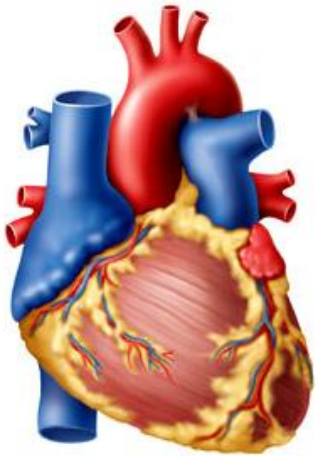
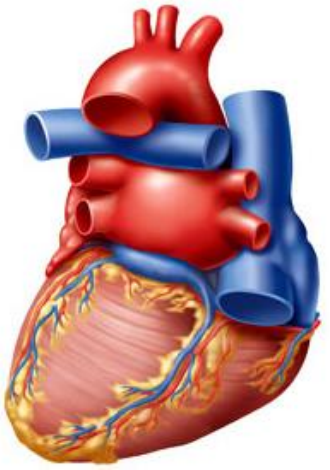




The Cardiovascular System
Part -2-

Ms. Mais Abdelhaq

Cardiac Muscle Contraction

- Heart muscle:
  - Contracts spontaneously and independently
    - Regular & continuous way
  - Contracts as a unit
  - Contracts & depolarizes without nervous system stimulation
    - Rhythm can be altered by ANS

Two Systems Regulate Heart Activity

1. **Autonomic nervous system**
    - Increase or decrease heart rate depending on the division activated
2. **Intrinsic conduction system (nodal system):**
    - Built into the heart tissue

Regulation of Heart Rate: Autonomic Nervous System

- Sympathetic nervous system (SNS) stimulation is activated by stress, anxiety, excitement, or exercise
- Parasympathetic nervous system (PNS) stimulation is mediated by acetylcholine and opposes the SNS

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

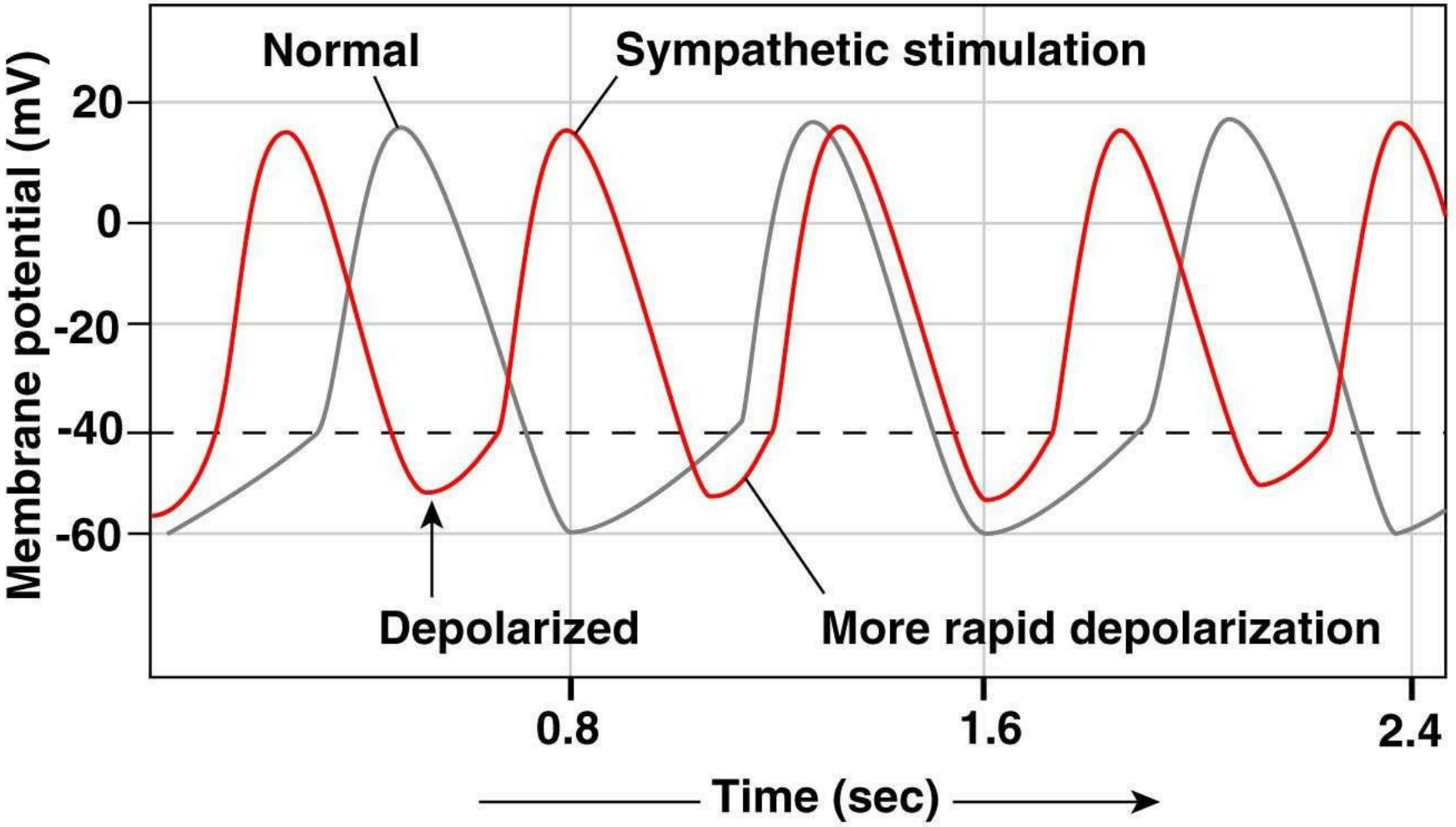


Figure 14-16a

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

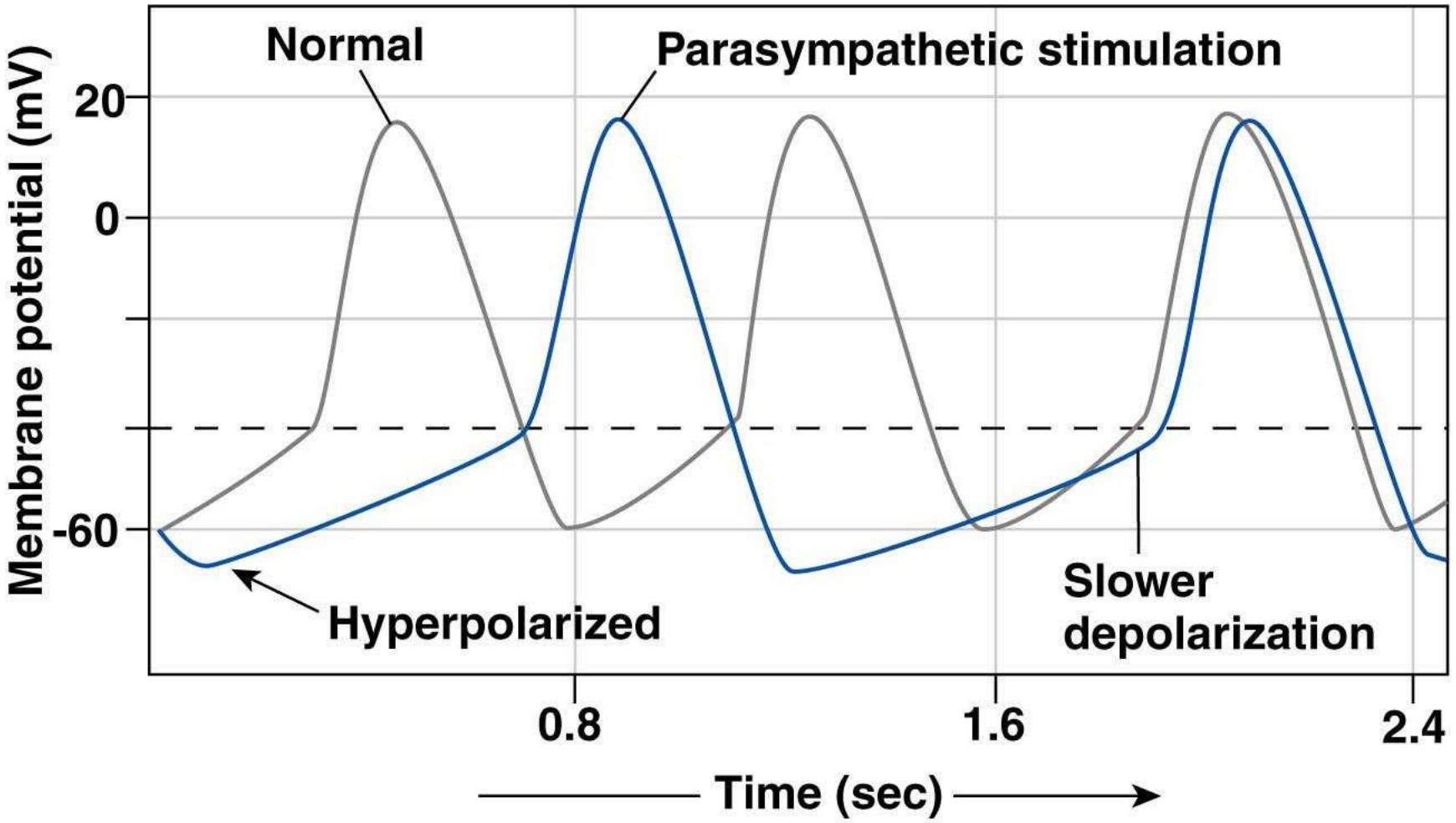


Figure 14-16b

Cardiac Intrinsic Conduction

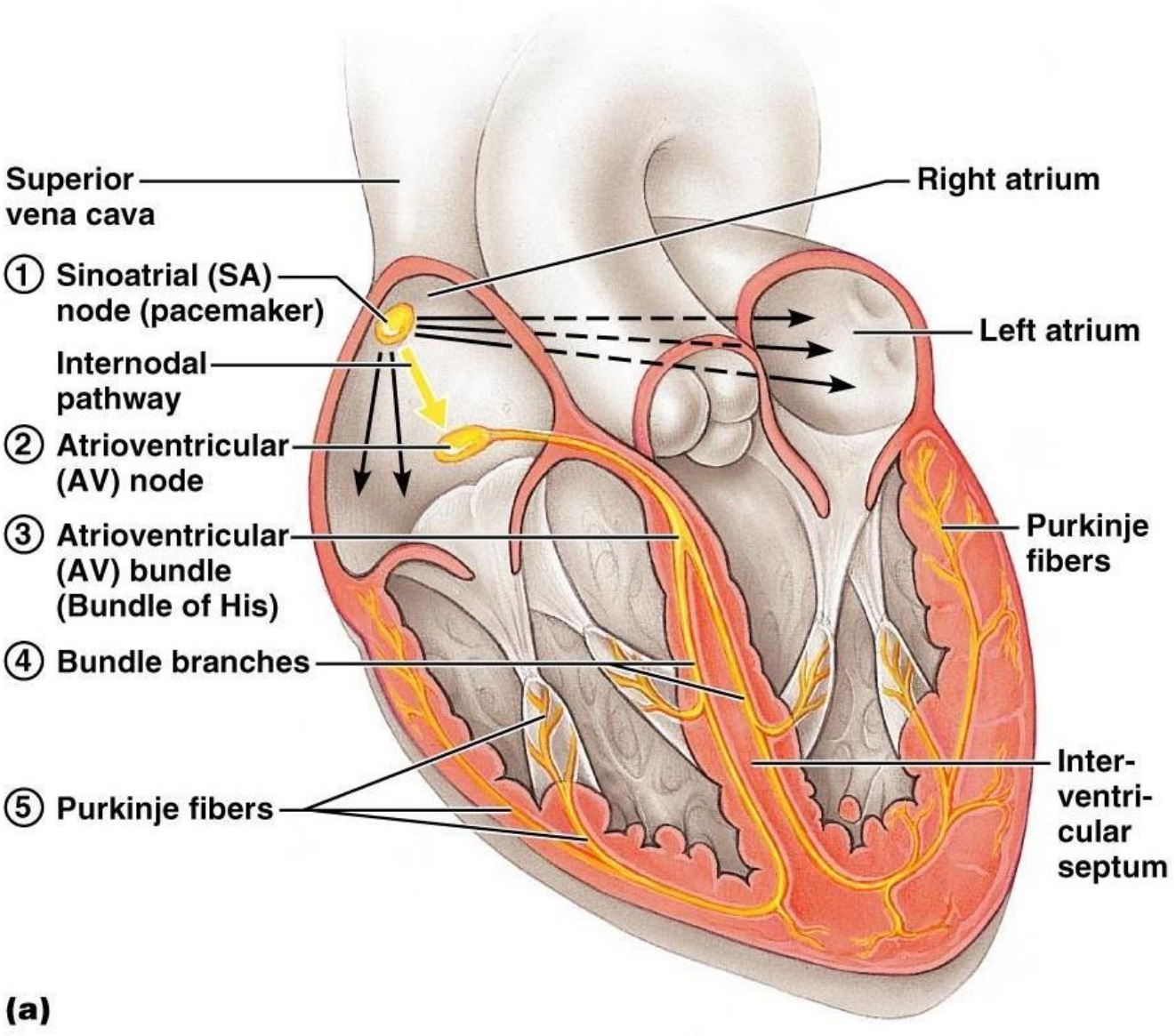


Figure 18.14a

Heart Physiology: Sequence of Excitation

- Sinoatrial (SA) node generates impulses about 75 times/minute
- Atrioventricular (AV) node delays the impulse approximately 0.1 second
- Impulse passes from atria to ventricles via the atrioventricular bundle (bundle of His)

Heart Physiology: Sequence of Excitation

- AV bundle splits into two pathways in the interventricular septum (bundle branches)
  - Bundle branches carry the impulse toward the apex of the heart
- Purkinje fibers carry the impulse to the heart apex and ventricular walls
- Purkinje fibers are specialized conducting cells that transmit electrical signals very rapidly.
- The electrical signal for contraction begins when SA node fires an AP and depolarization spreads to adjacent cells through gap junction

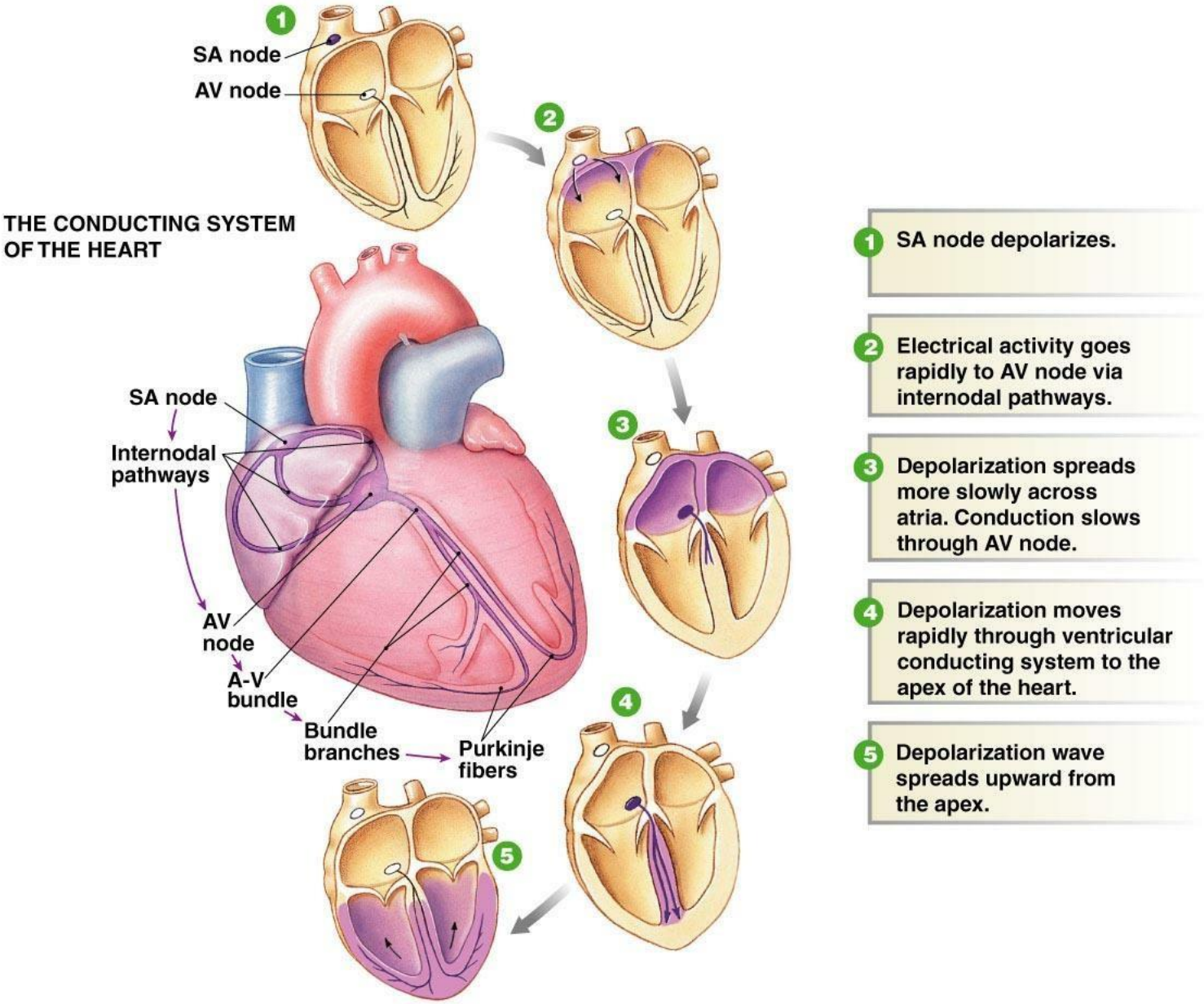
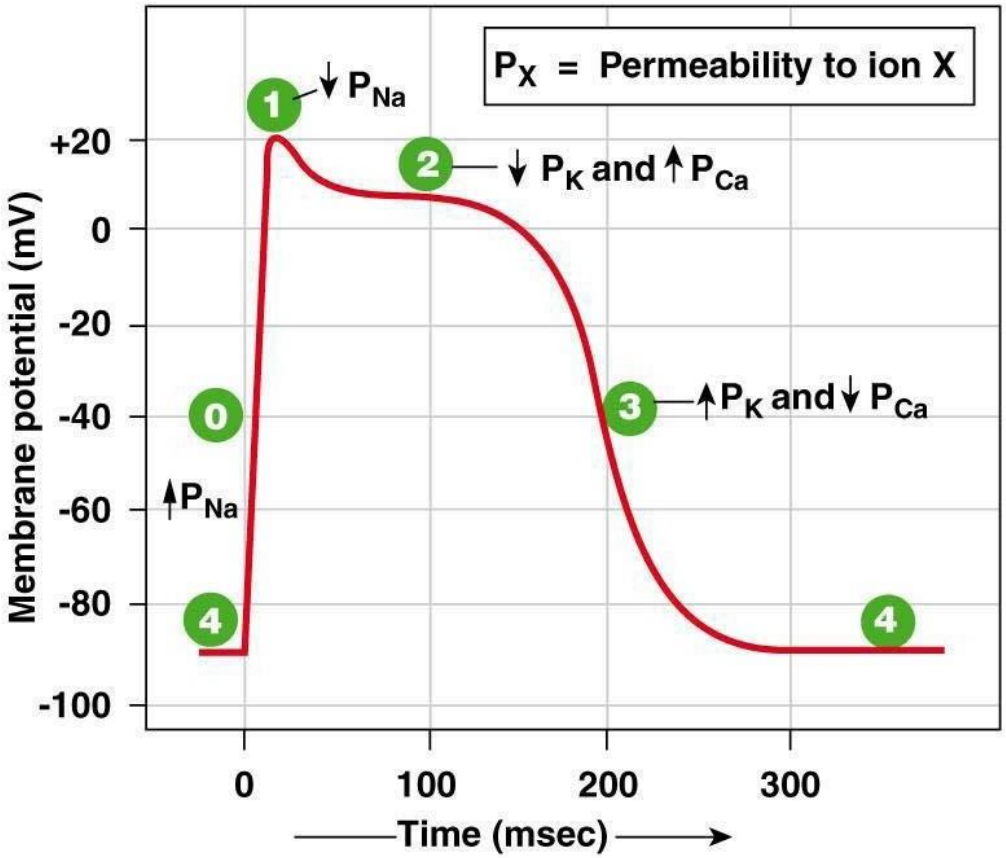


Figure 14-18

Myocardial Contractile Cells



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

Action Potential of a Myocardial contractile cell

Phase 4: Resting membrane potential -90mV

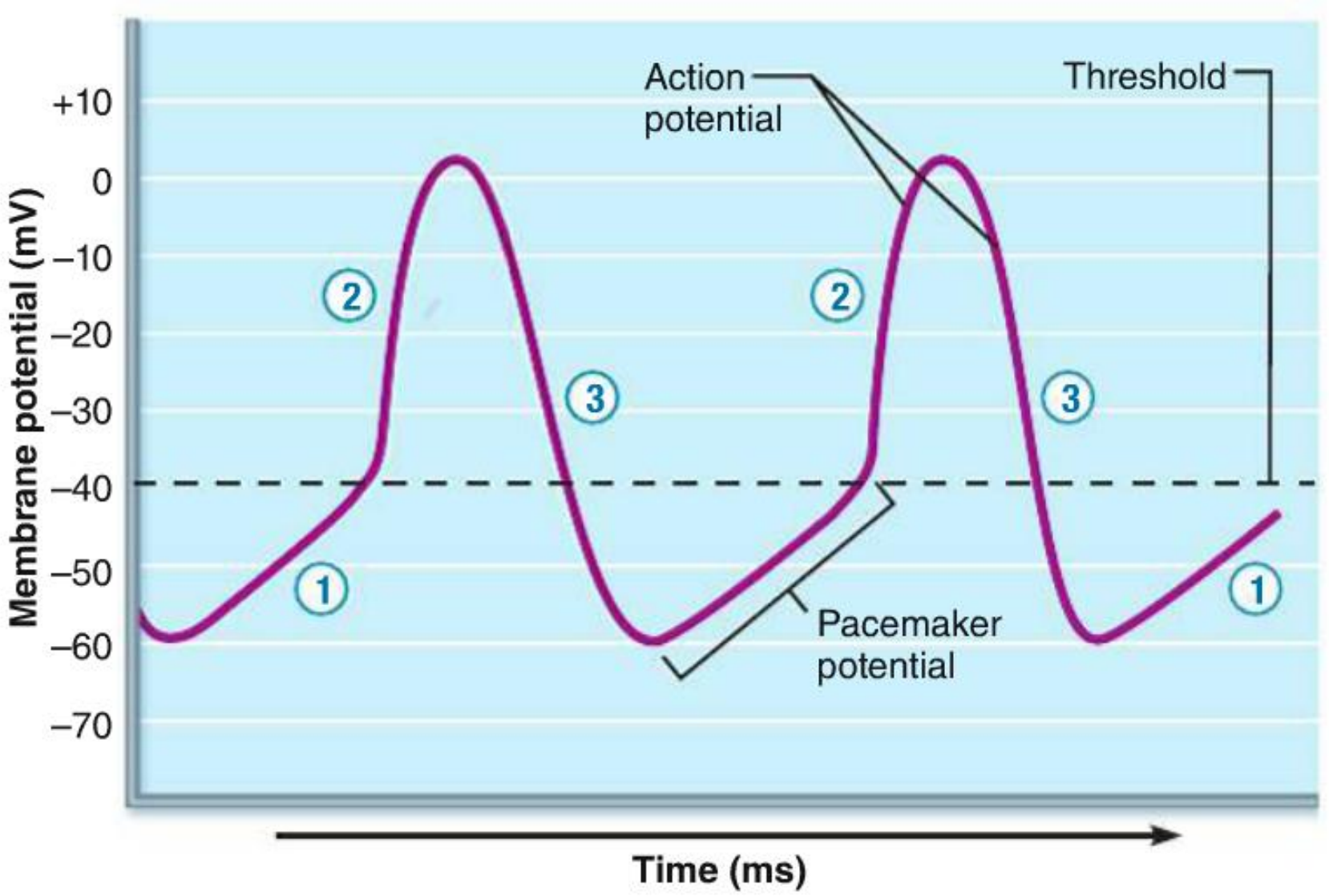
Phase 0: depolarization. A wave of depolarization move to the contractile cell through gap junctions, membrane potential become more positive. Voltage-gated Na+ channels open.

Phase1: initial repolarization. Na+ close, cell begin to repolarize as K+ leaves through open K+ channel.

Phase 2: the Plateau. Results from two events: decrease in K+ permeability and increase in Ca2+ permeability.

Phase 3: rapid repolarization. The plateau ends when Ca2+ channels close and K+ permeability increase once more

Pacemaker and Action Potentials of the Heart



Pacemaker and Action Potentials of the Heart

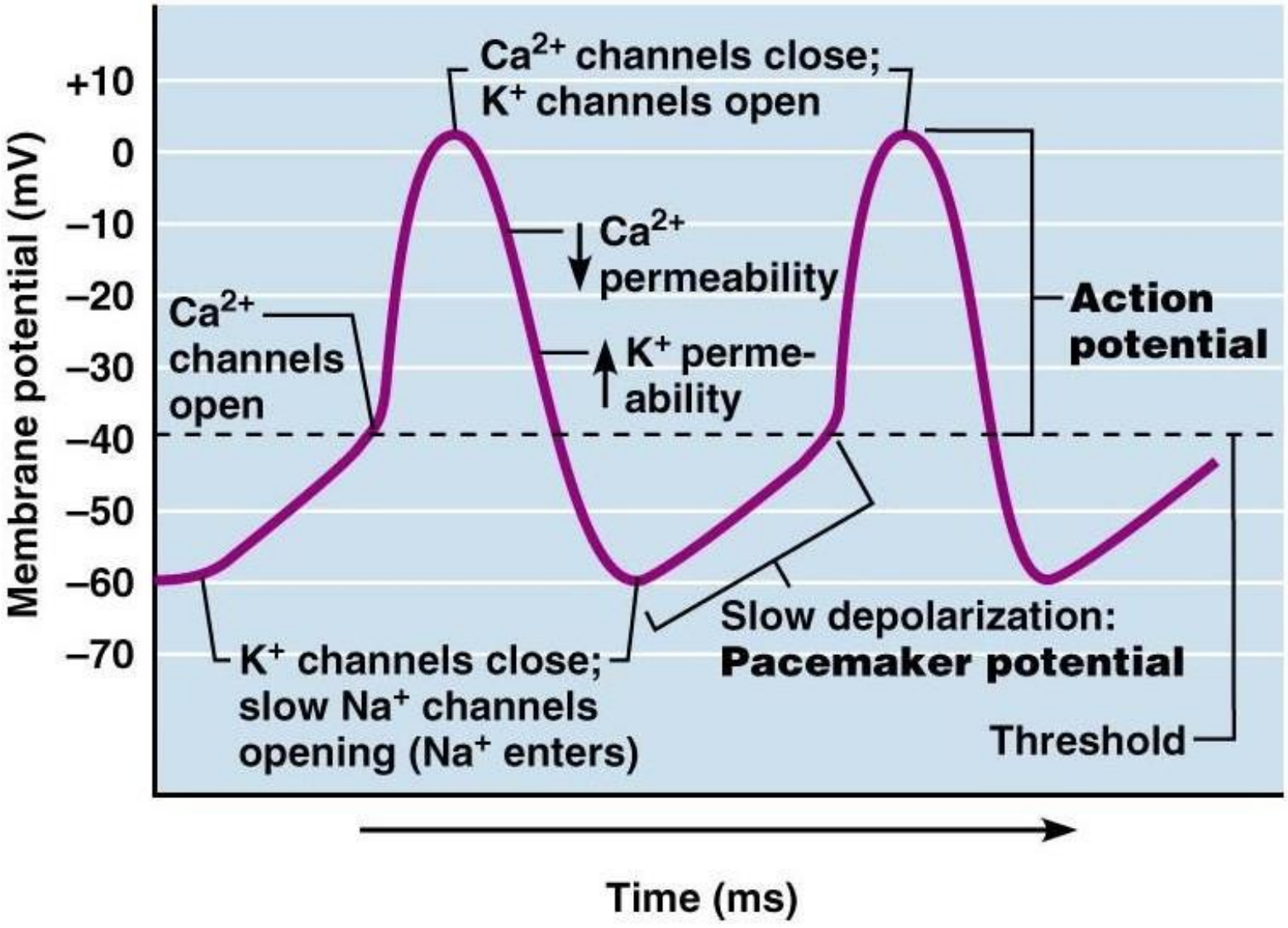
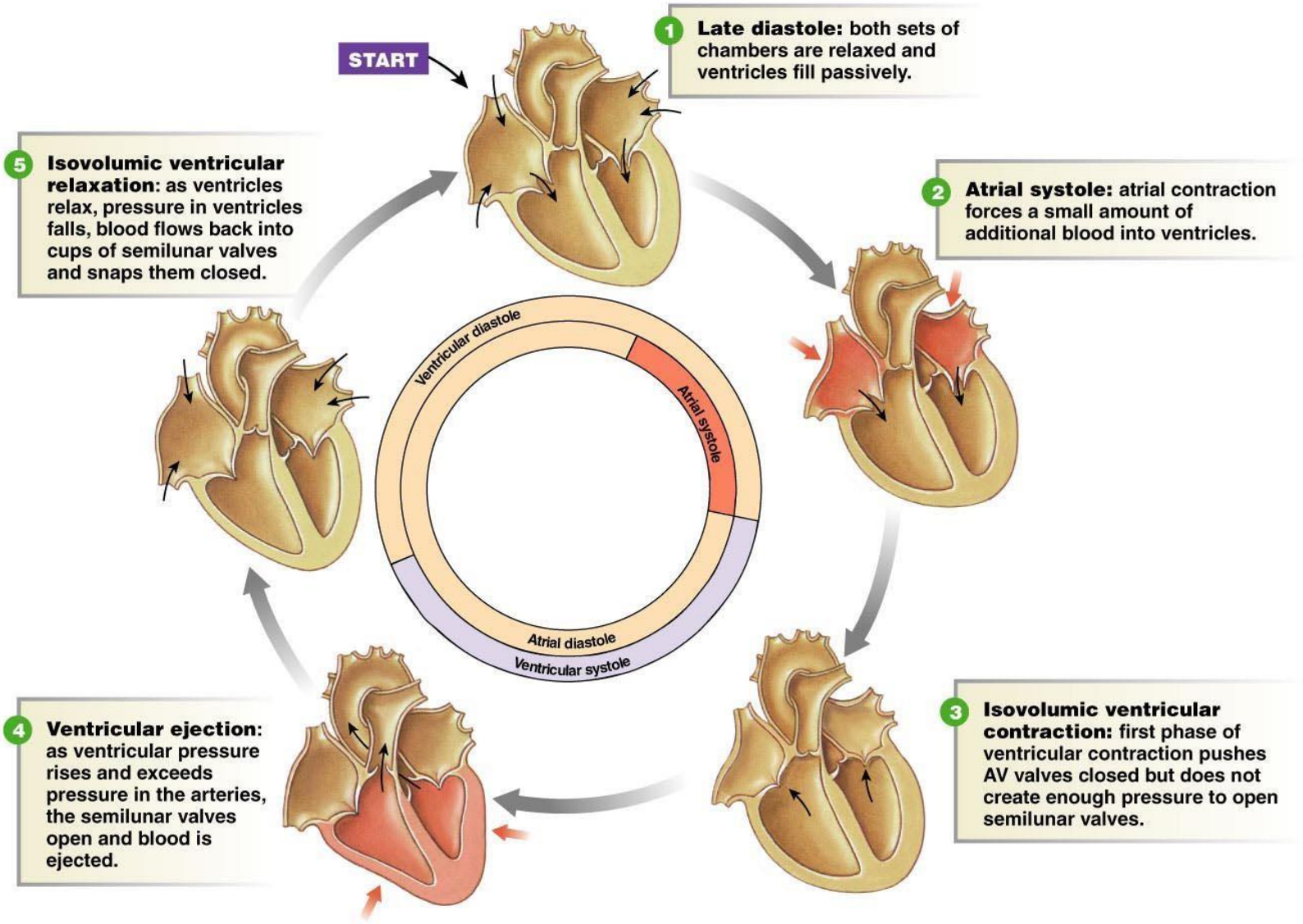


Figure 18.13

Cardiac Cycle



Electrocardiography

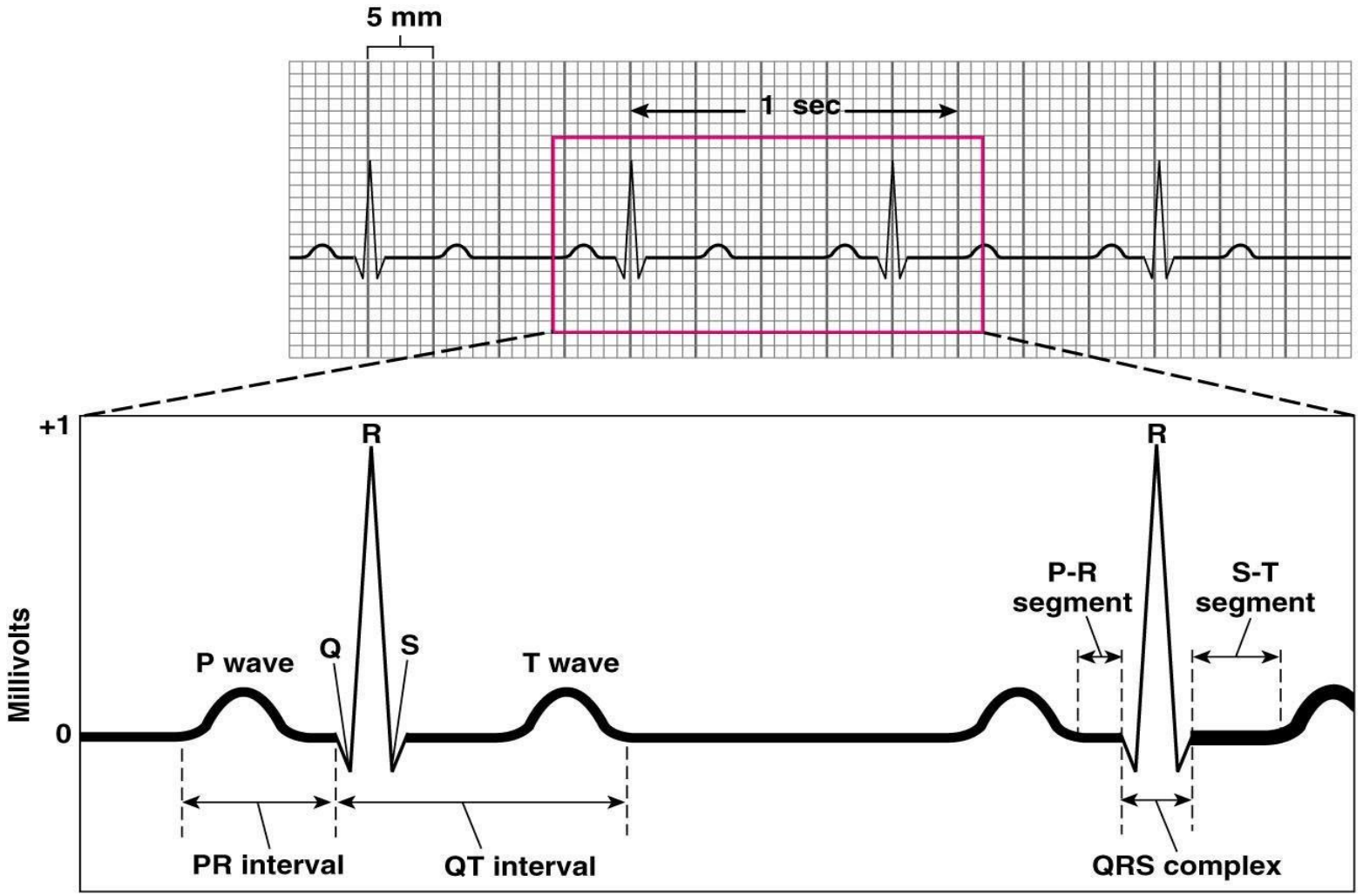


Figure 18.16

Electrocardiography

- Electrical activity is recorded by electrocardiogram (ECG)
- P wave corresponds to depolarization of SA node
- QRS complex corresponds to ventricular depolarization
- T wave corresponds to ventricular repolarization
- Atrial repolarization record is masked by the larger QRS complex

Heart Excitation Related to ECG

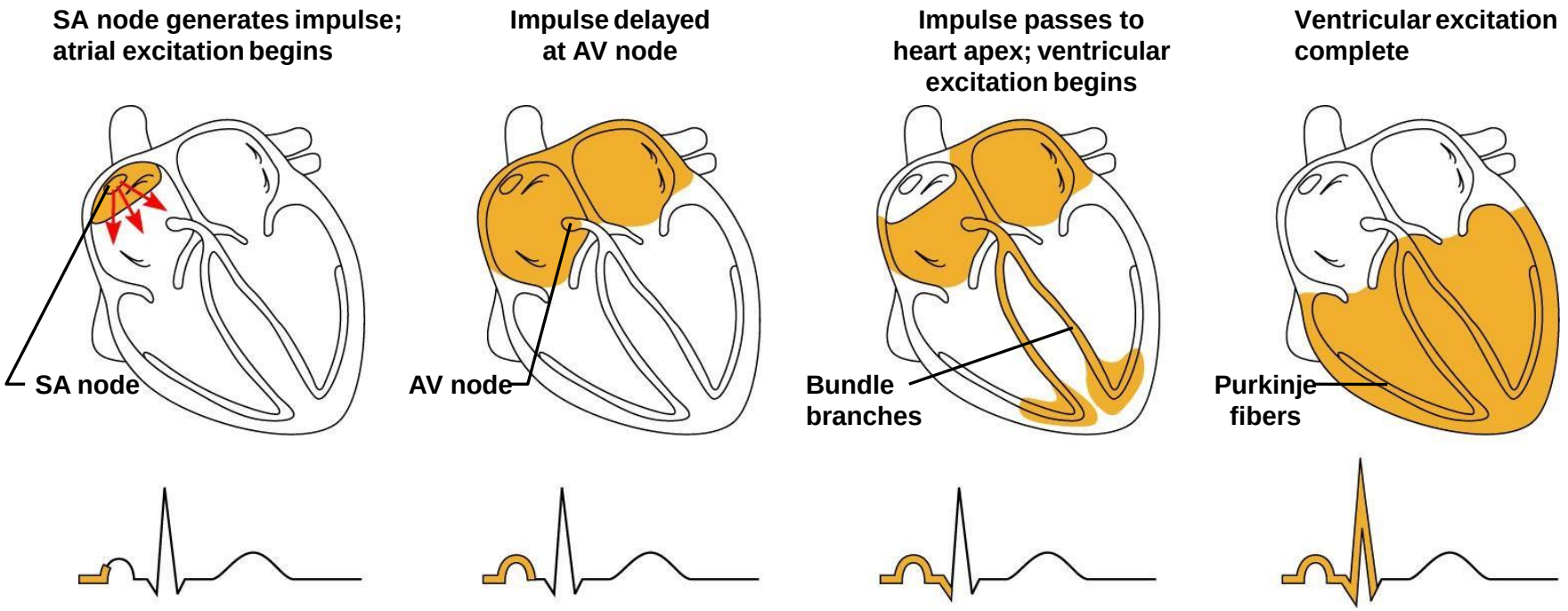


Figure 18.17

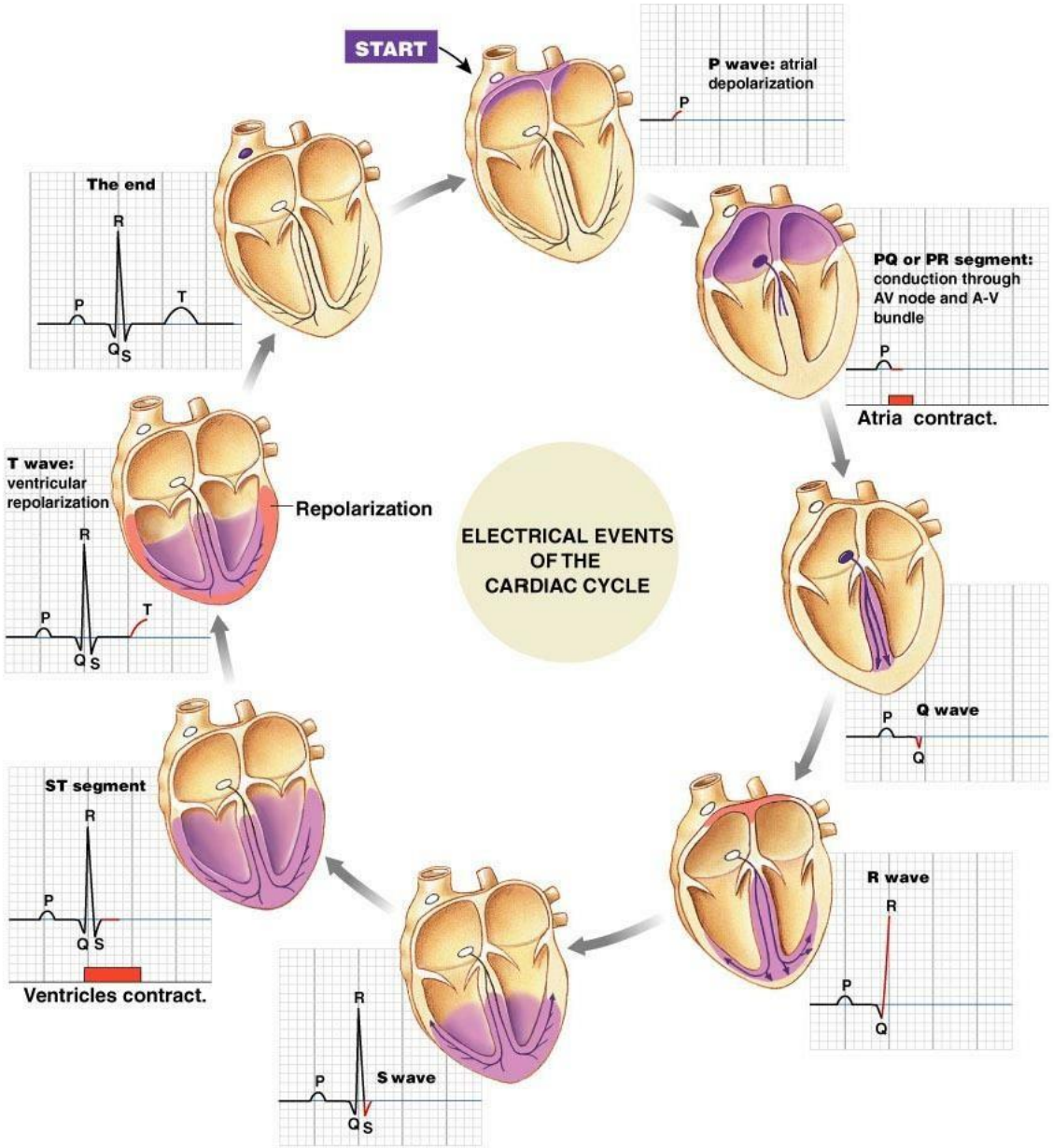
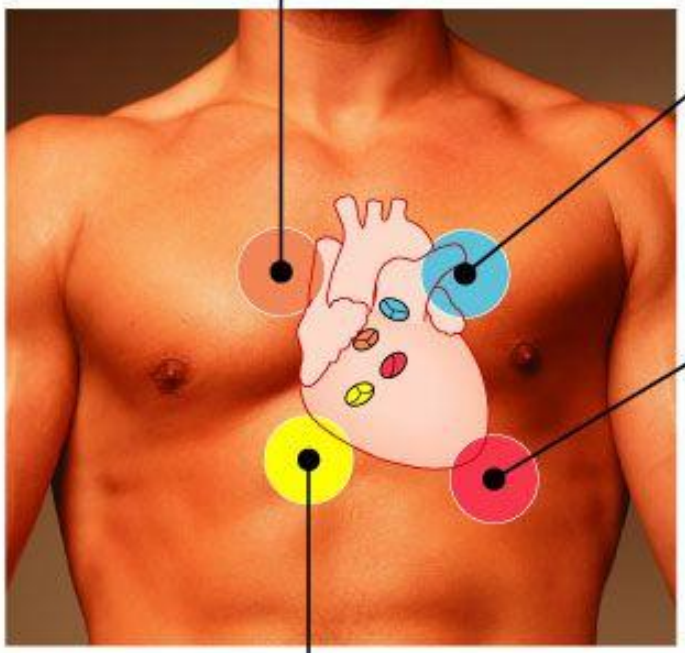


Figure 14-21 - Overview (1 of 9)

Heart Sounds

Heart sounds (lub-dup) are associated with closing of heart valves

- **First sound** occurs as AV valves close and signifies beginning of systole (contraction)
- **Second sound** occurs when SL valves close at the beginning of ventricular diastole (relaxation)



Cardiac Output (CO) and Reserve

- CO is the amount of blood pumped by each ventricle in one minute
- CO is the product of heart rate (HR) and stroke volume (SV)
- HR is the number of heart beats per minute
- SV is the amount of blood pumped out by a ventricle with each beat
- Cardiac reserve is the difference between resting and maximal CO

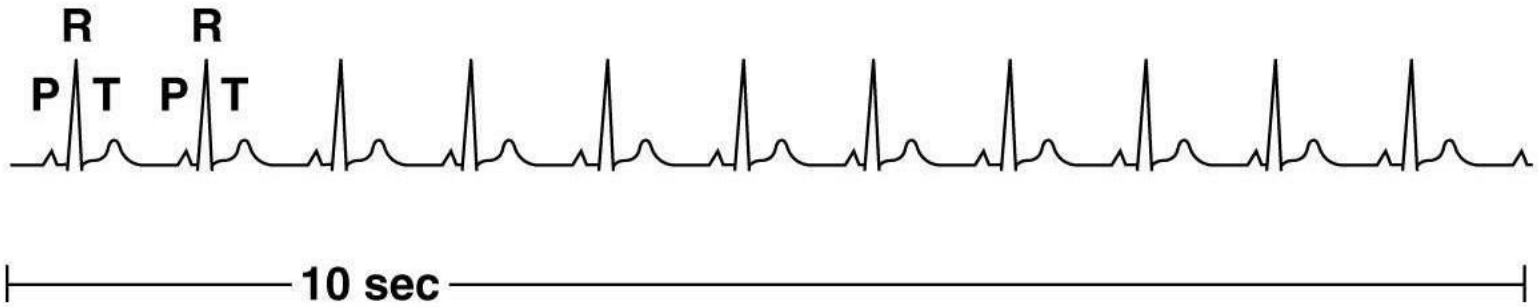
Cardiac Output:

- Resting HR for fetus (140-160 b/m)
- Male's HR(64-72 b/m)
- Female's HR (72-80 b/m)
- CO (ml/min) = HR (75 beats/min) x SV (70 ml/beat)
- CO = 5250 ml/min (5.25 L/min)

Congestive Heart Failure (CHF)

- Congestive heart failure (CHF) is caused by:
- When the pumping efficiency of the heart is depressed so that circulation is inadequate to meet tissue needs, CHF occurs
- Coronary atherosclerosis
- Persistent high blood pressure
- Multiple myocardial infarcts
- Dilated cardiomyopathy (DCM)

(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?

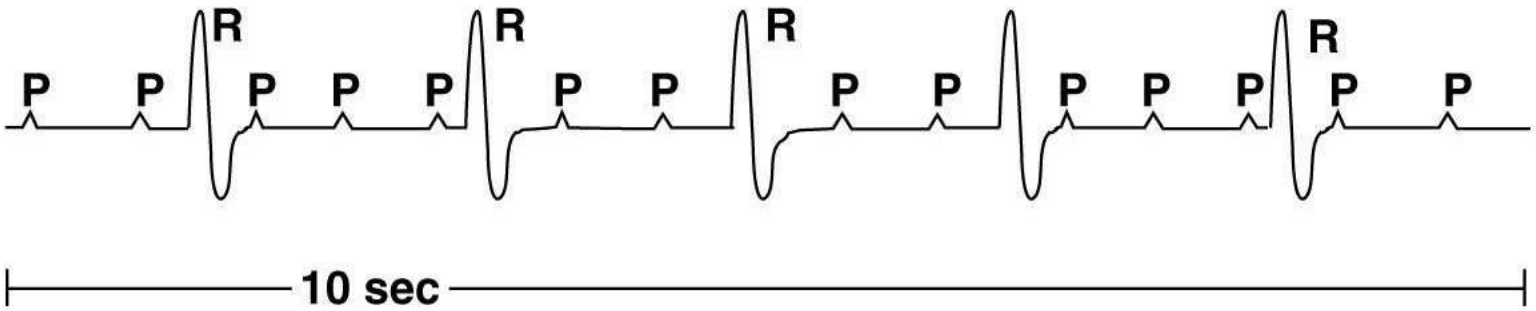
3. Are all normal waves present in recognizable form?

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



Questions to ask when analyzing ECG tracings:

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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?**

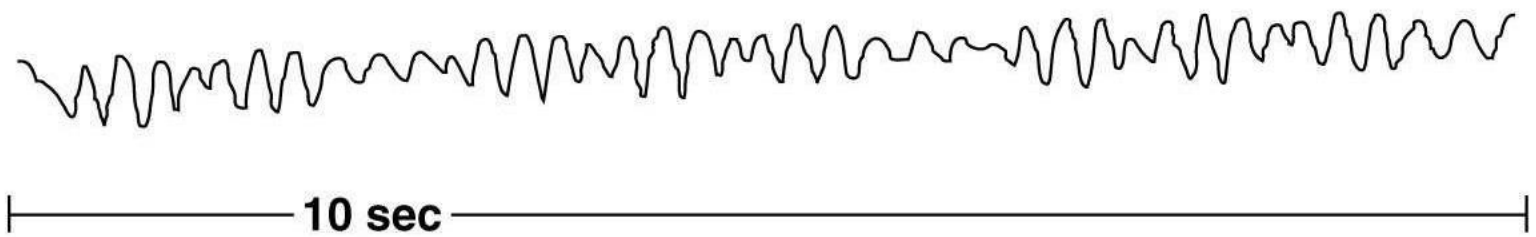
3. **Are all normal waves present in recognizable form?**

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

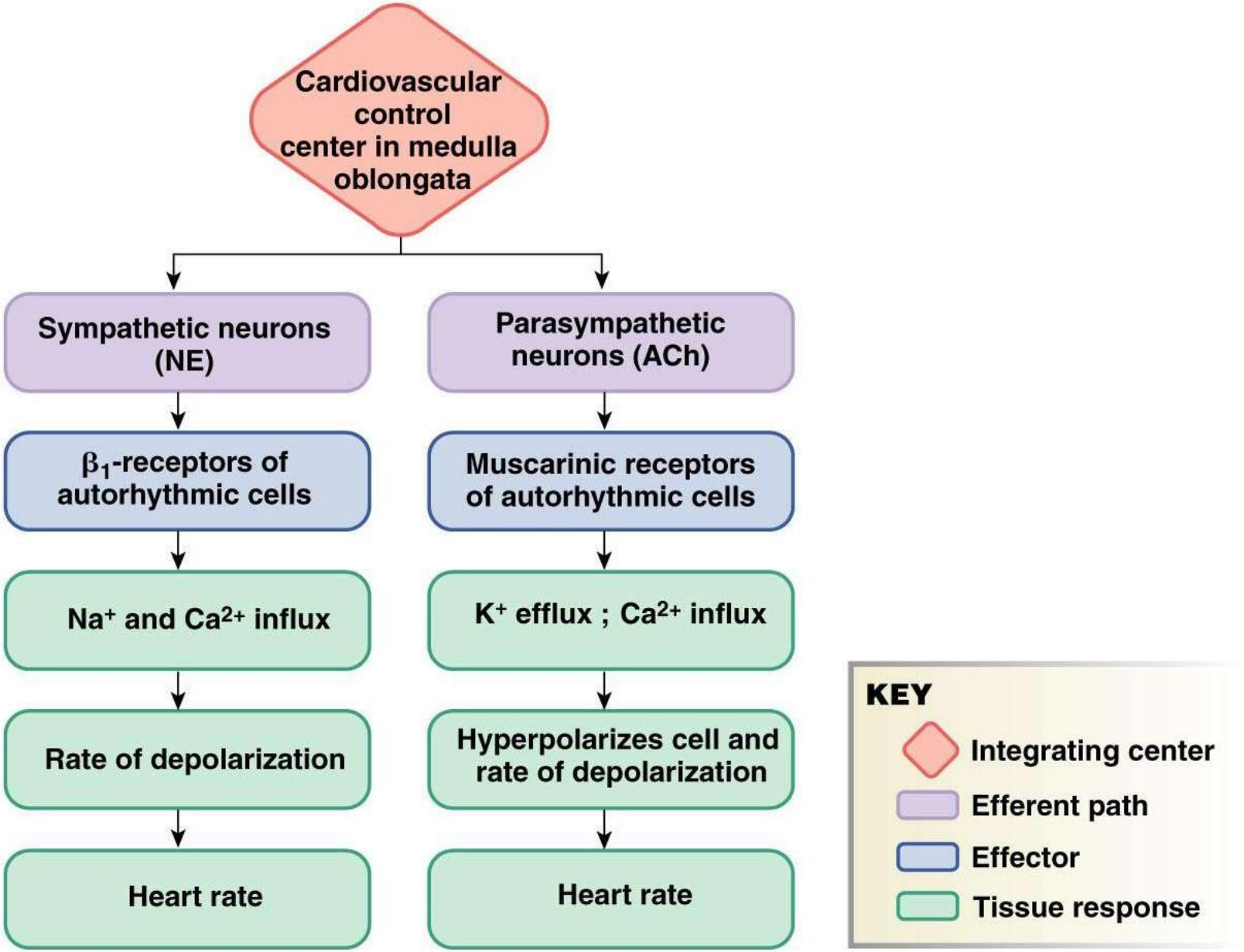


Figure 14-

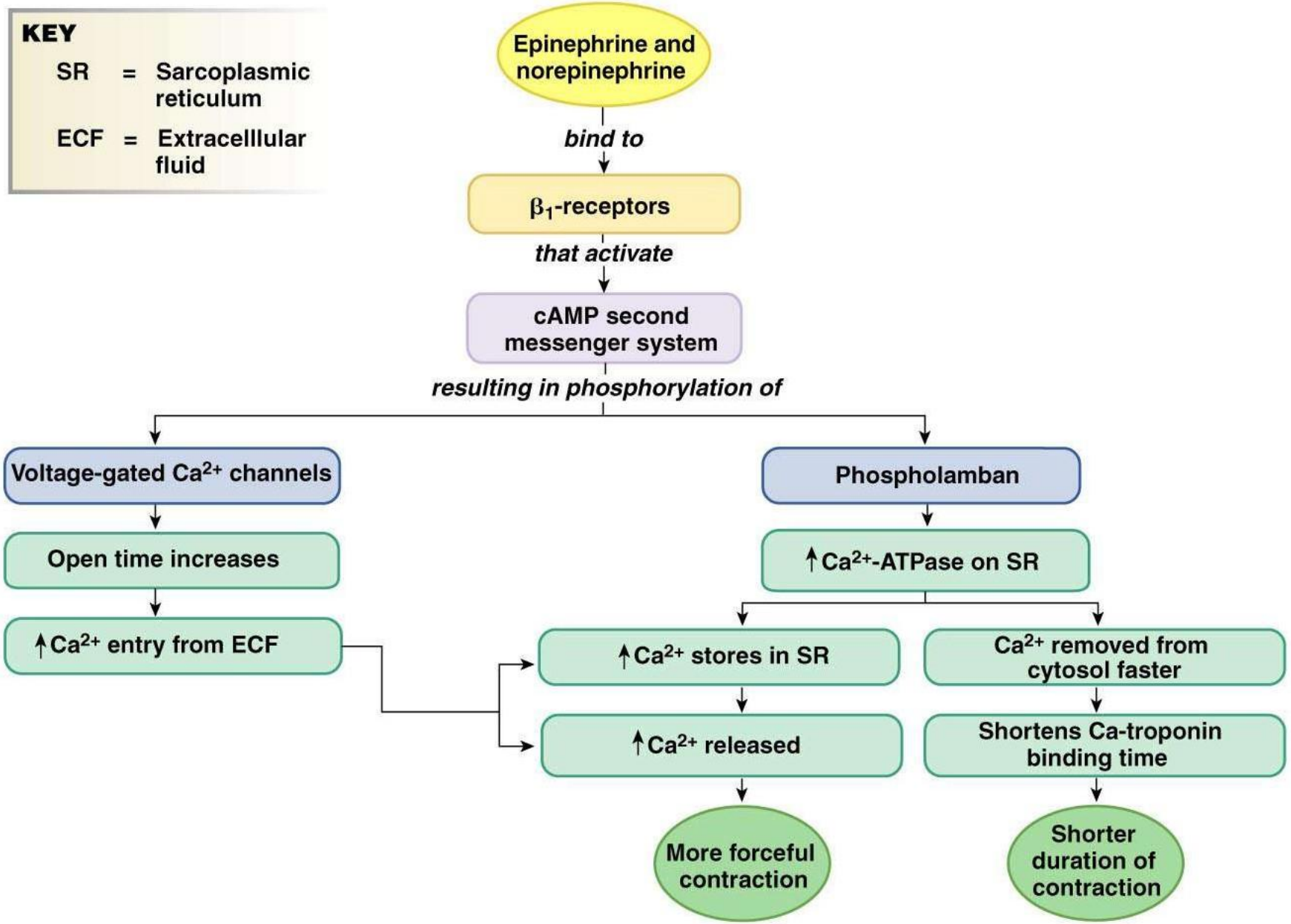


Figure 14.30

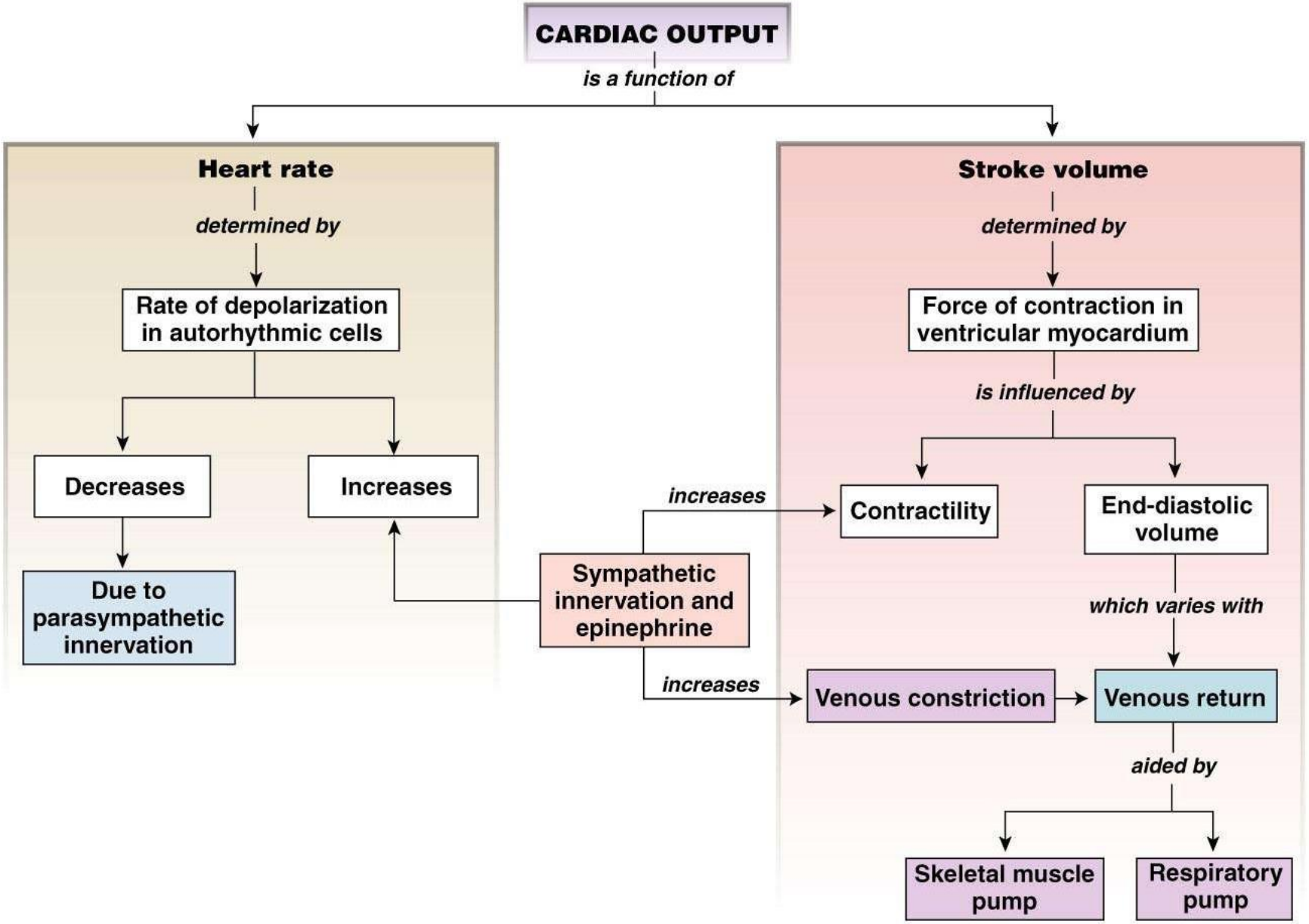


Figure 14.31

Thank You