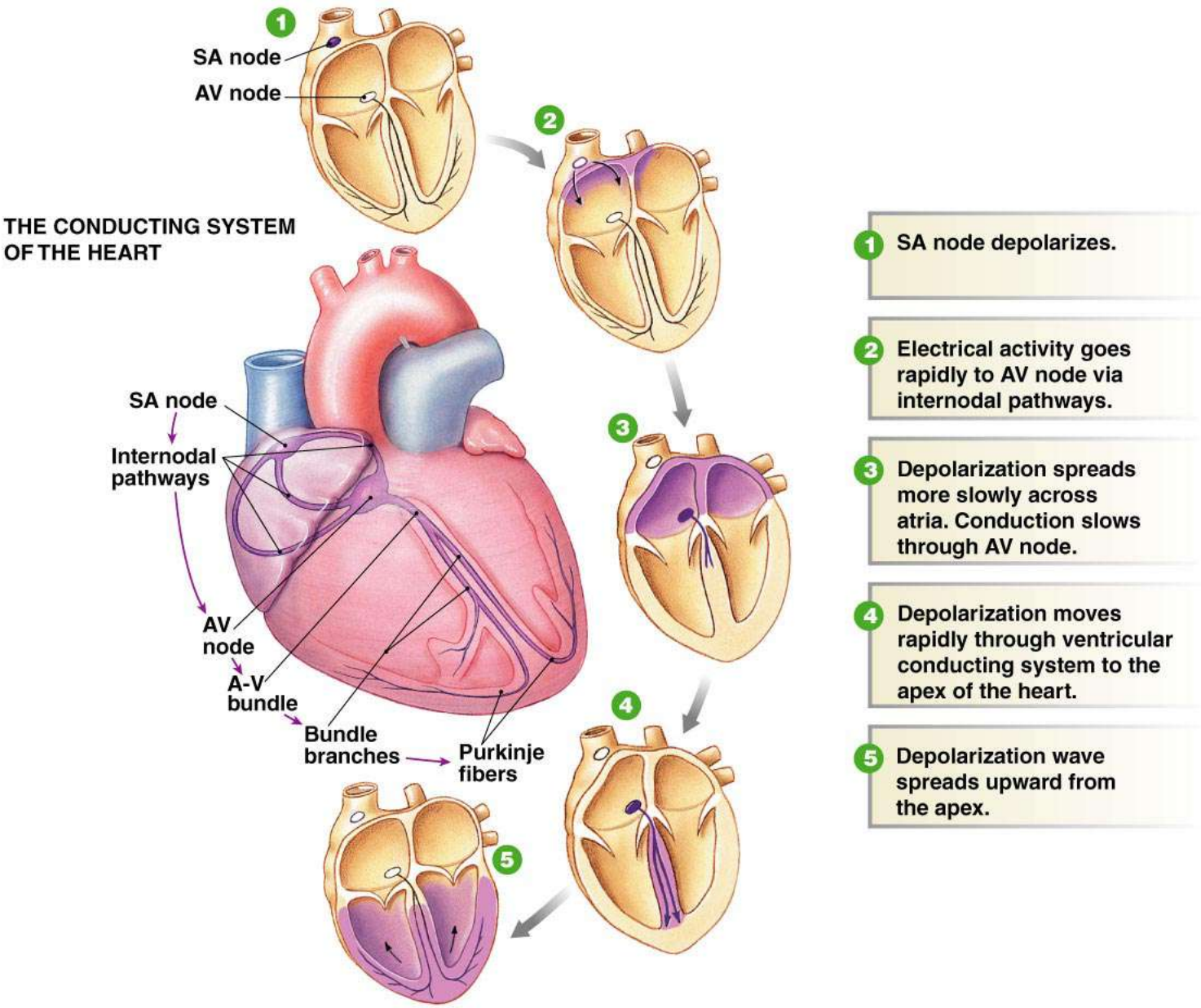


Figure 14-18

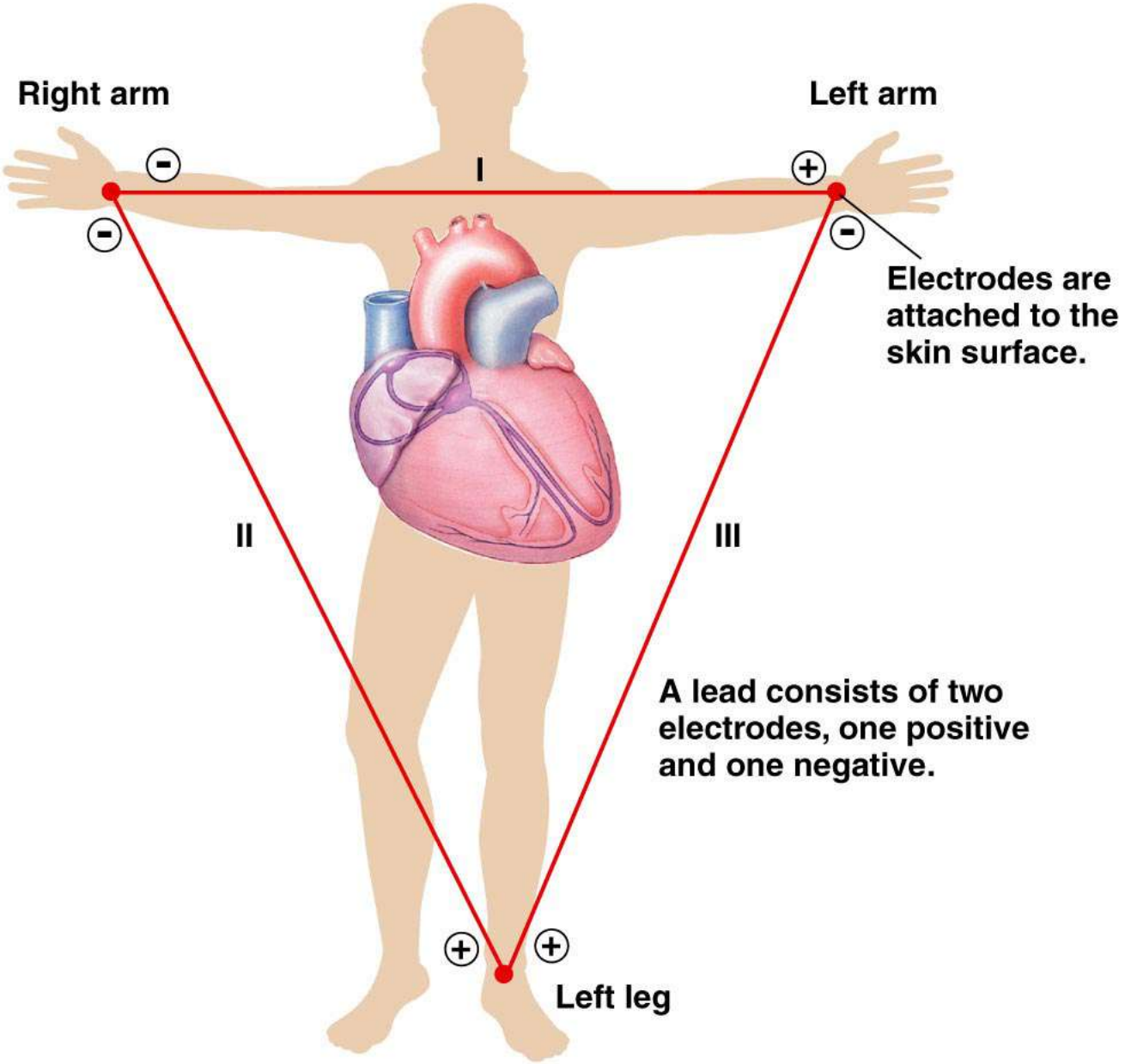


Figure 14-19

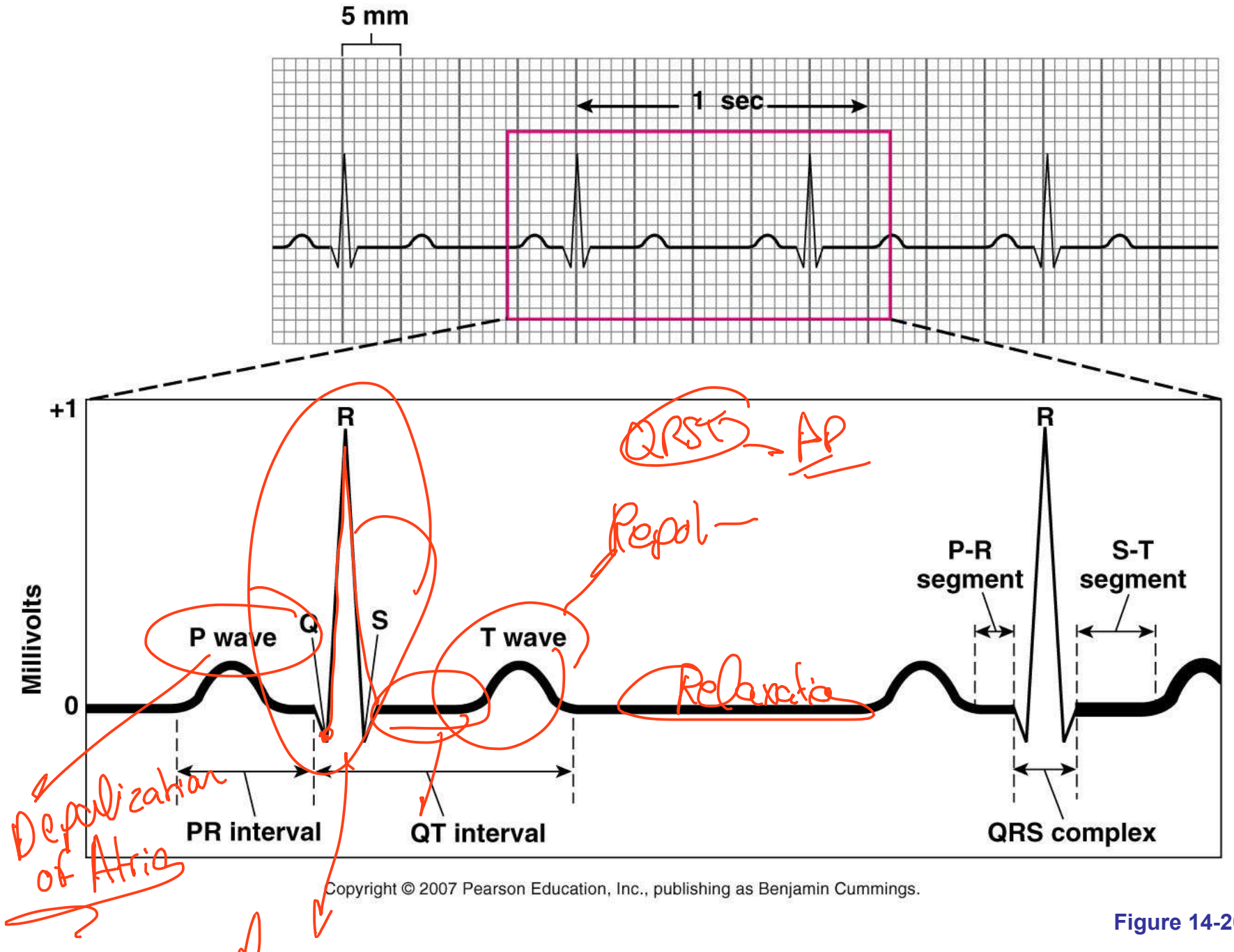


Figure 14-20

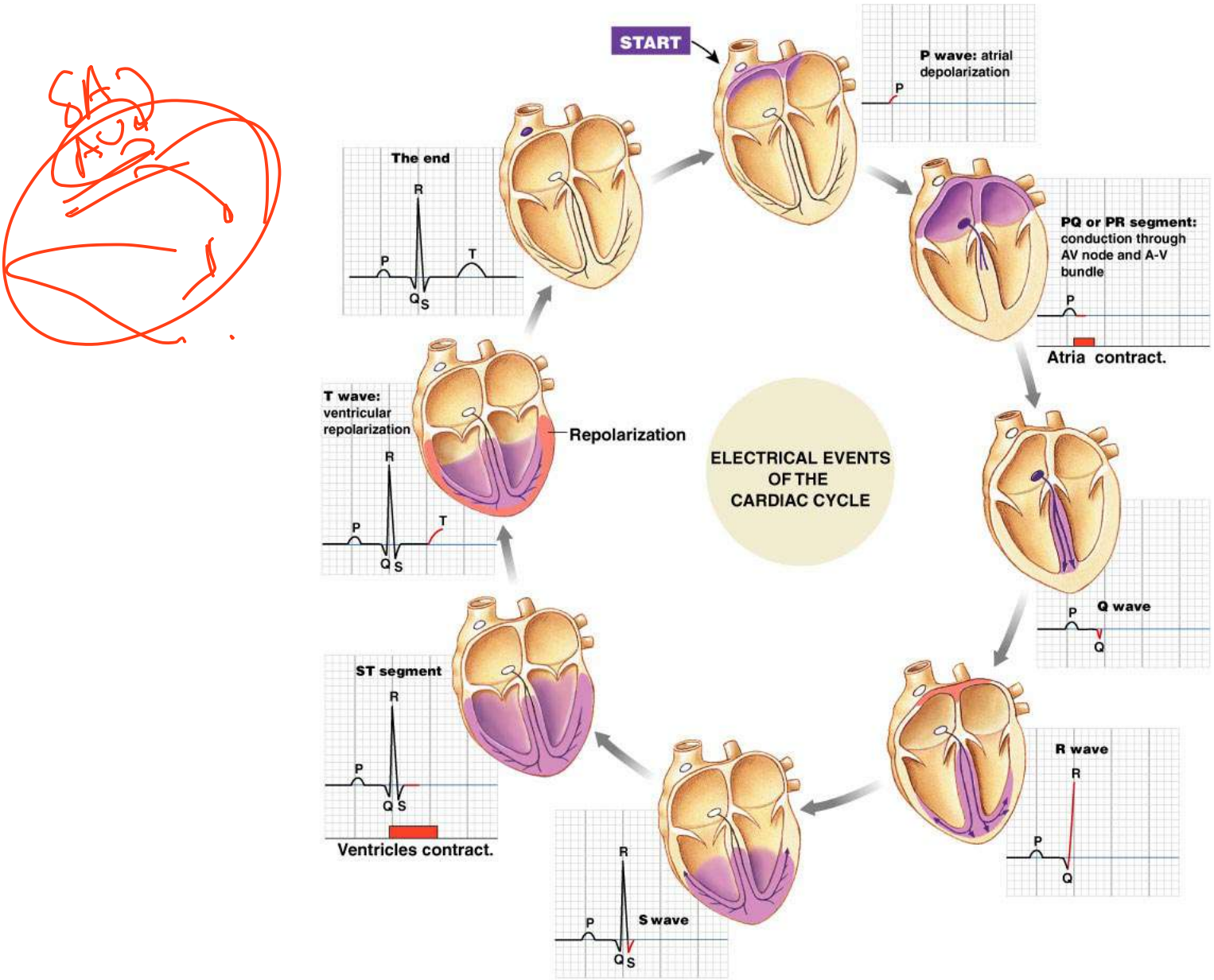
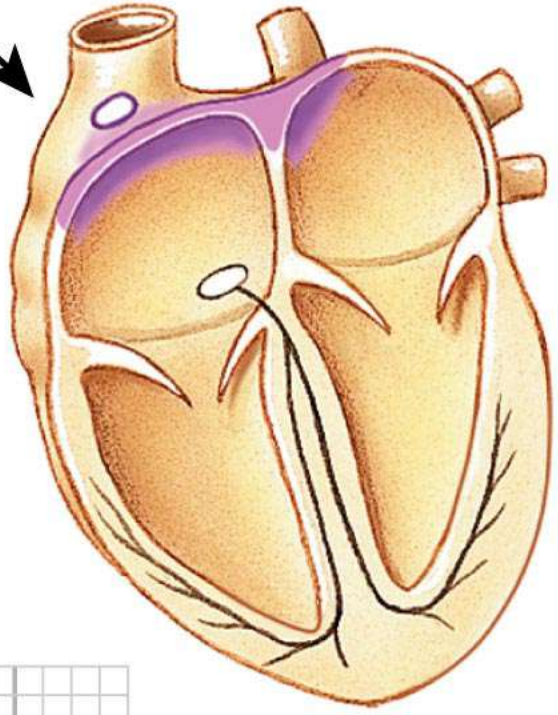


Figure 14-21 - Overview (1 of 9)

ELECTRICAL EVENTS OF THE CARDIAC CYCLE

START



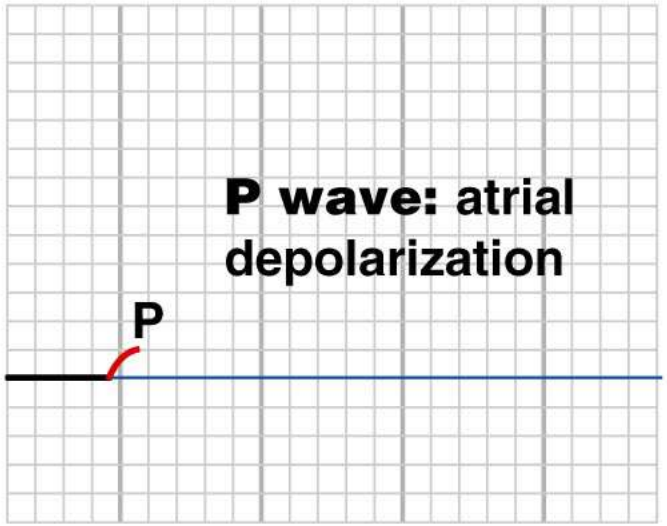
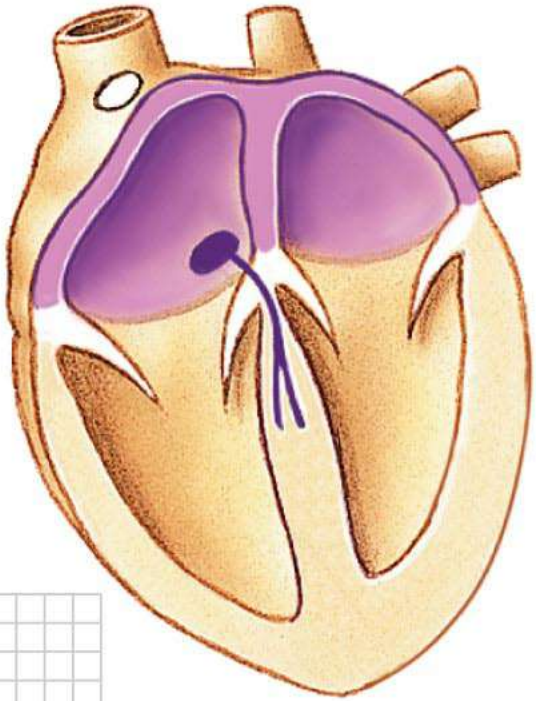
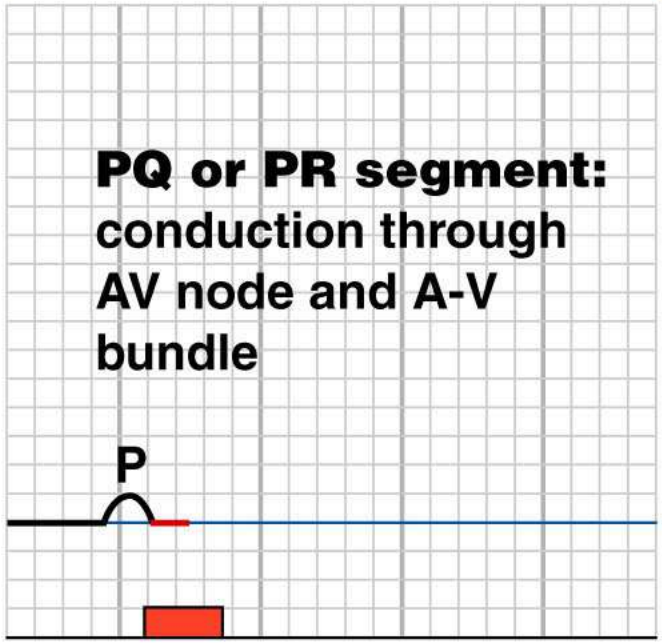


Figure 14-21 (2 of 9)

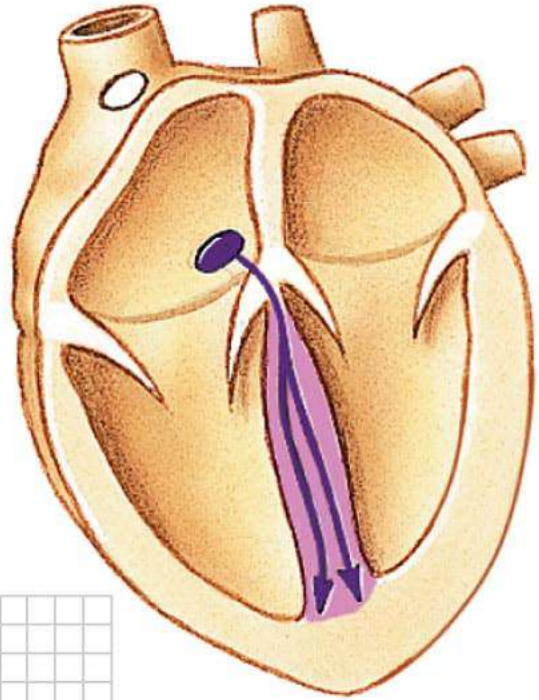
ELECTRICAL EVENTS OF THE CARDIAC CYCLE





Atria contract.

ELECTRICAL EVENTS OF THE CARDIAC CYCLE



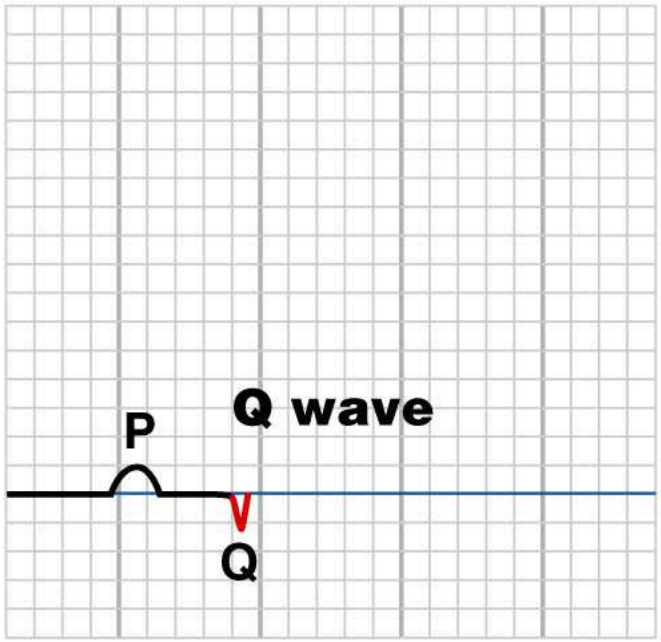
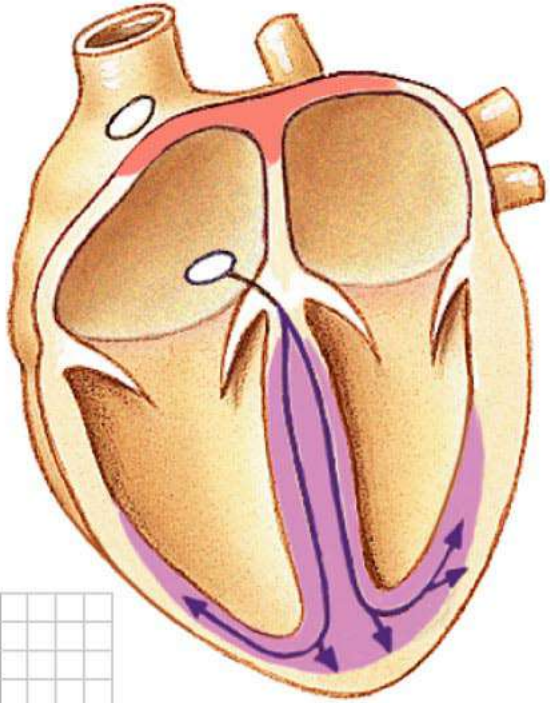


Figure 14-21 (4 of 9)

ELECTRICAL EVENTS OF THE CARDIAC CYCLE



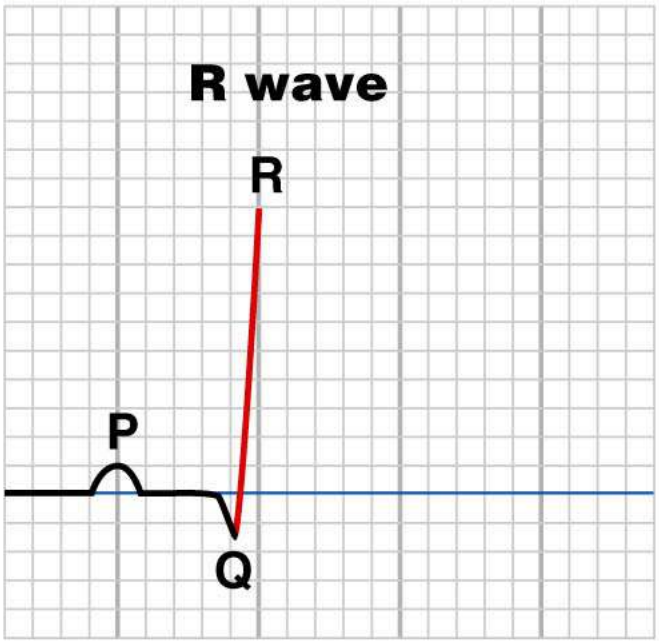
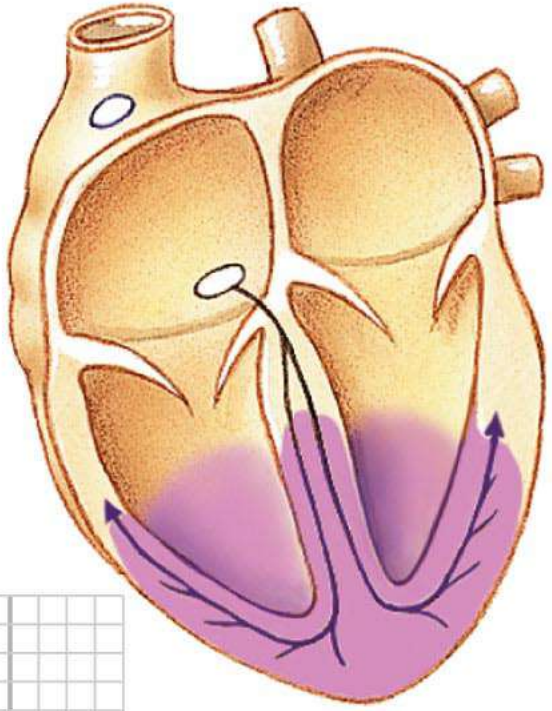


Figure 14-21 (5 of 9)

ELECTRICAL EVENTS OF THE CARDIAC CYCLE



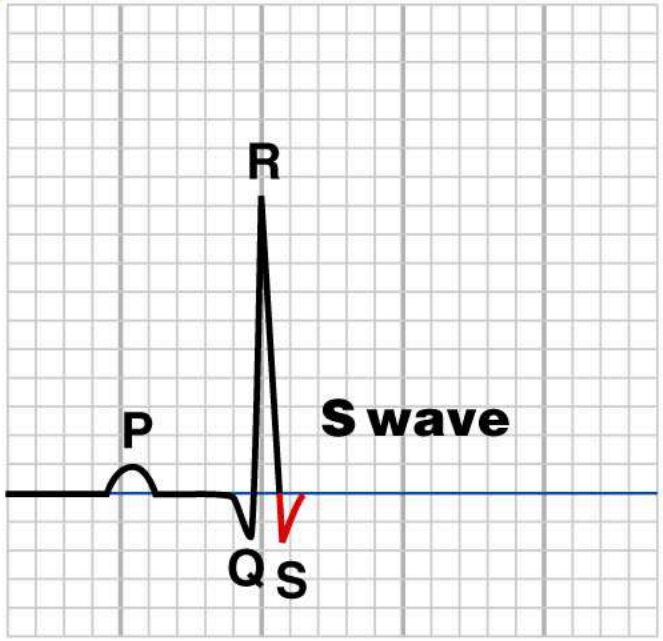
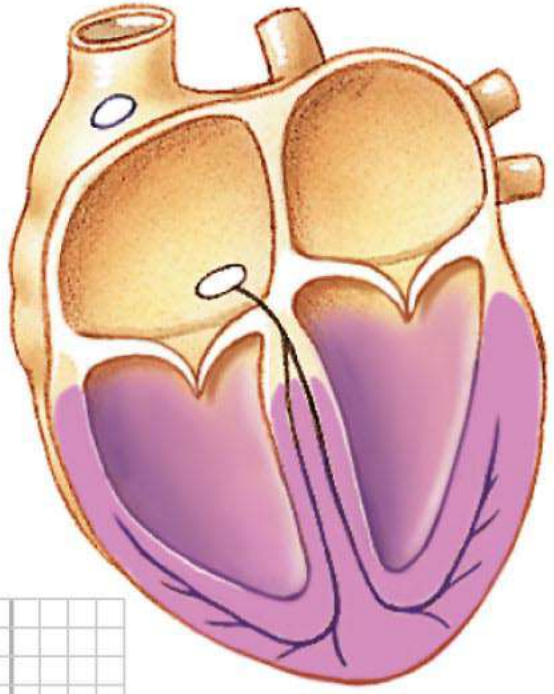
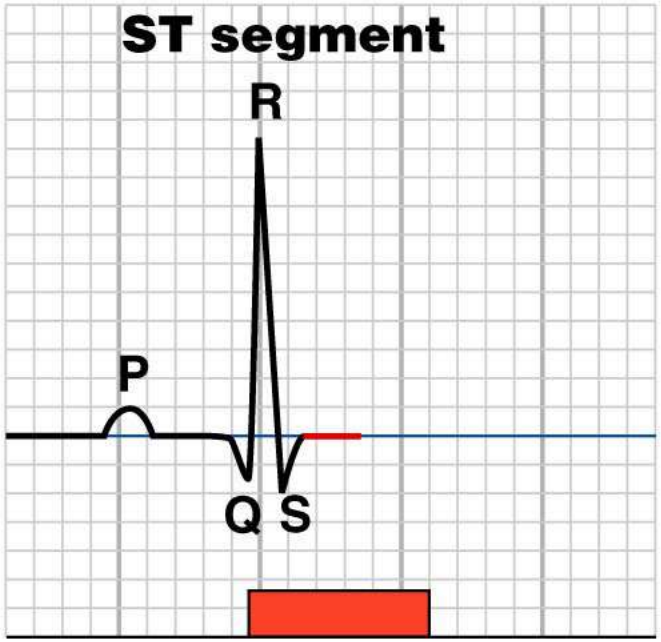


Figure 14-21 (6 of 9)

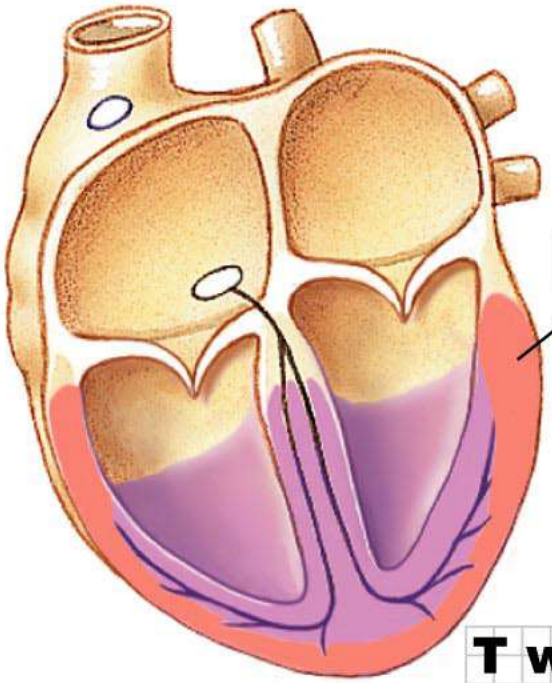
ELECTRICAL EVENTS OF THE CARDIAC CYCLE



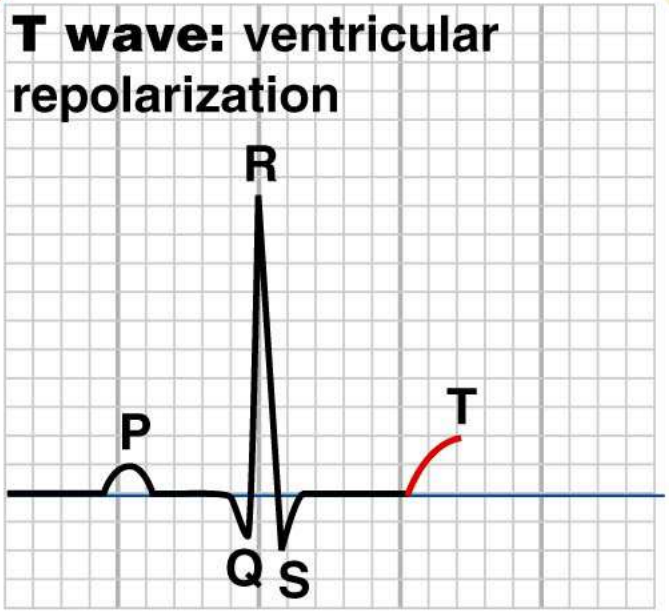


Ventricles contract.

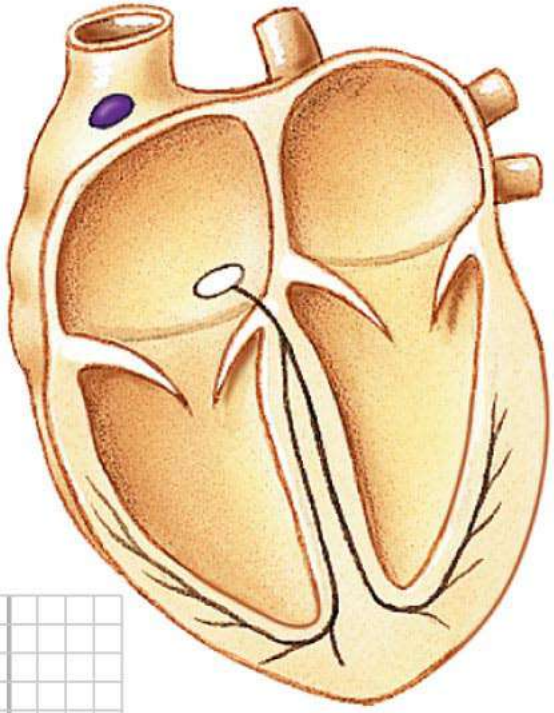
Figure 14-21 (7 of 9)



ELECTRICAL EVENTS OF THE CARDIAC CYCLE



ELECTRICAL EVENTS OF THE CARDIAC CYCLE



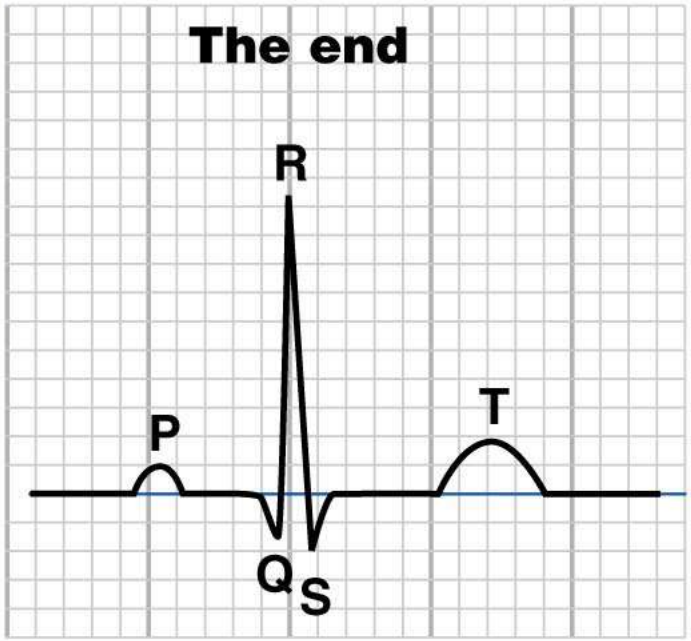
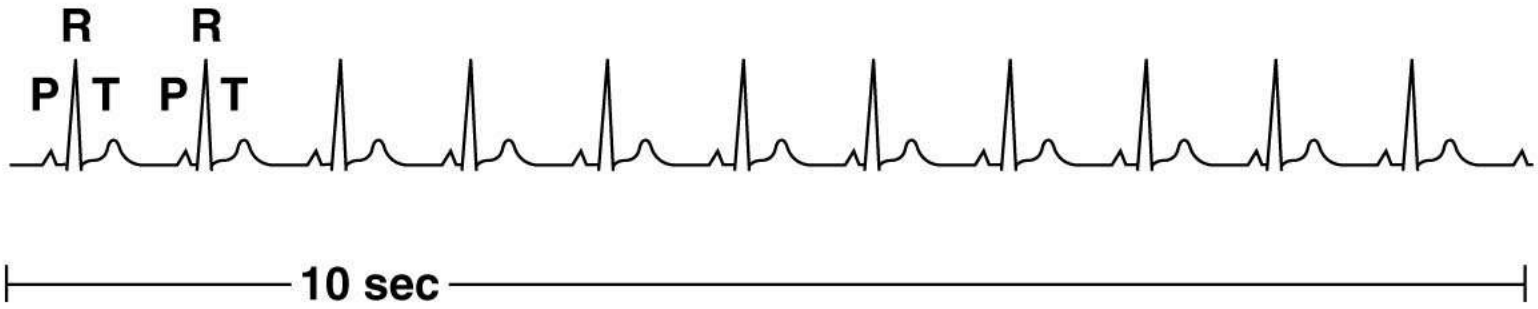


Figure 14-21 (9 of 9)

(a) Normal ECG



Questions to ask when analyzing ECG tracings:

1. What is the rate? Is it within the normal range of 60-100 beats per minute?

2. Is the rhythm regular?

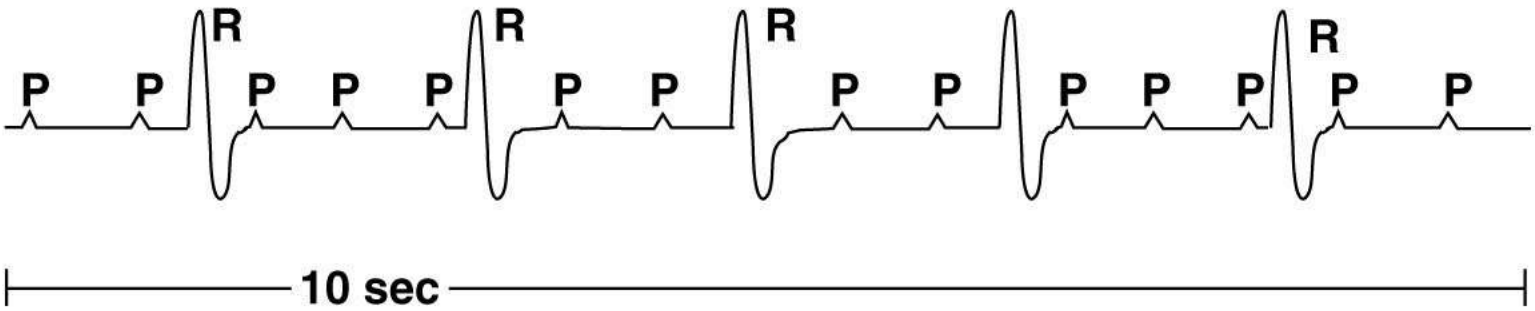
3. Are all normal waves present in recognizable form?

4. Is there one QRS complex for each P wave?
   If yes, is the P-R segment constant in length?

5. If there is not one QRS complex for each P wave, count the heart rate using the P waves, then count it according to the R waves. Are the rates the same? Which wave would agree with the pulse felt at the wrist?

Figure 14-23a

(b) Third-degree block



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1. What is the rate? Is it within the normal range of 60-100 beats per minute?

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3. Are all normal waves present in recognizable form?

4. Is there one QRS complex for each P wave?
   If yes, is the P-R segment constant in length?

5. If there is not one QRS complex for each P wave, count the heart rate using the P waves, then count it according to the R waves. Are the rates the same? Which wave would agree with the pulse felt at the wrist?

Figure 14-23b

(c) Atrial fibrillation

Questions to ask when analyzing ECG tracings:

1. What is the rate? Is it within the normal range of 60-100 beats per minute?

2. Is the rhythm regular?

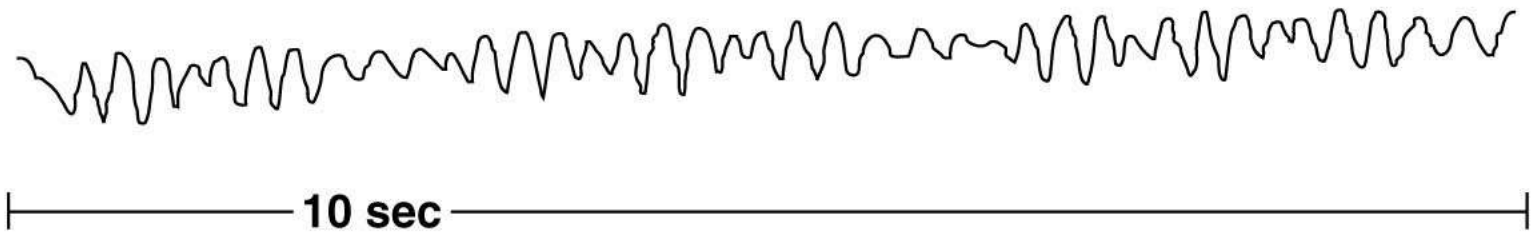
3. Are all normal waves present in recognizable form?

4. Is there one QRS complex for each P wave?
   If yes, is the P-R segment constant in length?

5. If there is not one QRS complex for each P wave, count the heart rate using the P waves, then count it according to the R waves. Are the rates the same? Which wave would agree with the pulse felt at the wrist?

Figure 14-23c

(d) Ventricular fibrillation



Questions to ask when analyzing ECG tracings:

1. What is the rate? Is it within the normal range of 60-100 beats per minute?

2. Is the rhythm regular?

3. Are all normal waves present in recognizable form?

4. Is there one QRS complex for each P wave?
   If yes, is the P-R segment constant in length?

5. If there is not one QRS complex for each P wave, count the heart rate using the P waves, then count it according to the R waves. Are the rates the same? Which wave would agree with the pulse felt at the wrist?

Figure 14-23d

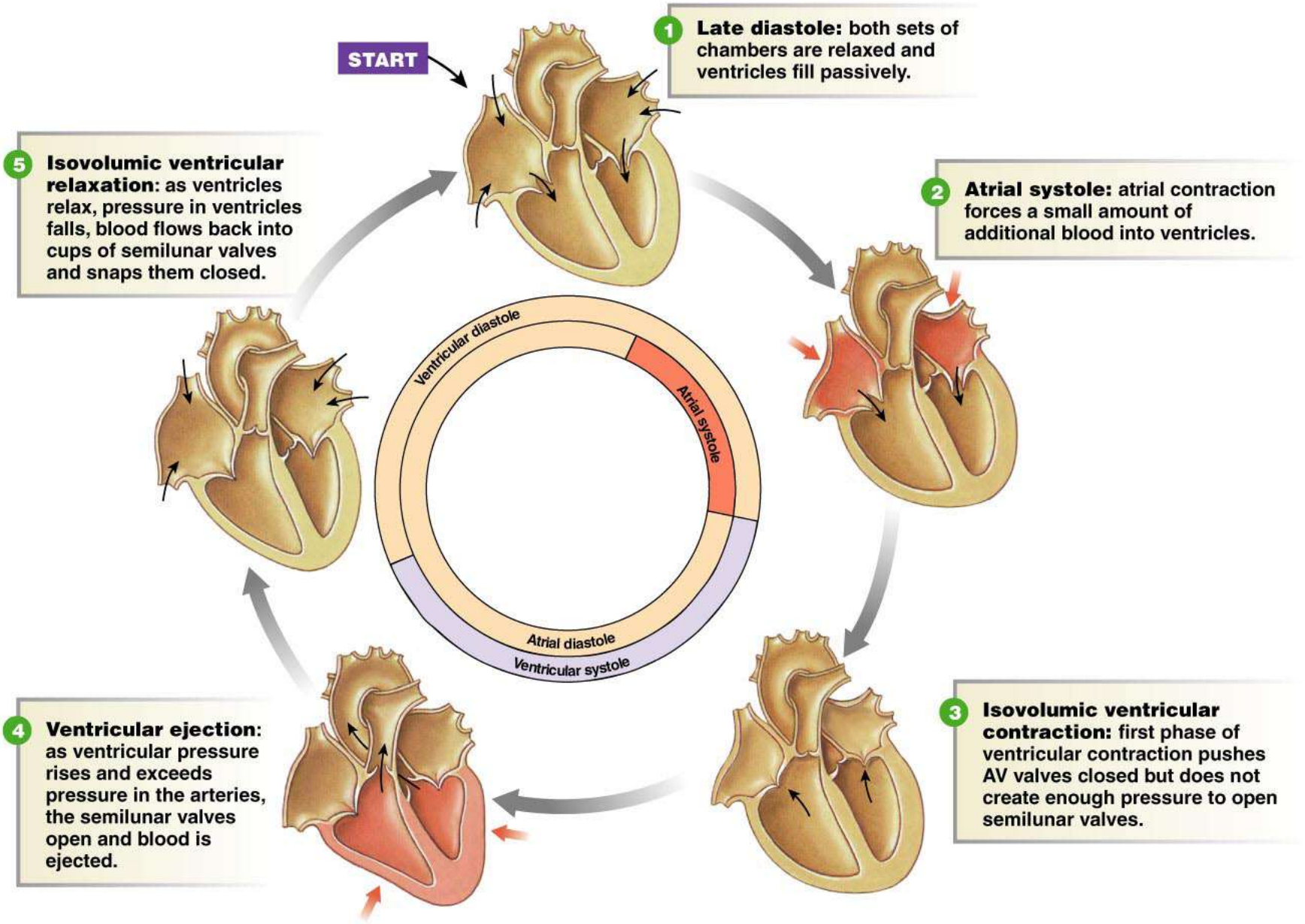


Figure 14-24 - Overview

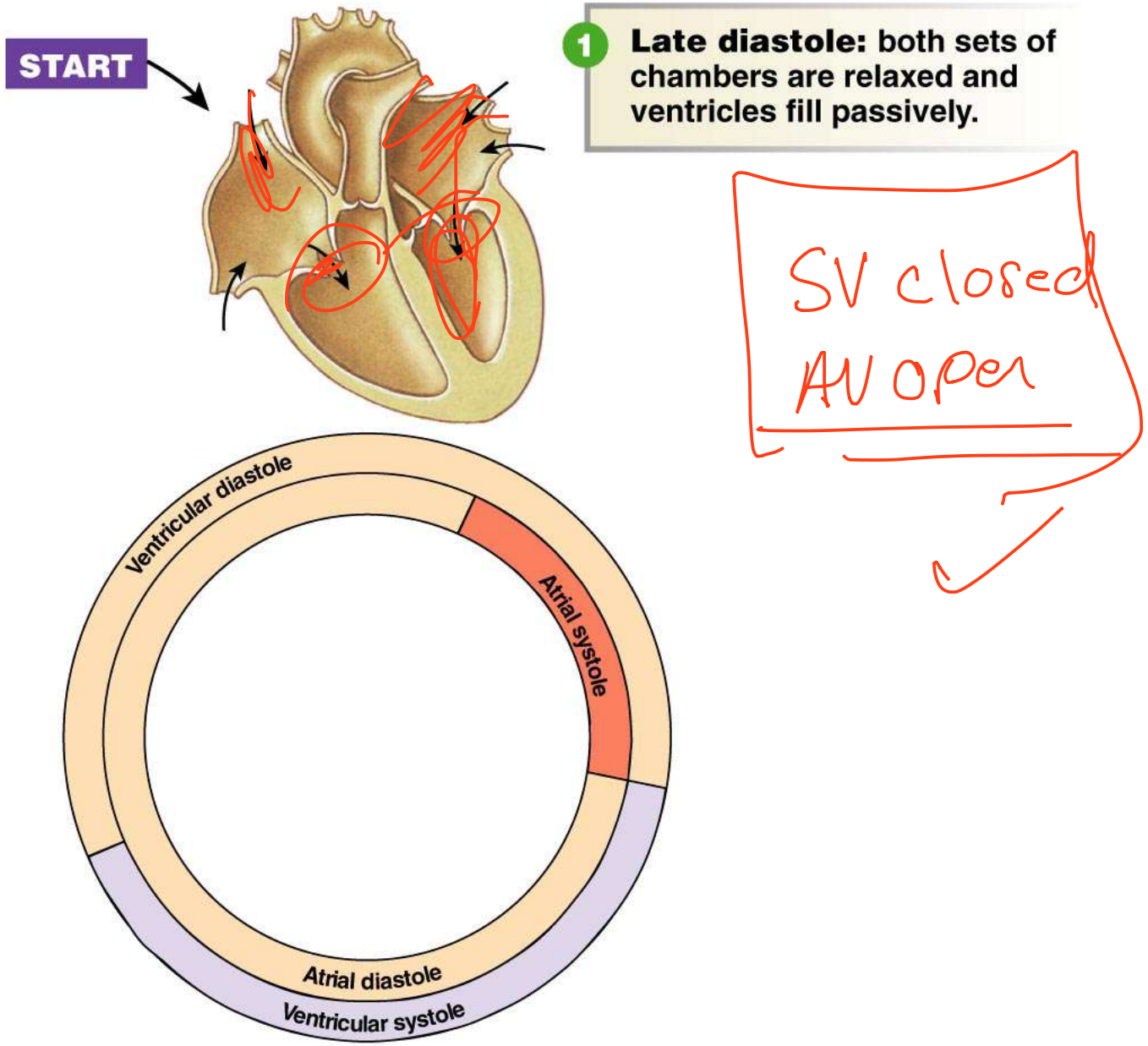


Figure 14-24, step 1

SV closed
AV open

SV

2 **Atrial systole:** atrial contraction forces a small amount of additional blood into ventricles.

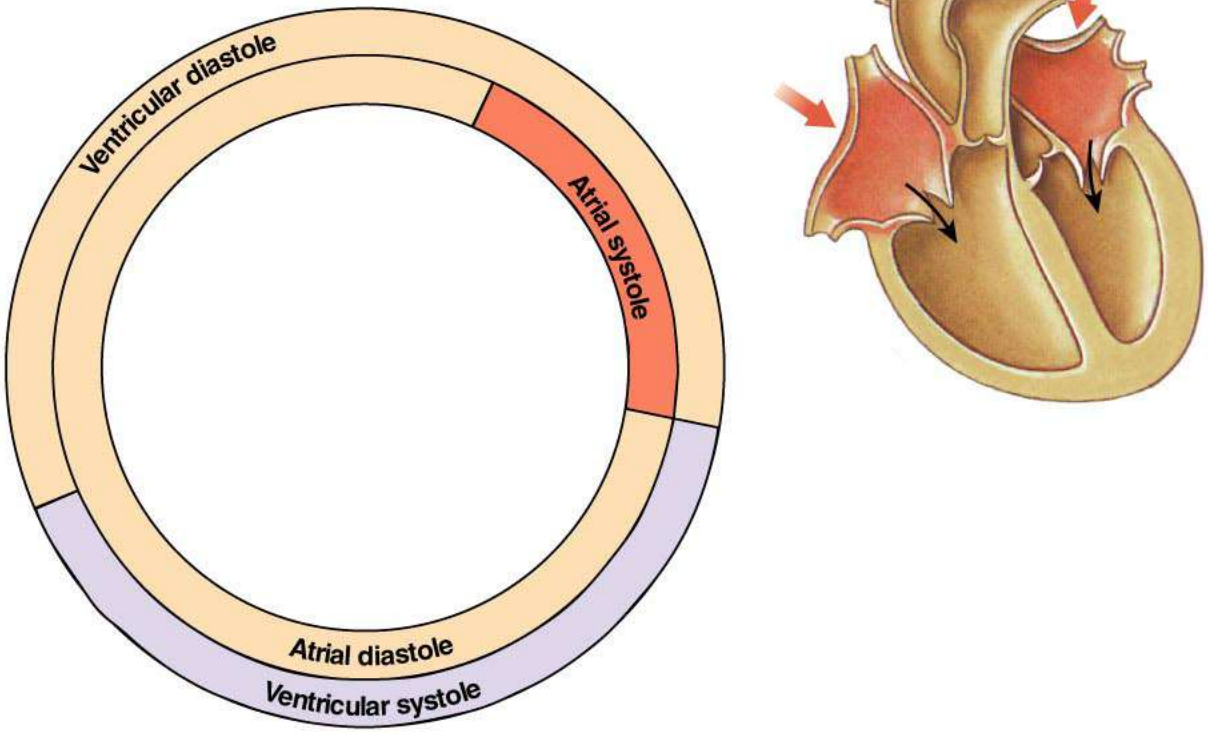
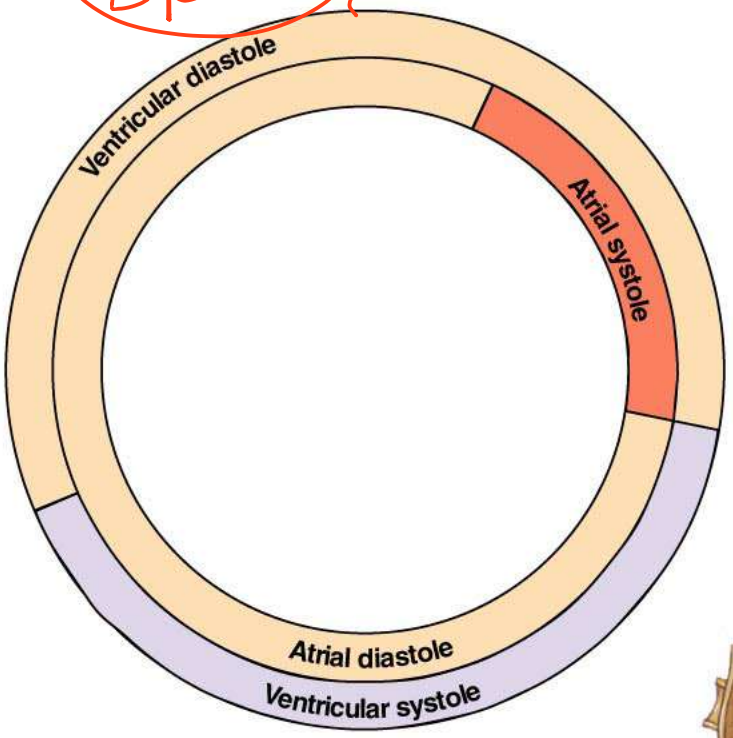
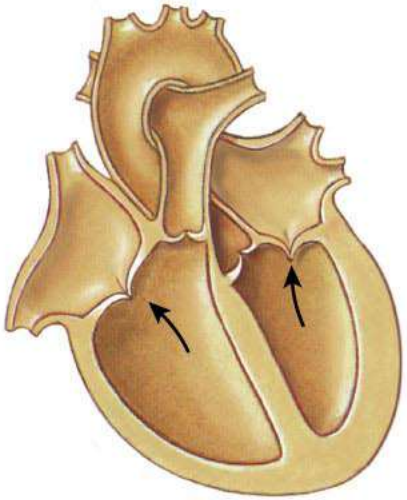


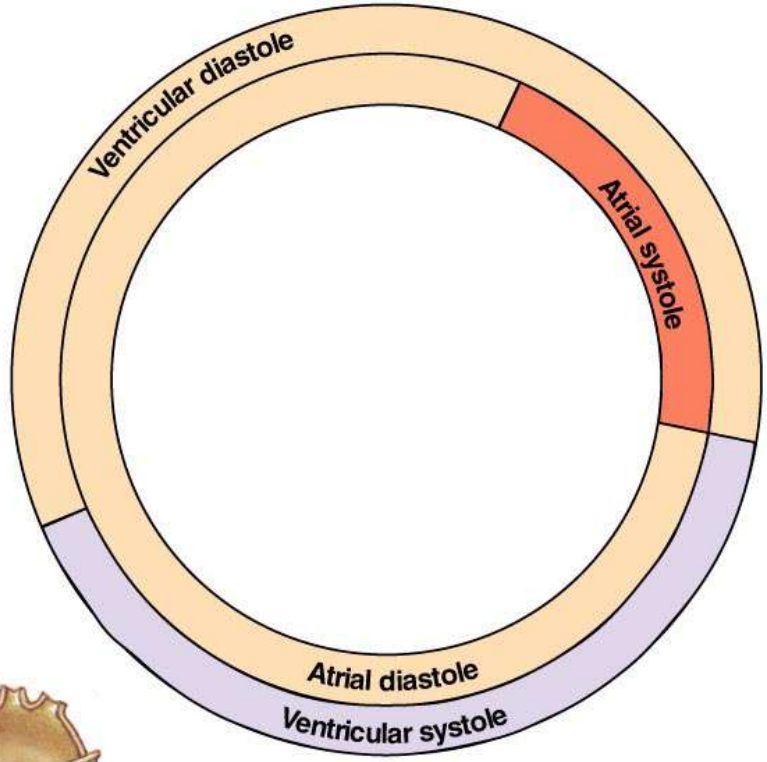
Figure 14-24, step 2





3 **Isovolumic ventricular contraction:** first phase of ventricular contraction pushes AV valves closed but does not create enough pressure to open semilunar valves.

Figure 14-24, step 3



4 **Ventricular ejection:** as ventricular pressure rises and exceeds pressure in the arteries, the semilunar valves open and blood is ejected.

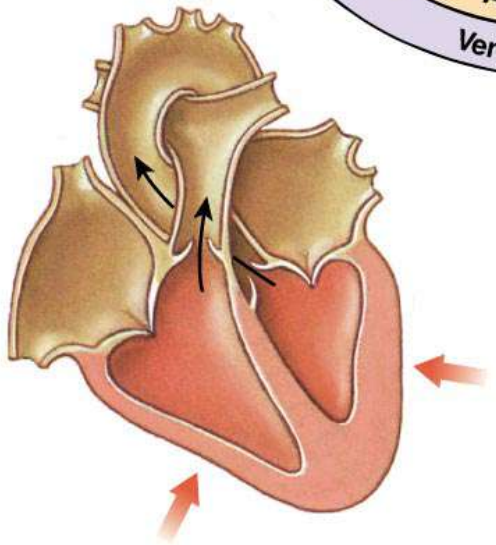


Figure 14-24, step 4

5 **Isovolumic ventricular relaxation:** as ventricles relax, pressure in ventricles falls, blood flows back into cups of semilunar valves and snaps them closed.

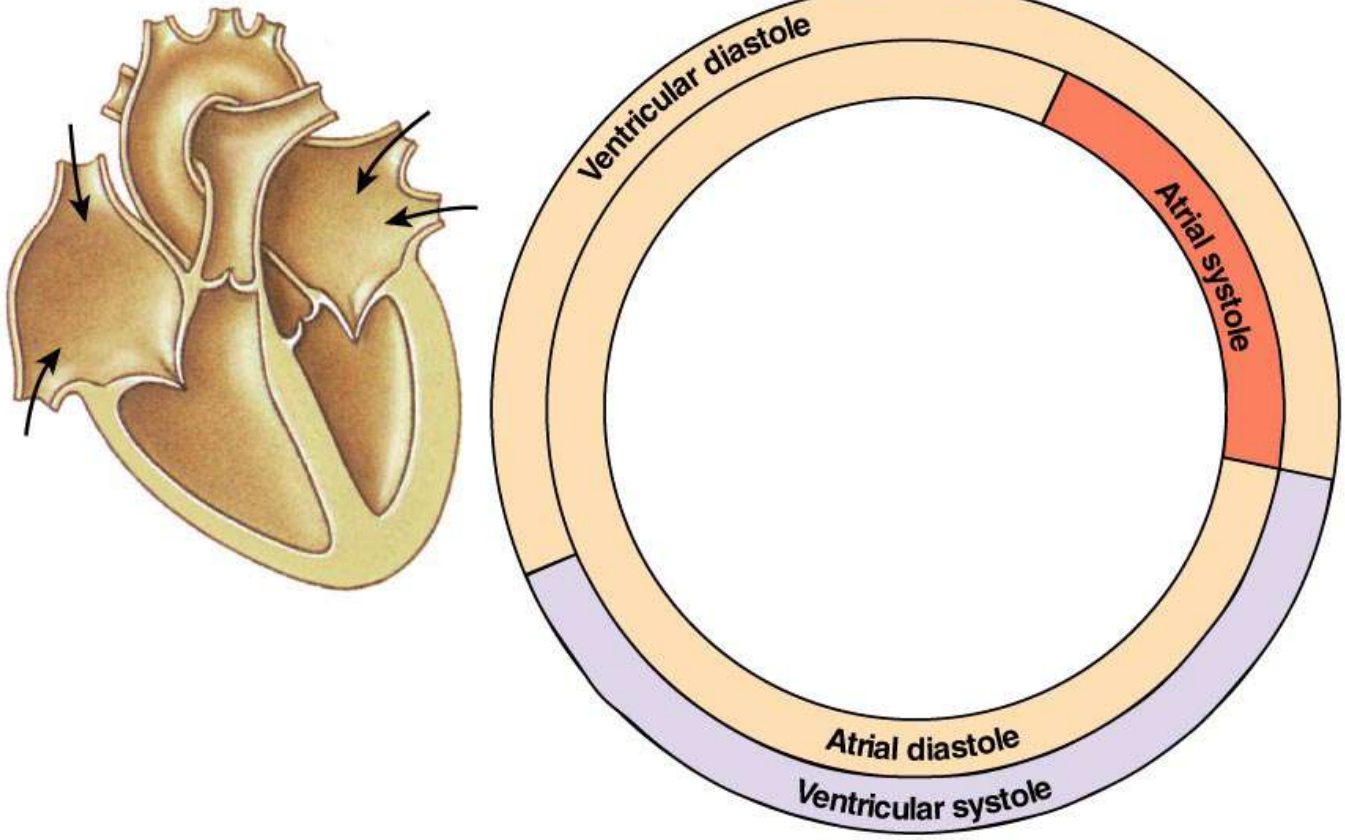


Figure 14-24, step 5

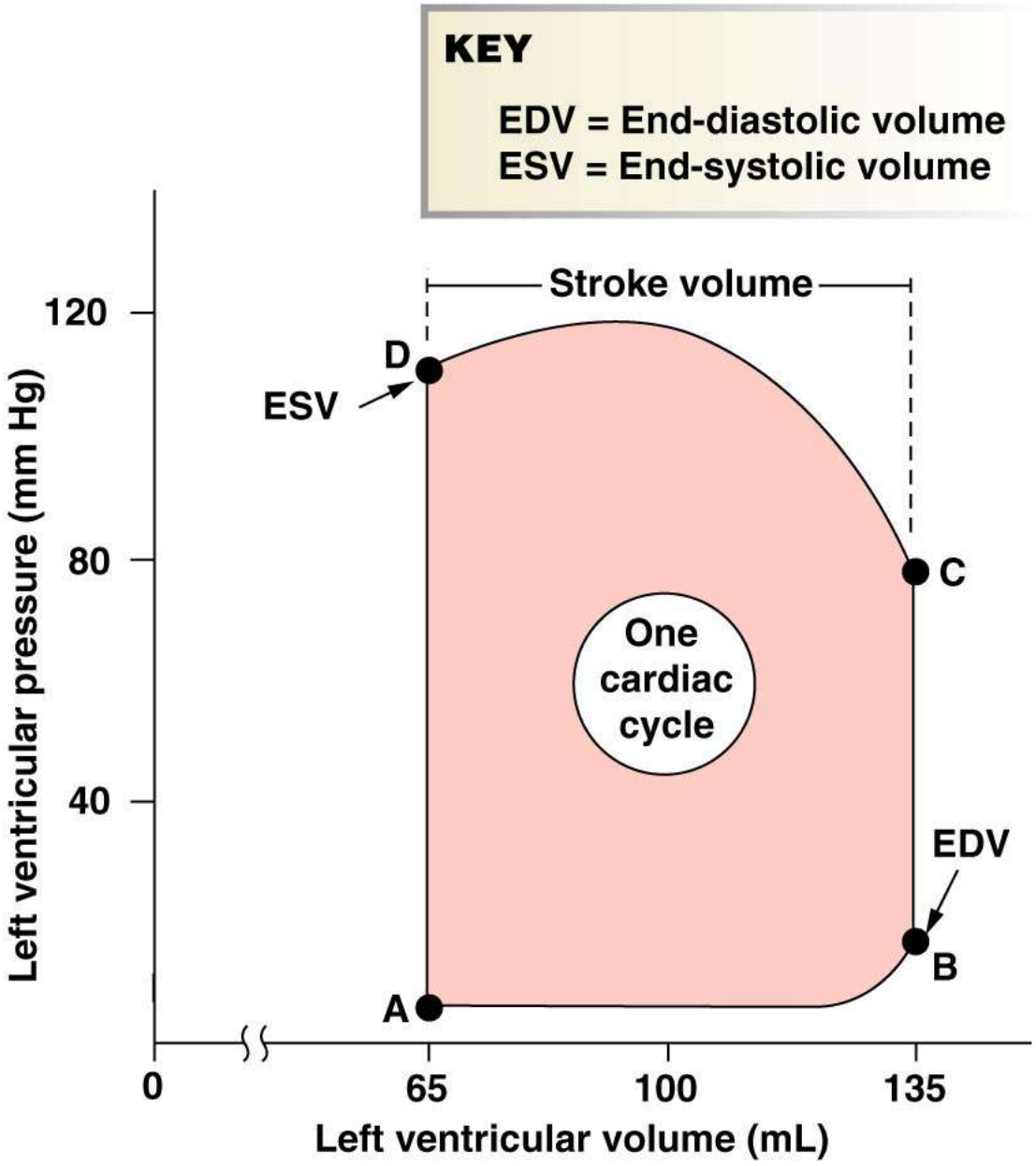


Figure 14-25

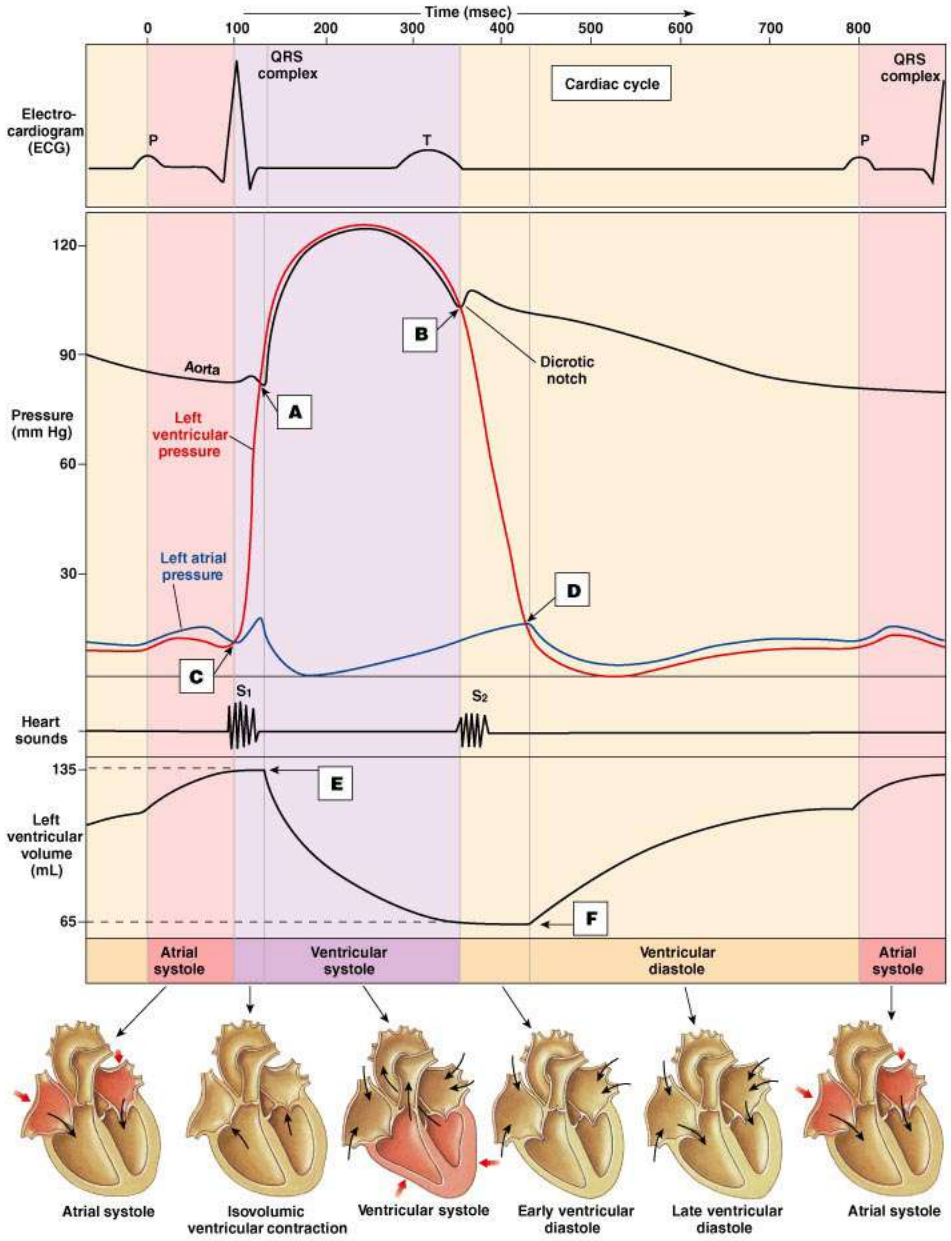


Figure 14-26 – Overview (1 of 5)

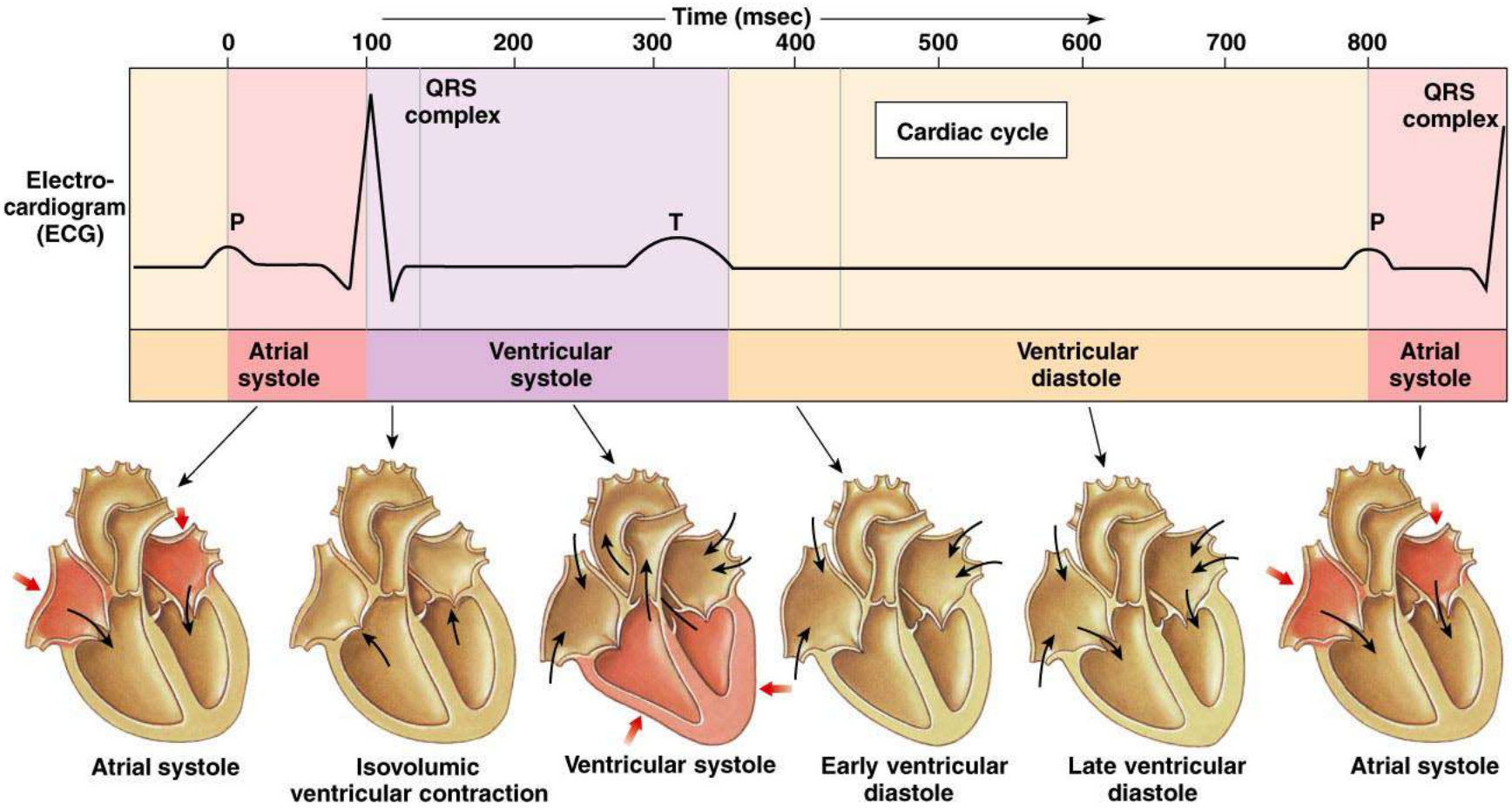


Figure 14-26 (2 of 5)

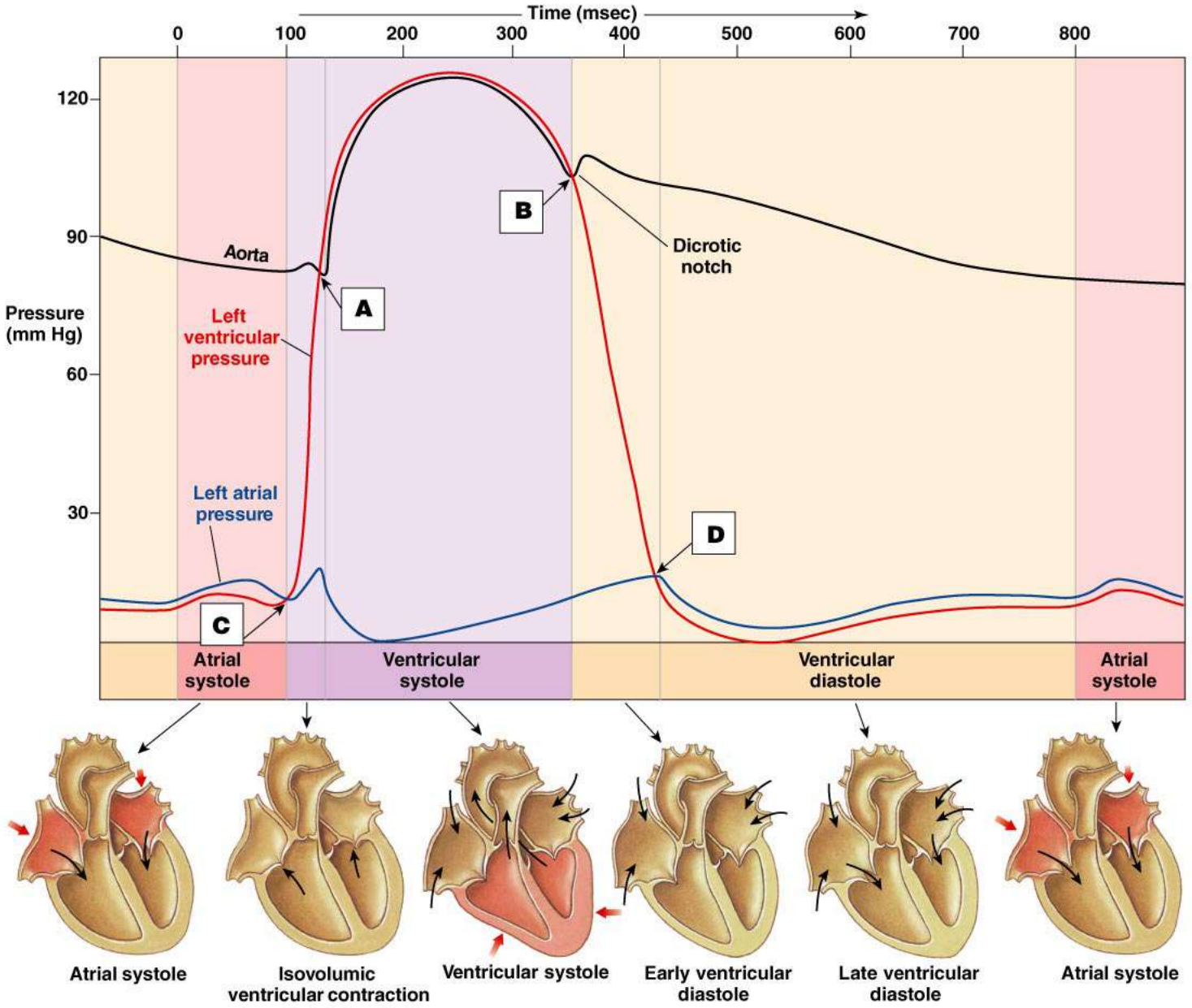


Figure 14-26 (3 of 5)

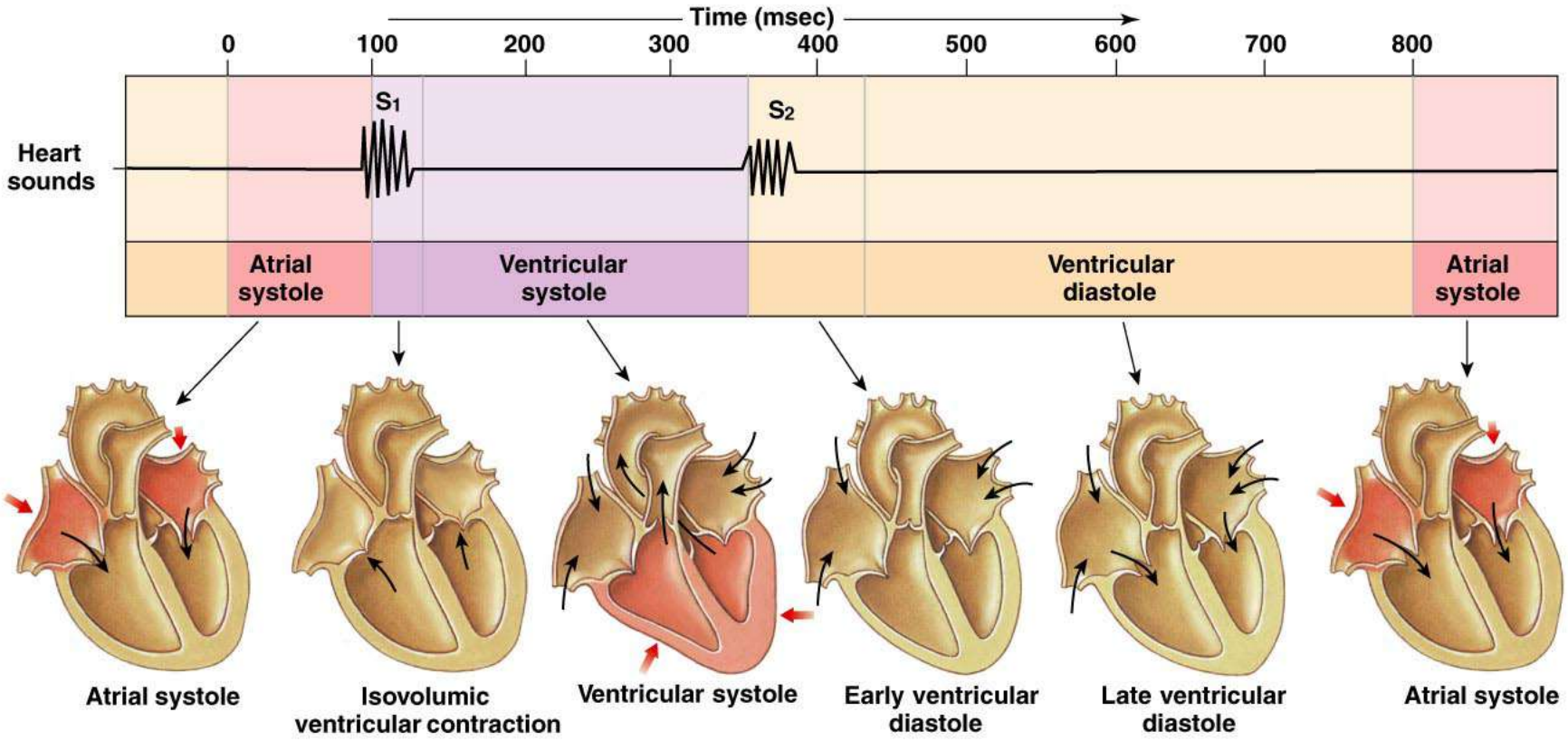


Figure 14-26 (4 of 5)

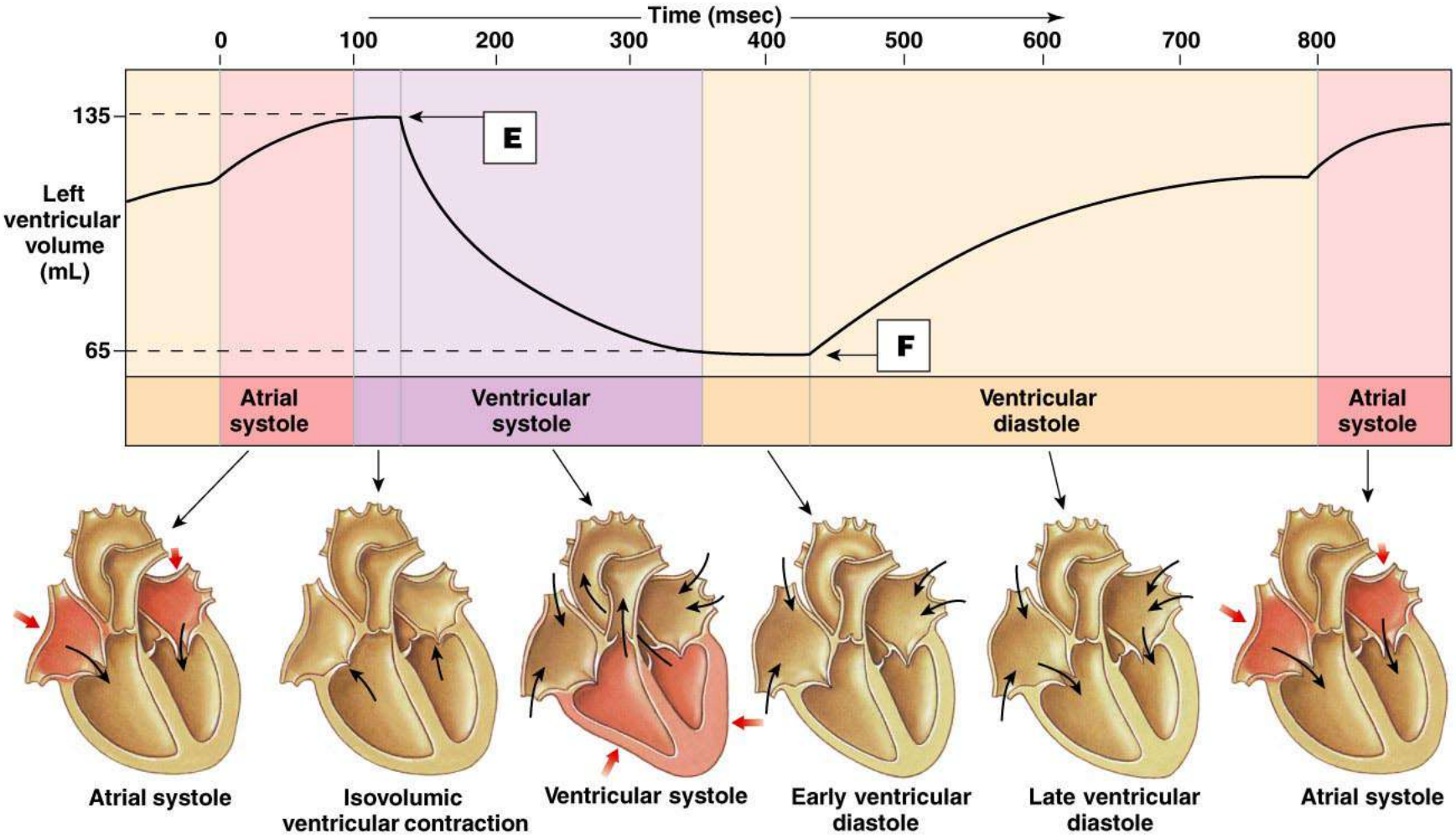


Figure 14-26 (5 of 5)

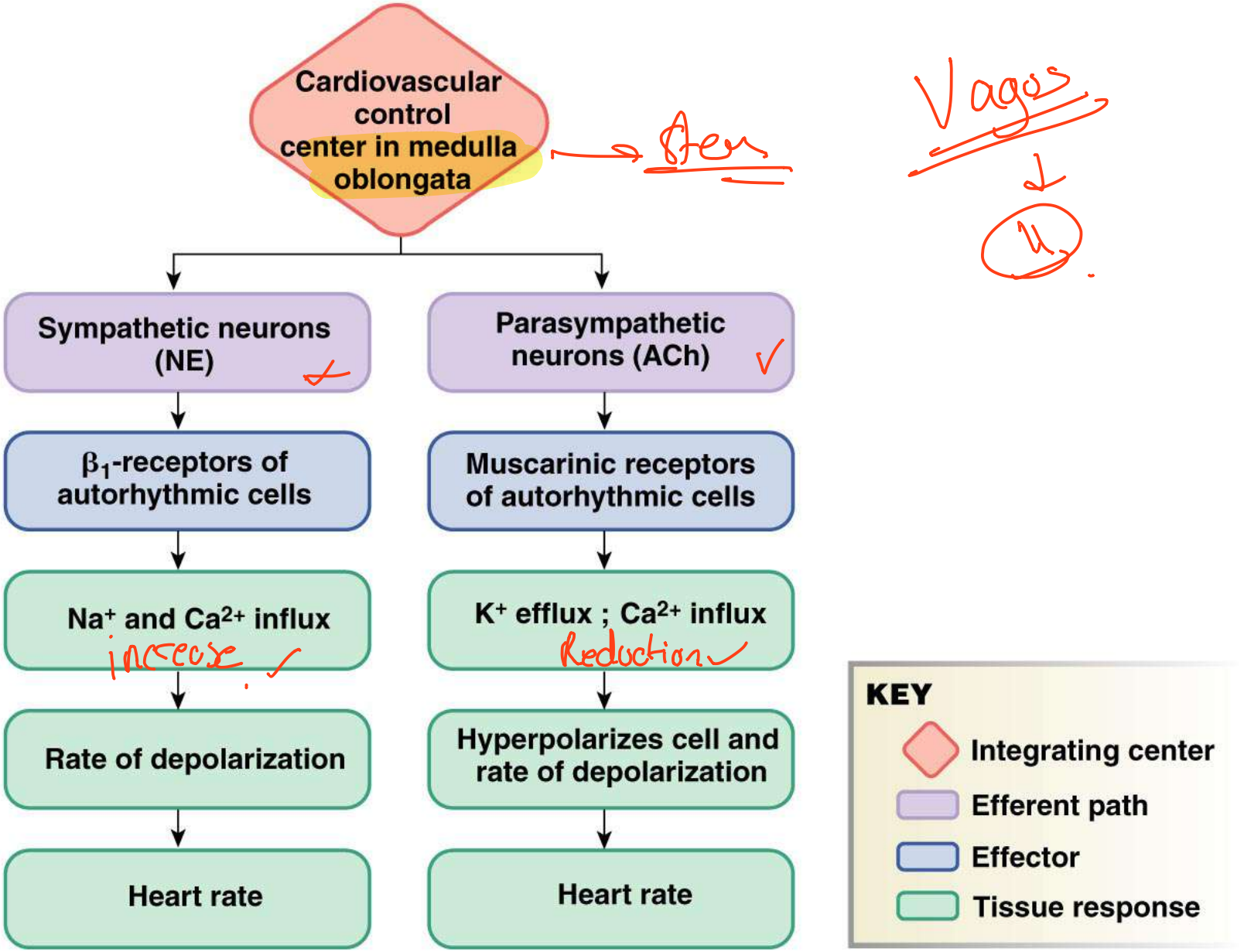


Figure 14-27

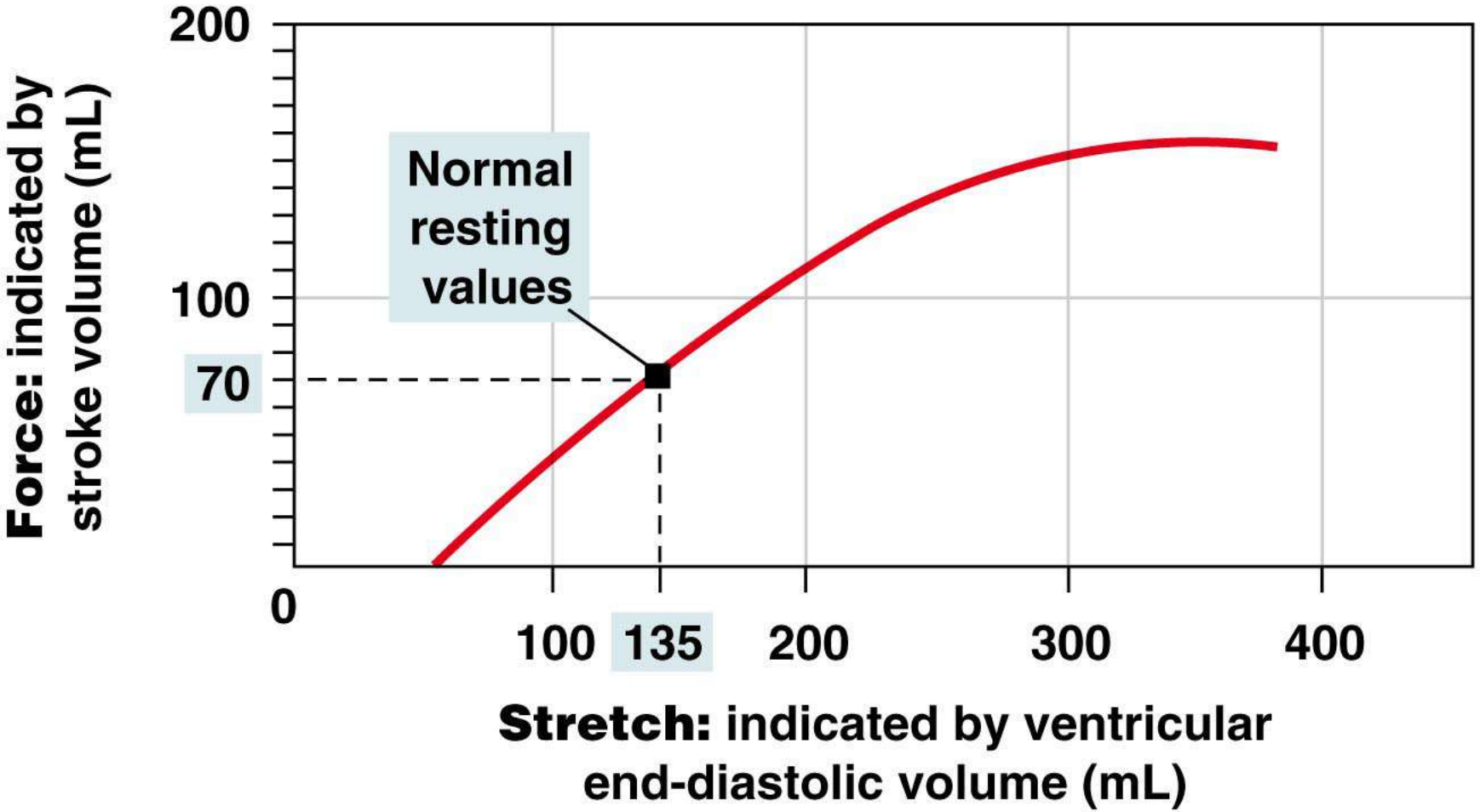


Figure 14-28

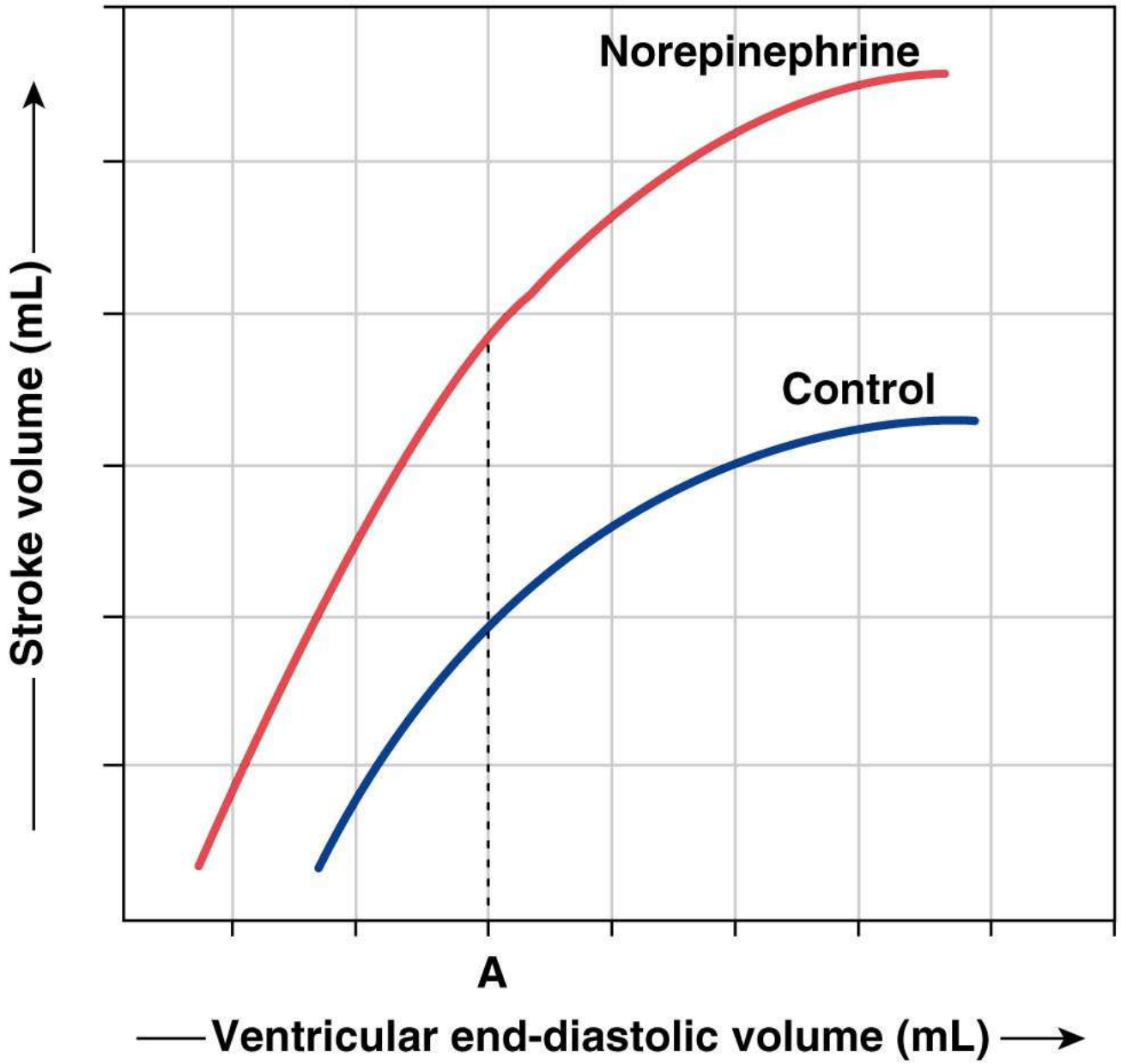


Figure 14-29

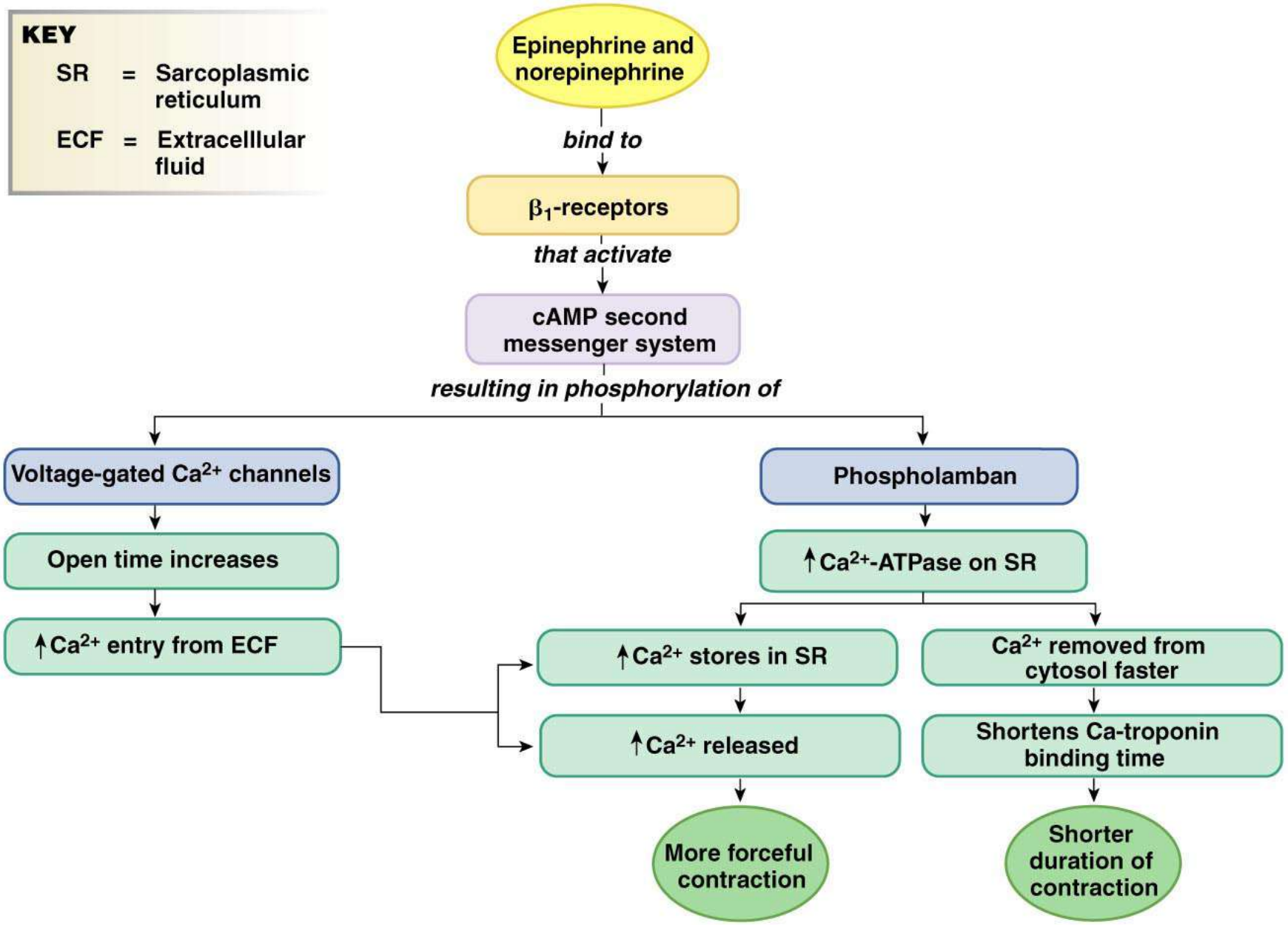


Figure 14-30

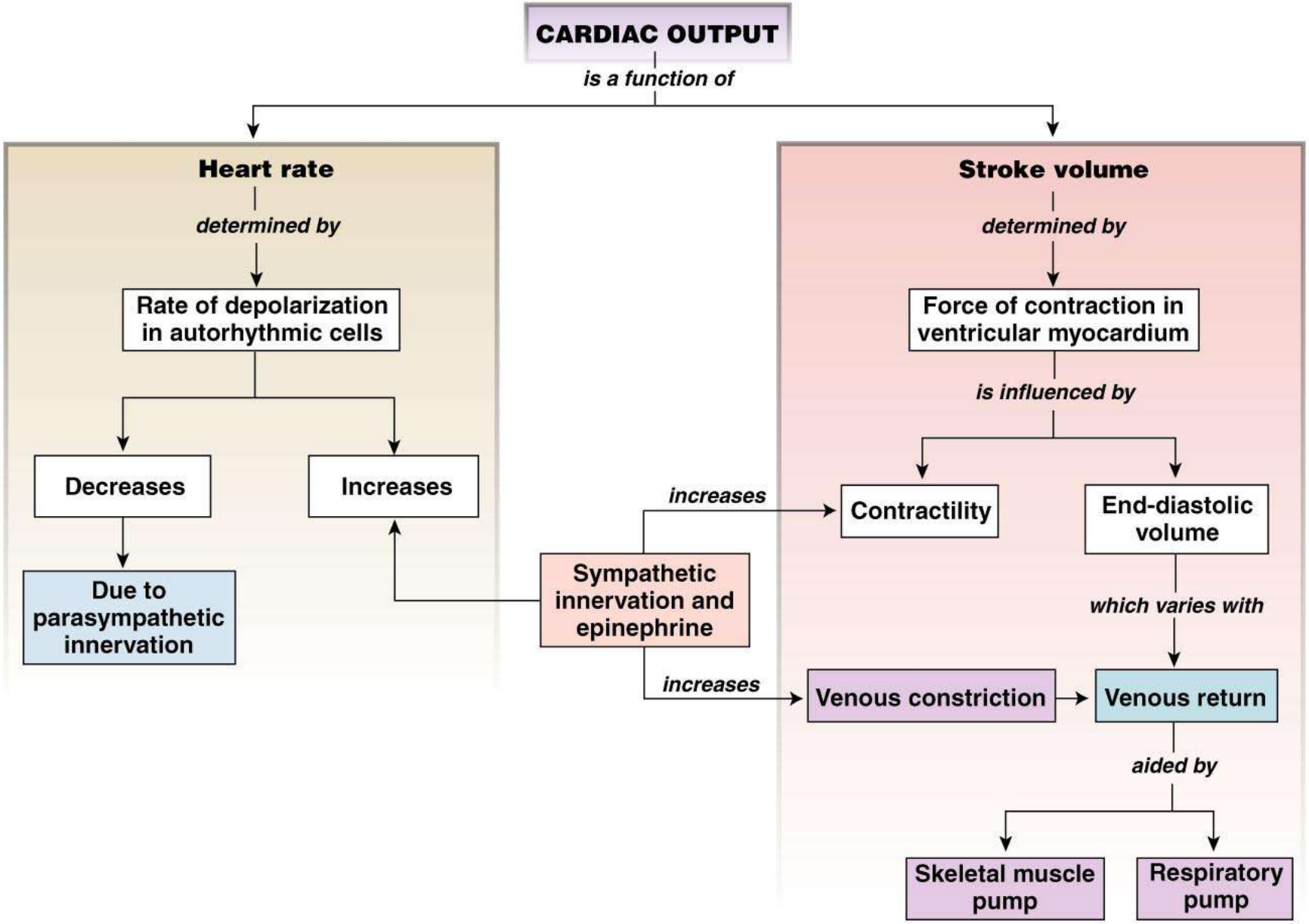


Figure 14-31