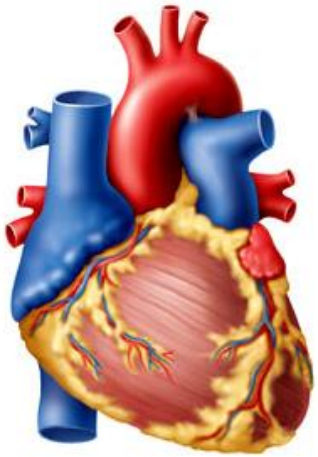

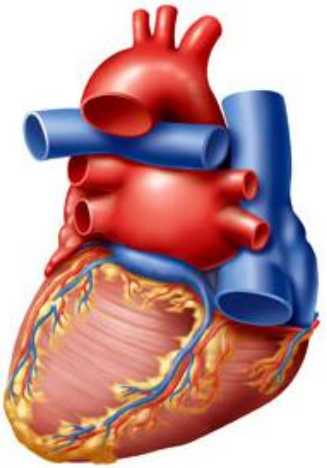

The Cardiovascular System
Part -2-

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

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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

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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

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

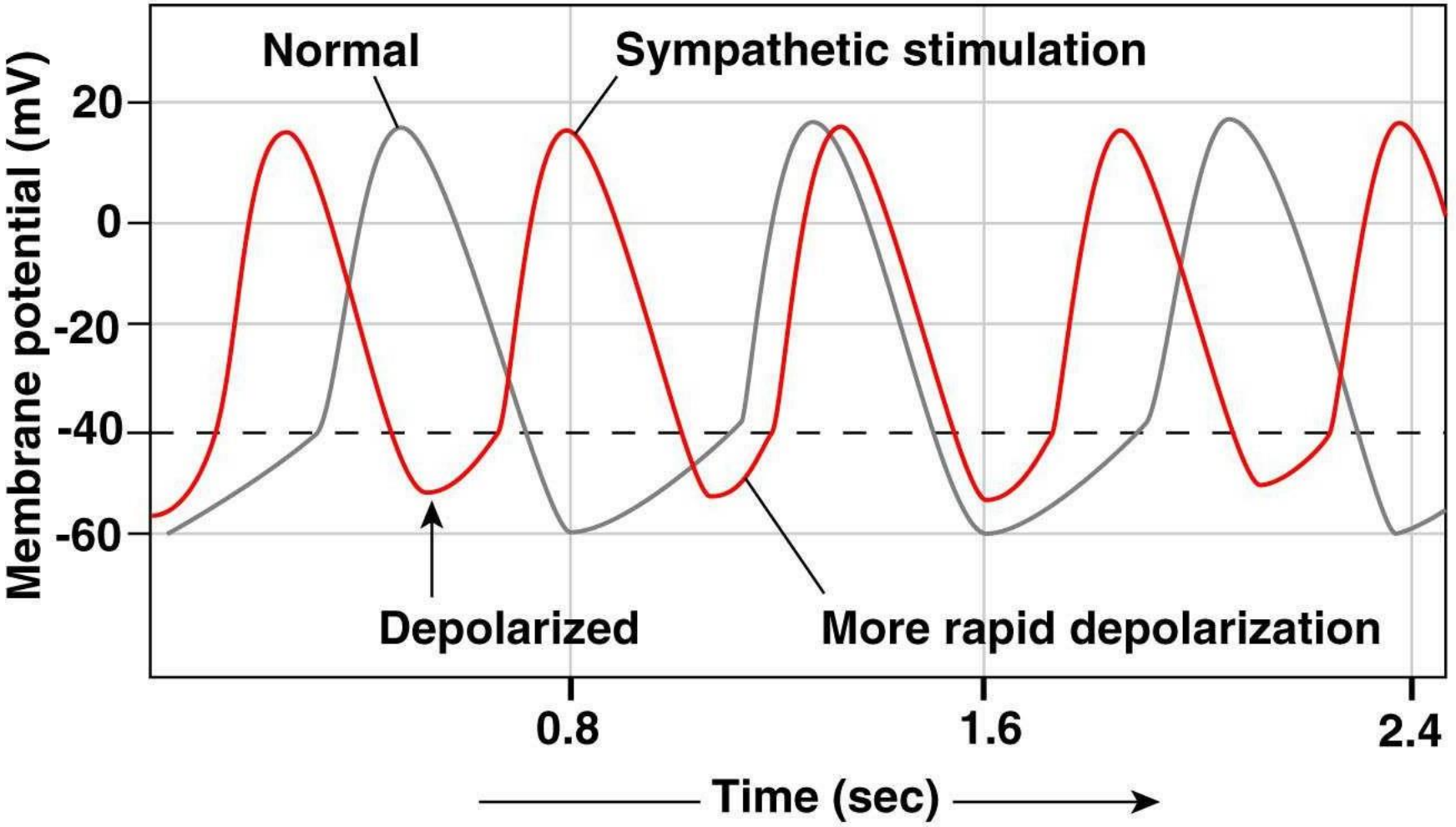

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Figure 14-16a

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

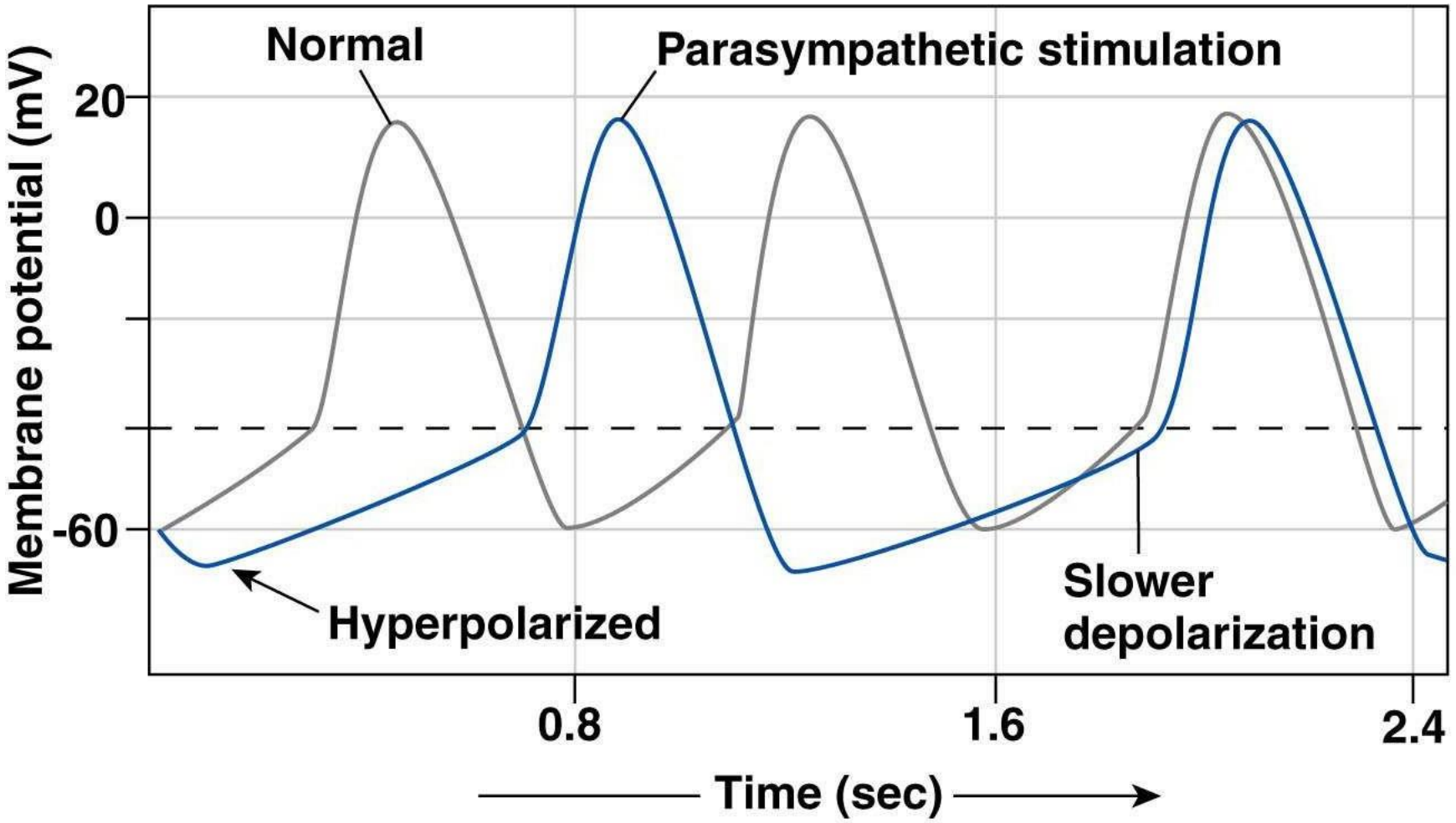

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Figure 14-16b

Cardiac Intrinsic Conduction

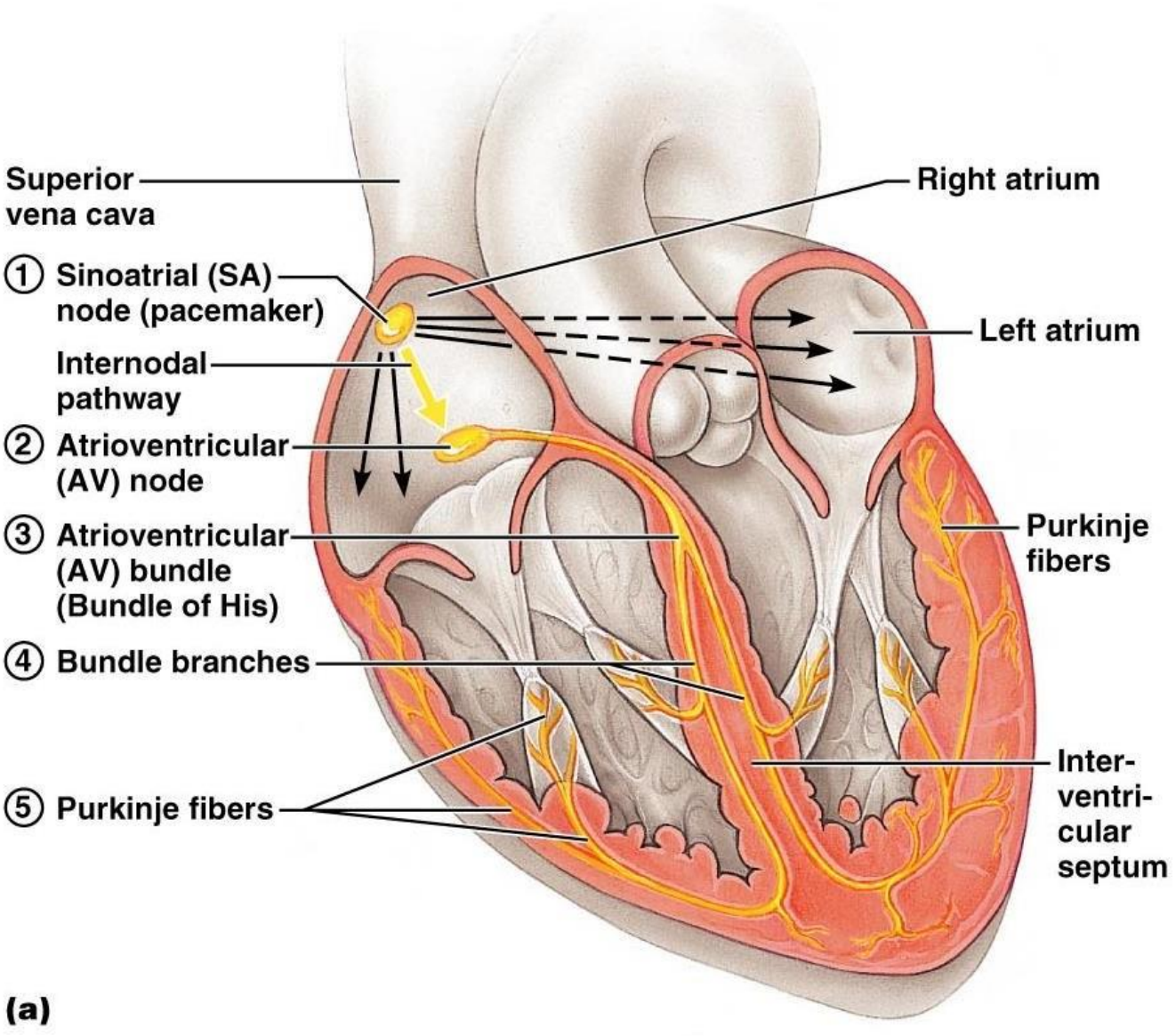

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Figure 18.14a

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)

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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

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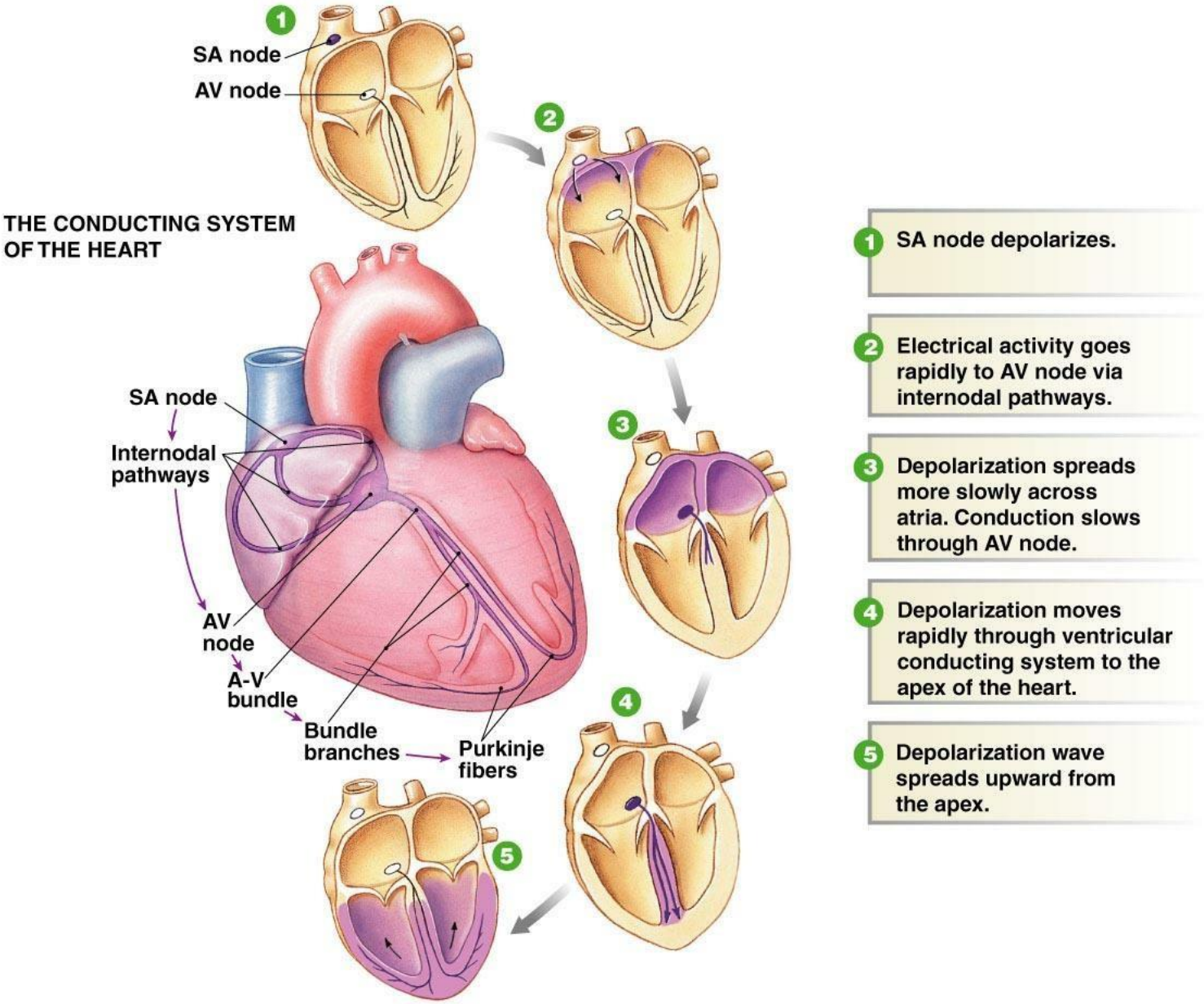

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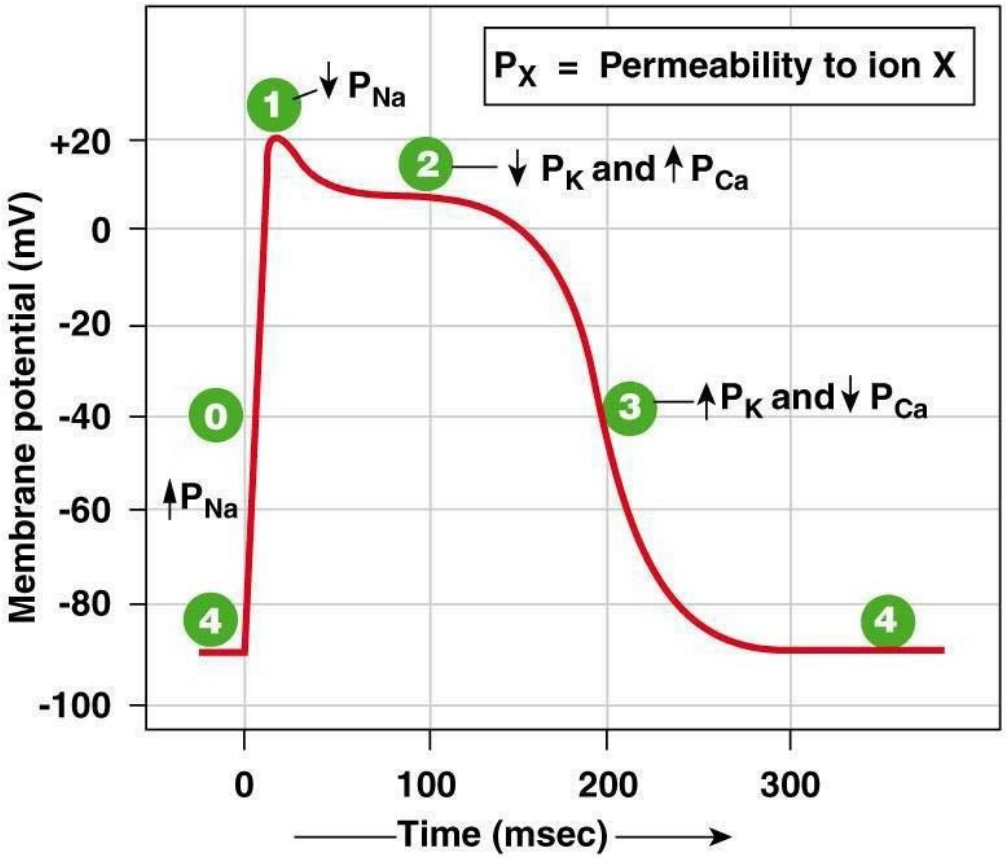
Figure 14-18

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

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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

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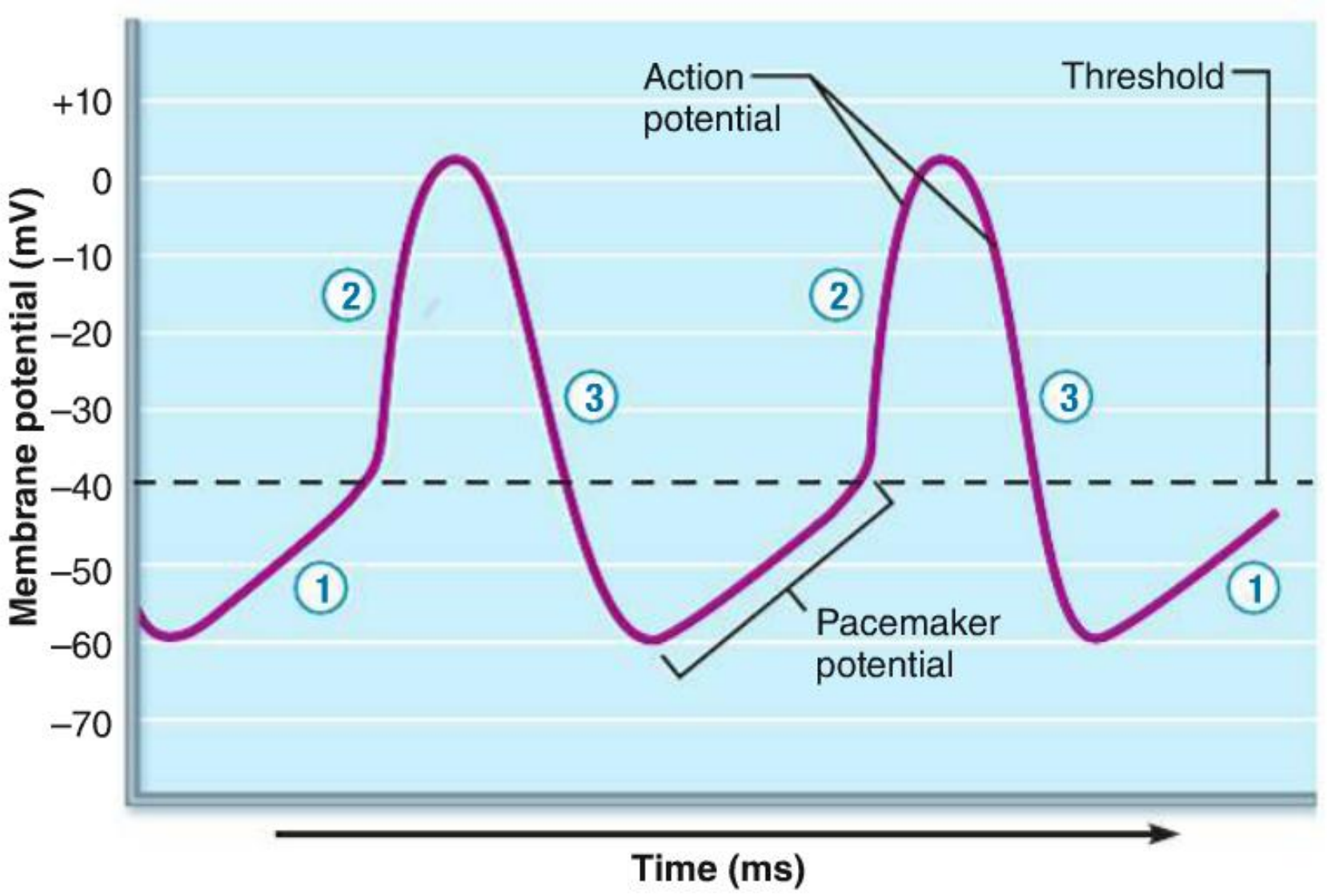
Pacemaker and Action Potentials of the Heart



Pacemaker and Action Potentials of the Heart

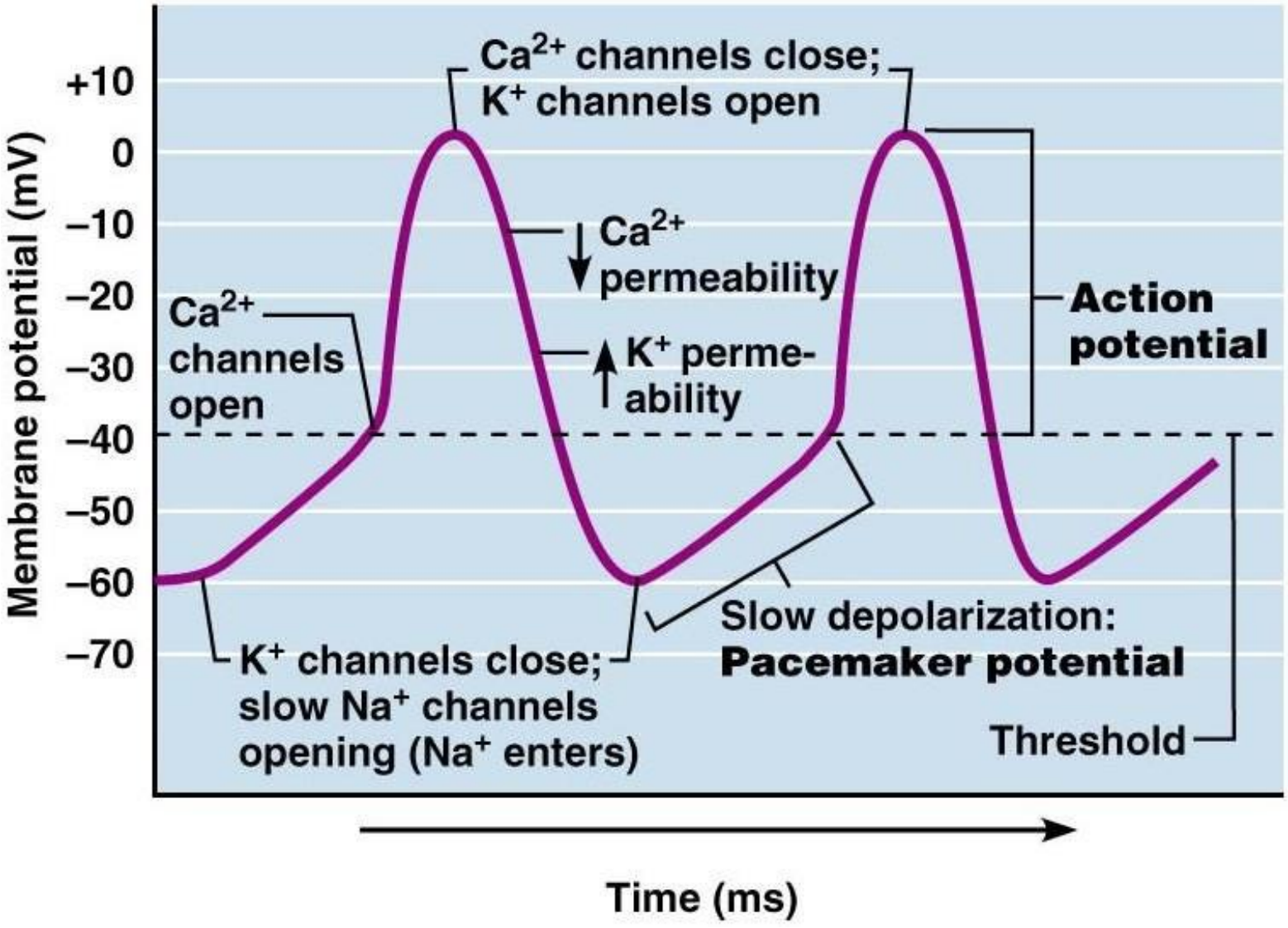


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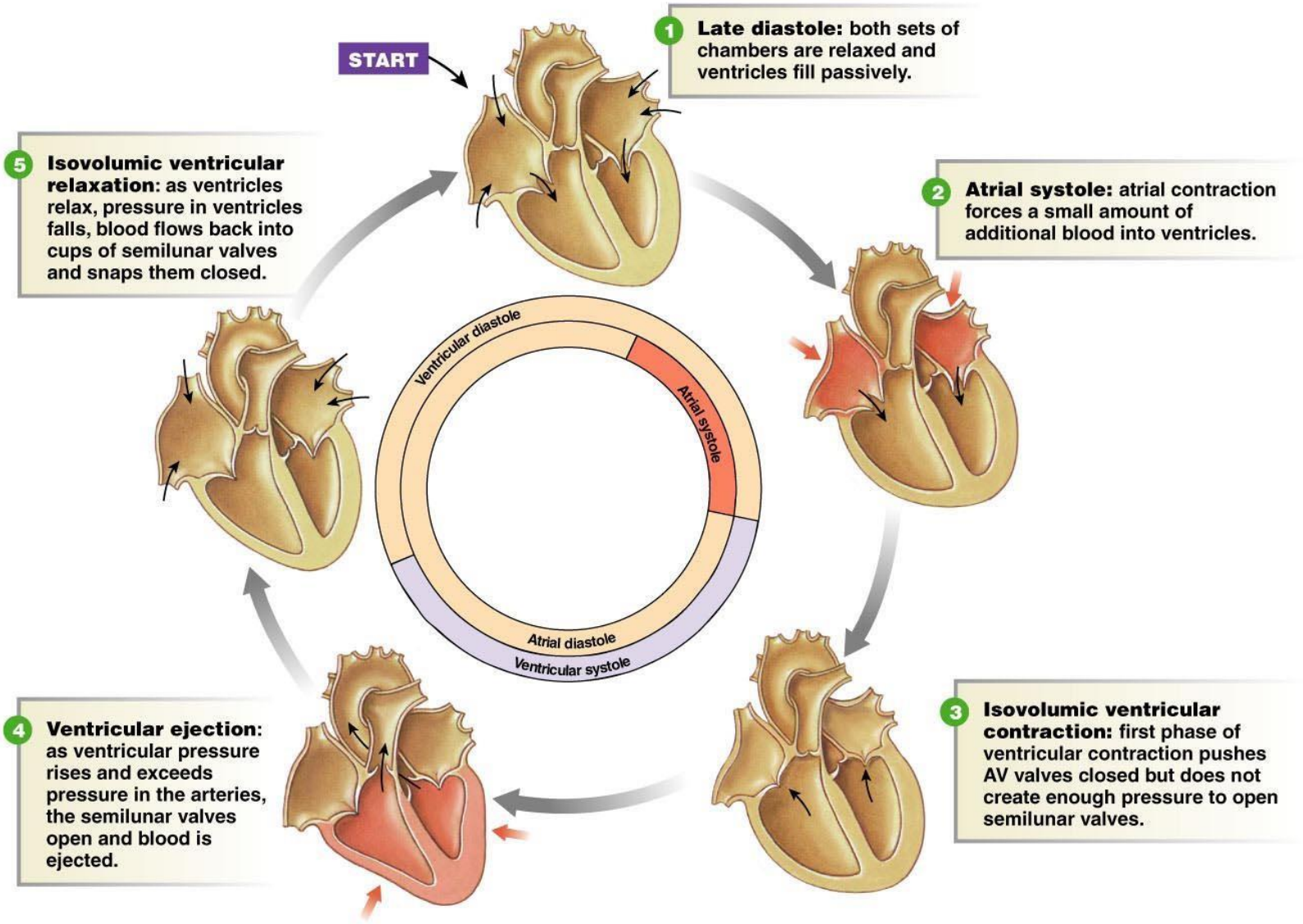
Figure 18.13

Cardiac Cycle



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Electrocardiography

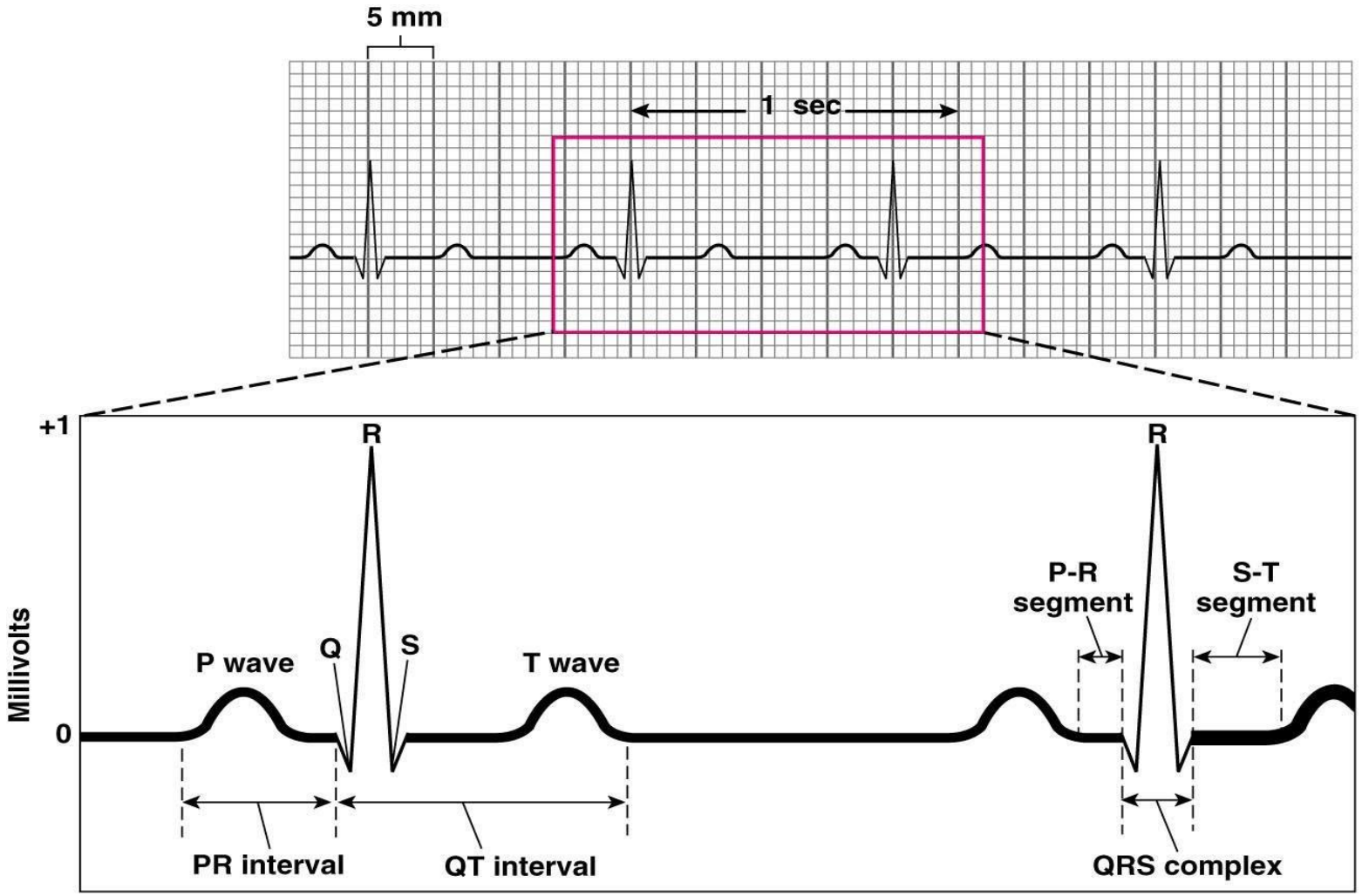

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Figure 18.16

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

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Heart Excitation Related to ECG

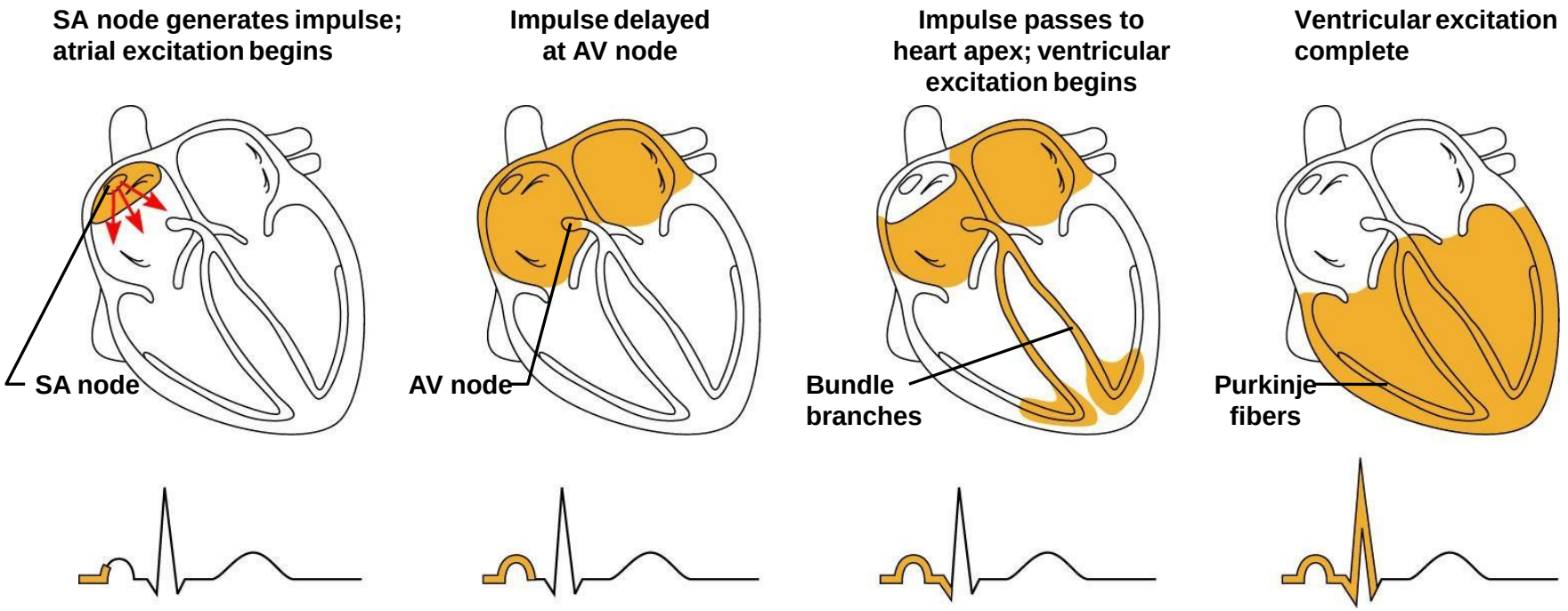

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Figure 18.17

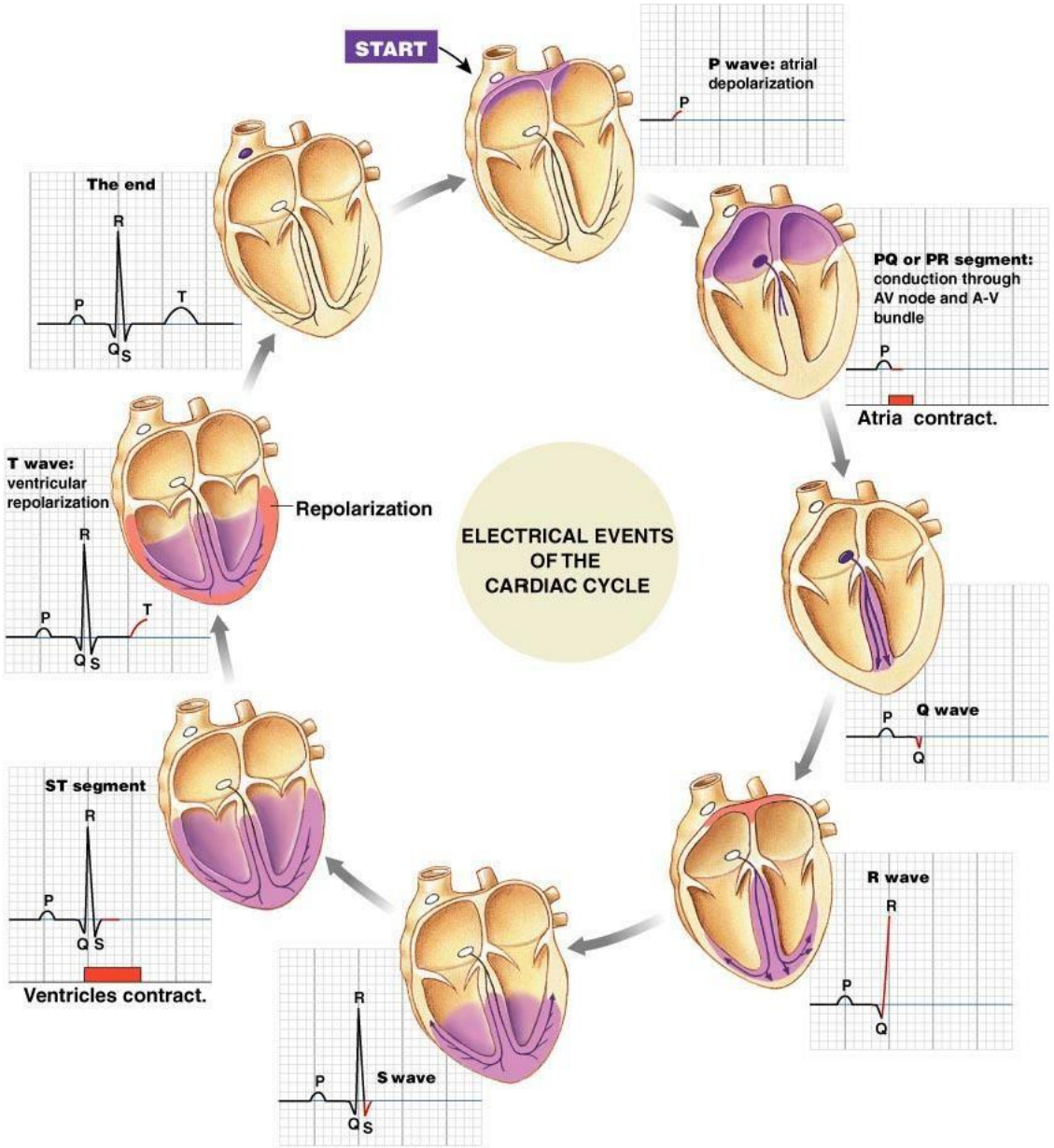

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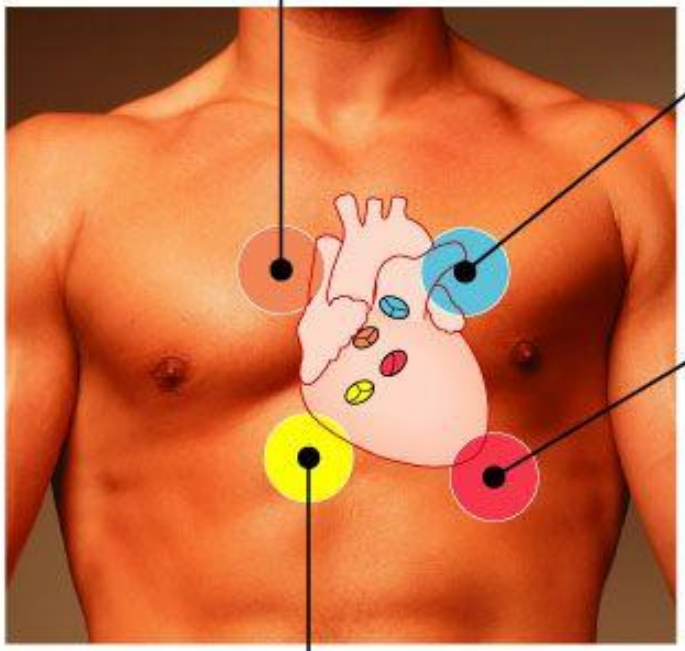
Figure 14-21 - Overview (1 of 9)

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)



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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

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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)

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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)

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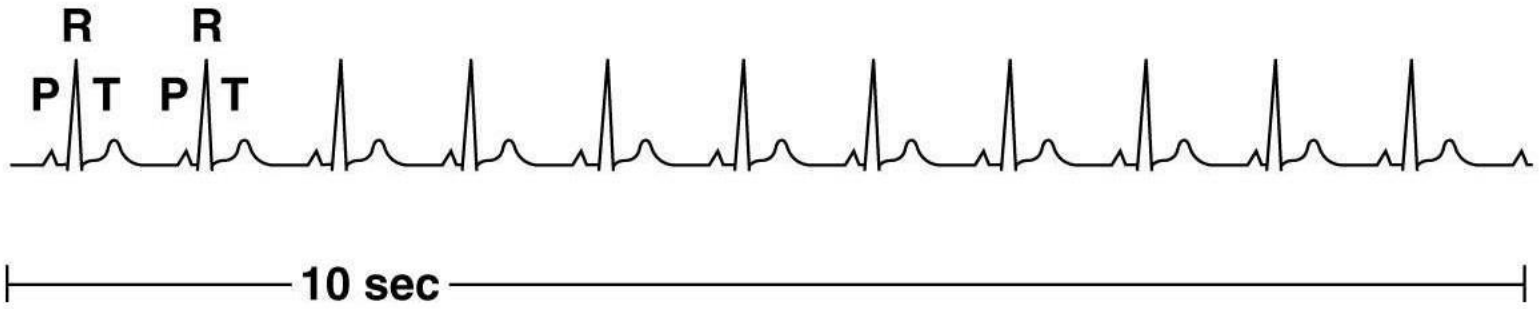
(a) Normal ECG



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?

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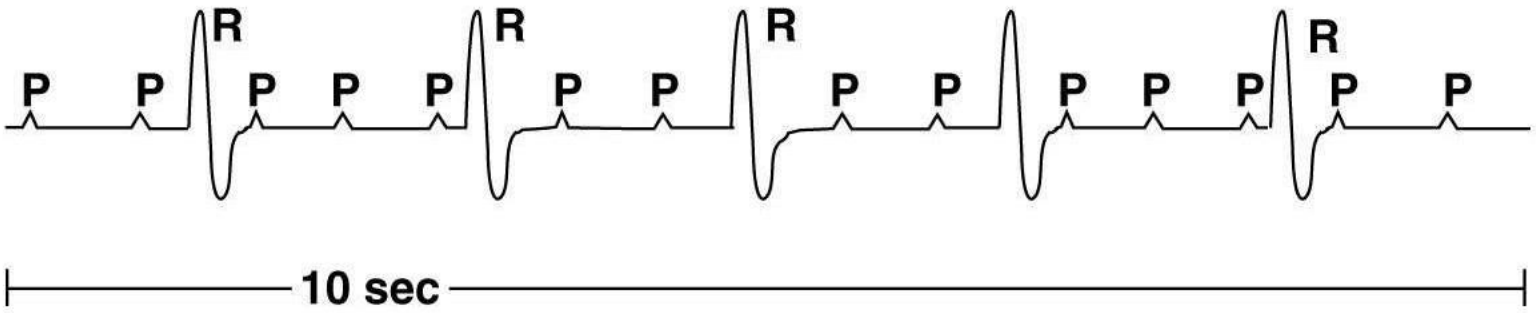
Figure 14-23a

(b) Third-degree block



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?**

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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?

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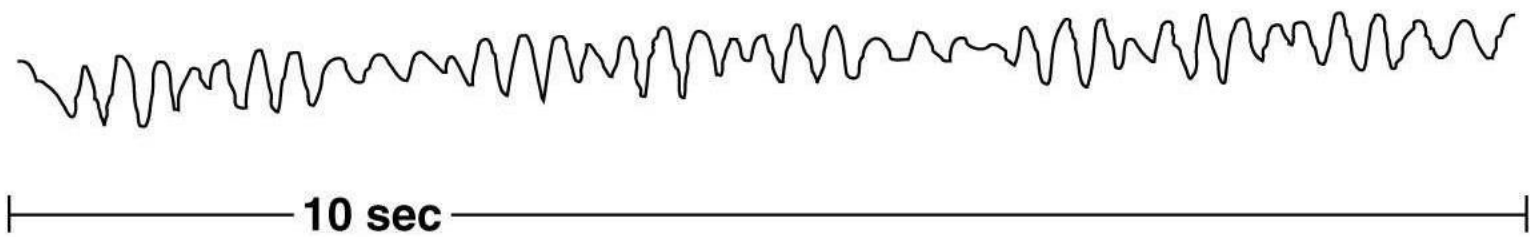
Figure 14-23c

(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?

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Figure 14-23d

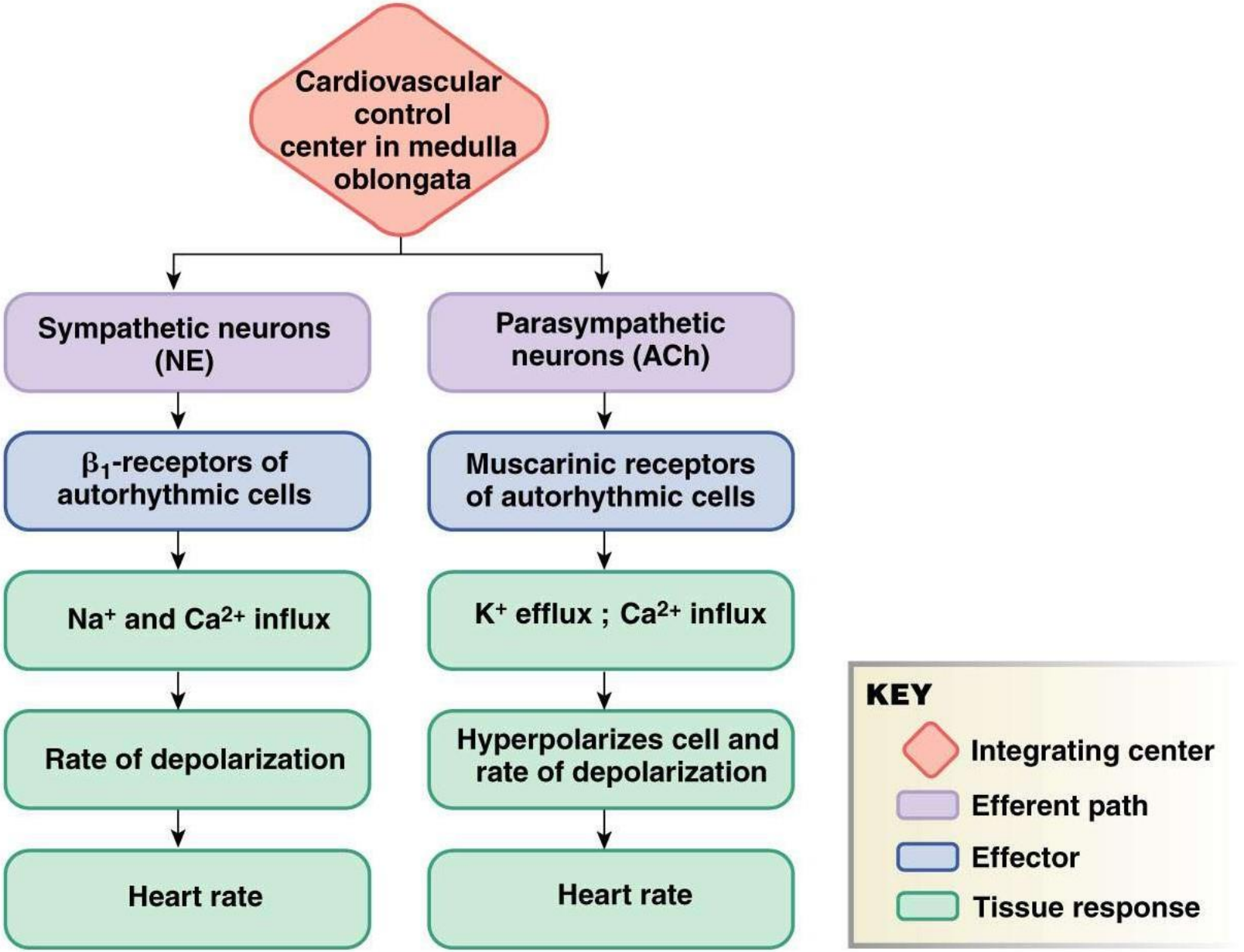

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Figure 14-

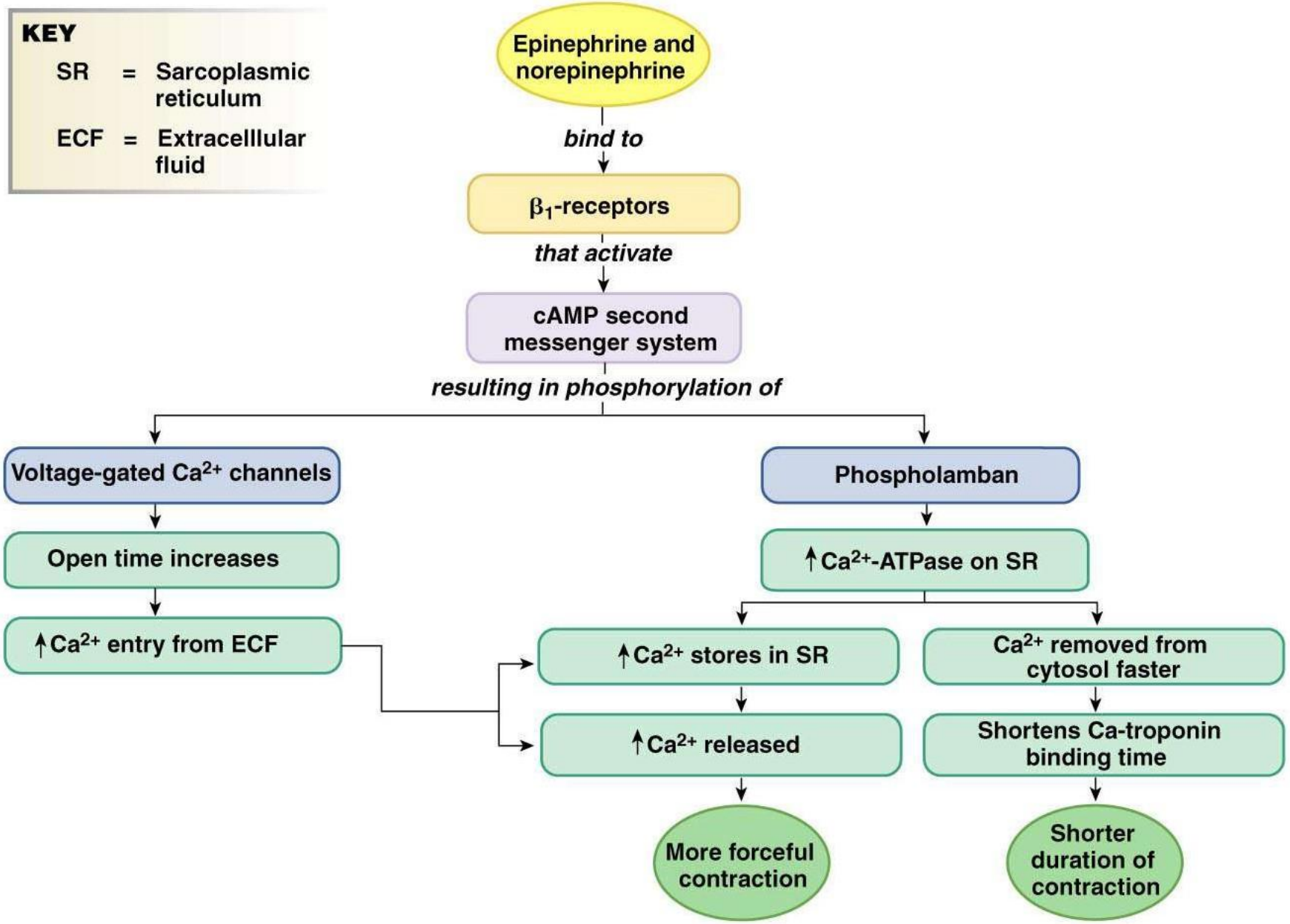

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Figure 14-30

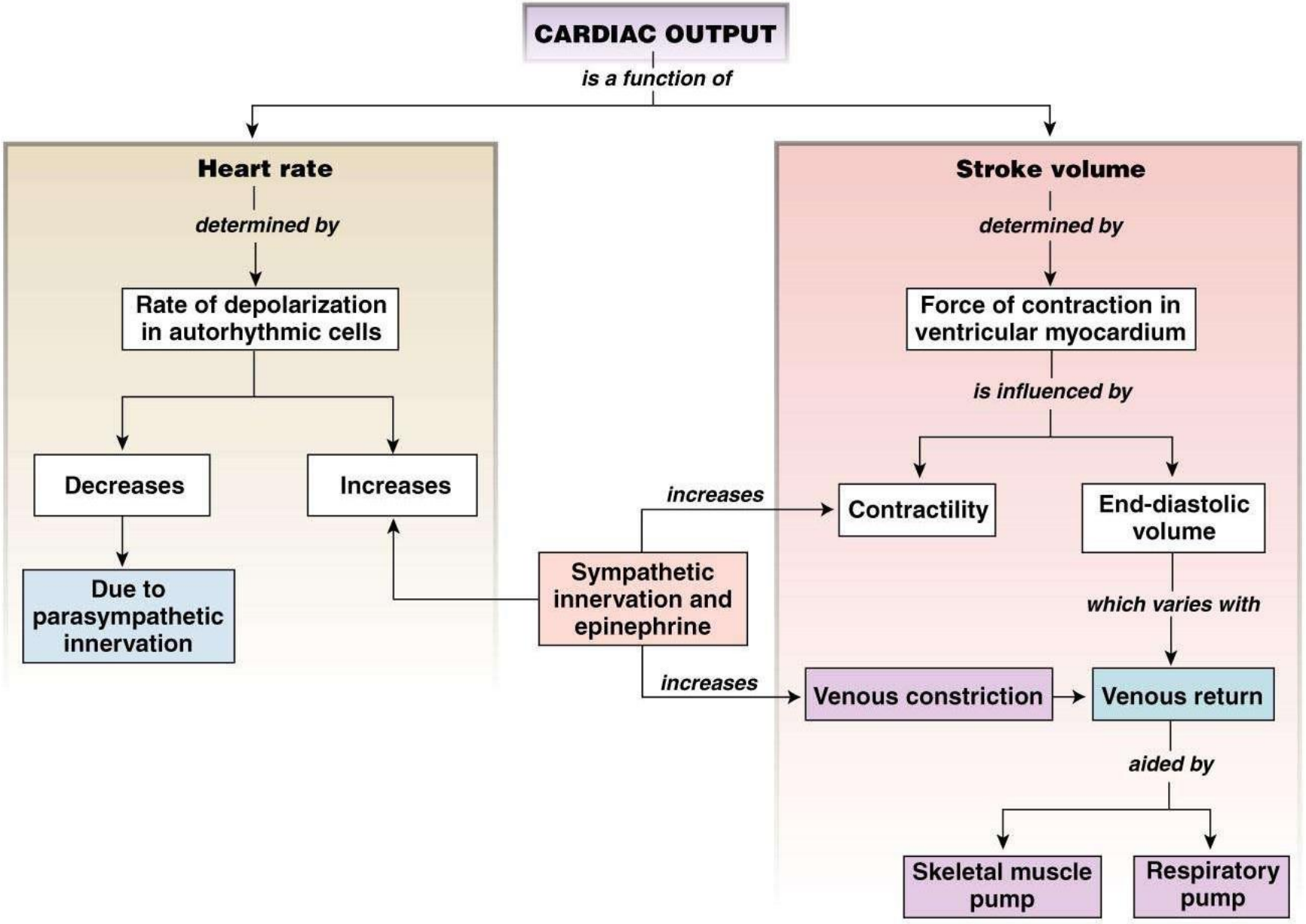

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Figure 14-31

Thank You