The Cardiovascular System

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
  - Less than 1 lb.

The Heart

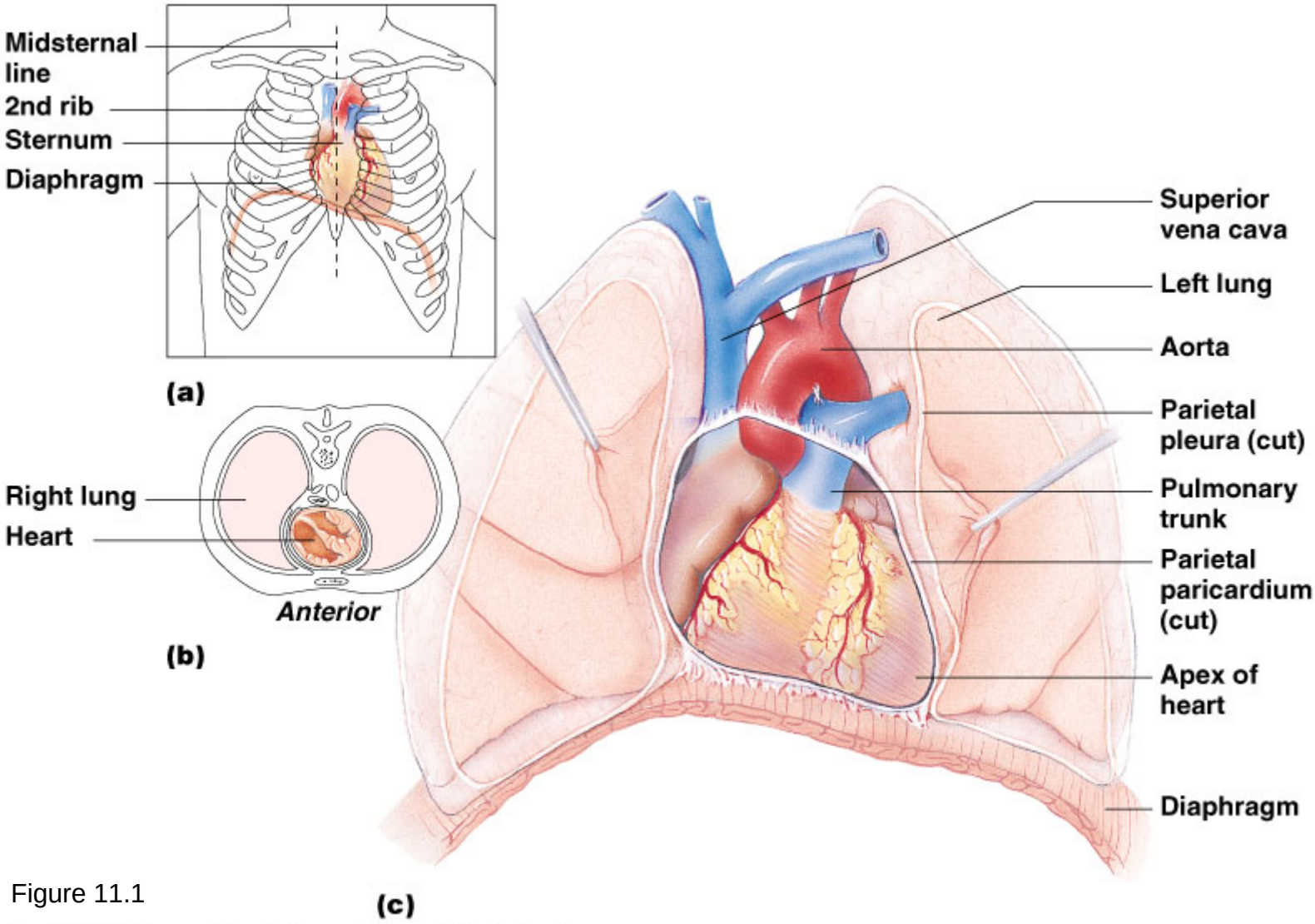


Figure 11.1

The Heart: Coverings

- Pericardium – a double serous membrane
  - Visceral pericardium
    - Next to heart
  - Parietal pericardium
    - Outside layer
- Serous fluid fills the space between the layers of pericardium

The Heart: Heart Wall

- Three layers
  - Epicardium
    - Outside layer
    - This layer is the parietal pericardium
    - Connective tissue layer
  - Myocardium
    - Middle layer
    - Mostly cardiac muscle
  - Endocardium
    - Inner layer
    - Endothelium

External Heart Anatomy

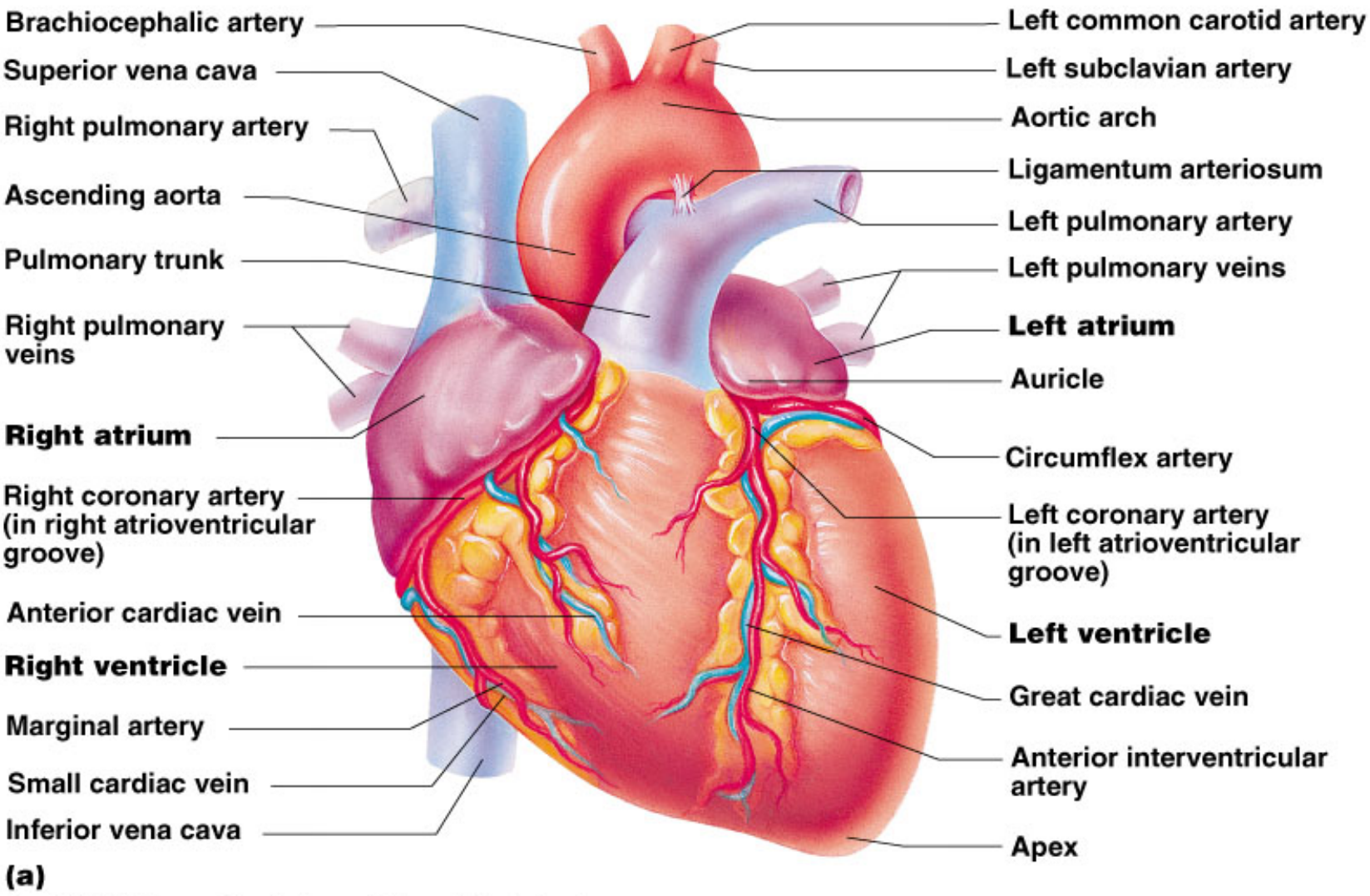


Figure 11.2a

The Heart: Chambers

- Right and left side act as separate pumps
- Four chambers
  - Atria
    - Receiving chambers
      - Right atrium
      - Left atrium
  - Ventricles
    - Discharging chambers
      - Right ventricle
      - Left ventricle

Blood Circulation

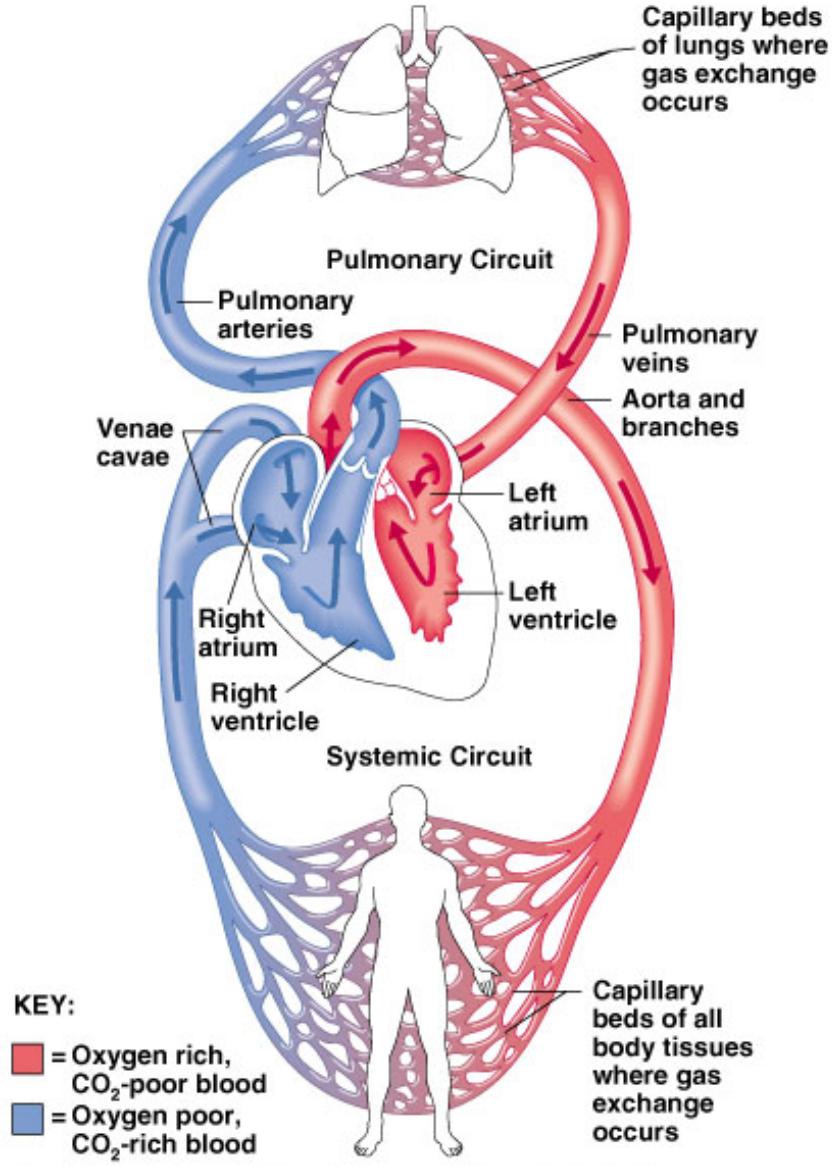


Figure 11.3

The Heart: Valves

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

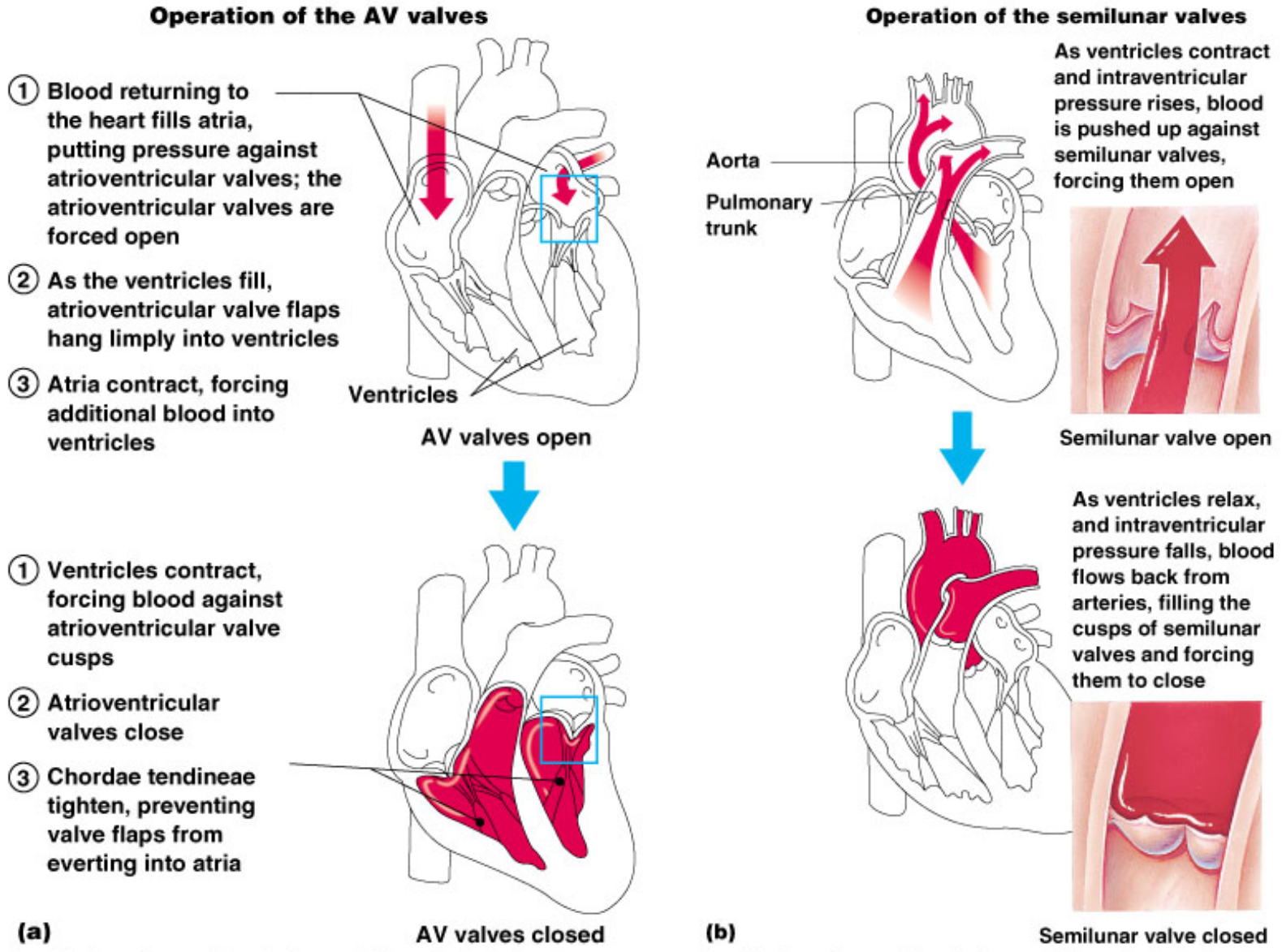


Figure 11.4

Valve Pathology

- Incompetent valve = backflow and repump
- Stenosis = stiff= heart workload increased
- May be replaced
- Lup Dub Heart Sound

The Heart: Associated Great Vessels

- Aorta
  - Leaves left ventricle
- Pulmonary arteries
  - Leave right ventricle
- Vena cava
  - 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
  - Cardiac veins
  - Blood empties into the right atrium via the coronary sinus

Cardiac Pathology

- Rapid heart beat
- = Inadequate blood
- = Angina Pectoris

The Heart: Conduction System

- Intrinsic conduction system (nodal system)
  - Heart muscle cells contract, without nerve impulses, in a regular, continuous way

The Heart: Conduction System

- Special tissue sets the pace
  - Sinoatrial node (right atrium)
    - Pacemaker
  - Atrioventricular node (junction of r&l atria and ventricles)
  - Atrioventricular bundle (Bundle of His)
  - Bundle branches (right and left)
  - Purkinje fibers

Heart Contractions

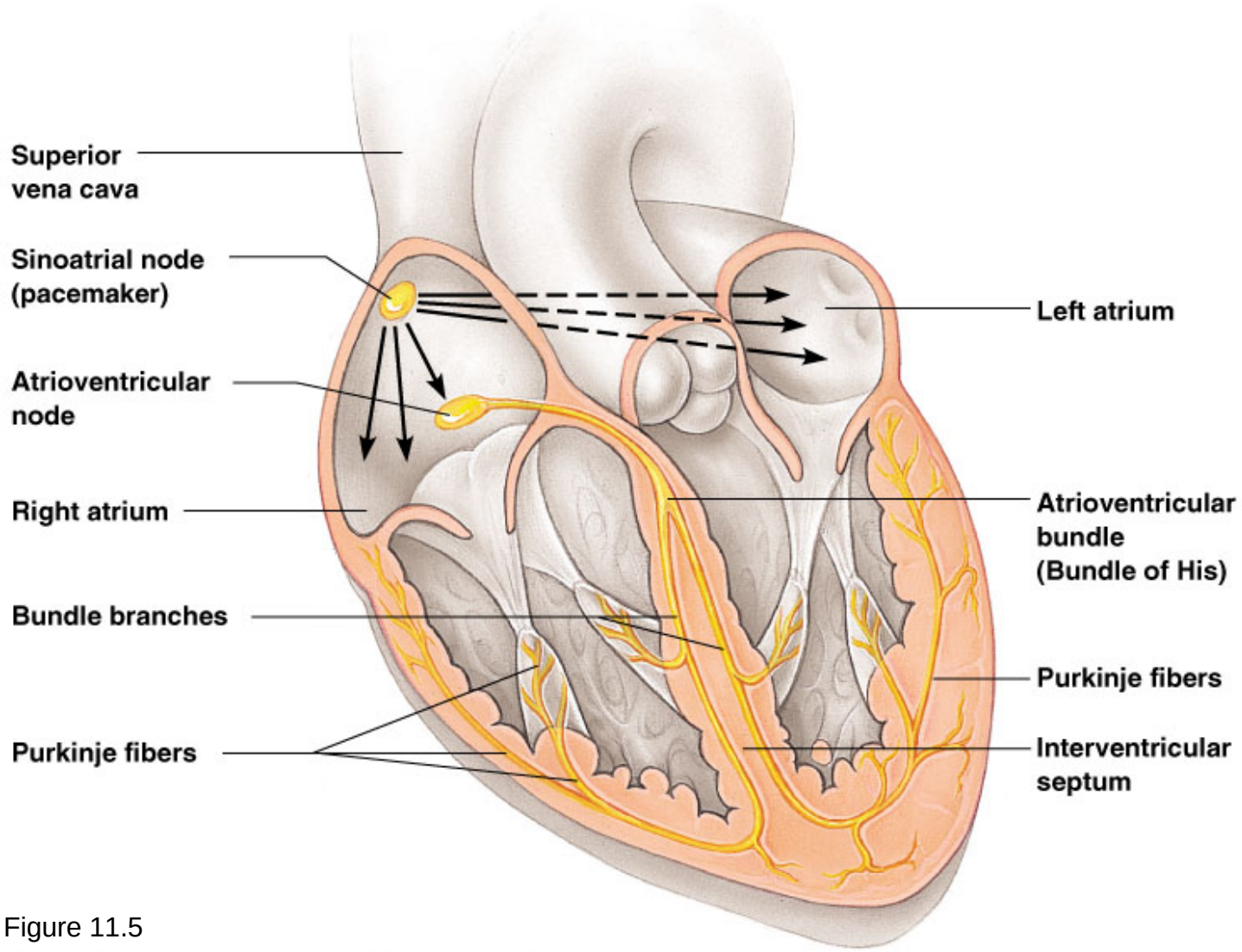
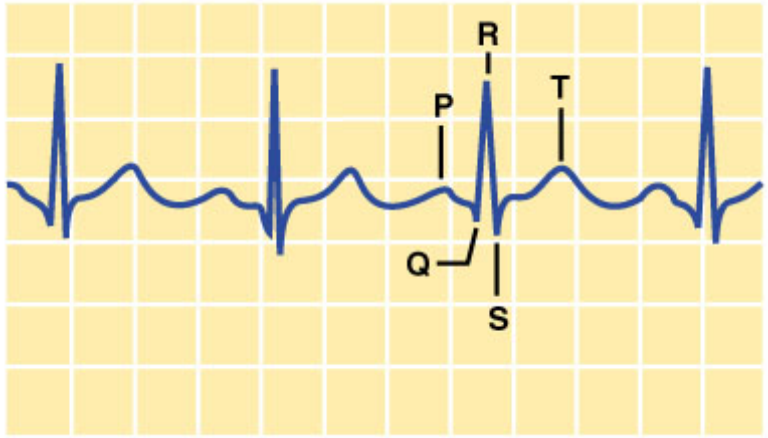


Figure 11.5

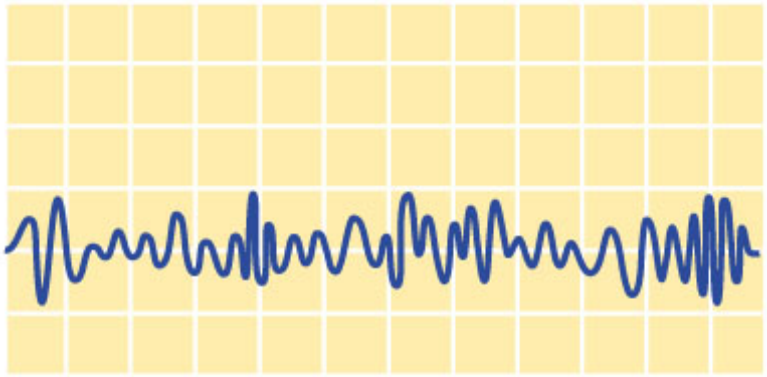
Electrocardiograms (EKG/ECG)

- Three formations
  - P wave: impulse across atria
  - QRS complex: spread of impulse down septum, around ventricles in Purkinje fibers
  - T wave: end of electrical activity in ventricles

Electrocardiograms (EKG/ECG) (*cont.*)



(b) A normal ECG recording



(c) Ventricular fibrillation

Figure 8.15B, C

Pathology of the Heart

- Damage to AV node = release of ventricles from control = slower heart beat
- Slower heart beat can lead to fibrillation
- Fibrillation = lack of blood flow to the heart
- Tachycardia = more than 100 beats/min
- Bradychardia = less than 60 beats/min

The Heart: Cardiac Cycle

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

Filling of Heart Chambers – the Cardiac Cycle

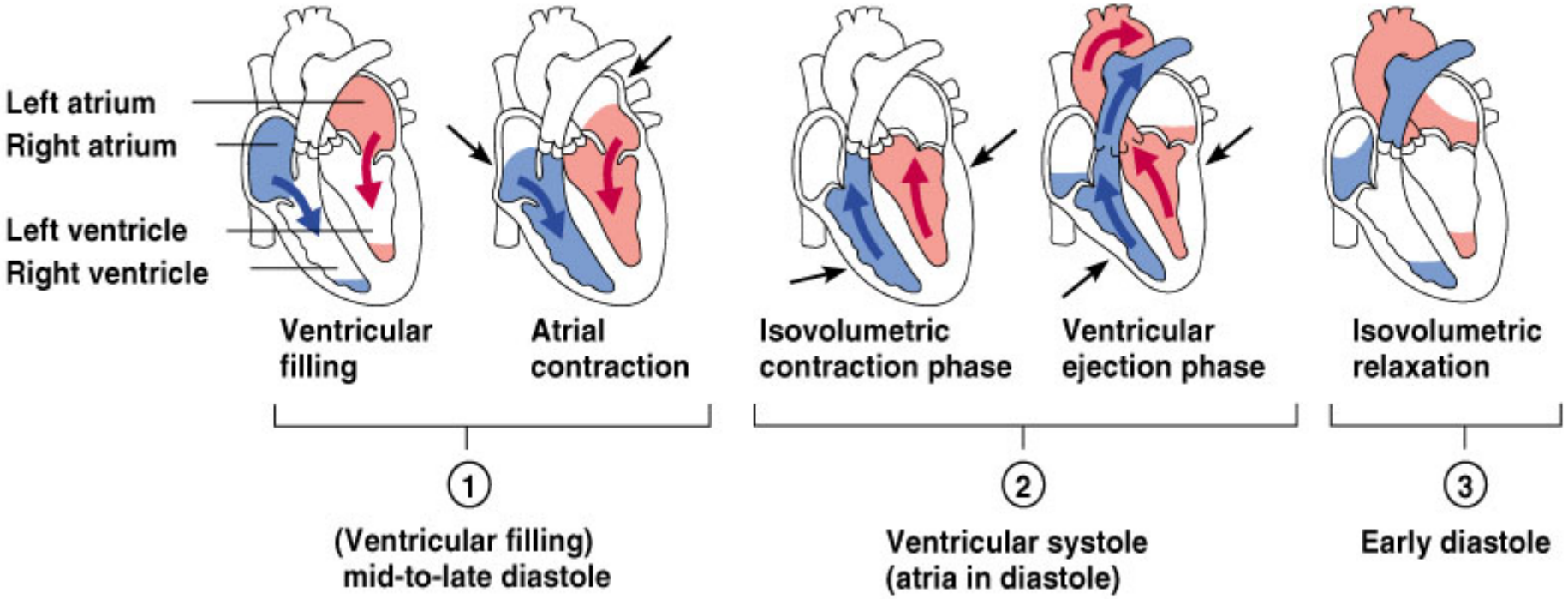


Figure 11.6

The Heart: Cardiac Output

- Cardiac output (CO)
  - Amount of blood pumped by each side of the heart in one minute
  - CO = (heart rate [HR]) x (stroke volume [SV])
- Stroke volume
  - Volume of blood pumped by each ventricle in one contraction

Cardiac output, cont.

- CO = HR x SV
- 5250 ml/min = 75 beats/min x 70 mls/beat
- Norm = 5000 ml/min
- Entire blood supply passes through body once per minute.
- CO varies with demands of the body.

Cardiac Output Regulation

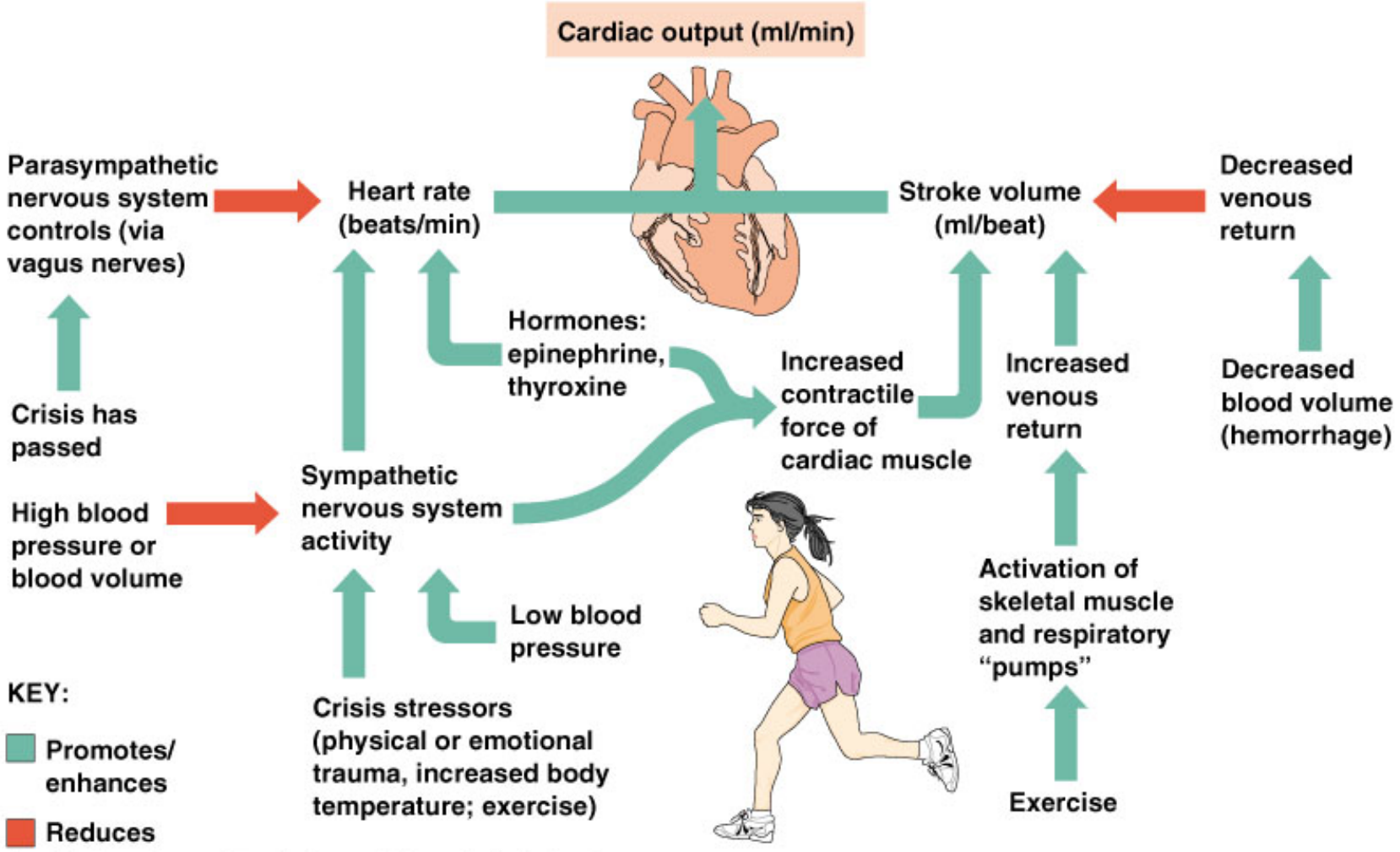


Figure 11.7

The Heart: Regulation of Heart Rate

- Stroke volume usually remains relatively constant
  - Starling's law of the heart – the more that the cardiac muscle is stretched, the stronger the contraction
- Changing heart rate is the most common way to change cardiac output

Regulation of Heart Rate

- Increased heart rate
  - Sympathetic nervous system
    - Crisis
    - Low blood pressure
  - Hormones
    - Epinephrine
    - Thyroxine
  - Exercise
  - Decreased blood volume

The Heart: Regulation of Heart Rate

- Decreased heart rate
  - Parasympathetic nervous system
  - High blood pressure or blood volume
  - Dereased venous return
  - In Congestive Heart Failure the heart is worn out and pumps weakly. Digitalis works to provide a slow, steady, but stronger beat.

Congestive Heart Failure (CHF)

- Decline in pumping efficiency of heart
- Inadequate circulation
- Progressive, also coronary atherosclerosis, high blood pressure and history of multiple Myocardial Infarctions
- Left side fails = pulmonary congestion and suffocation
- Right side fails = peripheral congestion and edema

Blood Vessels: The Vascular System

- Taking blood to the tissues and back
  - Arteries
  - Arterioles
  - Capillaries
  - Venules
  - Veins

The Vascular System

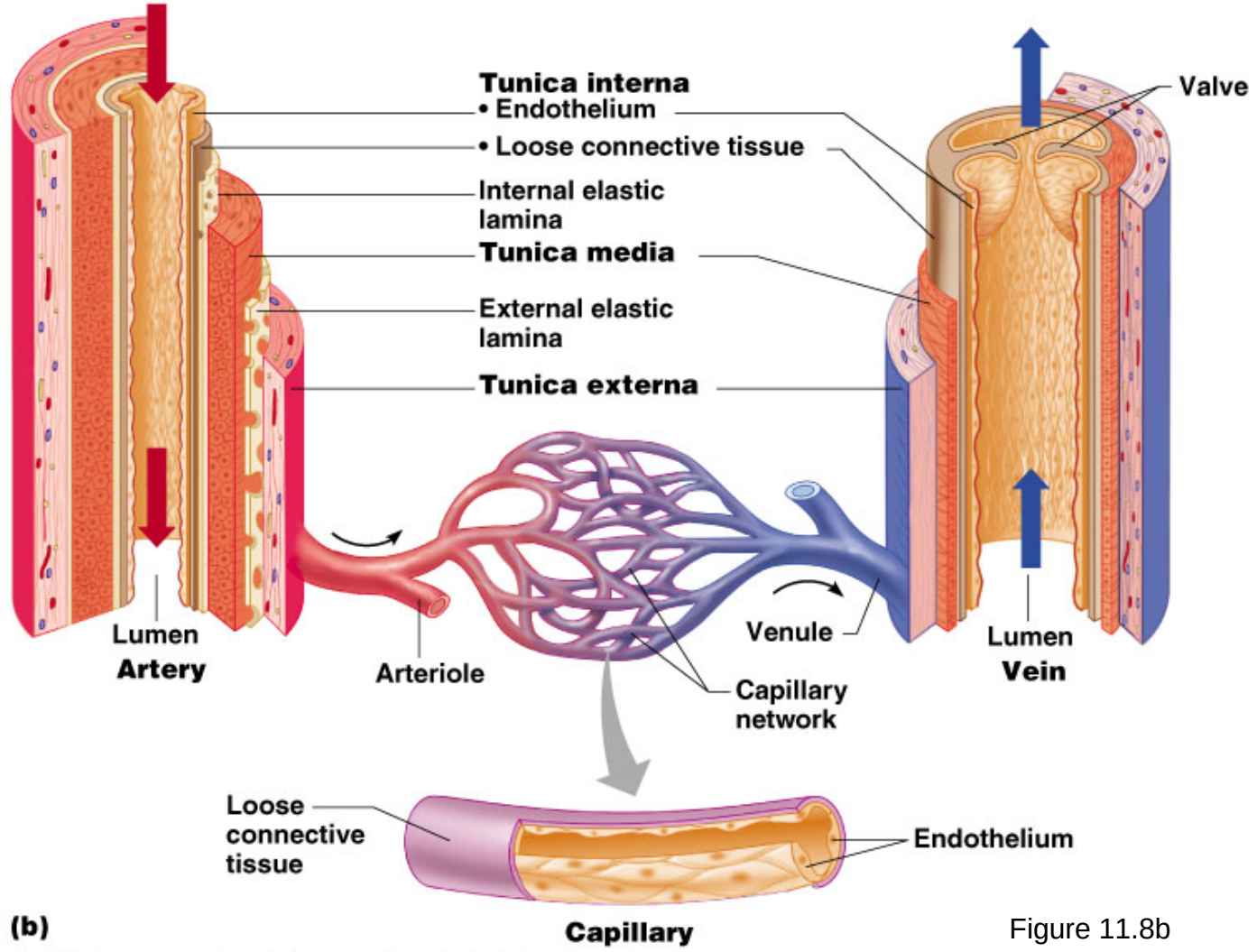


Figure 11.8b

Blood Vessels: Anatomy

- Three layers (tunics)
  - Tunic intima
    - Endothelium
  - Tunic media
    - Smooth muscle
    - Controlled by sympathetic nervous system
  - Tunic externa
    - Mostly fibrous connective tissue

Differences Between Blood Vessel Types

- Walls of arteries are the thickest
- Lumens of veins are larger
- Skeletal muscle “milks” blood in veins toward the heart
- Walls of capillaries are only one cell layer thick to allow for exchanges between blood and tissue

Movement of Blood Through Vessels

- Most arterial blood is pumped by the heart
- Veins use the milking action of muscles to help move blood

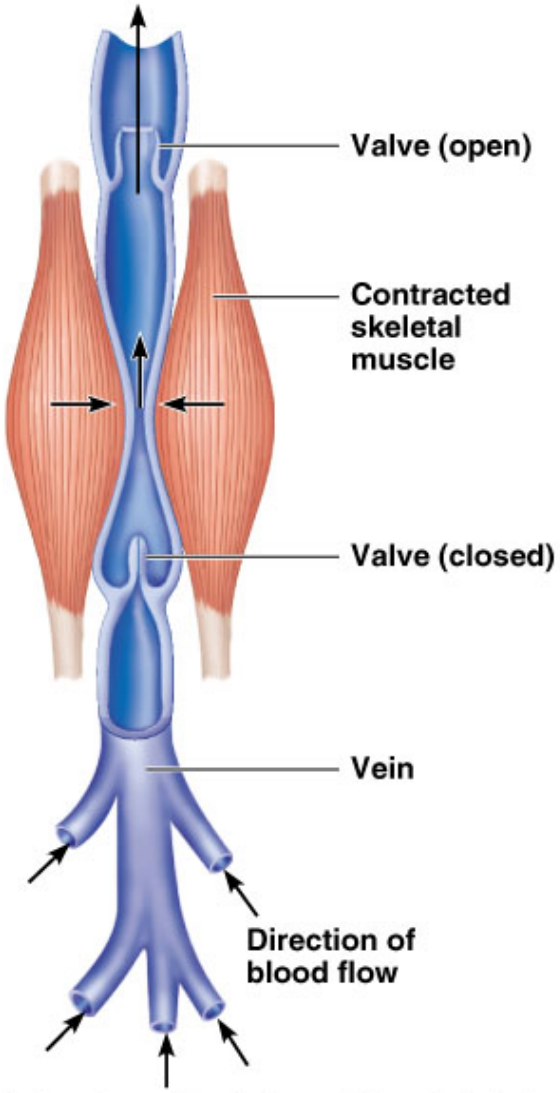


Figure 11.9

Capillary Beds

- Capillary beds consist of two types of vessels
  - Vascular shunt – directly connects an arteriole to a venule

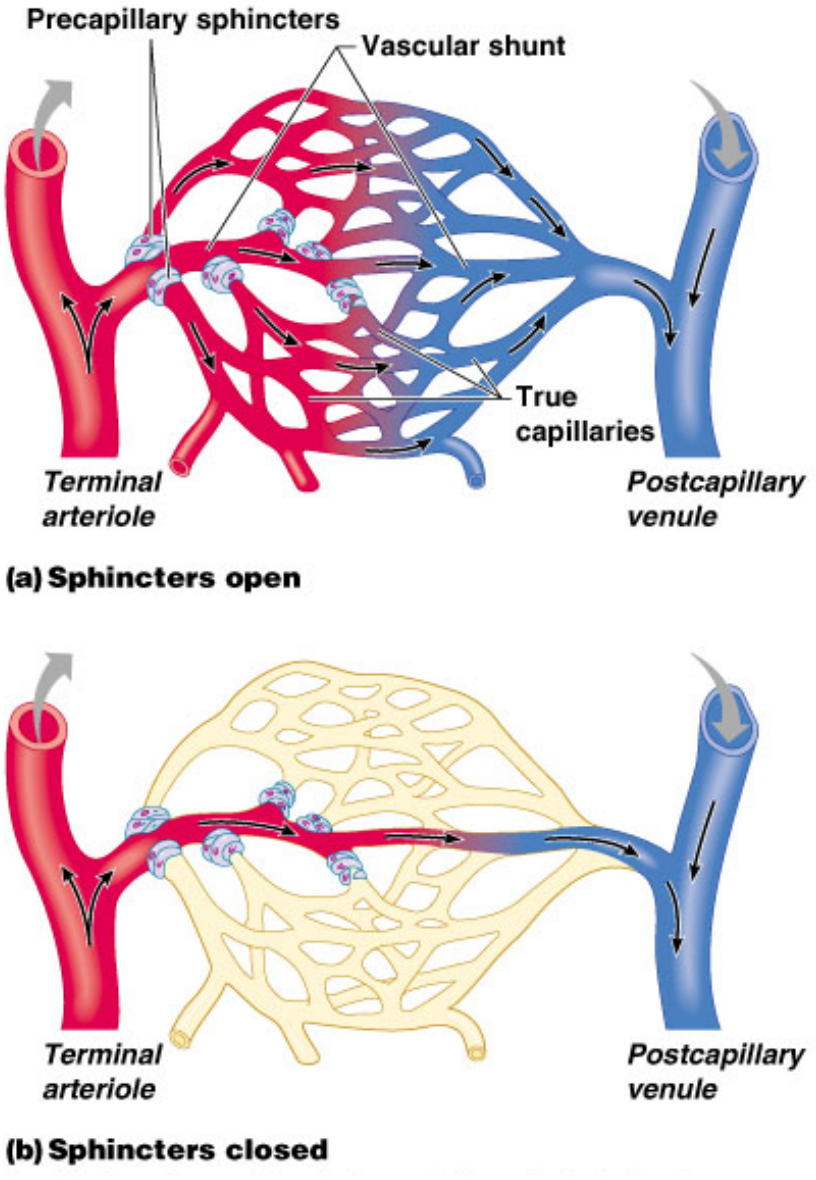


Figure 11.10

Capillary Beds

- True capillaries – exchange vessels
  - Oxygen and nutrients cross to cells
  - Carbon dioxide and metabolic waste products cross into blood

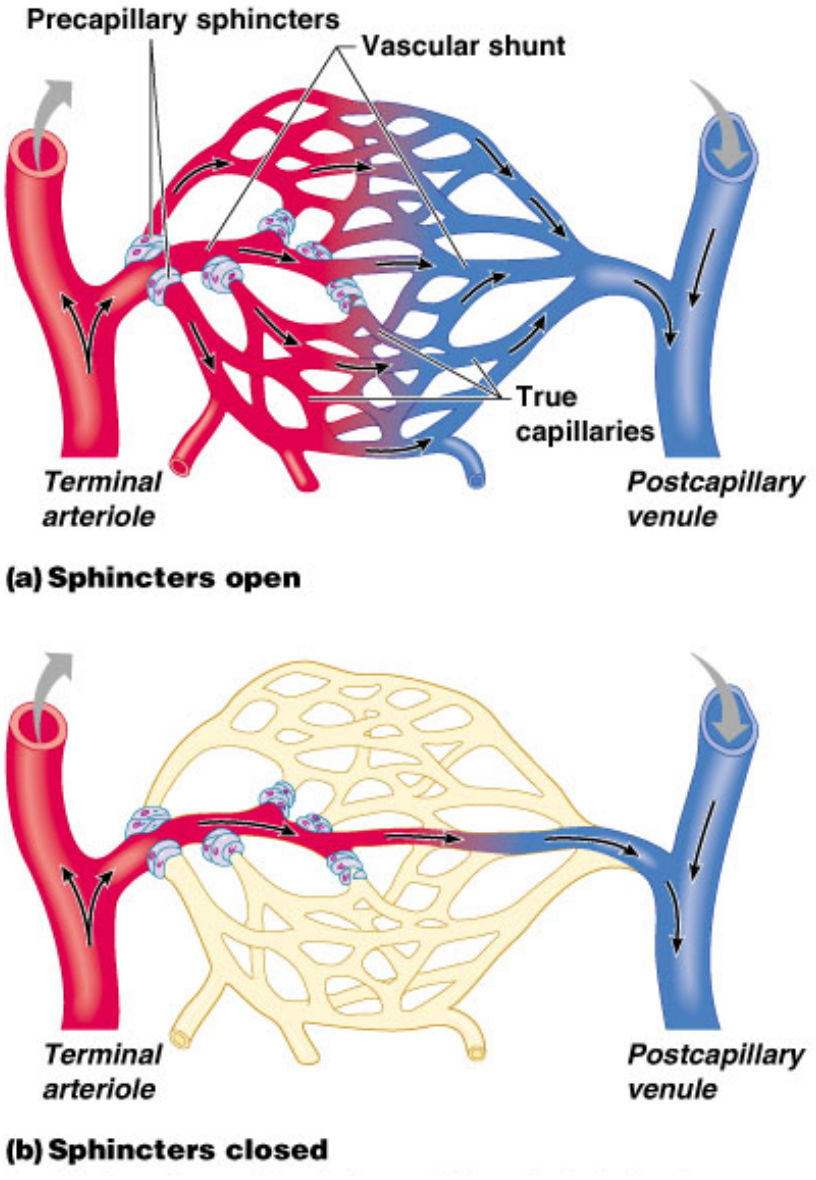


Figure 11.10

Diffusion at Capillary Beds

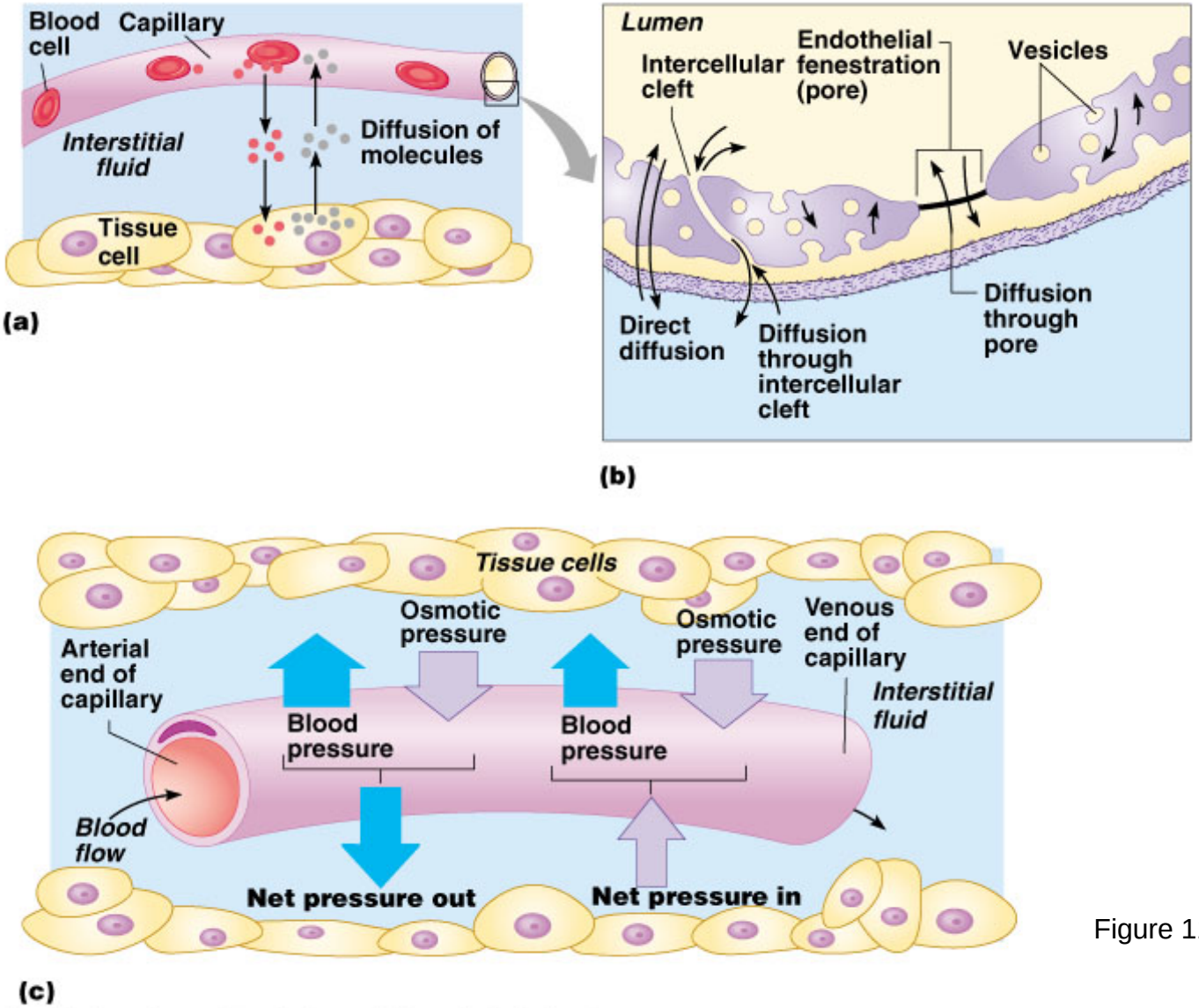


Figure 11.20

Vital Signs

- Arterial pulse
- Blood pressure
- Repiratory Rate
- Body Temperature
- All indicate the efficiency of the system

Pulse

- Pulse – pressure wave of blood
- Monitored at “pressure points” where pulse is easily palpated

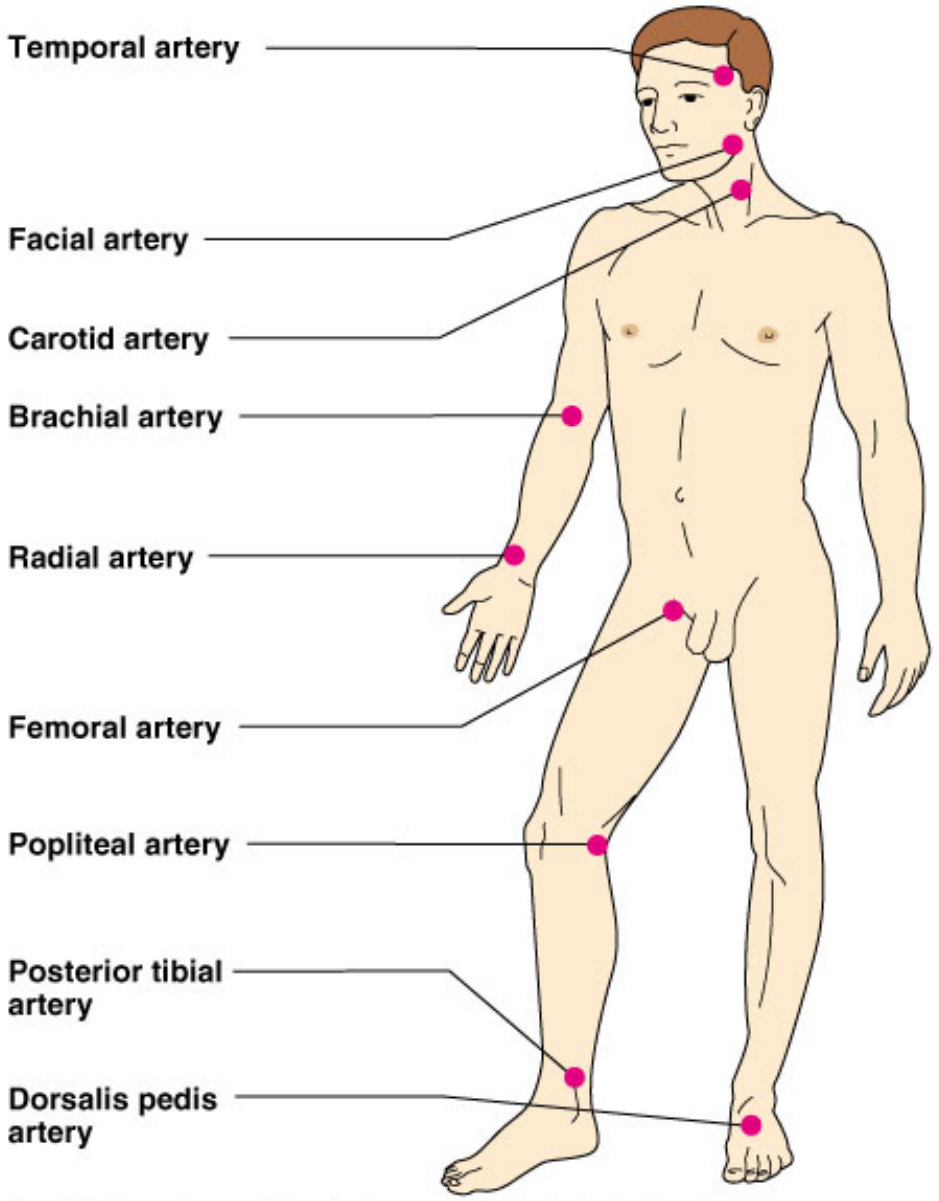


Figure 11.16

Blood Pressure

- Measurements by health professionals are made on the pressure in large arteries
  - Systolic – pressure at the peak of ventricular contraction
  - Diastolic – pressure when ventricles relax
- Pressure in blood vessels decreases as the distance away from the heart increases

Measuring Arterial Blood Pressure

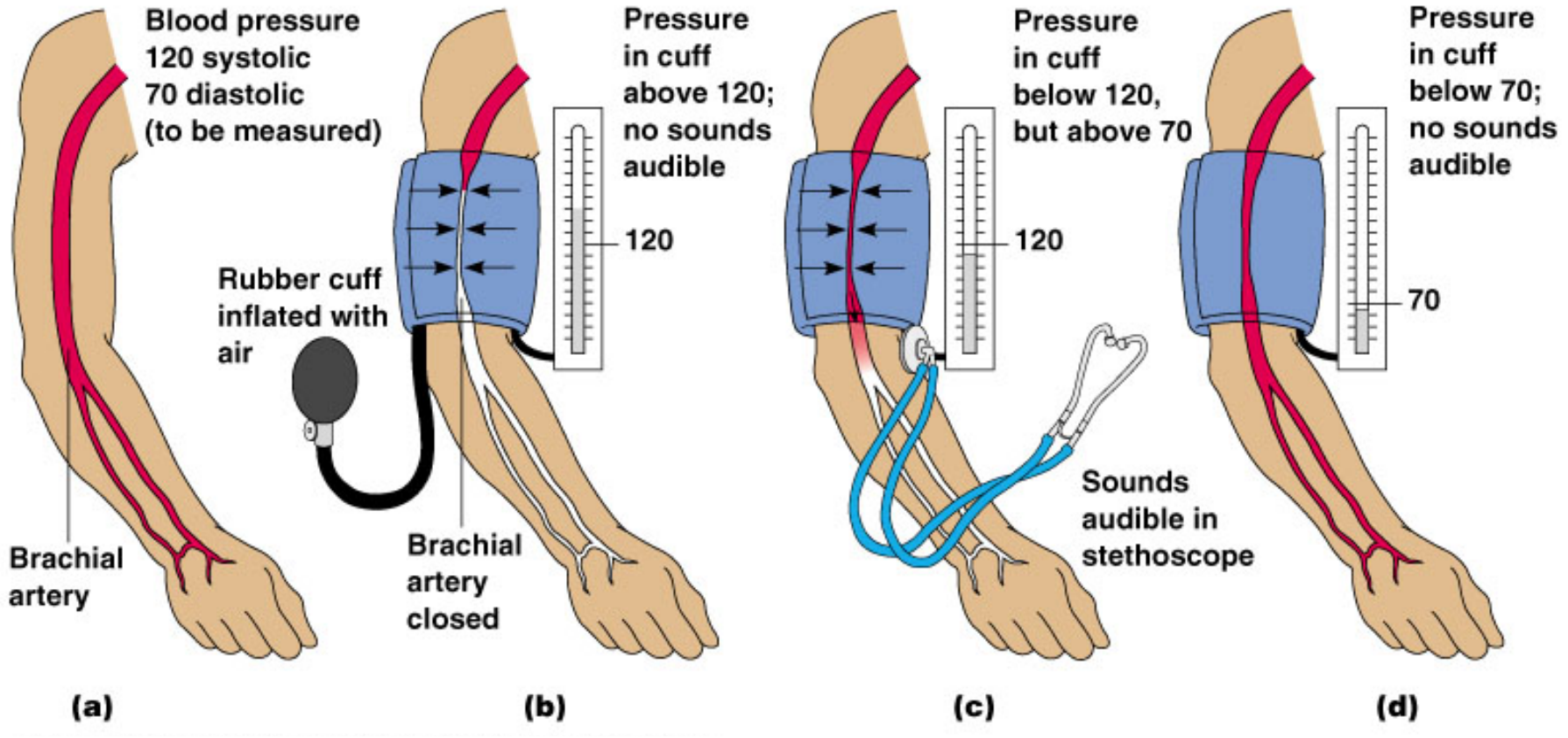


Figure 11.18

Blood Pressure: Effects of Factors

- Neural factors
  - Autonomic nervous system adjustments (sympathetic division)
- Renal factors
  - Regulation by altering blood volume
  - Renin – hormonal control

Blood Pressure: Effects of Factors

- Temperature
  - Heat has a vasodilation effect
  - Cold has a vasoconstricting effect
- Chemicals
  - Various substances can cause increases or decreases
- Diet

Variations in Blood Pressure

- Human normal range is variable
  - Normal
    - 140–110 mm Hg systolic
    - 80–75 mm Hg diastolic
  - Hypotension
    - Low systolic (below 110 mm HG)
    - Often associated with illness
  - Hypertension
    - High systolic (above 140 mm HG)
    - Can be dangerous if it is chronic