

The Cardiovascular System (Heart)

The Cardiovascular System



- A closed system of the heart and blood vessels
 - The heart pumps blood
 - Blood vessels allow blood to circulate to all parts of the body
- The function of the cardiovascular system is to deliver oxygen and nutrients and to remove carbon dioxide and other waste products

The Heart



- **Location**
 - Thorax between the lungs
 - Pointed apex directed toward left hip
- **About the size of your fist**

The Heart

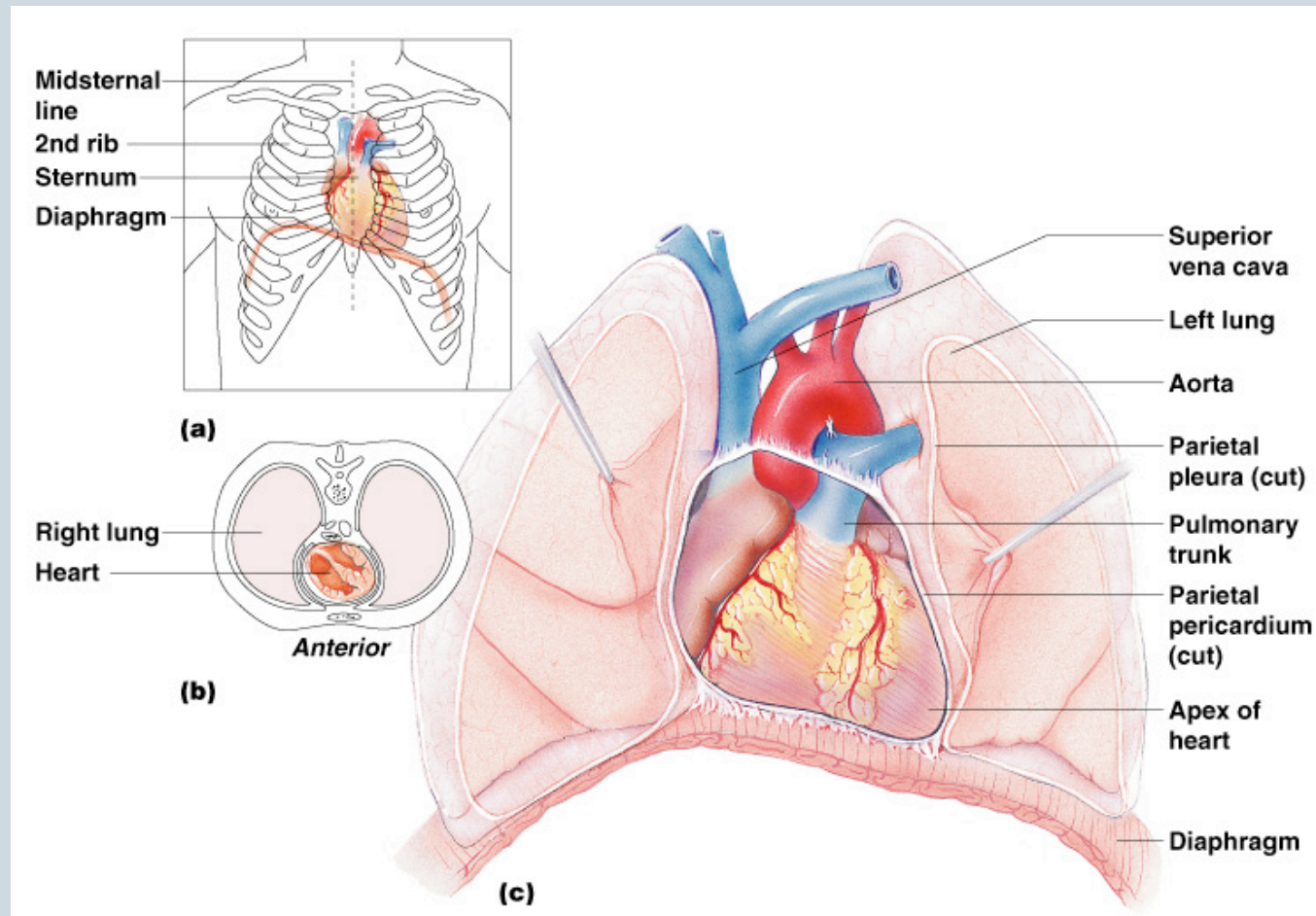


Figure 11.1

The Heart: Coverings



- Pericardium – a double serous membrane
 - Visceral pericardium
 - ✦ Next to heart
 - Parietal pericardium
 - ✦ Outside layer
- Serous fluid (slippery/lubricating) fills the space between the layers of pericardium and allows the heart to beat in a nearly frictionless environment.

The Heart: Heart Wall



- Three layers
 - Epicardium
 - ✦ Outside layer
 - ✦ Connective tissue layer
 - Myocardium
 - ✦ Middle layer
 - ✦ Mostly cardiac muscle
 - Endocardium
 - ✦ Inner layer

External Heart Anatomy

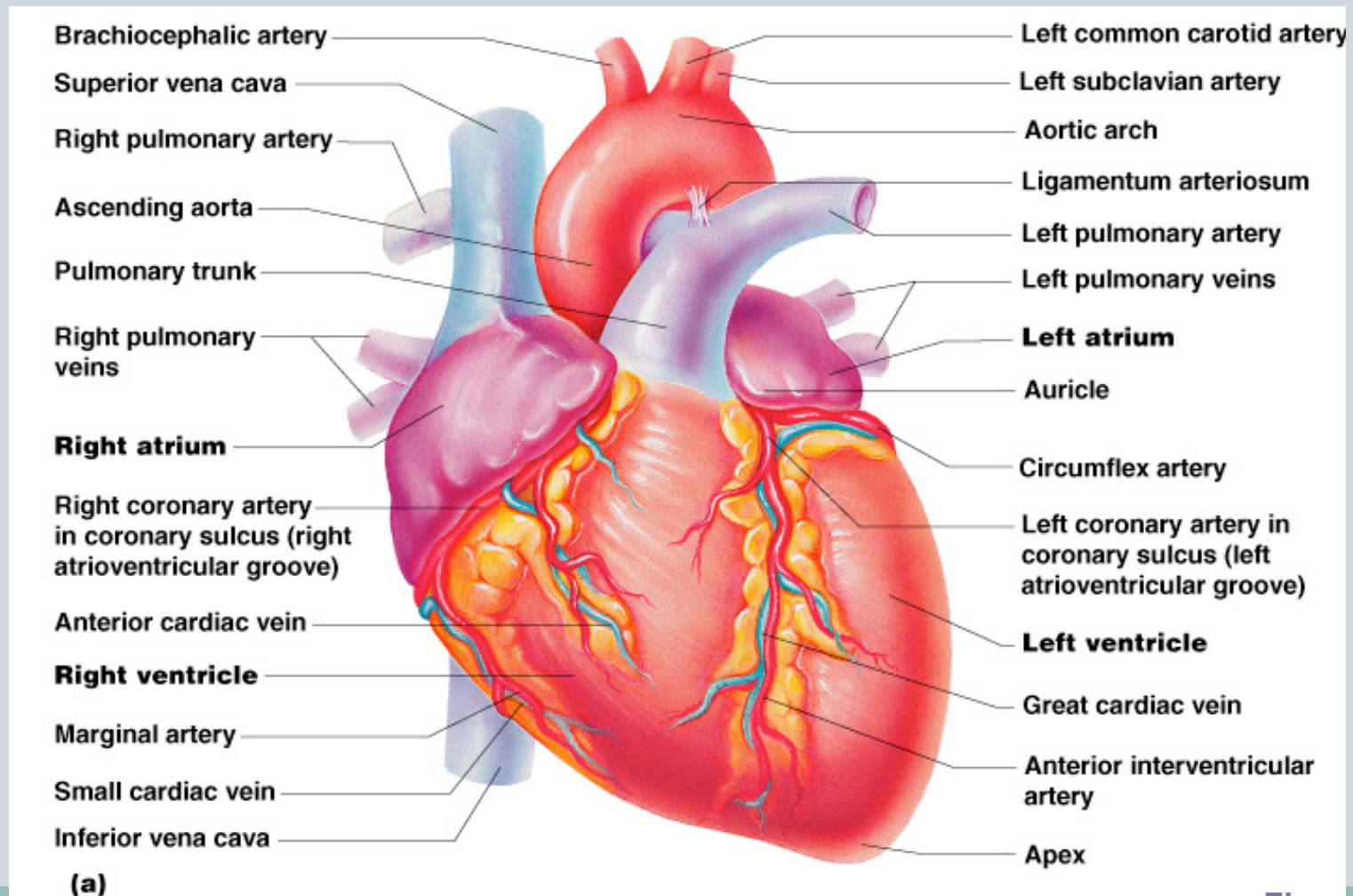


Figure 11.2a

The Heart: Chambers

- Right and left side act as separate pumps
- Four chambers
 - Atria
 - ✦ Receiving chambers (veins)
 - Right atrium
 - Left atrium
 - Ventricles
 - ✦ Discharging chambers (arteries)
 - Right ventricle
 - Left ventricle

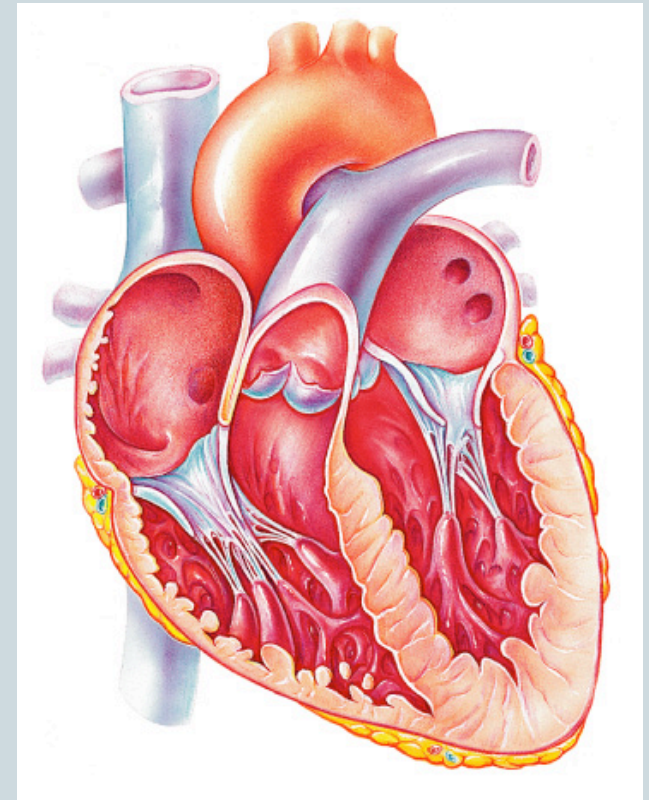


Figure 11.2c

Blood Circulation

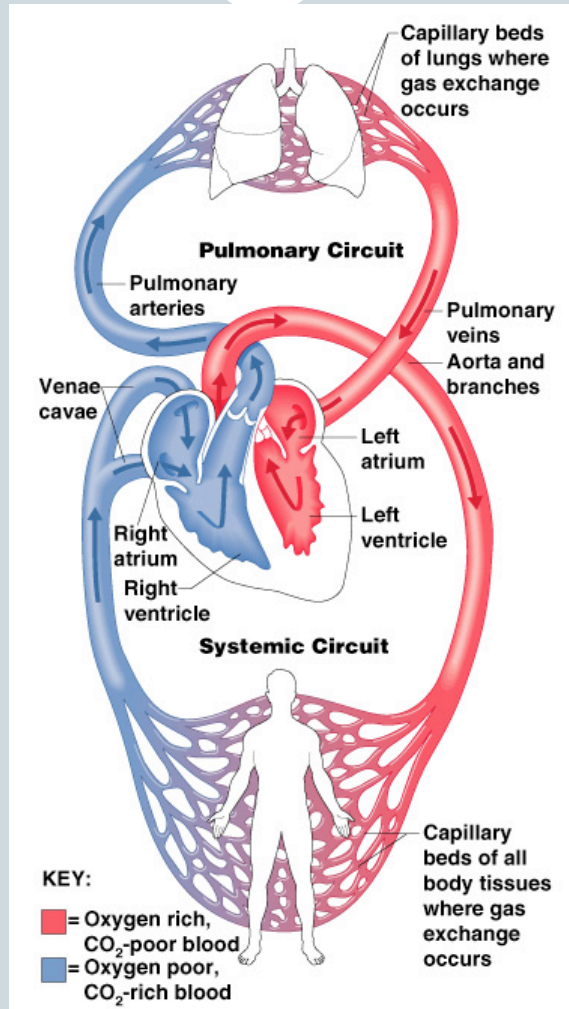


Figure 11.3

The Heart: Valves



- Allow blood to flow in only one direction
- Four valves
 - Atrioventricular valves (AV) – between atria and ventricles
 - ✦ Bicuspid valve (left)
 - ✦ Tricuspid valve (right)
 - Semilunar valves between ventricle and artery
 - ✦ Pulmonary valve
 - ✦ Aortic valve

The Heart: Valves



- Valves open as blood is pumped through
- Held in place by chordae tendineae (“heart strings”)
- Close to prevent backflow

Operation of Heart Valves

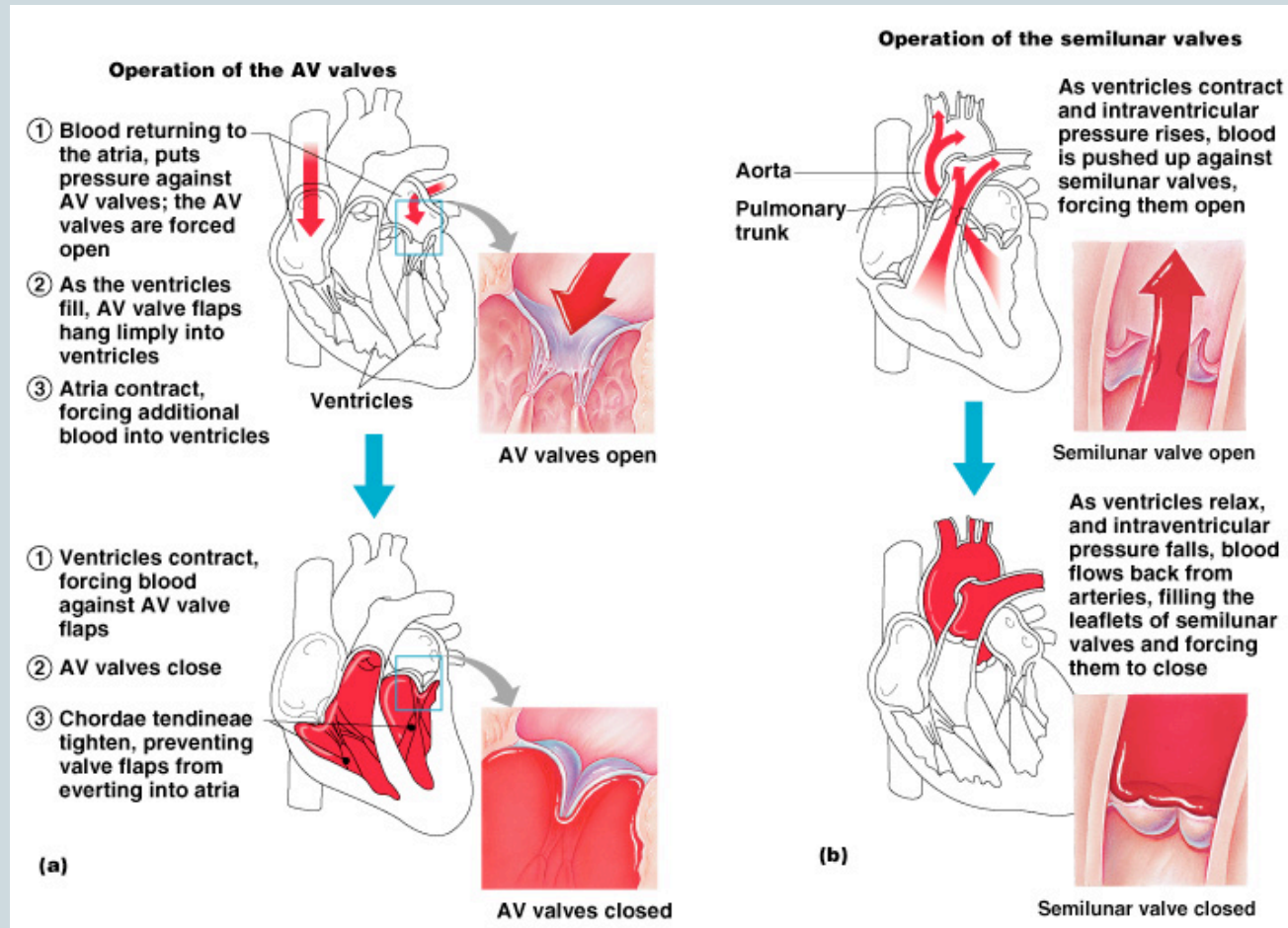


Figure 11.4

The Heart: Associated Great Vessels



- **Aorta**
 - Leaves left ventricle
- **Pulmonary arteries**
 - Leave right ventricle
- **Vena cava (Superior or Inferior)**
 - Enters right atrium
- **Pulmonary veins (four)**
 - Enter left atrium

Coronary Circulation



- Blood in the heart chambers does not nourish the myocardium
- The heart has its own nourishing circulatory system
 - Coronary arteries (clogging causes heart attack)
 - Cardiac veins

The Heart: Conduction System



- **Intrinsic conduction system (nodal system)**
 - Heart muscle cells contract, without nerve impulses, in a regular, continuous way
 - Can be restarted with electrical current

The Heart: Conduction System



- Special tissue sets the pace
 - ✦ Sinoatrial node
 - Pacemaker
 - ✦ Atrioventricular node
 - ✦ Atrioventricular bundle
 - ✦ Bundle branches
 - ✦ Purkinje fibers

Heart Contractions



- Contraction is initiated by the sinoatrial node
- Sequential stimulation occurs at other autorhythmic cells

Heart Contractions

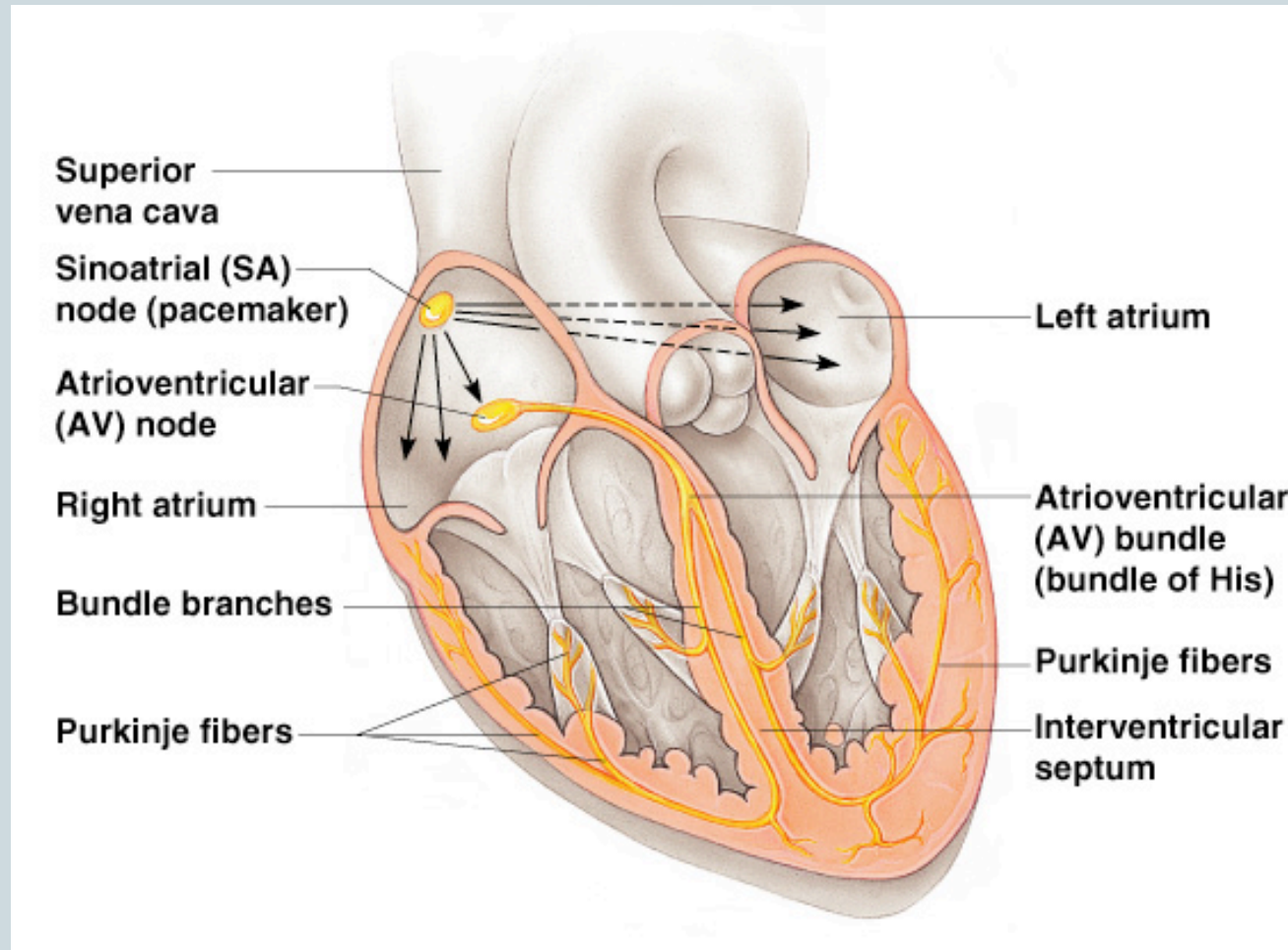


Figure 11.5

Filling of Heart Chambers – The Cardiac Cycle

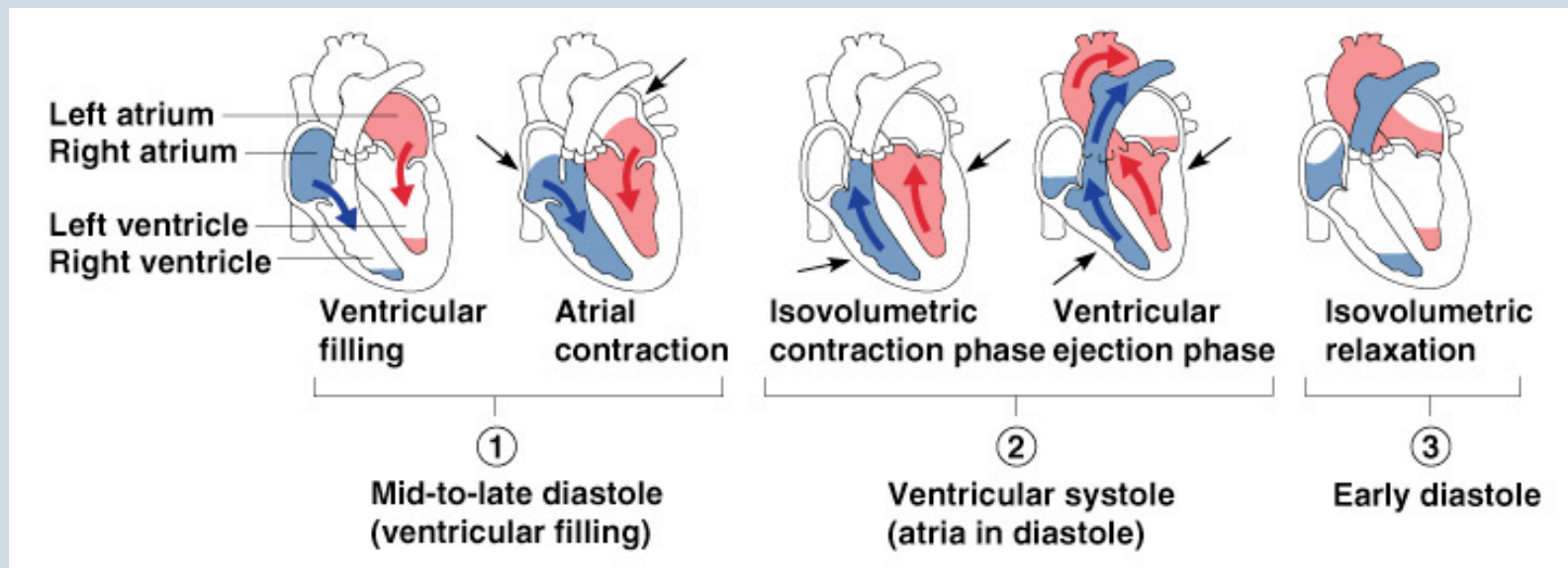


Figure 11.6

The Heart: Cardiac Cycle



- Atria contract simultaneously
- Atria relax, then ventricles contract
- Systole = contraction
- Diastole = relaxation

The Heart: Cardiac Cycle



- **Cardiac cycle – events of one complete heart beat**
 - Mid-to-late diastole – blood flows into ventricles
 - Ventricular systole – blood pressure builds before ventricle contracts, pushing out blood
 - Early diastole – atria finish re-filling, ventricular pressure is low

The Heart: Cardiac Output



- **Cardiac output (CO)**
 - Amount of blood pumped by each side of the heart in one minute
 - $CO = (\text{heart rate [HR]}) \times (\text{stroke volume [SV]})$
- **Stroke volume**
 - Volume of blood pumped by each ventricle in one contraction

Cardiac Output Regulation

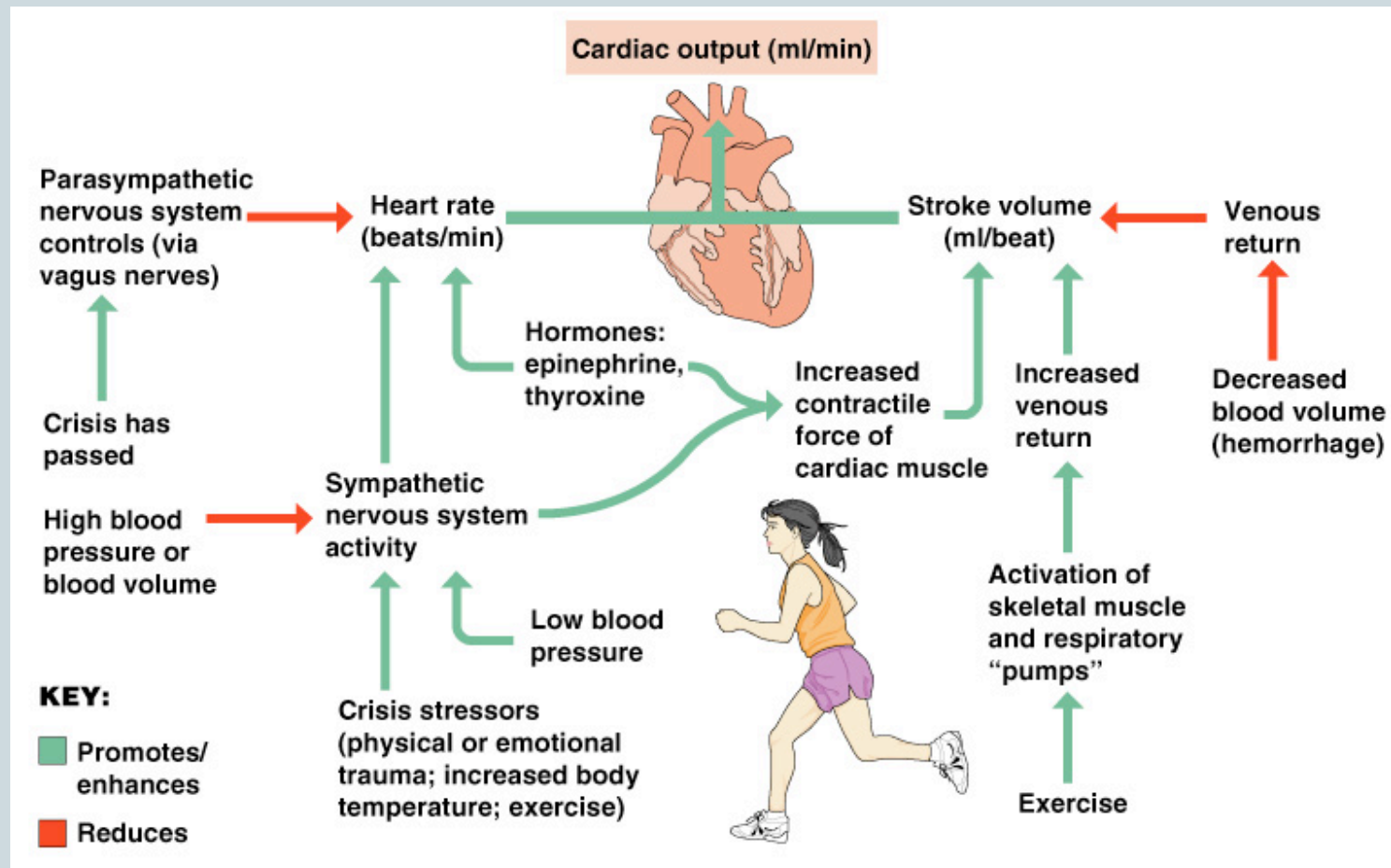


Figure 11.7