Title

- Blood

Essential Question

- Describe the structure and function of blood tissue.

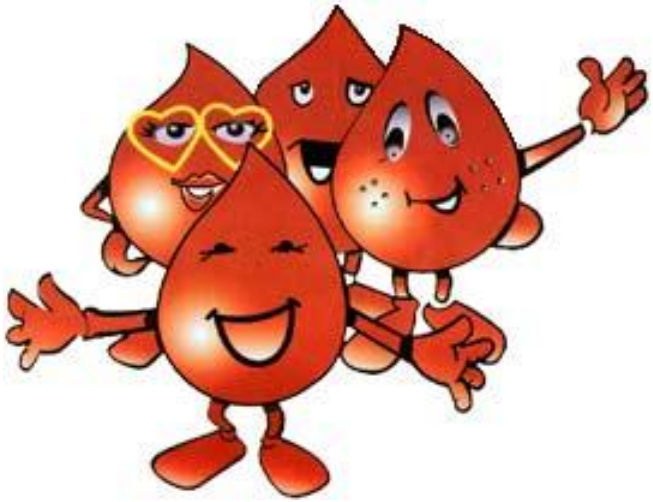
Essentials of Human Anatomy & Physiology

Seventh Edition

Elaine N. Marieb

Chapter 10

Blood



Lecture Slides in PowerPoint by Jerry L. Cook

Blood

Characteristics

- Fluid connective tissue composed of:
  - Living cells = formed elements
  - Non-living matrix = plasma

Blood

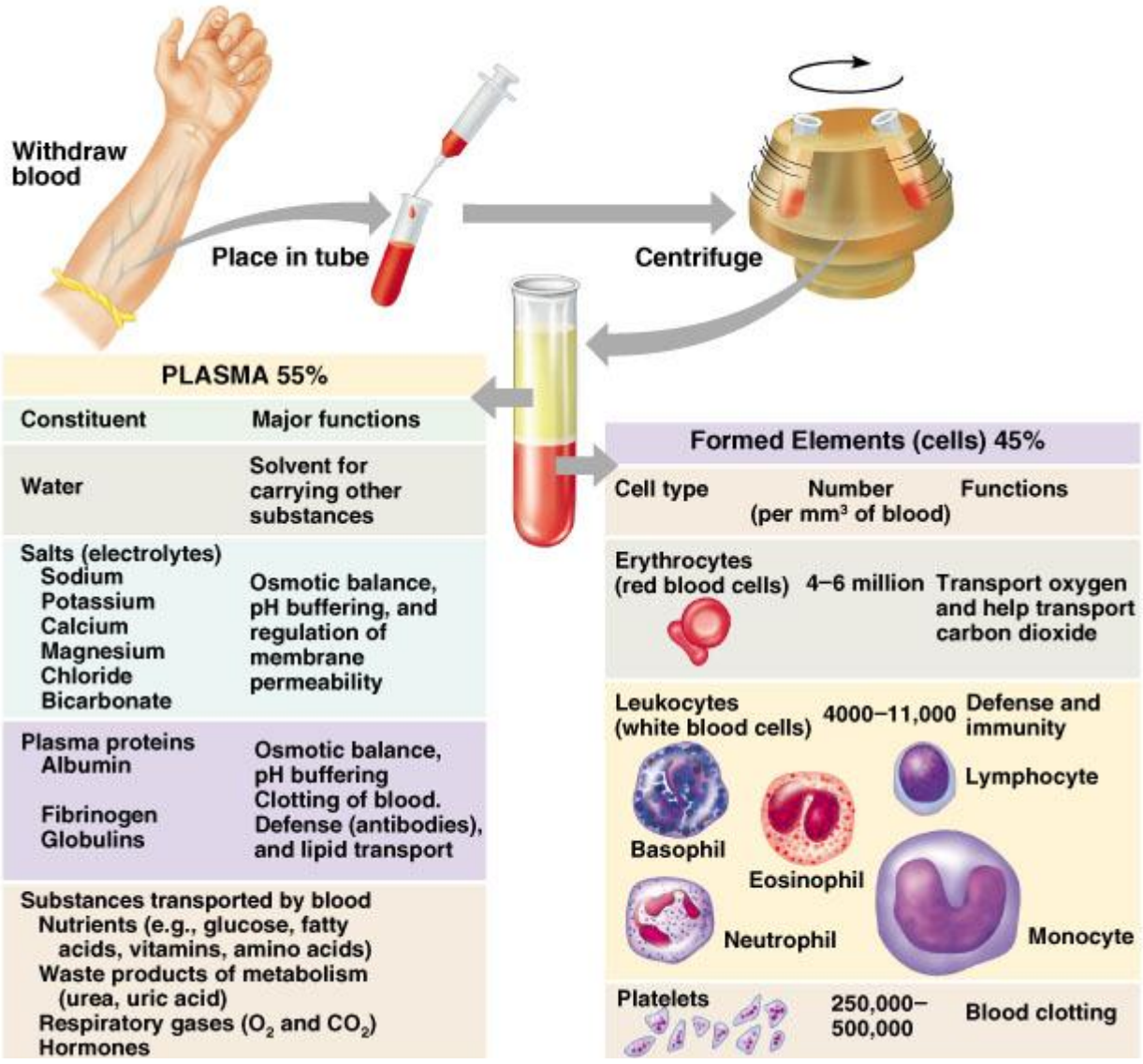


Figure 10.1

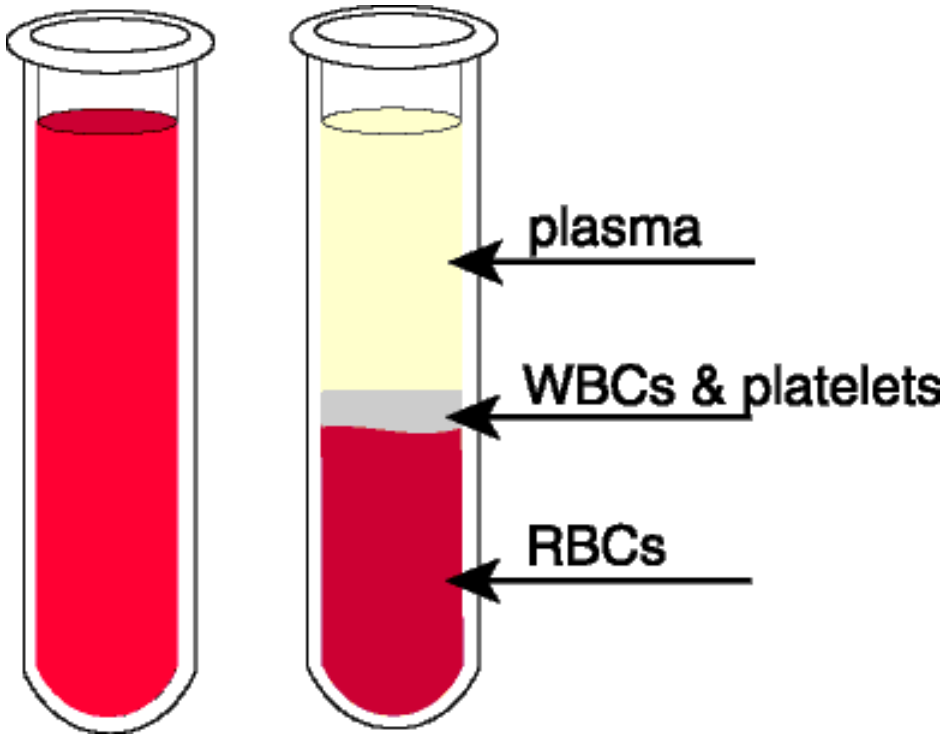
Physical Characteristics of Blood

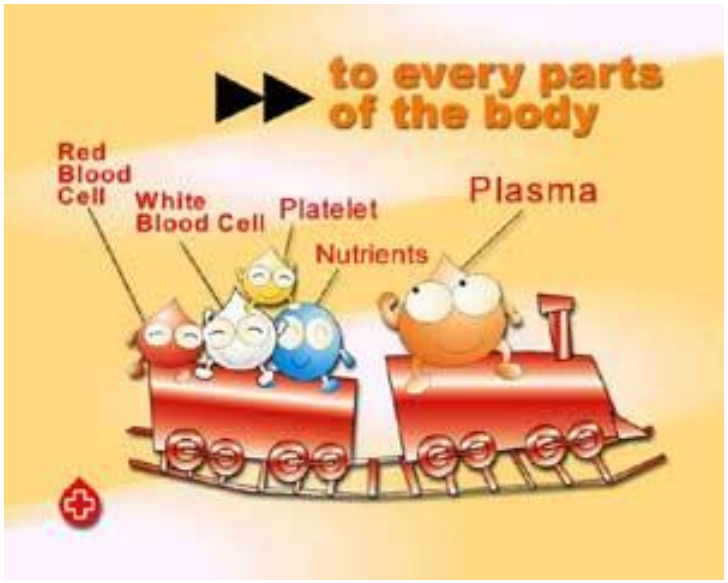
- Color range is scarlet red to dull red depending on O_2
- pH 7.35–7.45
- Blood temp. is slightly higher than body temp.

Blood Plasma

- 90 percent water
- Dissolved substances
  - Nutrients
  - Salts
  - Respiratory gases
  - Hormones
  - Proteins
  - Waste products

PLASMA


plasma
WBCs & platelets
RBCs


to every parts of the body
Red Blood Cell
White Blood Cell
Platelet
Nutrients
Plasma

Plasma Proteins

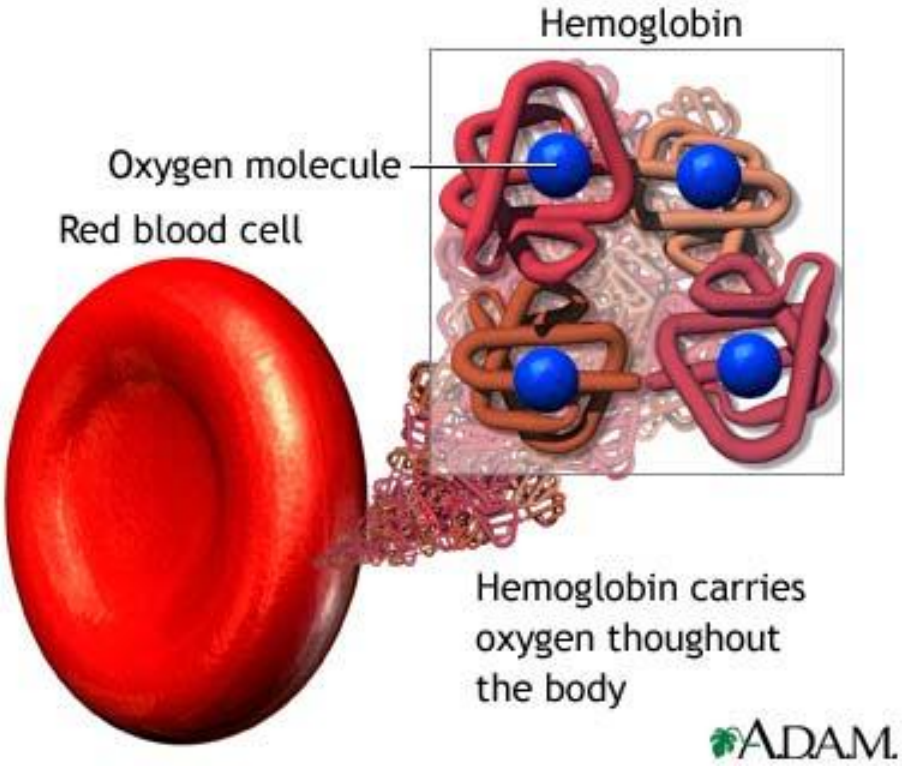
- Albumin – regulates osmotic pressure
- Clotting proteins
- Antibodies – immune cell

Formed Elements

- Erythrocytes = red blood cells made up of hemoglobin

LAWRENCE OF ANAEMIA

HEMOGLOBIN


Hemoglobin
Oxygen molecule
Red blood cell
Hemoglobin carries oxygen thoughout the body
A.D.A.M.

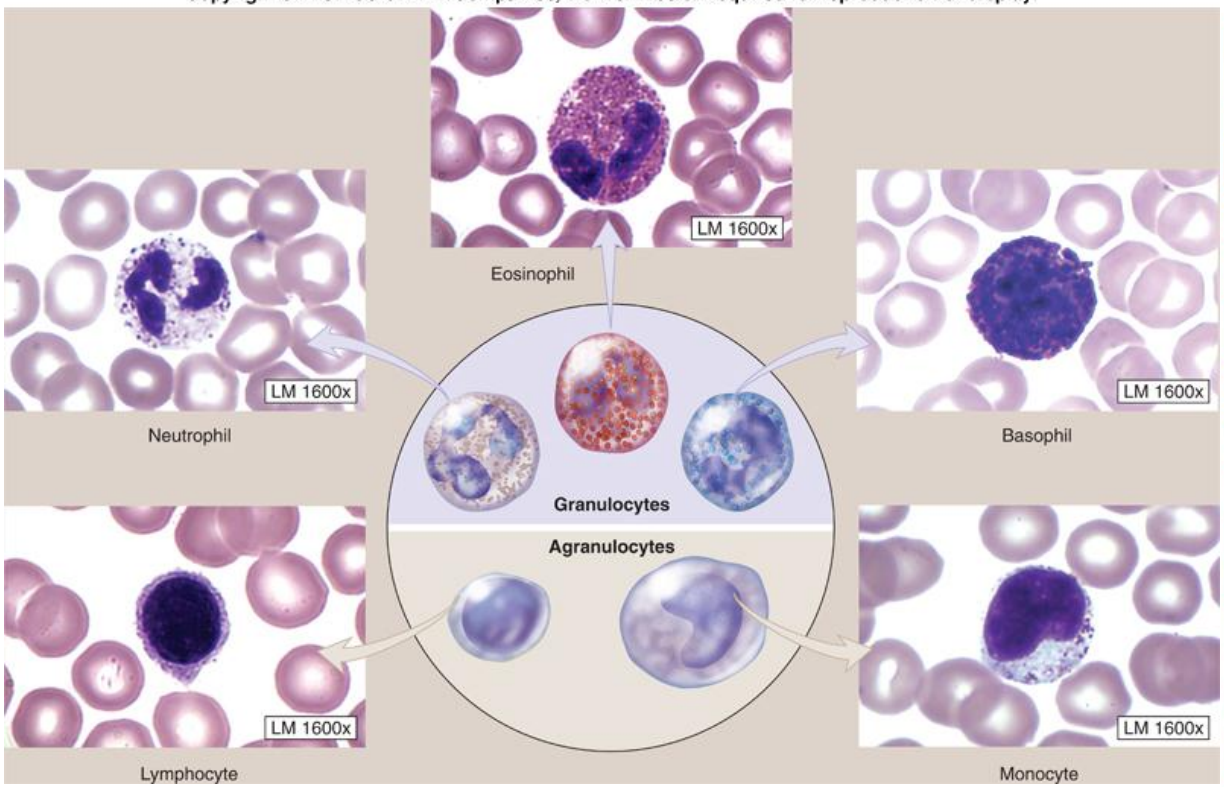
Hemoglobin

- Iron-containing protein
- Binds strongly, but reversibly, to oxygen
- has four oxygen binding sites
- Each RBC has 250 million hemoglobin molecules

Formed Elements

- Leukocytes = white blood cells

Leukocytes



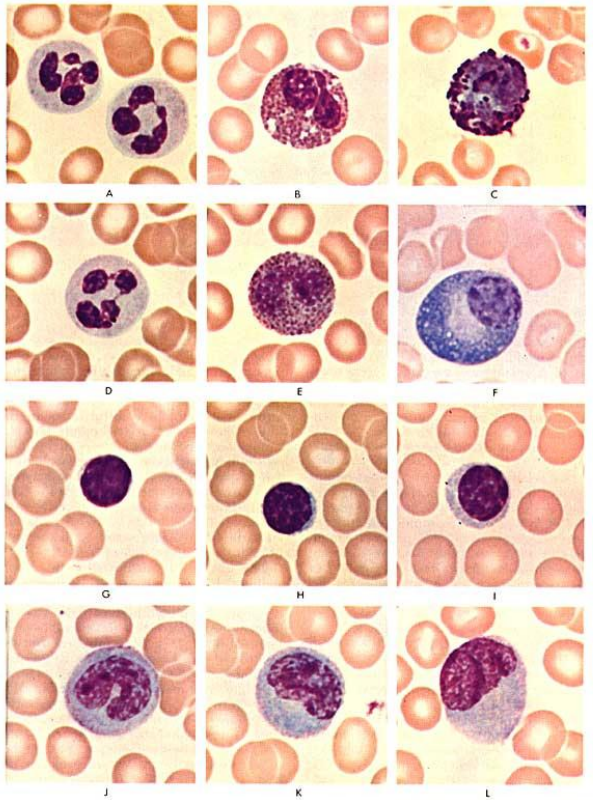


Figure 4–7. Human blood cells form a smear after Wright's stain. *A* and *D*, Neutrophilic leukocytes. *B* and *E*, Eosinophilic leukocytes. *C*, Basophilic leukocyte. *F*, Plasma cell; this is not a normal constituent of the peripheral blood but is included here for comparison with the nongranular leukocytes. *G* and *H*, Small lymphocytes. *I*, Medium lymphocytes. *J*, *K*, and *L*, Monocytes.

Types of Leukocytes

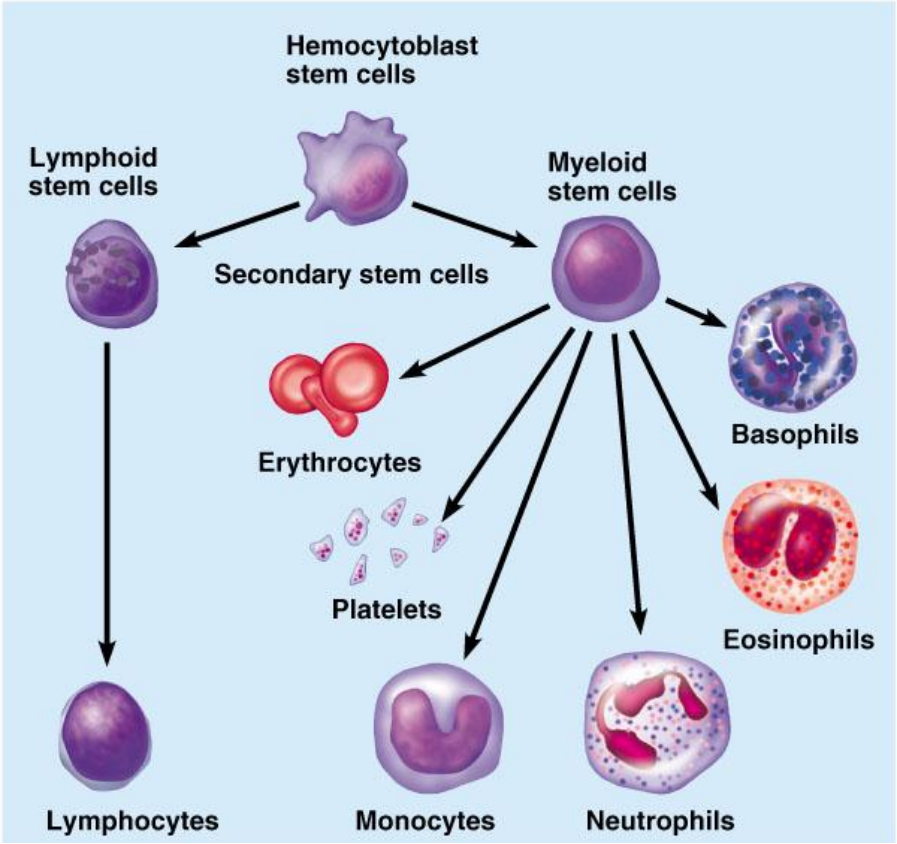


Figure 10.4

Leukocyte Levels in the Blood

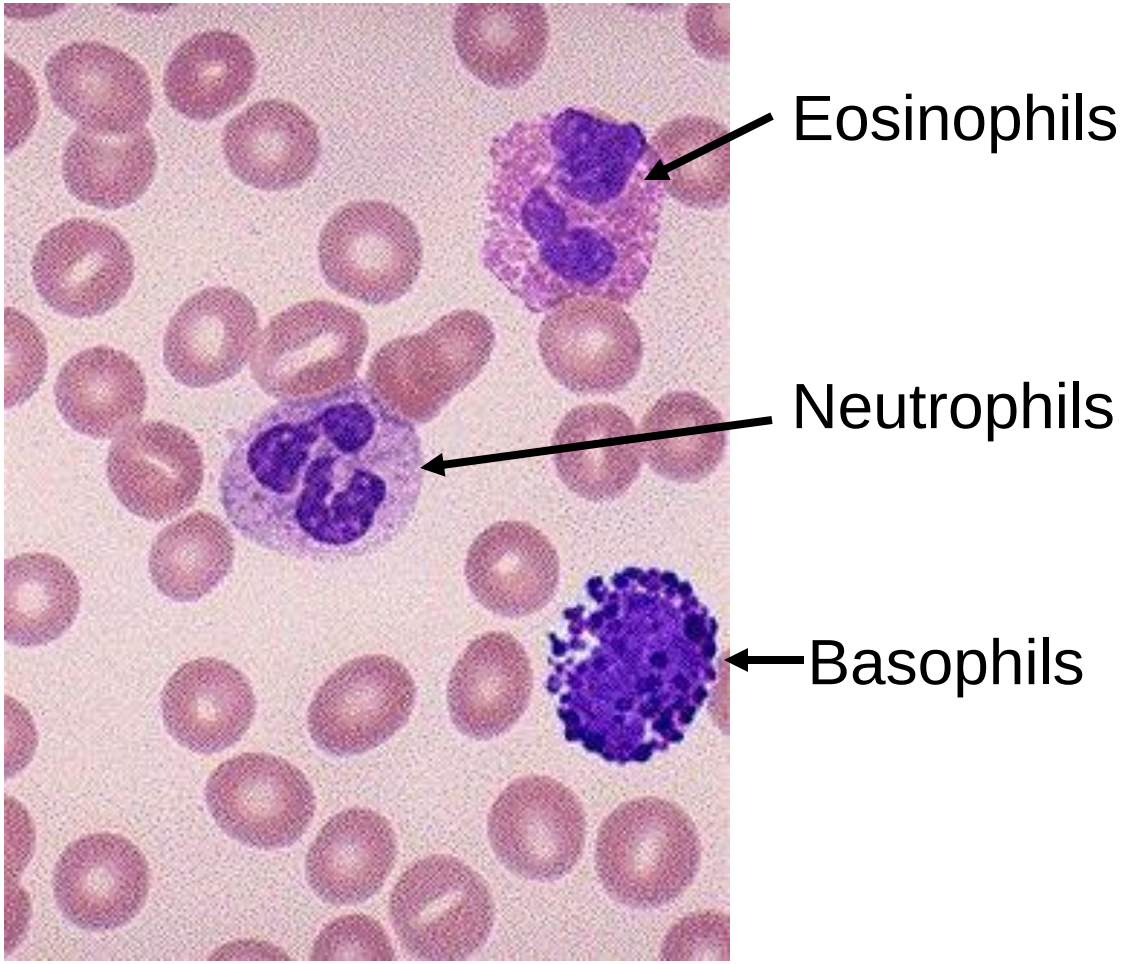
- Normal levels
  - Between 4,000 and 11,000 cells/mm^3

Leukocyte Levels in the Blood

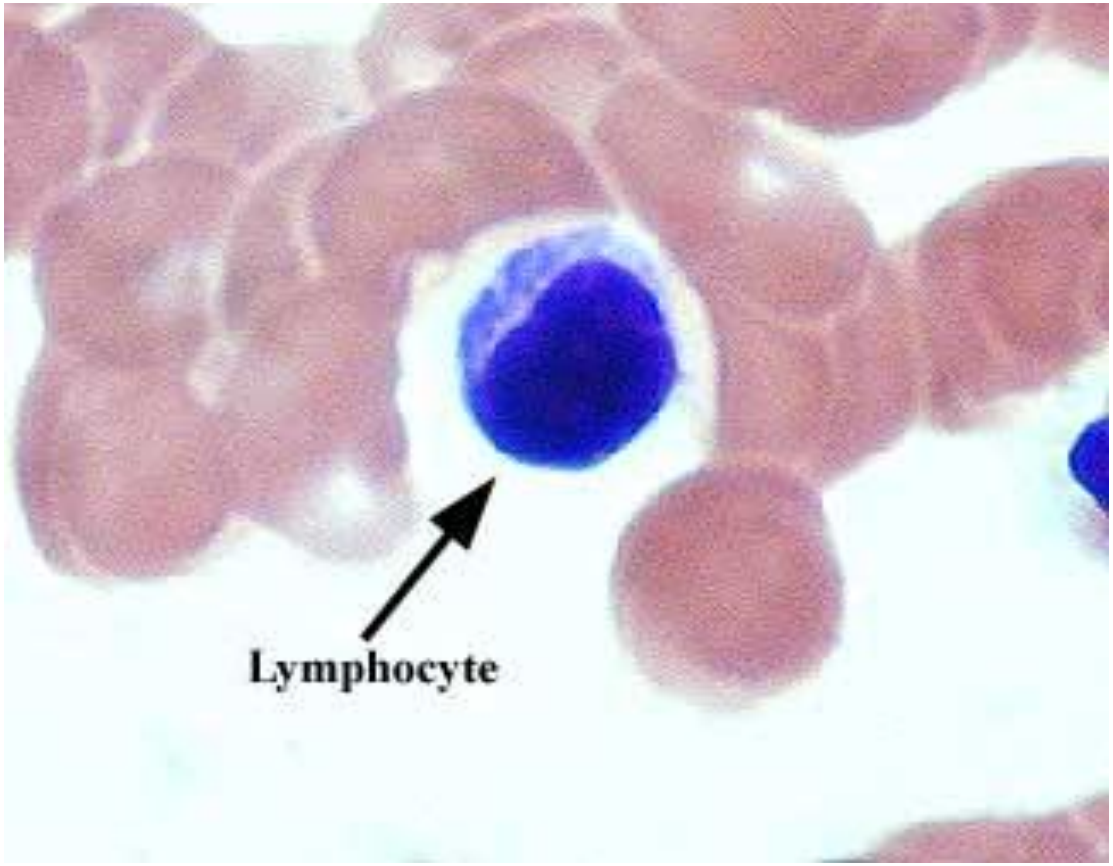
- Abnormal leukocyte levels
  - Leukocytosis
    - Above 11,000 leukocytes/mm^3
    - Generally indicates an infection

Leukocyte Levels in the Blood

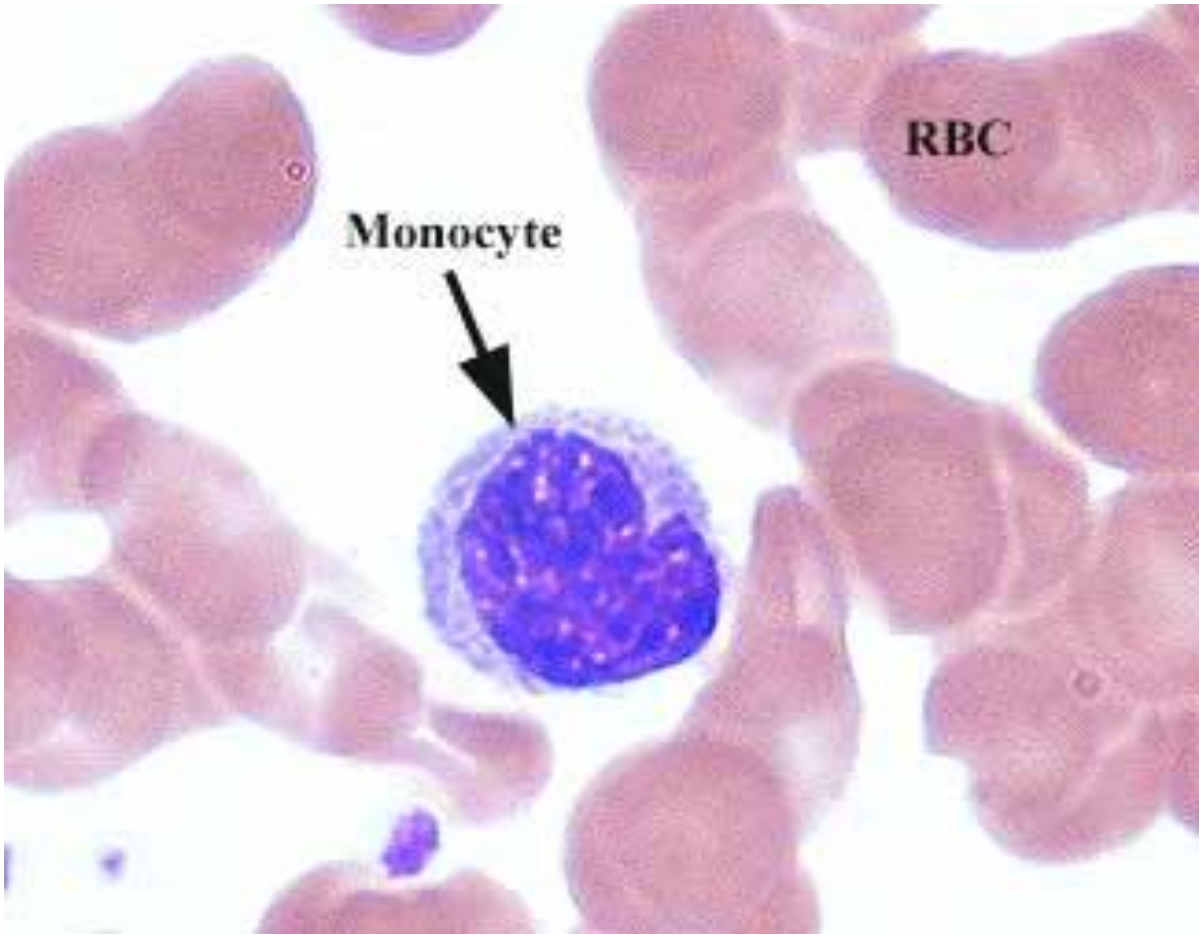
- Abnormal leukocyte levels
  - Leukopenia
    - Abnormally low leukocyte level
    - Commonly caused by certain drugs


Eosinophils
Neutrophils
Basophils

Agranulocytes - Lymphocytes



Agranulocytes - Monocytes



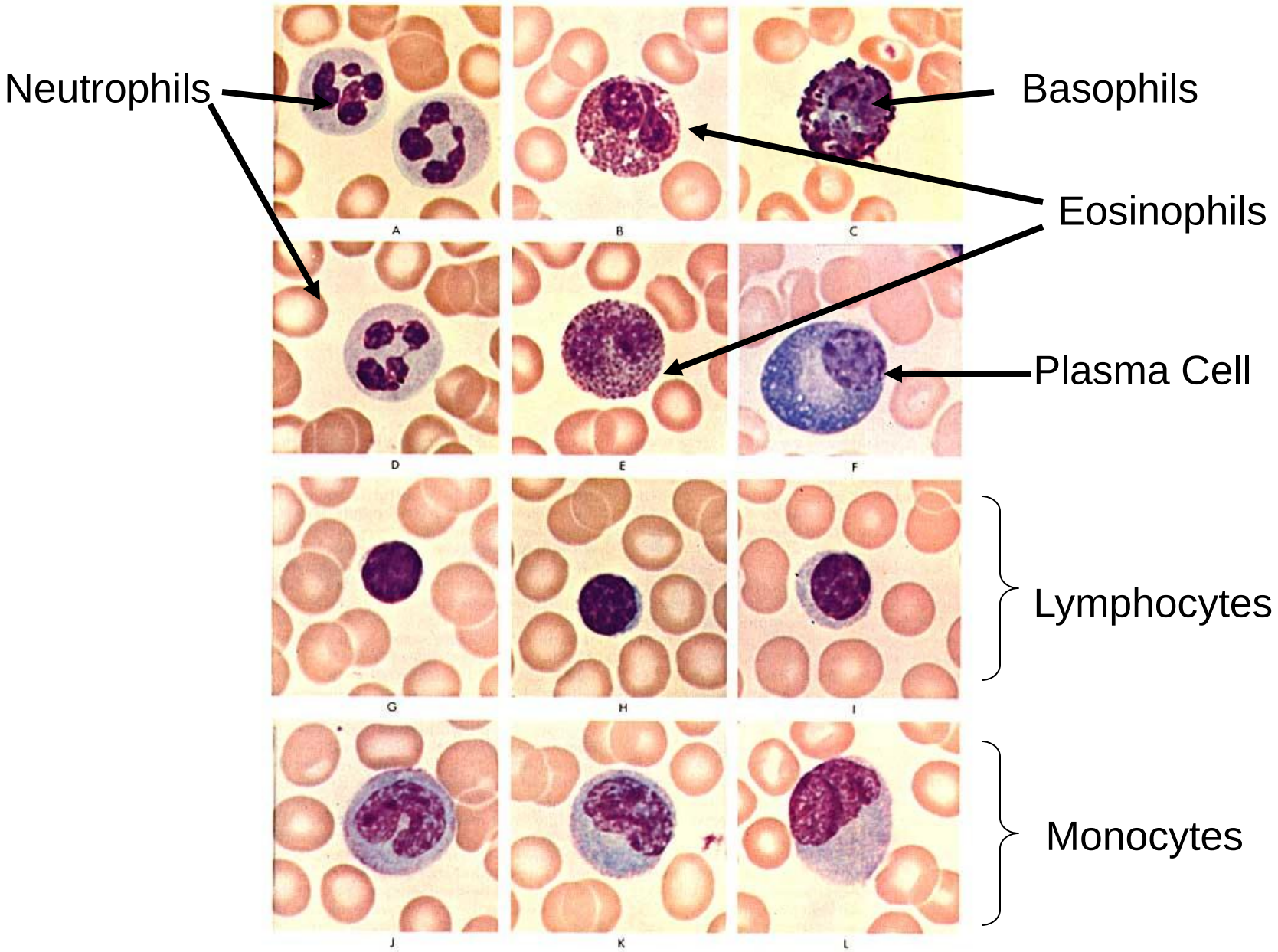


Figure 4–7. Human blood cells form a smear after Wright's stain. *A* and *D*, Neutrophilic leukocytes. *B* and *E*, Eosinophilic leukocytes. *C*, Basophilic leukocyte. *F*, Plasma cell; this is not a normal constituent of the peripheral blood but is included here for comparison with the nongranular leukocytes. *G* and *H*, Small lymphocytes. *I*, Medium lymphocytes. *J*, *K*, and *L*, Monocytes.

Formed Elements

- Platelets = cell fragments used for clotting

PLATELETS

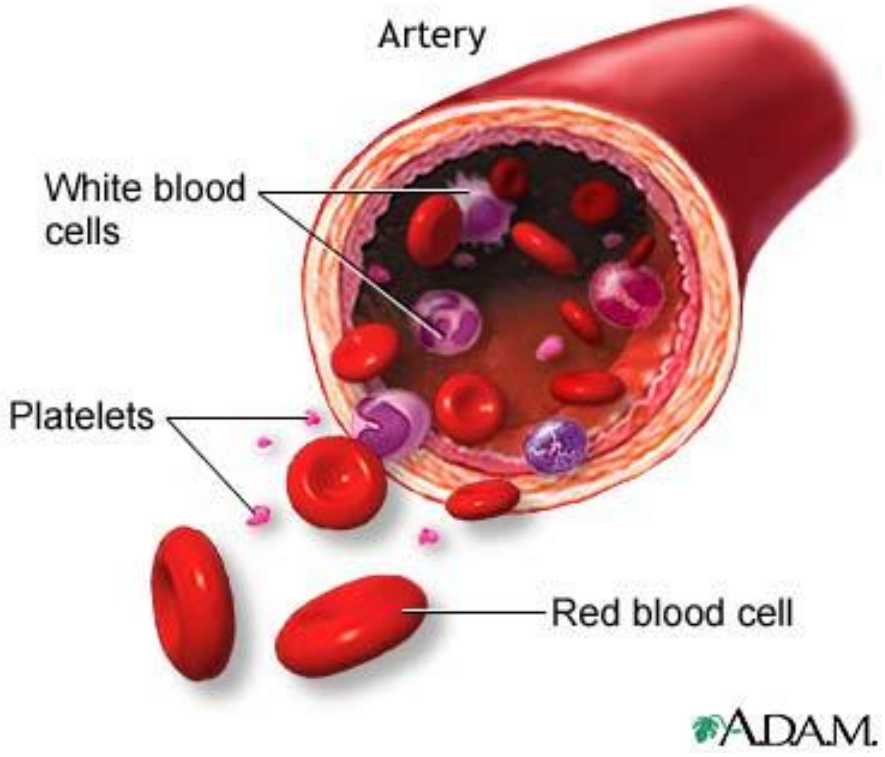


Table 10.2 Characteristics of Formed Elements of the Blood

Cell type	Occurrence in blood (per mm^3)	Cell anatomy*	Function
Erythrocytes (red blood cells, or RBCs) 	4–6 million	Salmon-colored biconcave disks; anucleate; literally, sacs of hemoglobin; most organelles have been ejected	Transport oxygen bound to hemoglobin molecules; also transport small amount of carbon dioxide
Leukocytes (white blood cells, or WBCs)	4000–11,000		
Granulocytes			
• Neutrophils 	3000–7000 (40–70% of WBCs)	Cytoplasm stains pale pink and contains fine granules, which are difficult to see; deep purple nucleus consists of three to seven lobes connected by thin strands of nucleoplasm	Active phagocytes; number increases rapidly during short-term or acute infections
• Eosinophils 	100–400 (1–4% of WBCs)	Red coarse cytoplasmic granules; figure-8 or bilobed nucleus stains blue-red	Kill parasitic worms; increase during allergy attacks; might phagocytize antigen-antibody complexes and inactivate some inflammatory chemicals

*Appearance when stained with Wright'

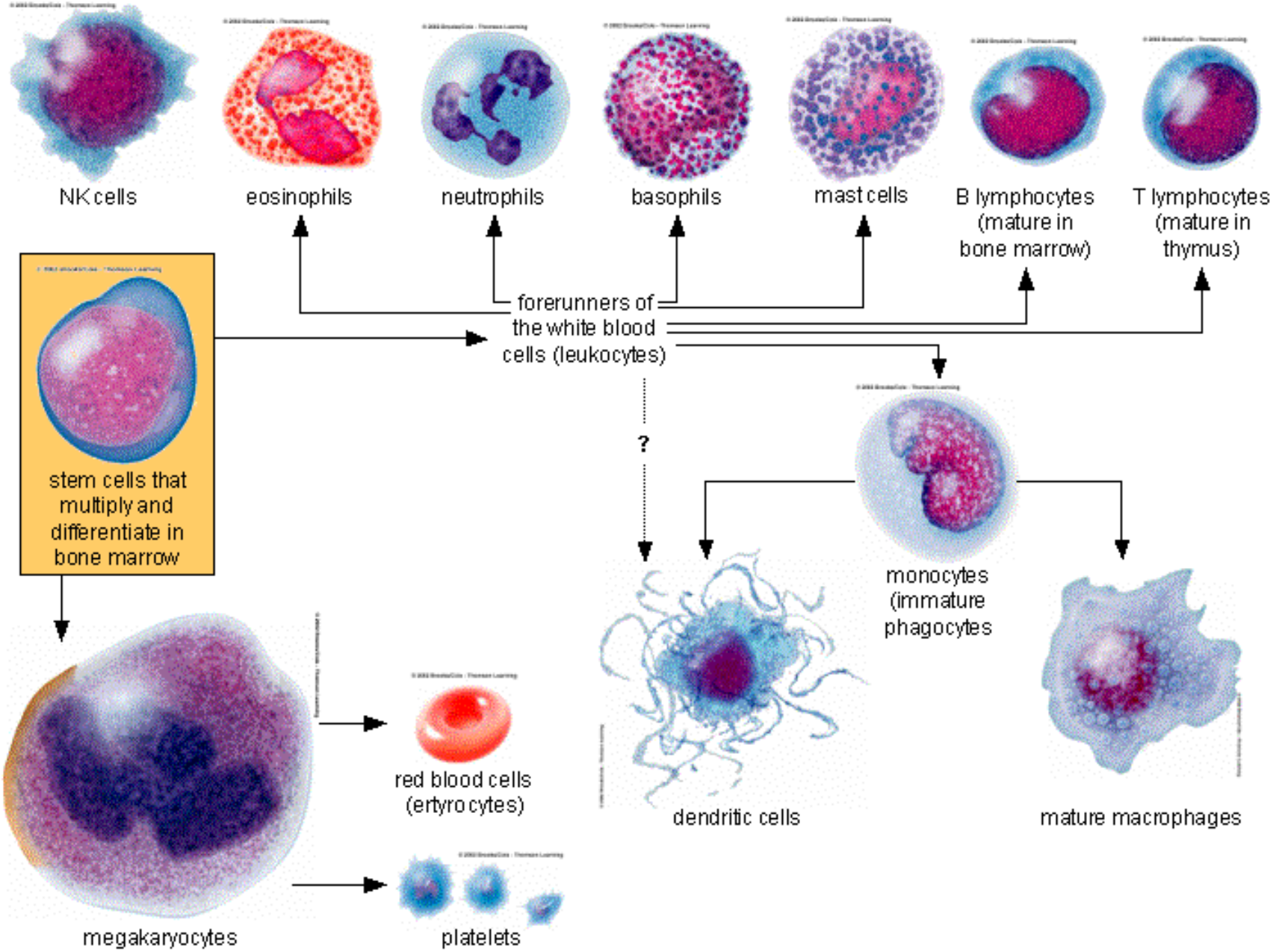
Table 10.2 Characteristics of Formed Elements of the Blood

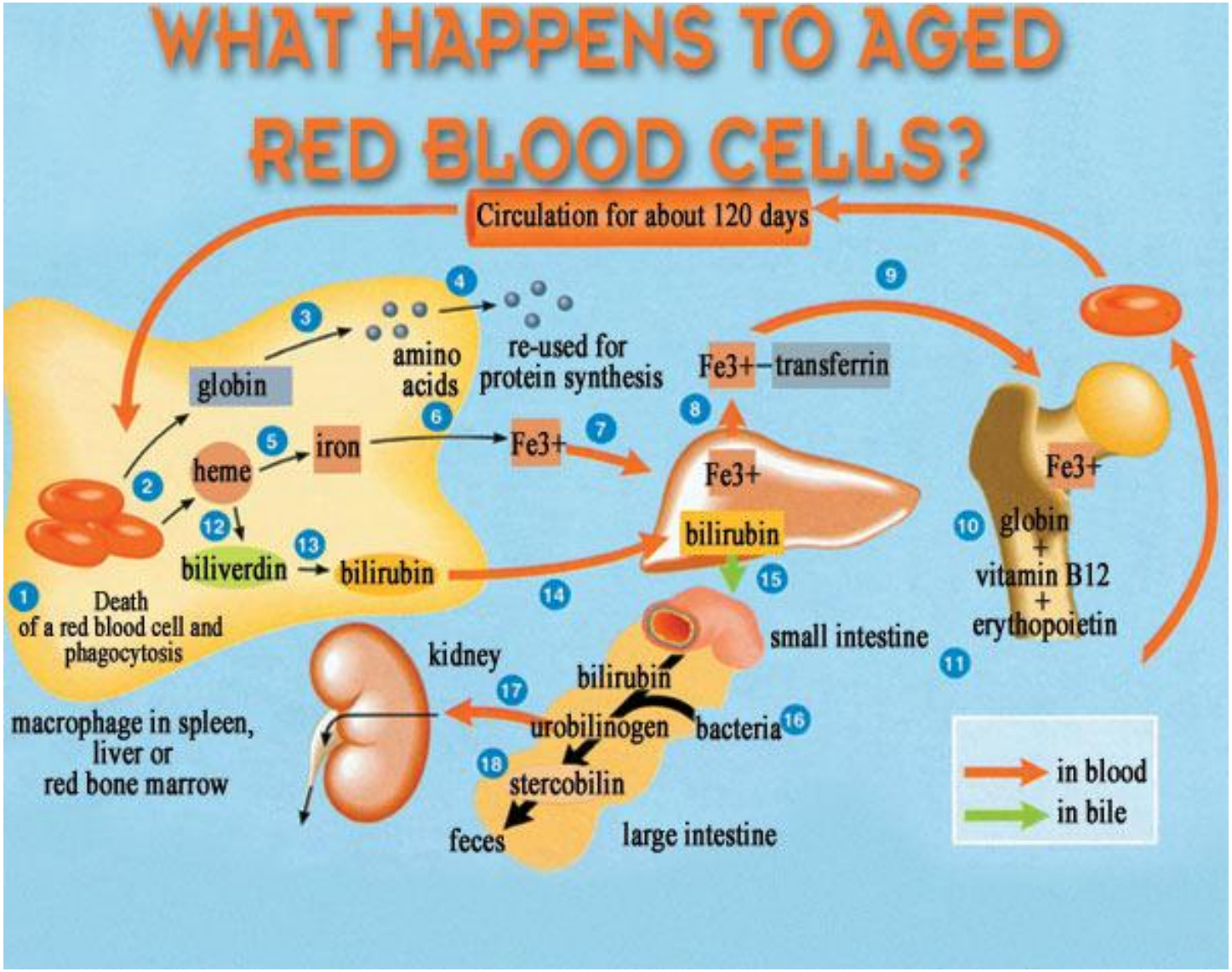
Cell type	Occurrence in blood (per mm^3)	Cell anatomy*	Function
• Basophils 	20–50 (0–1% of WBCs)	Cytoplasm has a few large blue-purple granules; U- or S-shaped nucleus with constrictions, stains dark blue	Granules contain histamine (vasodilator chemical), which is discharged at sites of inflammation
Agranulocytes			
• ymphocytes 	1500–3000 (20–45% of WBCs)	Cytoplasm pale blue and appears as thin rim around nucleus; spherical (or slightly indented) dark purple-blue nucleus	Part of immune system; one group (B lymphocytes) produces antibodies; other group (T lymphocytes) involved in graft rejection, fighting tumors and viruses, and activating B lymphocytes
• Monocytes 	100–700 (4–8% of WBCs)	Abundant gray-blue cytoplasm; dark blue-purple nucleus often kidney-shaped	Active phagocytes that become macrophages in the tissues; long-term "clean-up team"; increase in number during chronic infections such as tuberculosis
Platelets	250,000–500,000	Essentially irregularly shaped cell fragments; stain deep purple	Needed for normal blood clotting; initiate clotting cascade by clinging to broken area; help to control blood loss from broken blood vessels

*Appearance when stained with Wright'

Hematopoiesis

- Making blood cells
- Occurs in red bone marrow
- derived from a common stem cell (hemocytoblast)


NK cells
eosinophils
neutrophils
basophils
mast cells
B lymphocytes (mature in bone marrow)
T lymphocytes (mature in thymus)
forerunners of the white blood cells (leukocytes)
stem cells that multiply and differentiate in bone marrow
?
monocytes (immature phagocytes
red blood cells (ertyrocytes)
dendritic cells
mature macrophages
megakaryocytes
platelets


WHAT HAPPENS TO AGED RED BLOOD CELLS?
Circulation for about 120 days
1 Death of a red blood cell and phagocytosis
macrophage in spleen, liver or red bone marrow
2
3 globin
4 amino acids
re-used for protein synthesis
5 heme
iron
6 Fe3+
7
8 Fe3+
bilirubin
9 Fe3+ – transferrin
10 globin + vitamin B12 + erythopoietin
11
12 biliverdin
13 bilirubin
14
15 small intestine
bilirubin
urobilinogen
bacteria
16
17 kidney
18 stercobilin
feces
large intestine
in blood
in bile

Fate of Erythrocytes

- Unable to divide, grow, or make proteins
- Wear out in 100 to 120 days
- Eliminated by phagocytes in the spleen or liver
- Lost cells are replaced by division of hemocytoblasts

Control of Erythrocyte Production

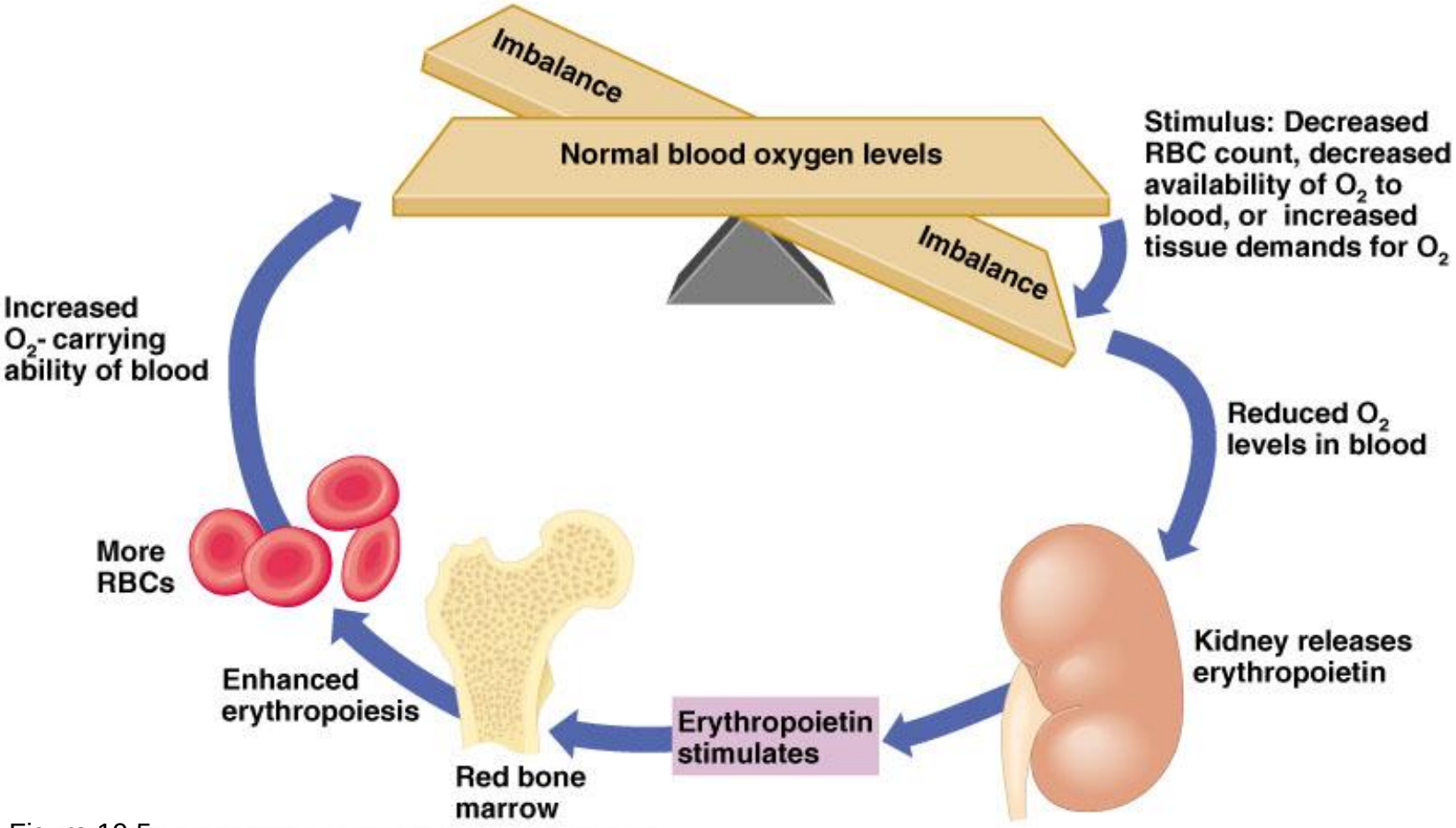


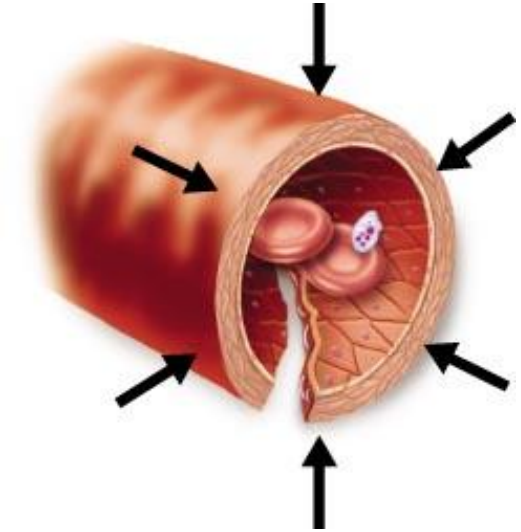
Figure 10.5

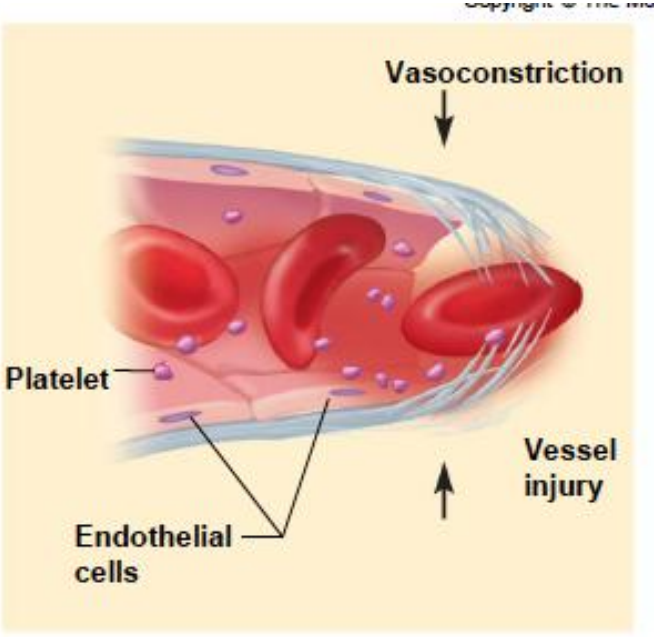
Hemostasis

- Definition
  - Stoppage of blood flow
  - Result of a break in a blood vessel

1. Vascular Spasms

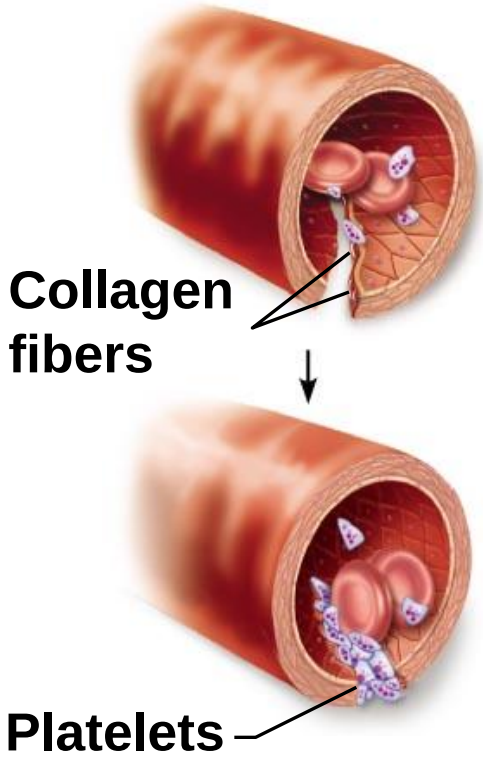
- Anchored platelets release serotonin.
- Smooth muscle contracts, causing vasoconstriction.
- Blood vessel narrows, decreasing blood loss





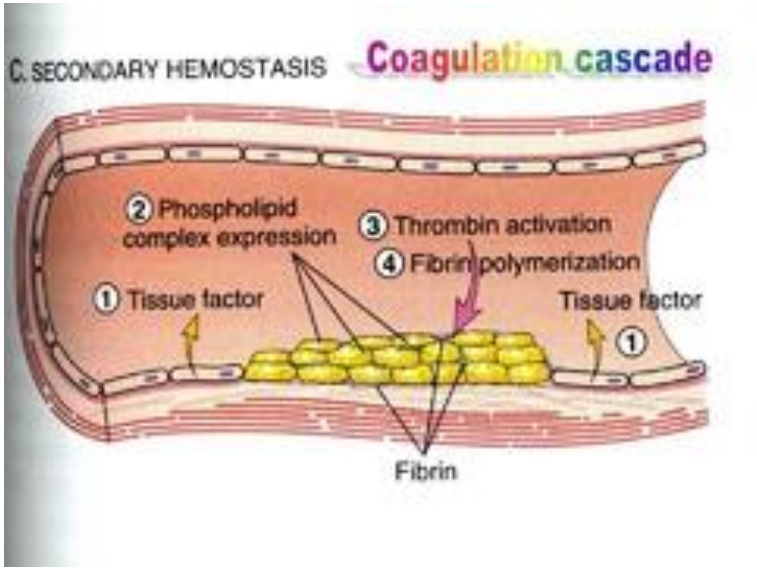
3. Platelet Plug Formation

- **Injury to lining of vessel exposes collagen fibers; platelets adhere.**
- **Platelets release chemicals that make nearby platelets sticky; platelet plug forms.**



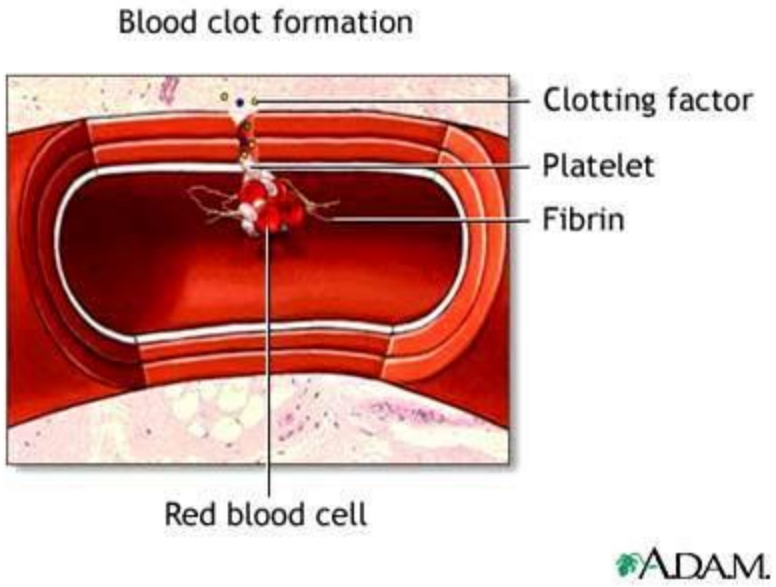
3. Coagulation

- Injured tissues release a series of chemicals to trigger a clotting cascade
- Fibrin forms a meshwork (the basis for a clot)



4. Blood Clotting

- Takes 3 to 6 minutes
- The clot remains as endothelium regenerates
- The clot is broken down after tissue repair



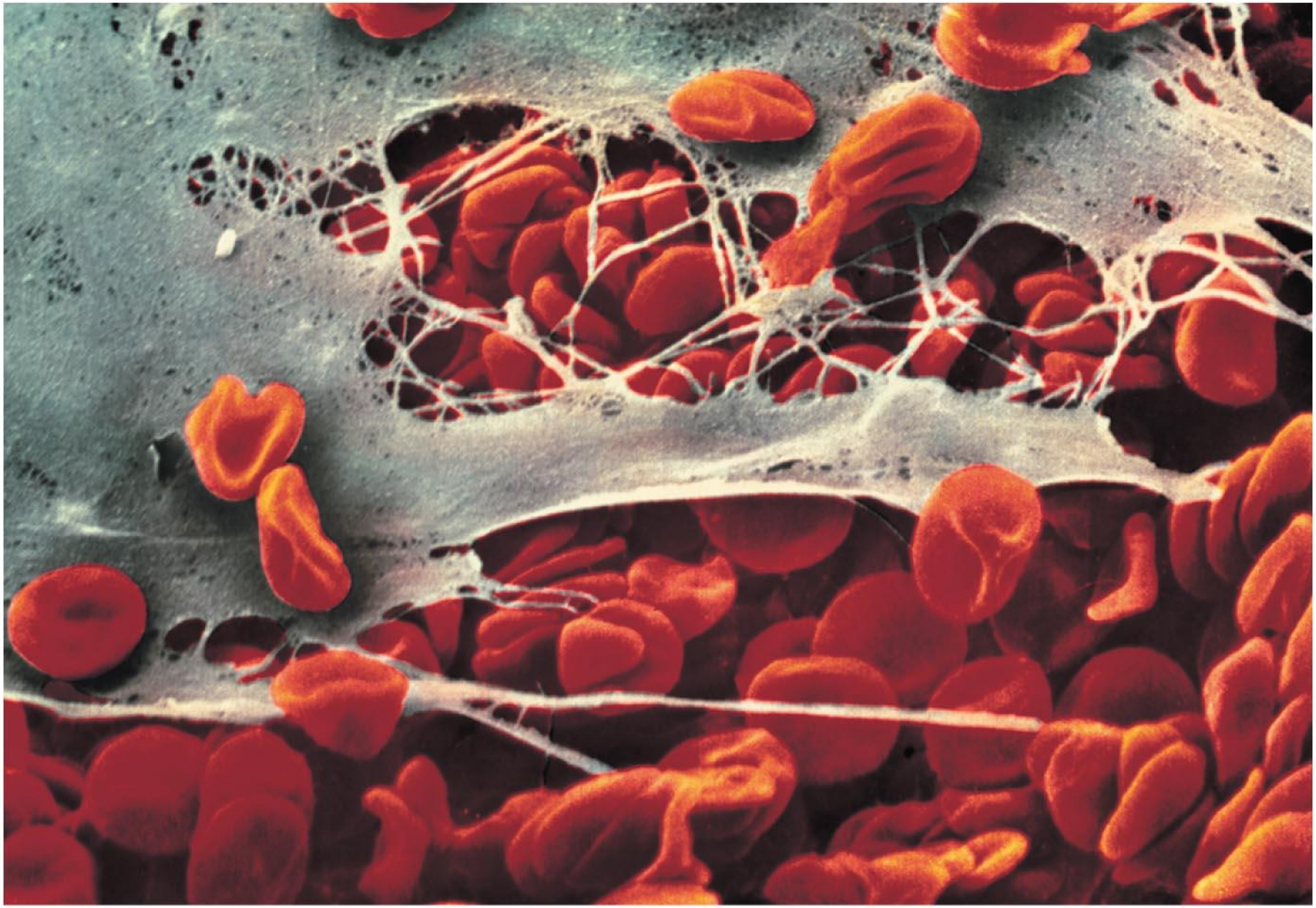
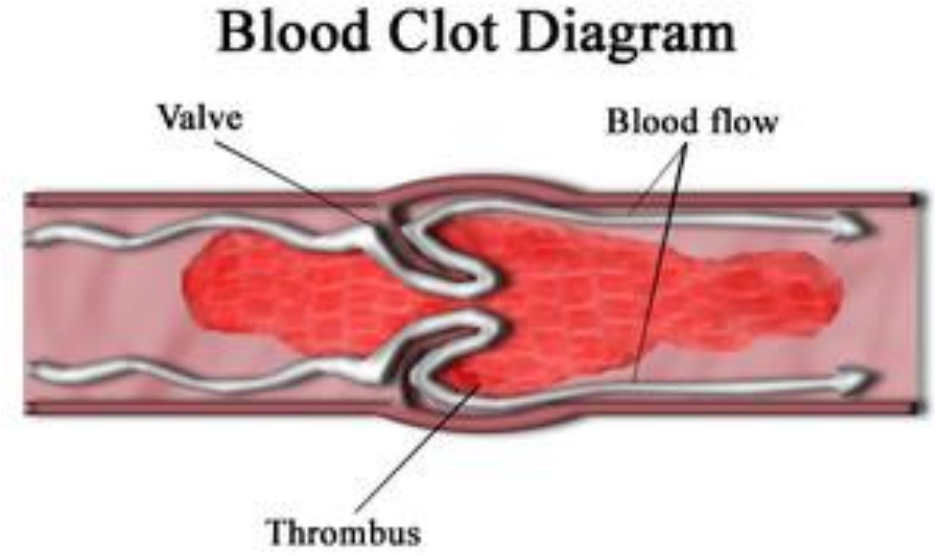


Figure 10.7

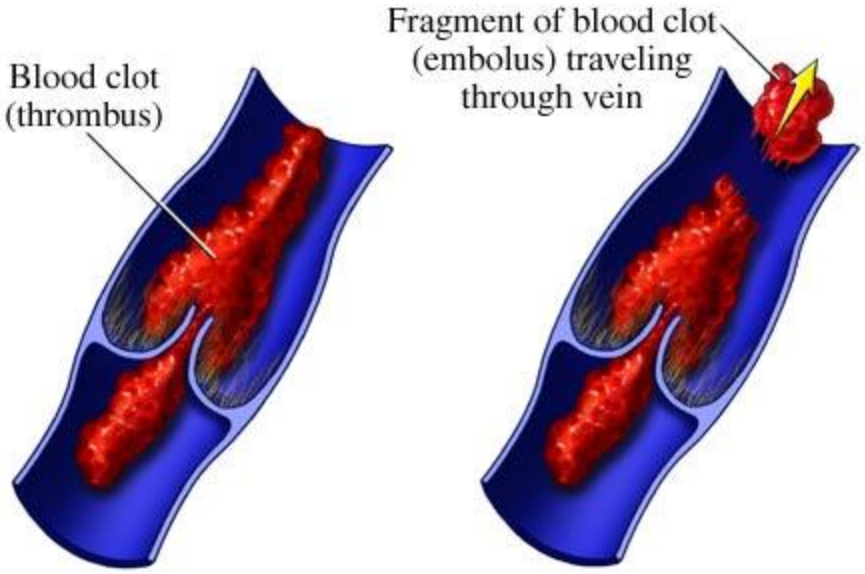
Undesirable Clotting

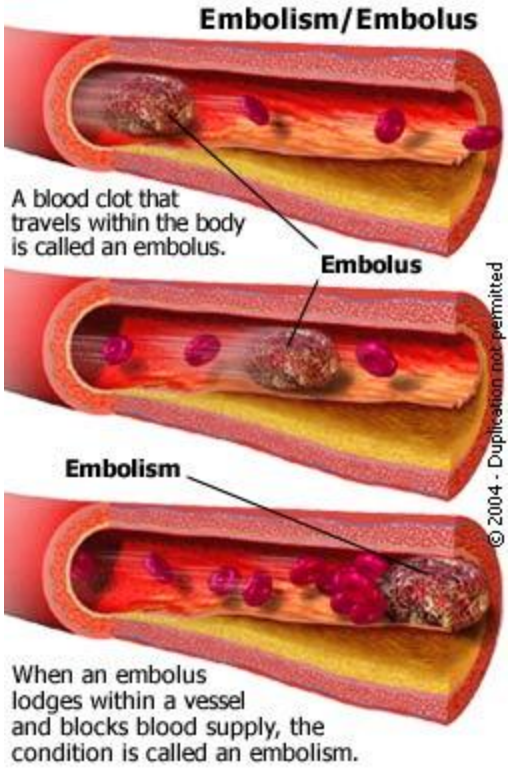
- Thrombus
  - A clot in an unbroken blood vessel
  - Can be deadly in areas like the heart



Undesirable Clotting

- Embolus
  - A thrombus that breaks away and floats freely in the bloodstream
  - Can later clog vessels in critical areas such as the brain





Blood Groups and Transfusions

- Large losses of blood
  - Loss of 15 to 30 percent causes pallor and weakness
  - Loss of over 30 percent causes severe shock, which can be fatal

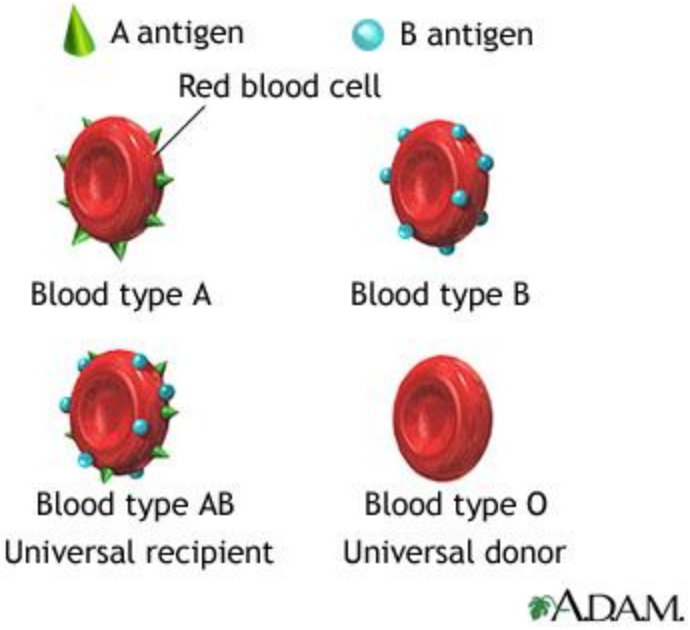
Blood Groups and Transfusions

- Transfusions
  - The only way to replace blood quickly
  - Blood must be of the same blood group

I agree O-positive is rather nice,
but my favourite by far is AB-negative...

Human Blood Groups

- Blood contains genetically determined proteins
- A foreign protein (antigen) may be attacked by the immune system and cause the blood to clump (agglutination)



ABO Blood Groups

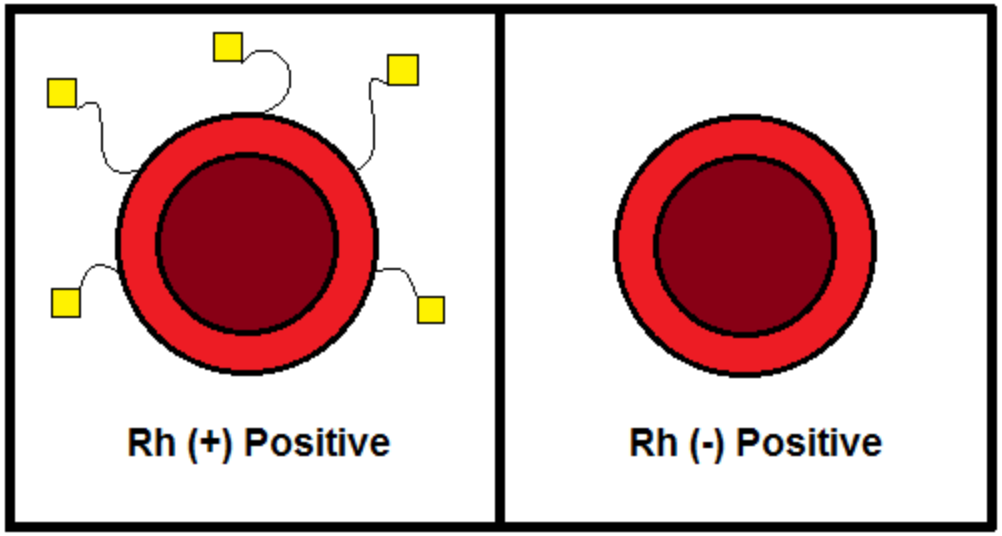
- Based on the presence or absence of two antigens
  - Type A
  - Type B
- The lack of these antigens is called type O

ABO Blood Groups

- The presence of both A and B is called type AB
- The presence of either A or B is called types A and B, respectively

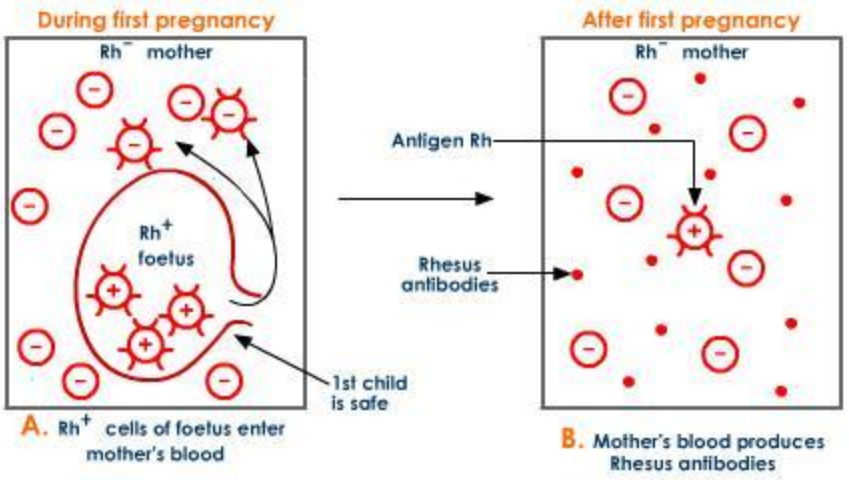
Rh Blood Groups

- Named because of the presence or absence of one of eight Rh antigens (agglutinogen D)
- Most Americans are Rh^+
- Problems can occur in mixing Rh^+ blood into a body with Rh^- blood



Rh Dangers During Pregnancy

- The mismatch of an Rh^- mother carrying an Rh^+ baby can cause problems for the unborn child
- The first pregnancy usually proceeds without problems, but the immune system is sensitized
- In a second pregnancy, the mother's immune system produces antibodies to attack the Rh^+ blood (hemolytic disease of the newborn)
- Mother is given RhoGam after first pregnancy



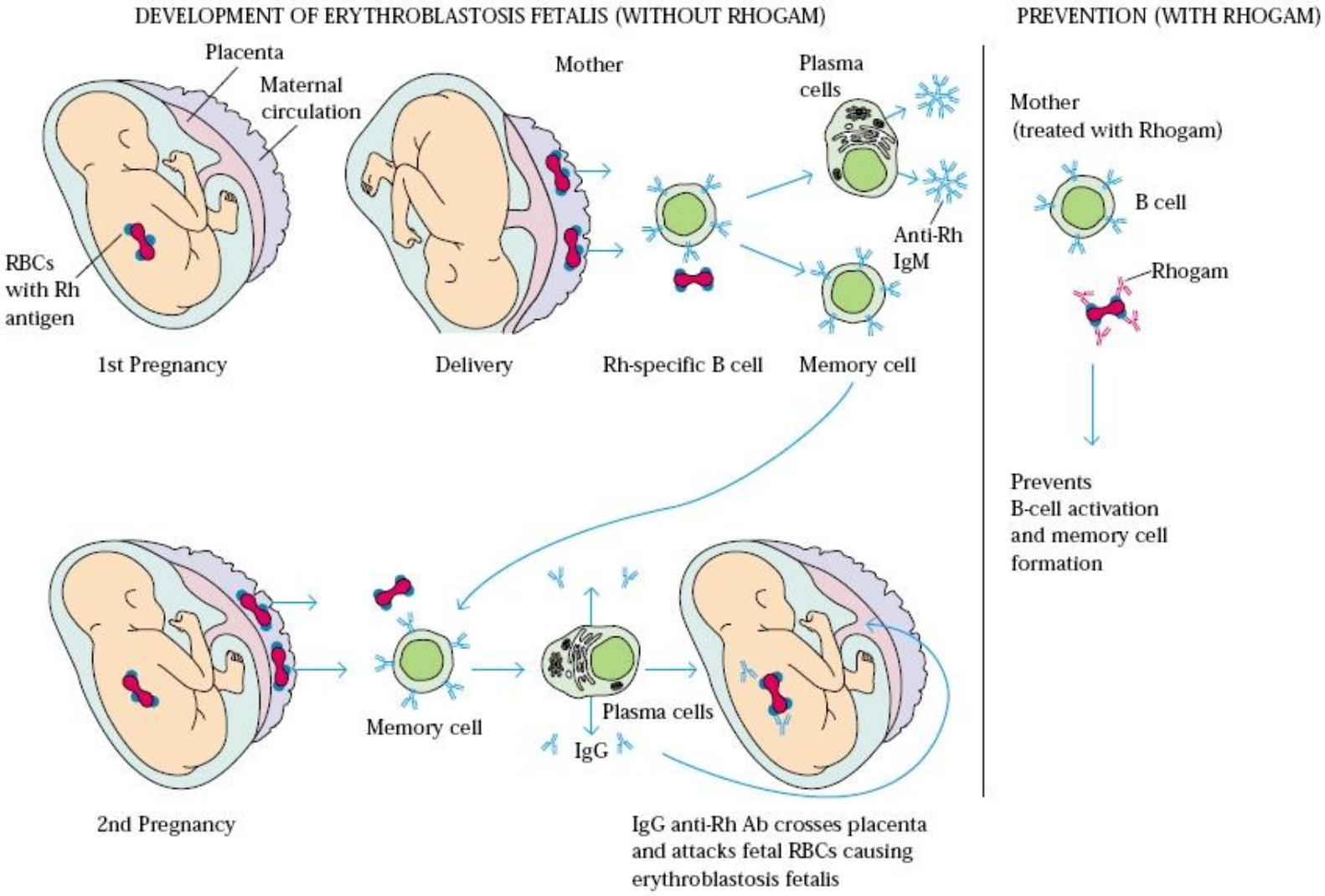


FIGURE 16-14 Development of erythroblastosis fetalis (hemolytic disease of the newborn) caused when an Rh^- mother carries an Rh^+ fetus (*left*), and effect of treatment with anti-Rh antibody, or Rhogam (*right*).


STOP

Title

- Anatomy of the heart and blood vessels

Essential Question

- Describe the anatomy of the heart and major blood vessels of the body.

Essentials of Human Anatomy & Physiology

Seventh Edition

Elaine N. Marieb

Chapter 11

The Cardiovascular System

Slides 11.1 – 11.19

Lecture Slides in PowerPoint by Jerry L. Cook

The Cardiovascular System

- **Structure**
  - A closed system of the heart and blood vessels
- **Function**
  - Deliver O_2 and nutrients **and** to remove CO_2 and other waste products

The Heart

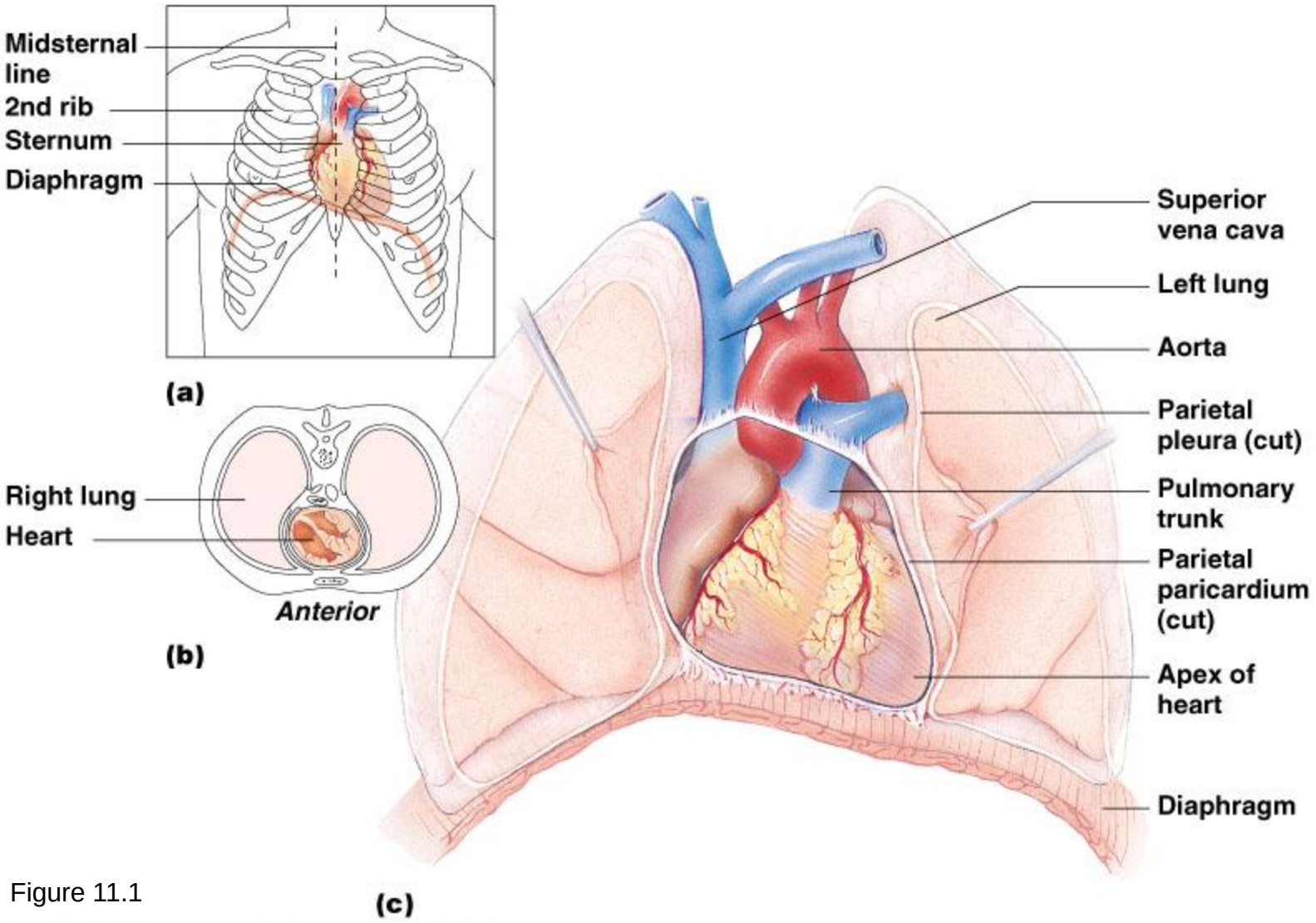
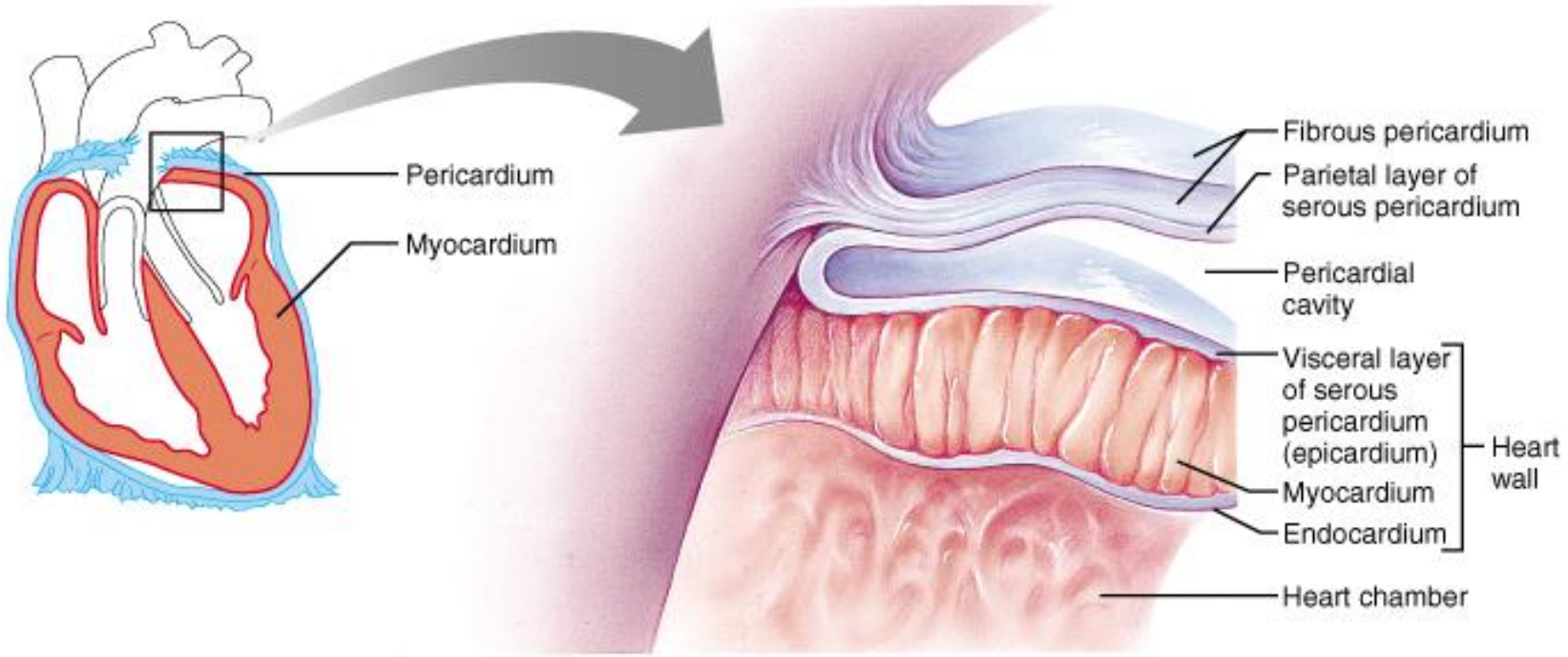


Figure 11.1

The Heart

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

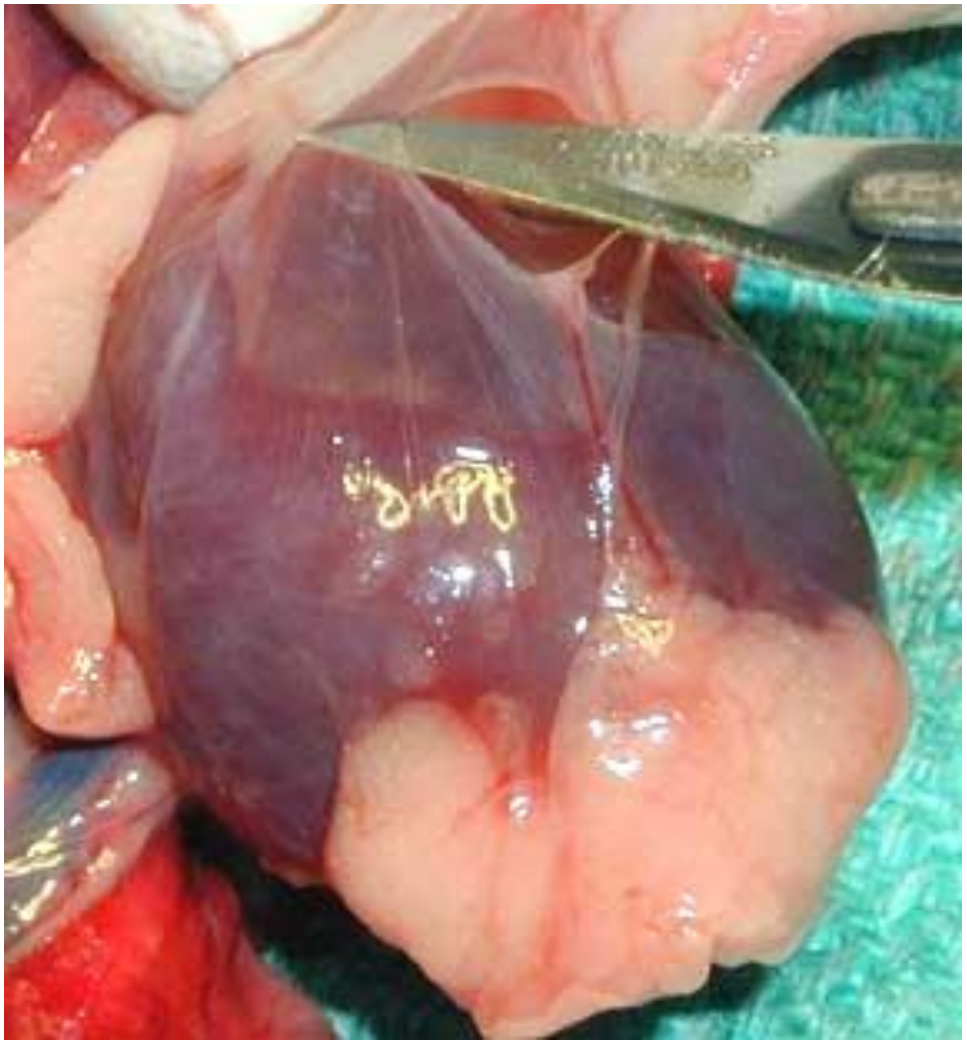
THE HEART: COVERINGS



The Heart: Coverings

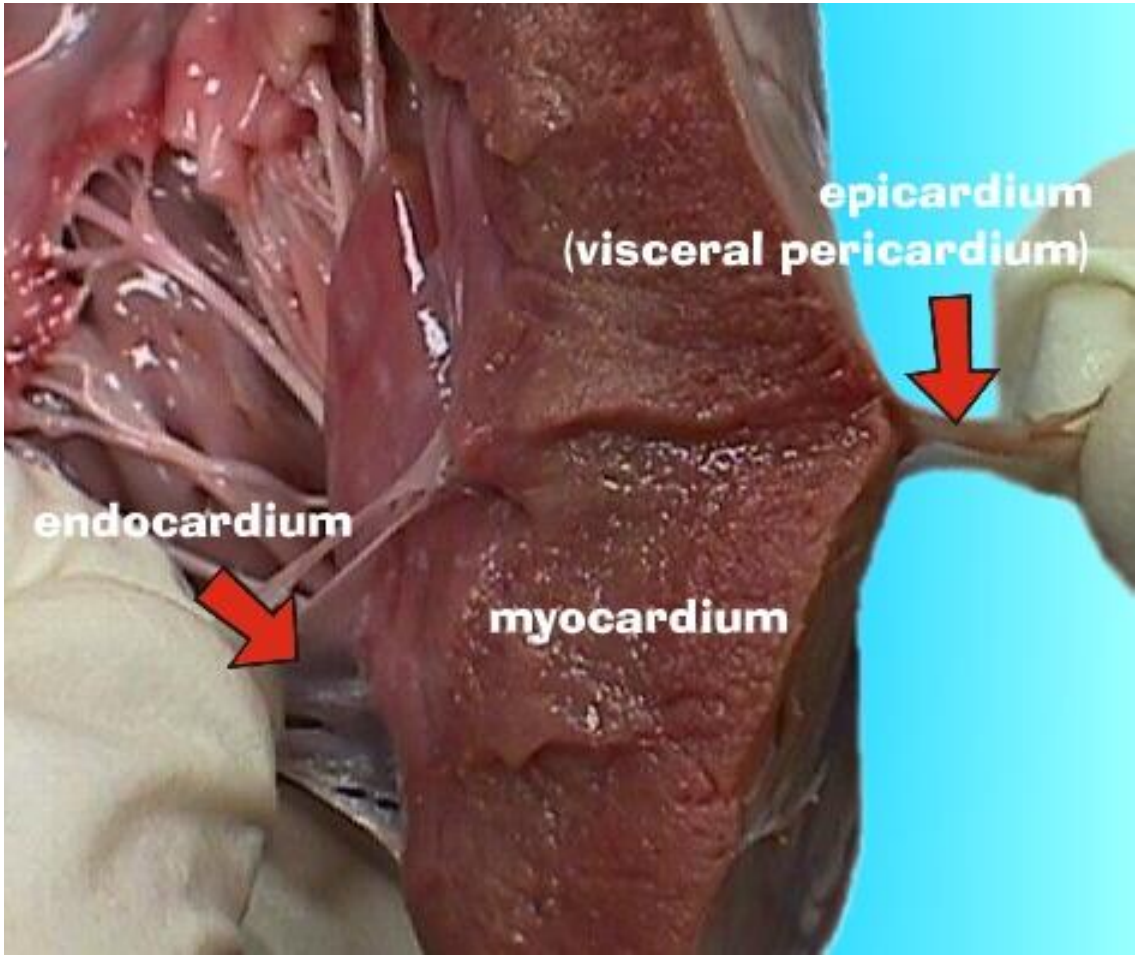
- Pericardium – a double serous membrane
  - Visceral Layer - next to heart
  - Parietal Layer - outside layer
  - Serous fluid fills the space between the layers of pericardium

THE HEART: COVERINGS



THE HEART: COVERINGS

The Heart: Heart Wall



The Heart: Heart Wall

- Three layers
  - **Epicardium**
    - Outside layer consists of connective tissue layer (visceral pericardium)

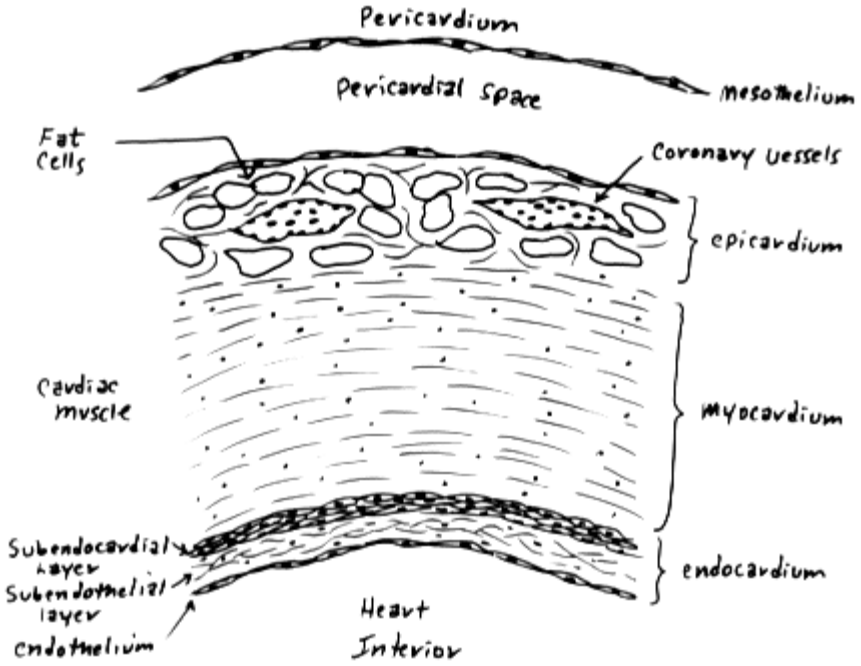
The Heart: Heart Wall

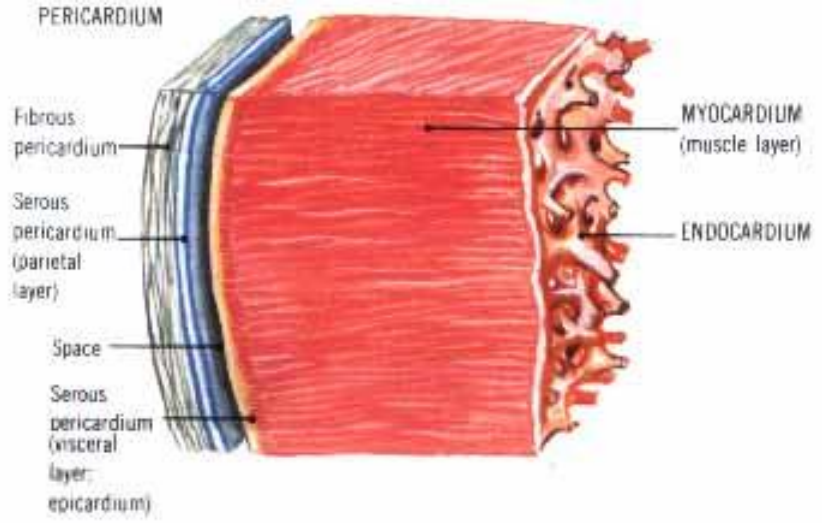
- Three layers
  - **Myocardium**
    - Middle layer, mostly cardiac muscle

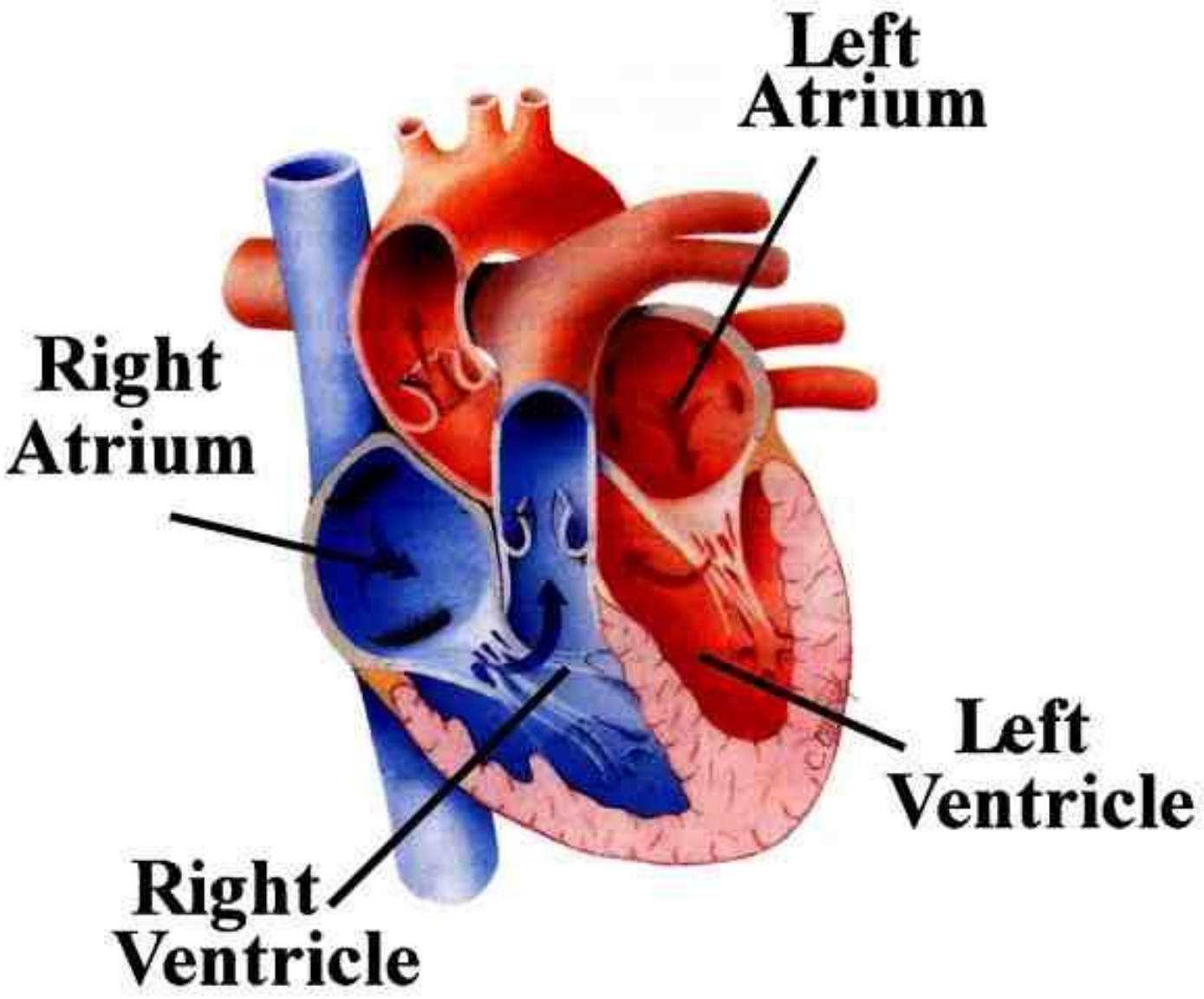
The Heart: Heart Wall

- Three layers
  - **Endocardium**
    - Inner layer; endothelium that lines the heart

Heart Wall


Pericardium
Pericardial Space
mesothelium
Fat Cells
Coronary vessels
epicardium
Cardiac muscle
myocardium
Subendocardial layer
Subendothelial layer
endothelium
endocardium
Heart Interior


PERICARDIUM
Fibrous pericardium
Serous pericardium (parietal layer)
Space
Serous pericardium (visceral layer; epicardium)
MYOCARDIUM (muscle layer)
ENDOCARDIUM


Left
Atrium
Right
Atrium
Left
Ventricle
Right
Ventricle

The Heart: Chambers

- **Right and left side act as separate pumps**
- Four chambers
  - **Atria** (right and left)
    - Receiving chambers
  - **Ventricles** (right and left)
    - Discharging chambers

External Heart Anatomy

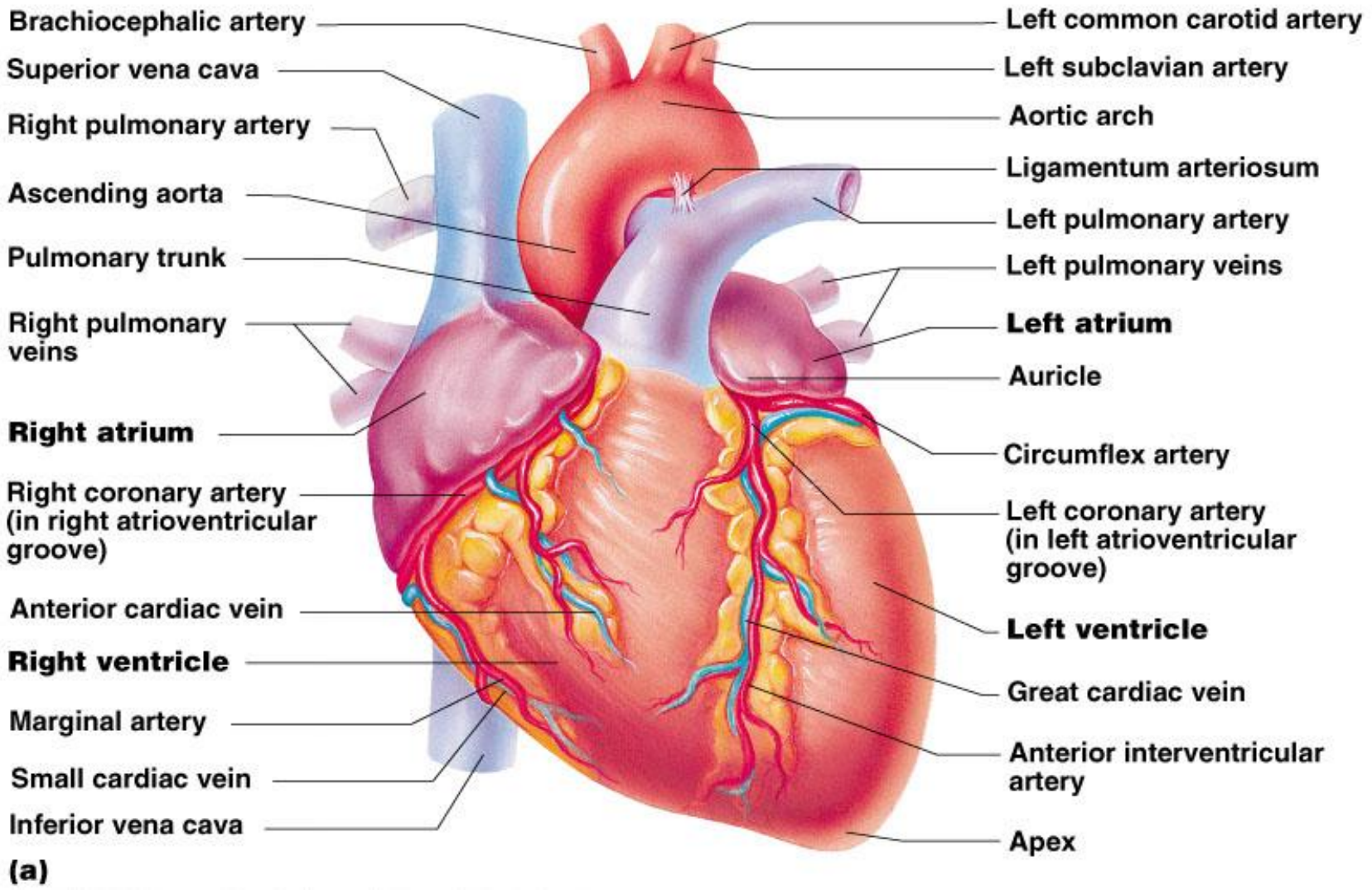
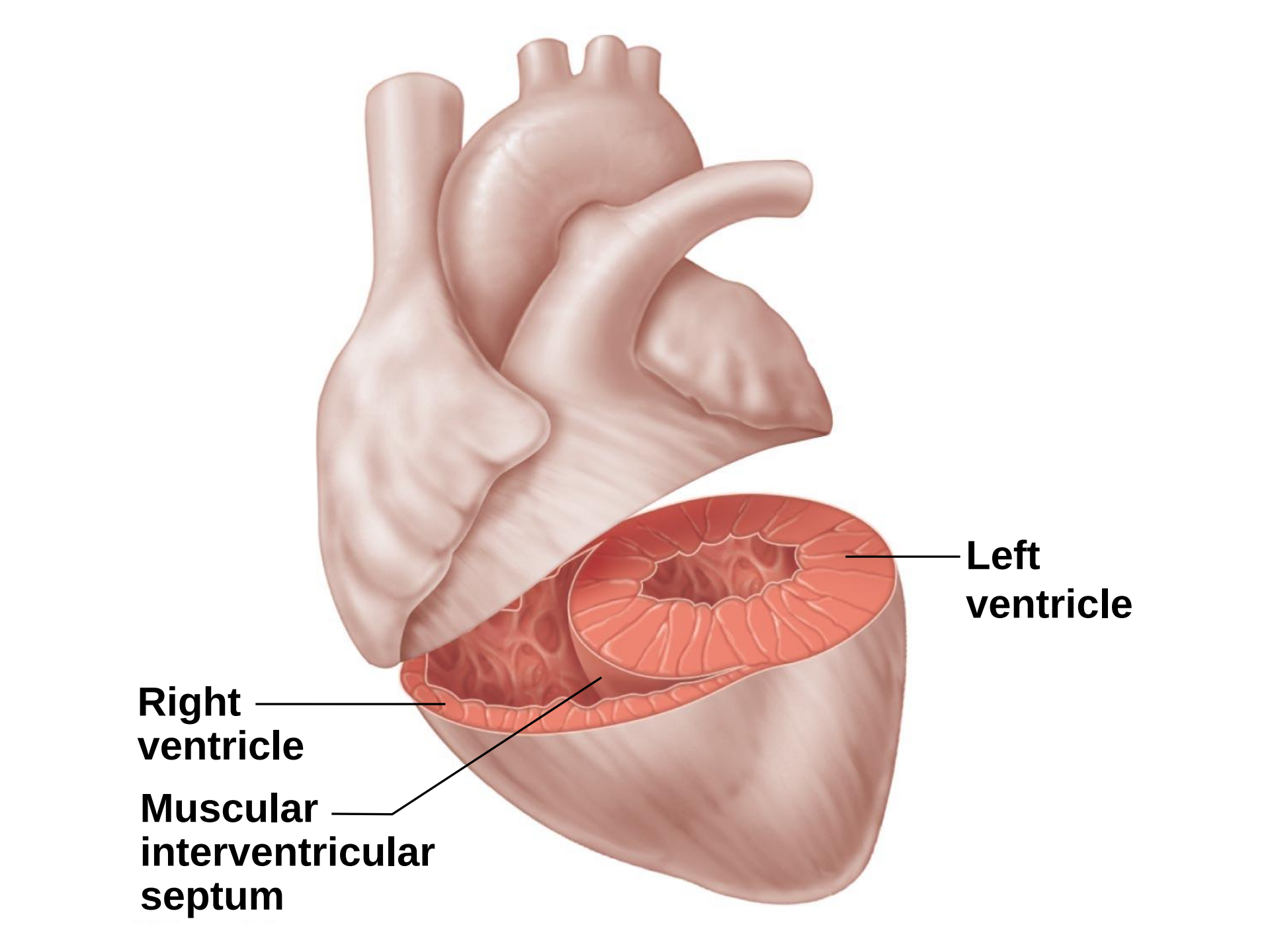


Figure 11.2a


Left ventricle
Right ventricle
Muscular interventricular septum

Blood Circulation

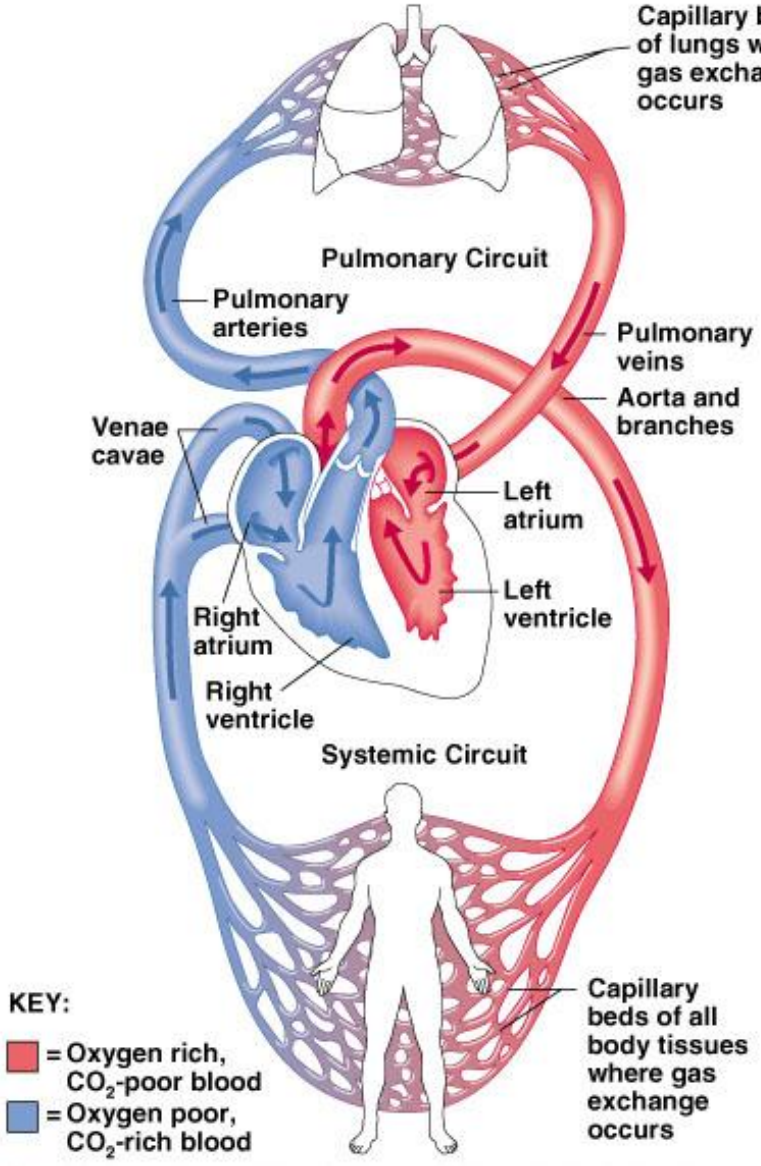
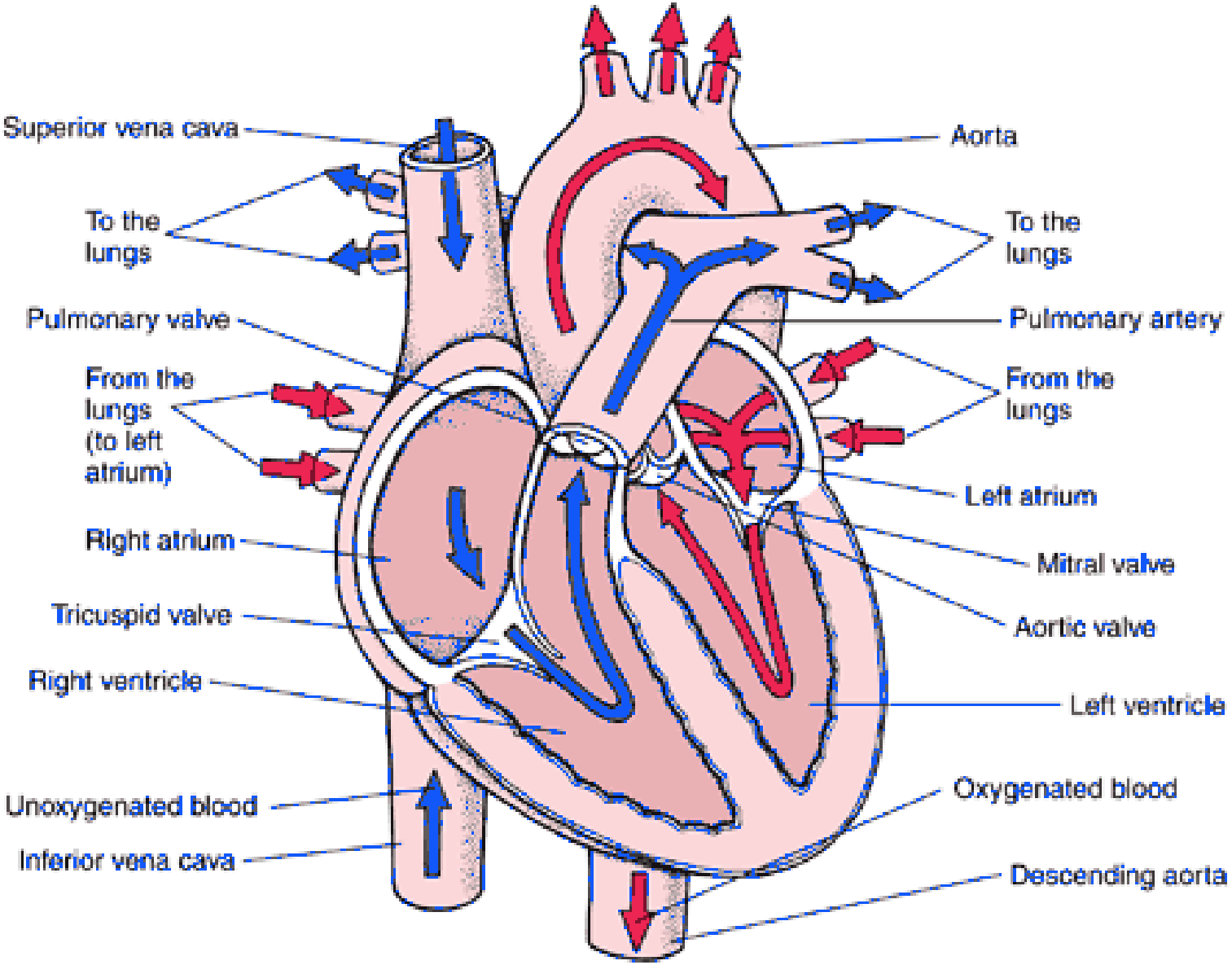
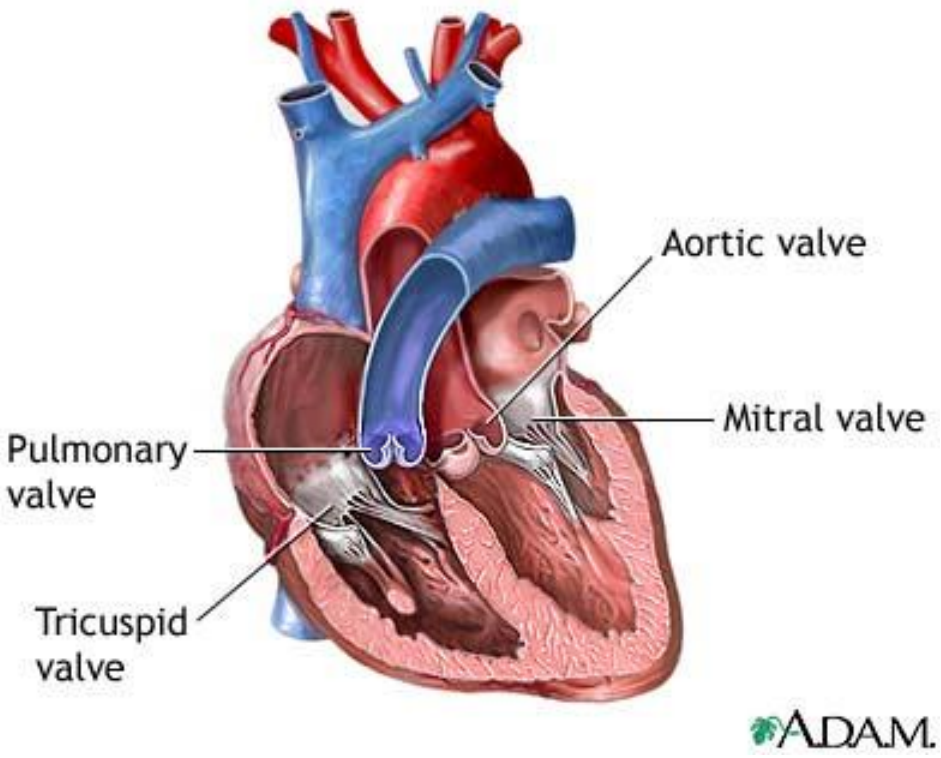


Figure 11.3


Superior vena cava
Aorta
To the lungs
To the lungs
Pulmonary valve
Pulmonary artery
From the lungs (to left atrium)
From the lungs
Left atrium
Right atrium
Mitral valve
Tricuspid valve
Aortic valve
Right ventricle
Left ventricle
Unoxygenated blood
Oxygenated blood
Inferior vena cava
Descending aorta

HEART VALVES



The Heart: Valves Characteristics

- Allow blood to flow in only one direction
- Open as blood is pumped through
- Close to prevent backflow

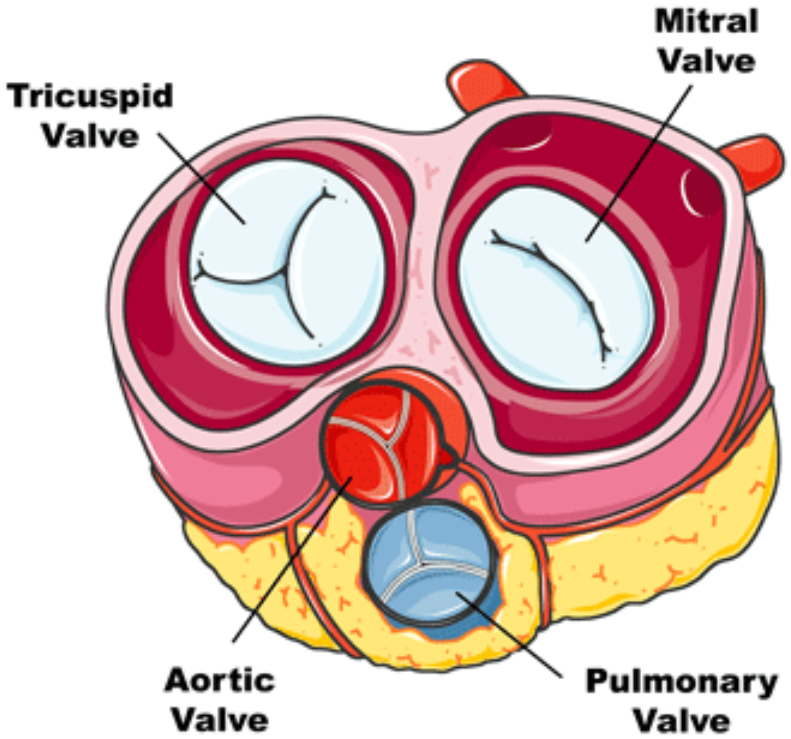
The Heart: Valves

- Four valves
  - Atrioventricular valves – between atria and ventricles
    - Bicuspid (mitral) valve – between the left atria and left ventricle
    - Tricuspid valve – between the right atria and right ventricle

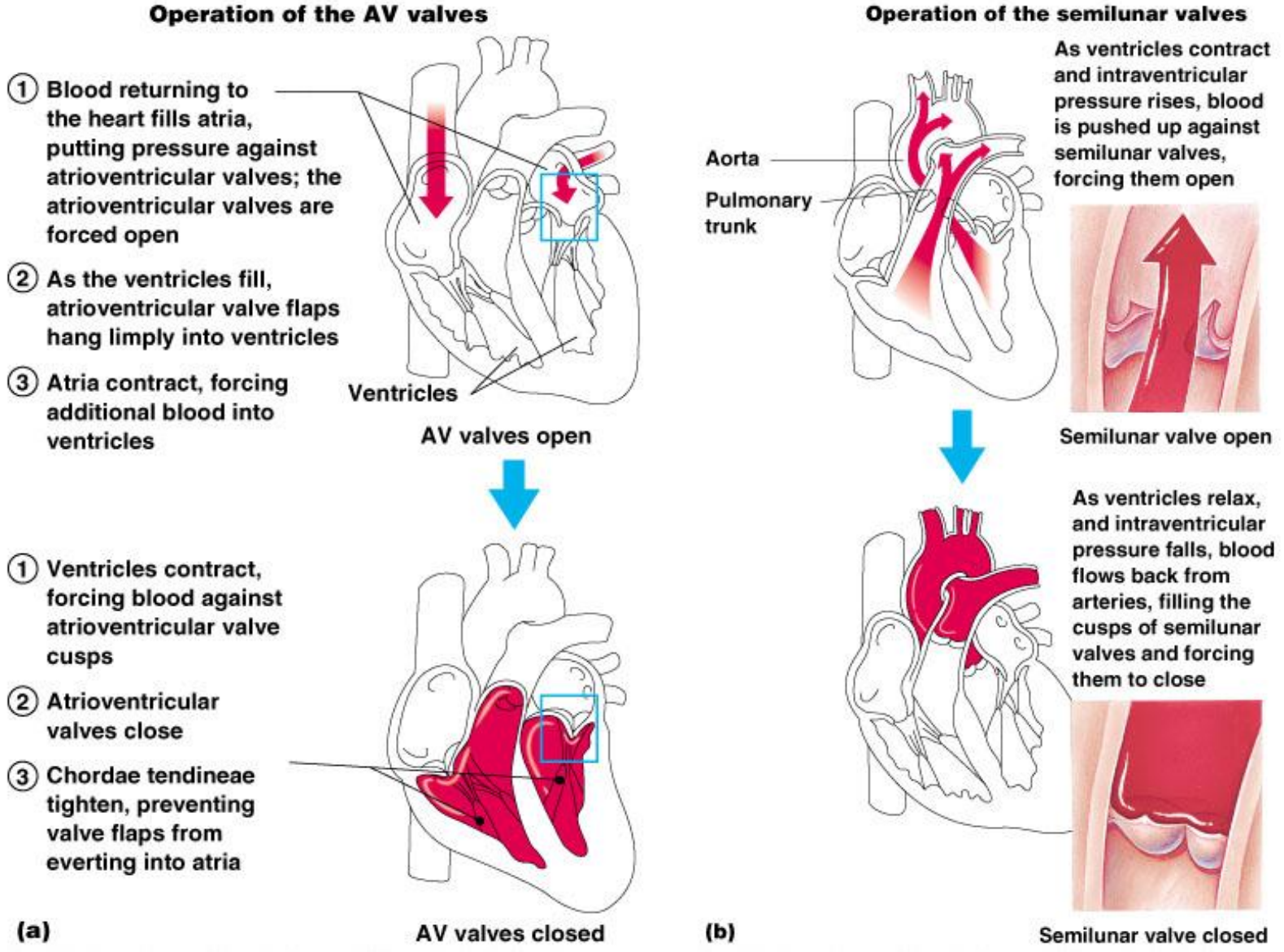
The Heart: Valves

- Four valves
  - Semilunar valves – between ventricle and major artery
    - Pulmonary semilunar valve – between RV and pulmonary artery
    - Aortic semilunar valve – between LV and aorta

HEART VALVES



Operation of Heart Valves



Podcast: Minimally Invasive Heart Valve Surgery

Figure 11.4

The Heart: Associated Great Vessels

Arteries

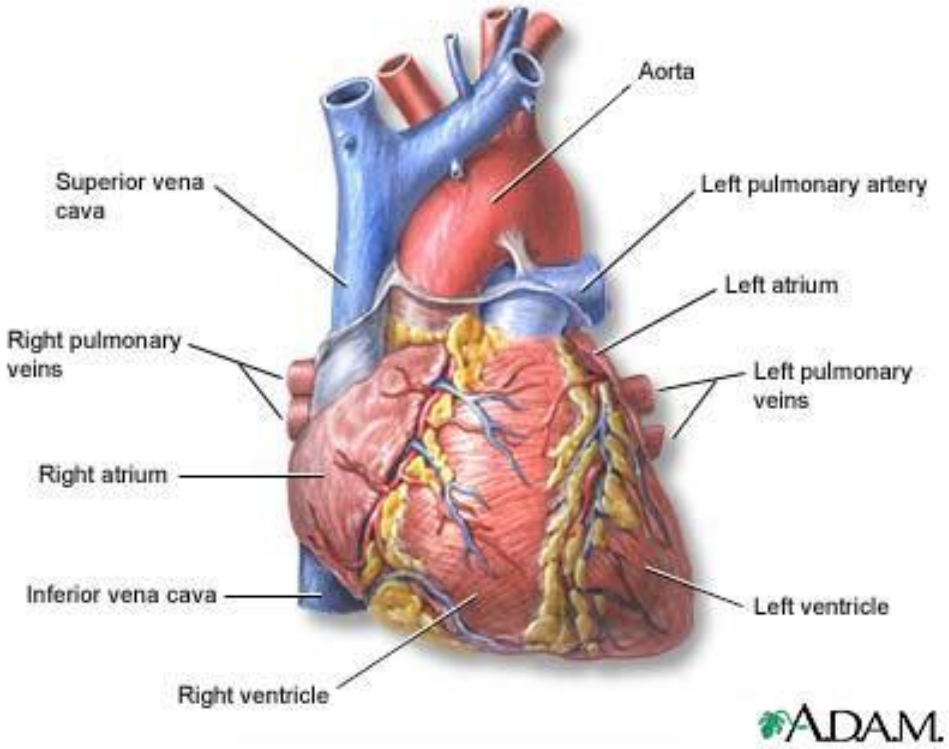
- **Aorta** →receives blood from LV and travels to rest of body (oxygenated)
- **Pulmonary arteries** →receives blood from RV and travels to lungs (deoxygenated)

The Heart: Associated Great Vessels

Veins

- **Vena cava** → blood entering RA from body (deoxygenated)
- **Pulmonary veins** (four) →blood entering LA from lungs (oxygenated)

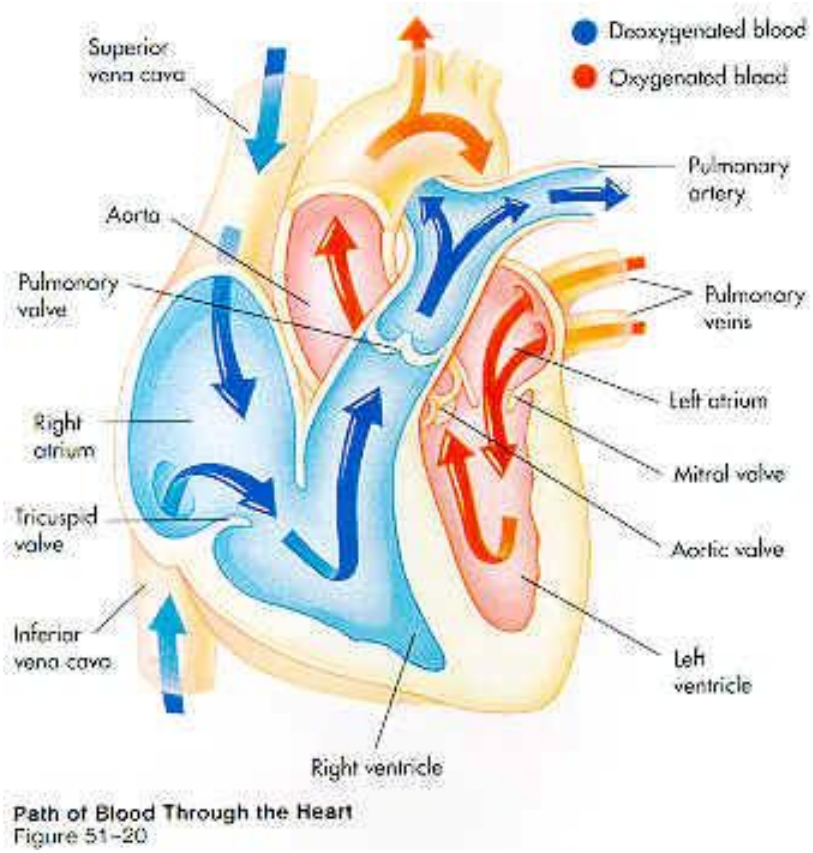
ASSOCIATED GREAT VESSELS



CORONARY CIRCULATION

AWAKE
Open Heart
Surgery

http://video.google.com/videoplay?docid=5304289071571962318&q=heart+surgery+site%3Avideo.google.com&total=305&start=10&num=10&so=0&type=search&plindex=2



Path of Blood Through the Heart
Figure 51-20

Coronary Circulation

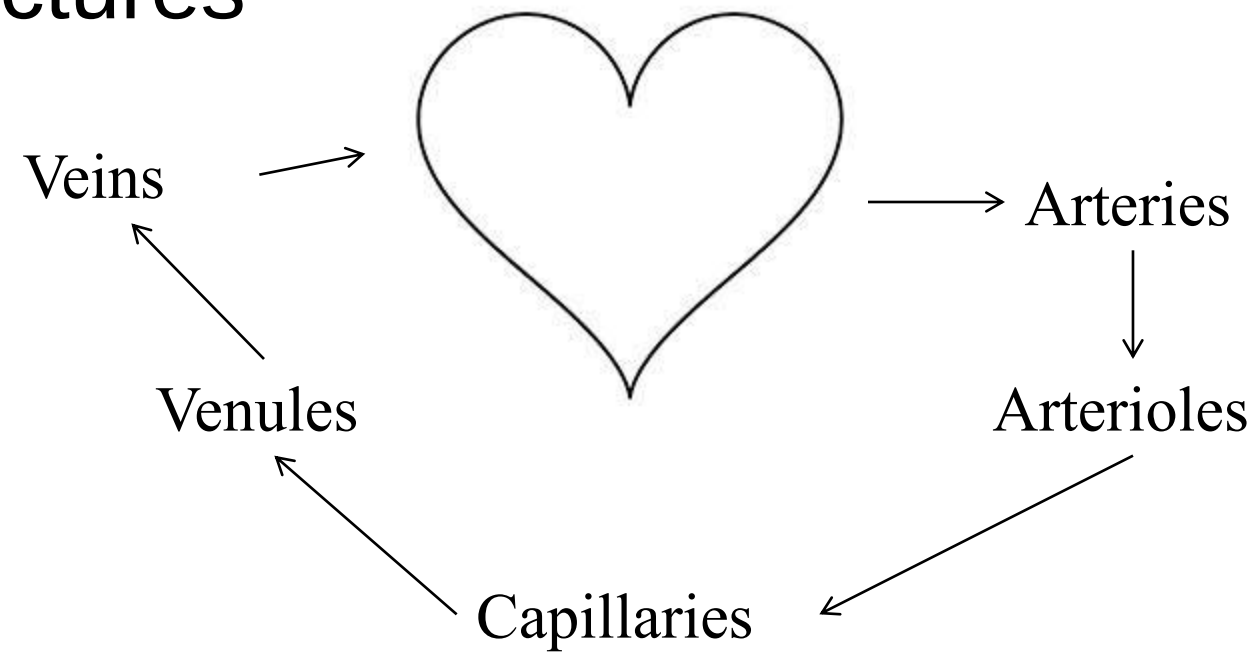
- Blood in the heart chambers does not nourish the myocardium
- Heart is nourished by coronary arteries and empties into the right atrium via the coronary sinus

Blood Vessels: The Vascular System

- Function → Taking blood to the tissues and back

Blood Vessels: The Vascular System

- Structures



The Vascular System

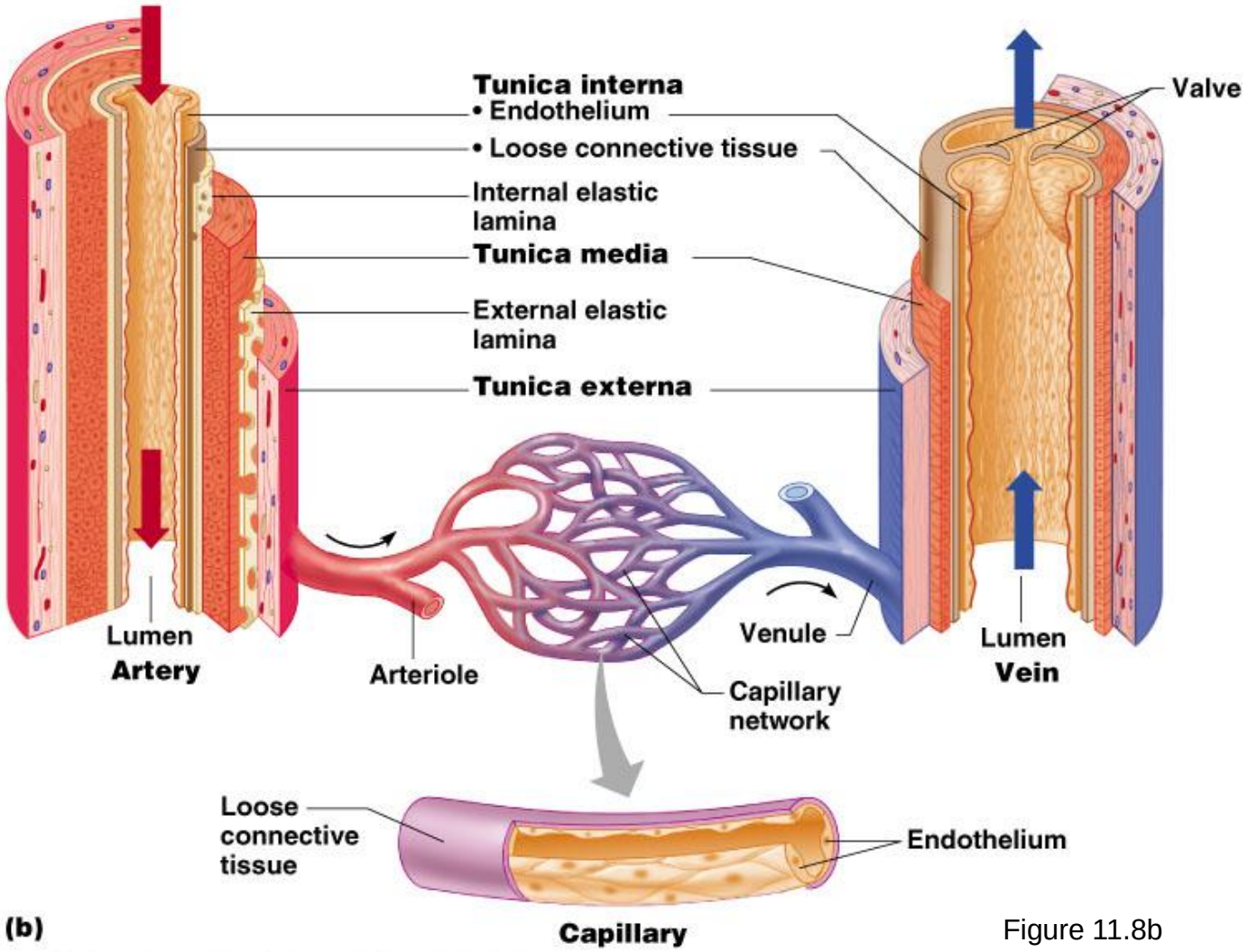
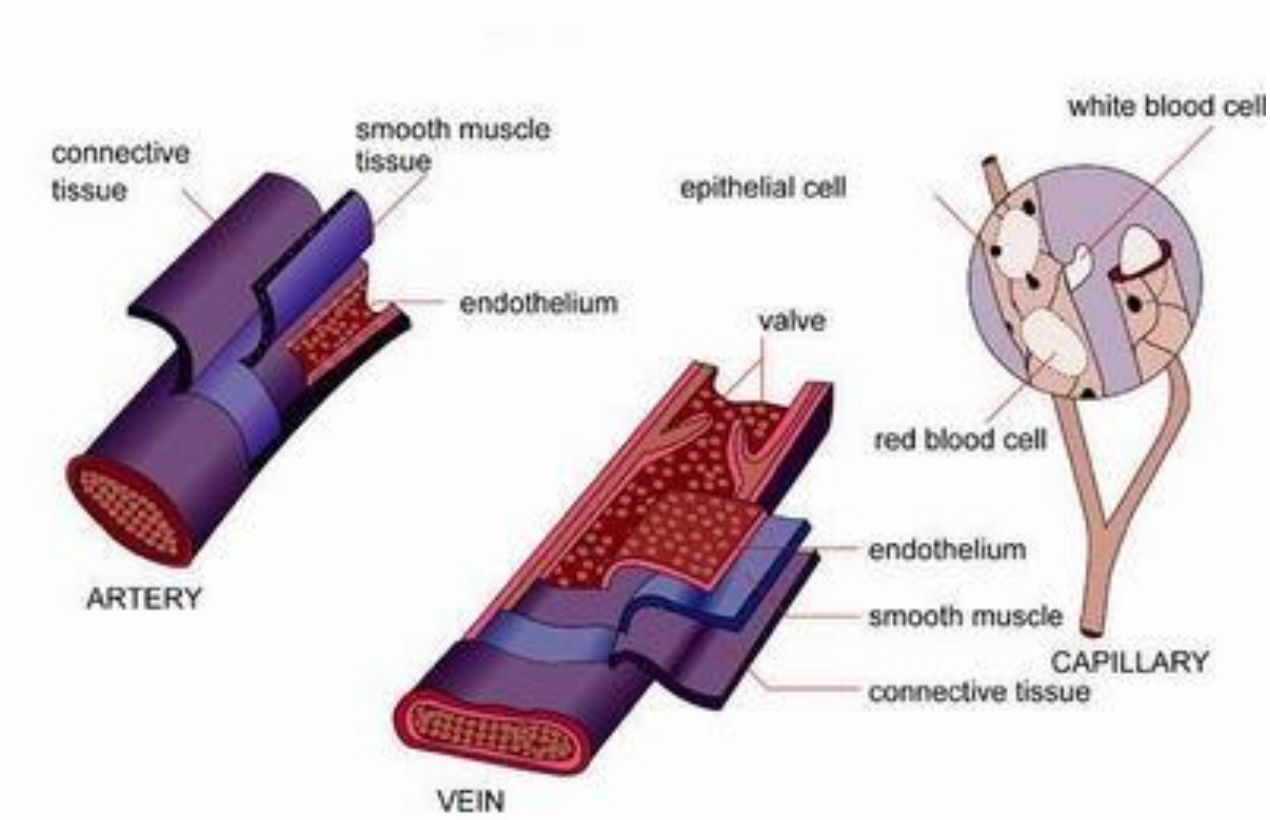


Figure 11.8b


connective tissue
smooth muscle tissue
endothelium
ARTERY
valve
VEIN
epithelial cell
white blood cell
red blood cell
endothelium
smooth muscle
connective tissue
CAPILLARY

Differences Between Blood Vessel Types

- Walls of arteries are the thickest
- Lumens of veins are larger
- Walls of capillaries are only one cell layer thick to allow for exchanges of gases and nutrients between blood and tissue

Diffusion at Capillary Beds

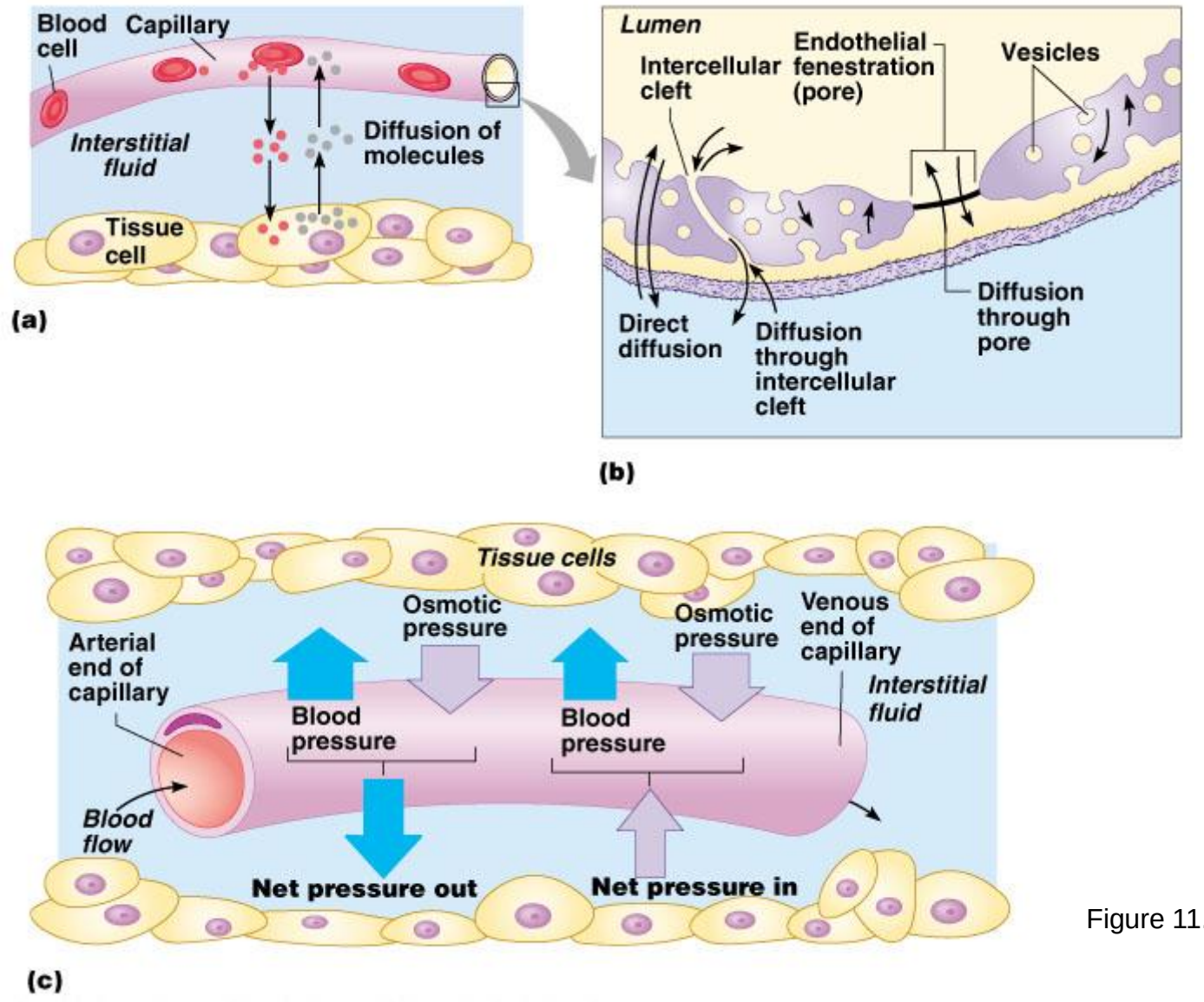


Figure 11.20

Movement of Blood Through Vessels

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

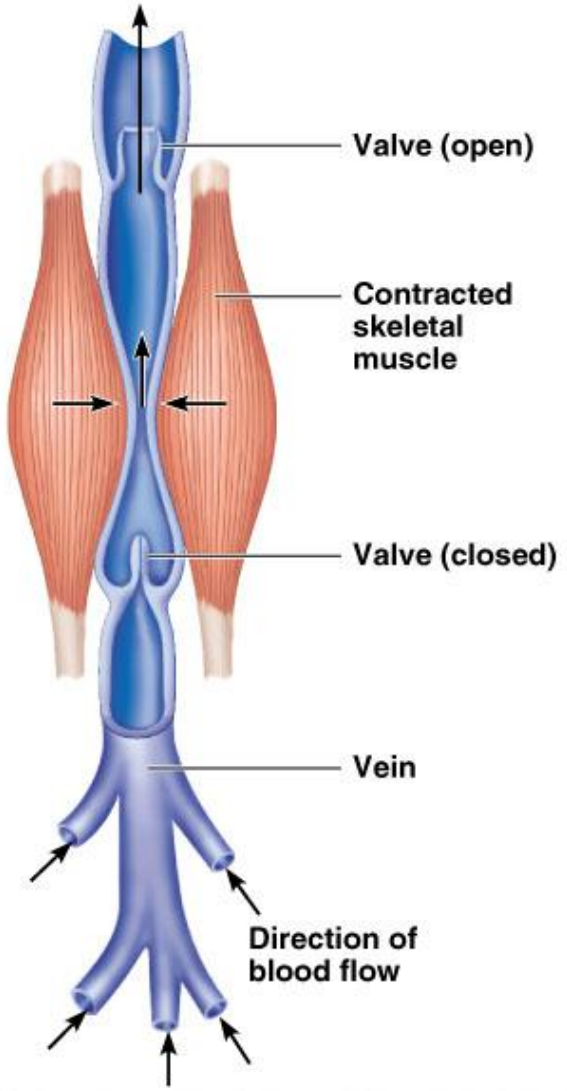


Figure 11.9

Major Arteries of Systemic Circulation

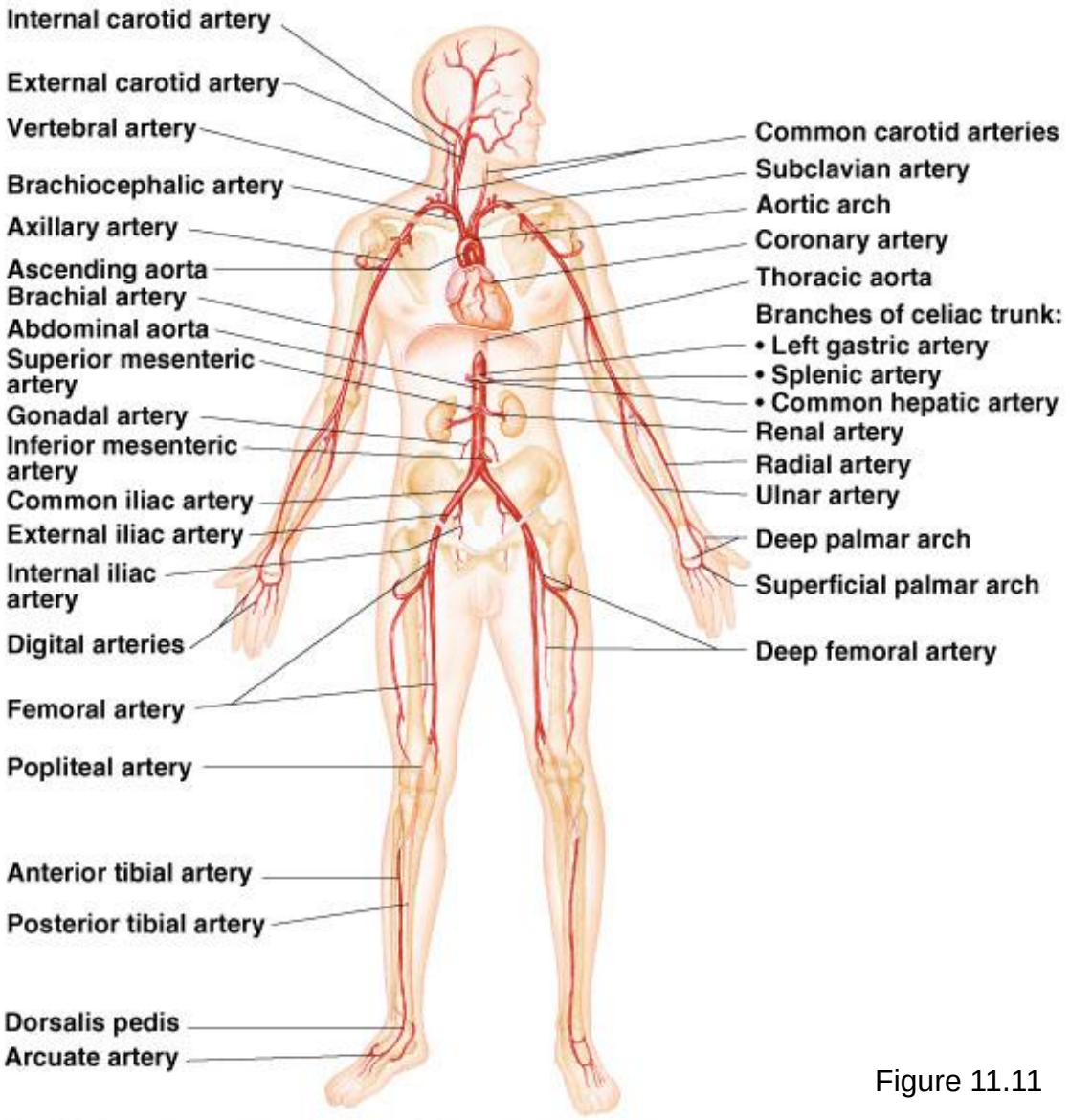


Figure 11.11

Major Veins of Systemic Circulation

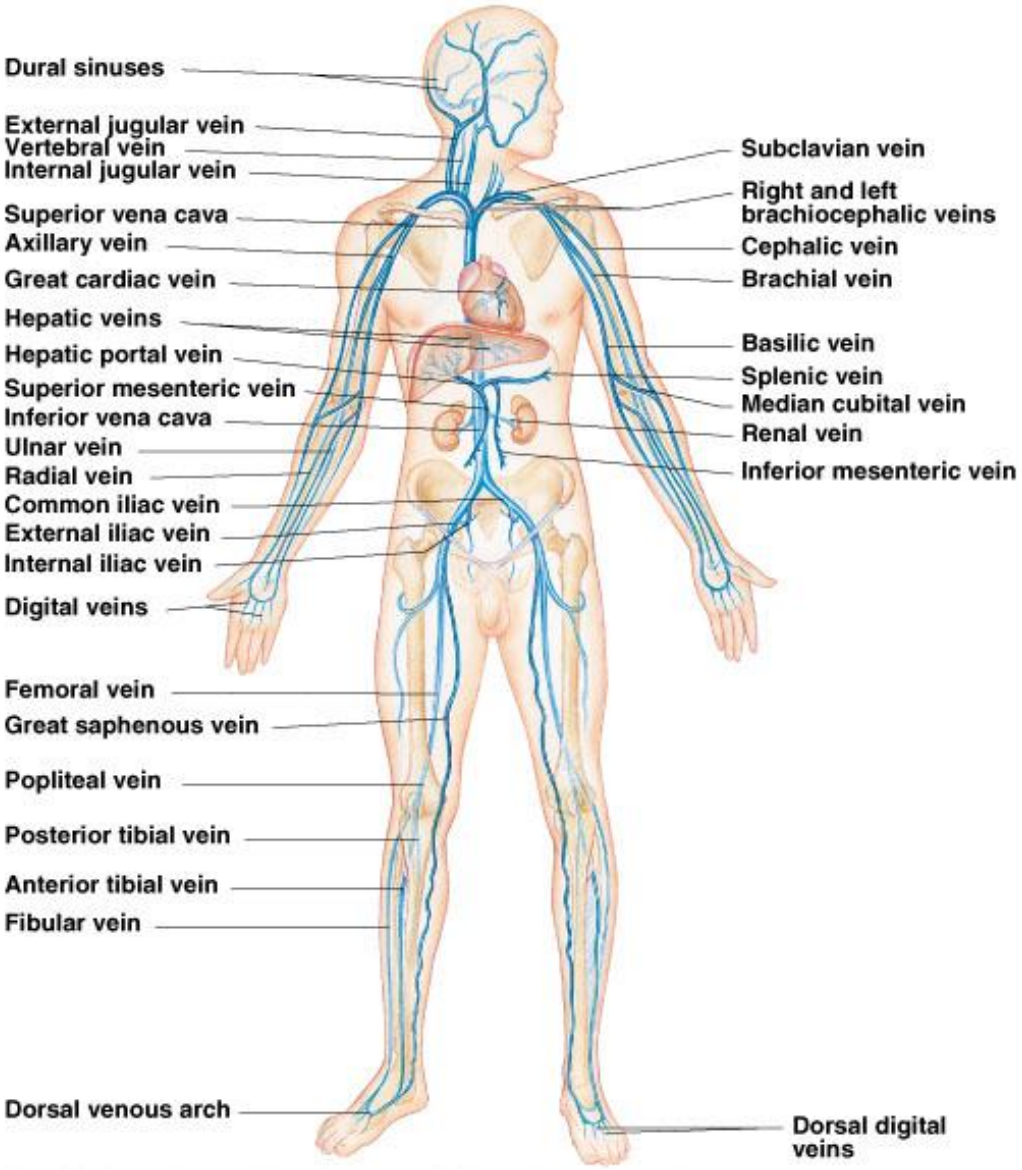


Figure 11.12

Arterial Supply of the Brain

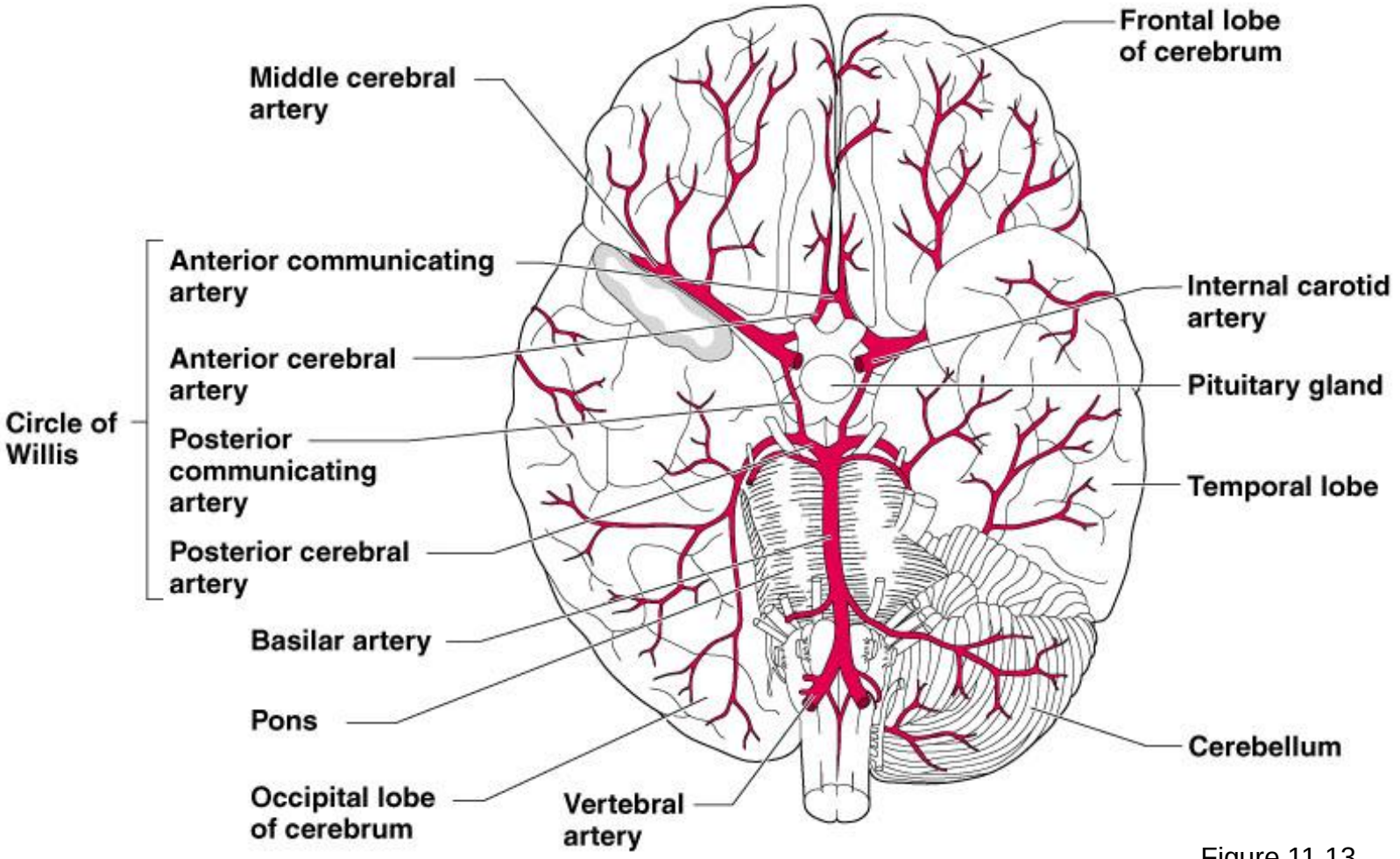


Figure 11.13

Hepatic Portal Circulation

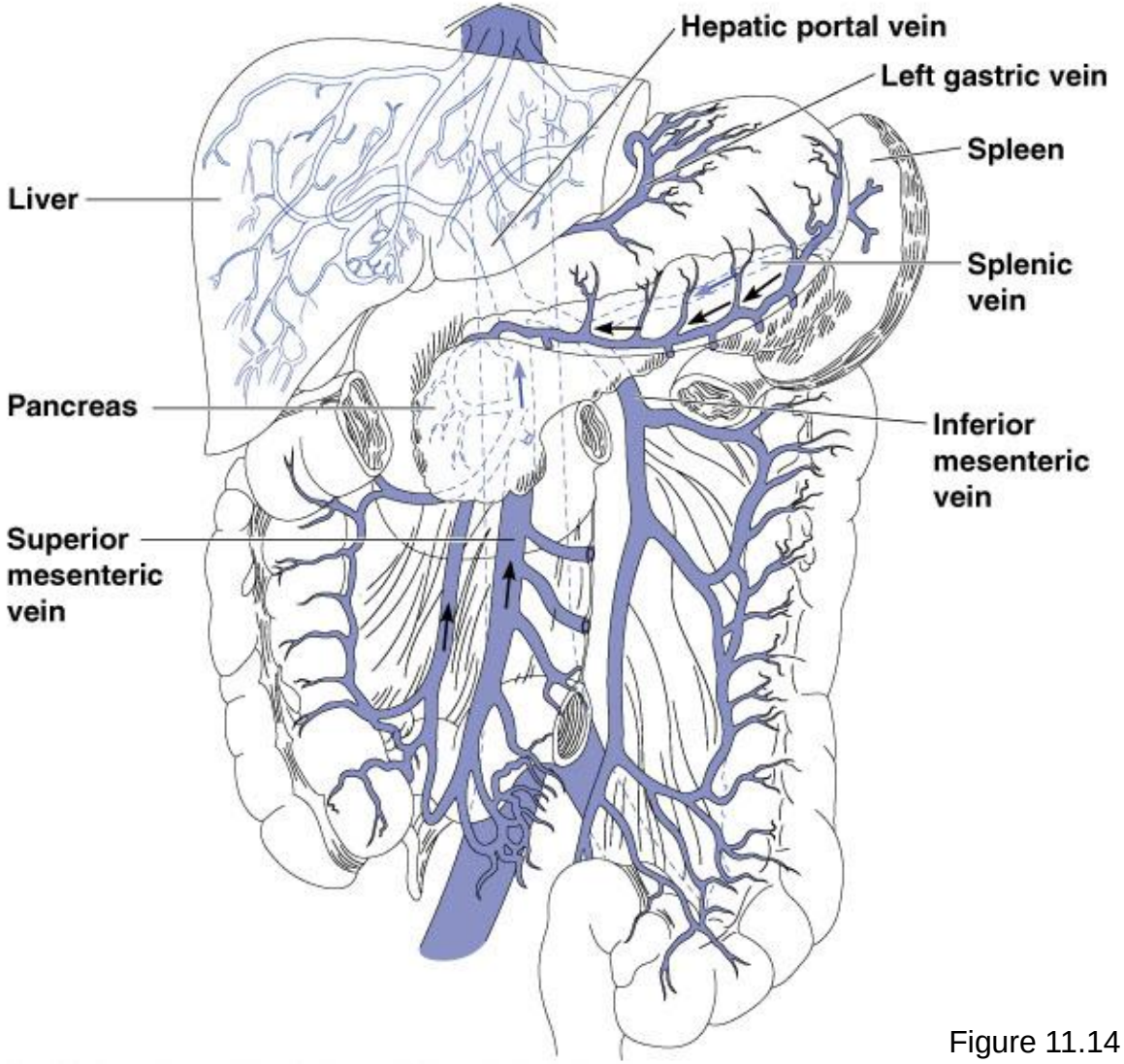


Figure 11.14

Circulation to the Fetus

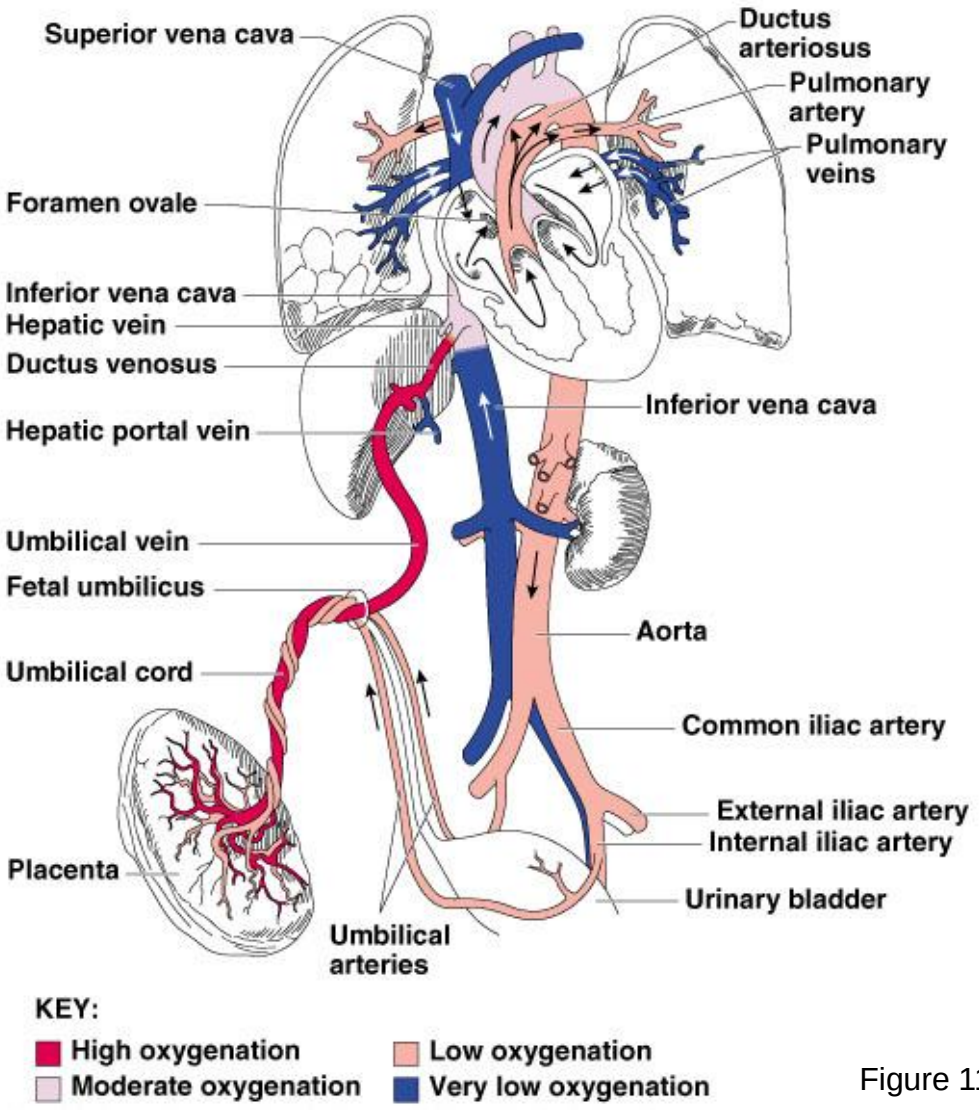


Figure 11.15


STOP

Title

- Physiology of the Heart

Essential Question

- Name the elements of the intrinsic conduction system of the heart, and describe the pathway of impulses through this system.

The Heart: Conduction System

- Intrinsic conduction system (nodal system)
  - muscle cells contract, w/o nerve impulses, in a regular, continuous way

The Heart: Conduction System

- Special tissues set the pace

Sinoatrial node (Pacemaker)

↓

Atrioventricular node

↓

Atrioventricular bundle

↓

Bundle branches

↓

Purkinje fibers

Heart Contractions

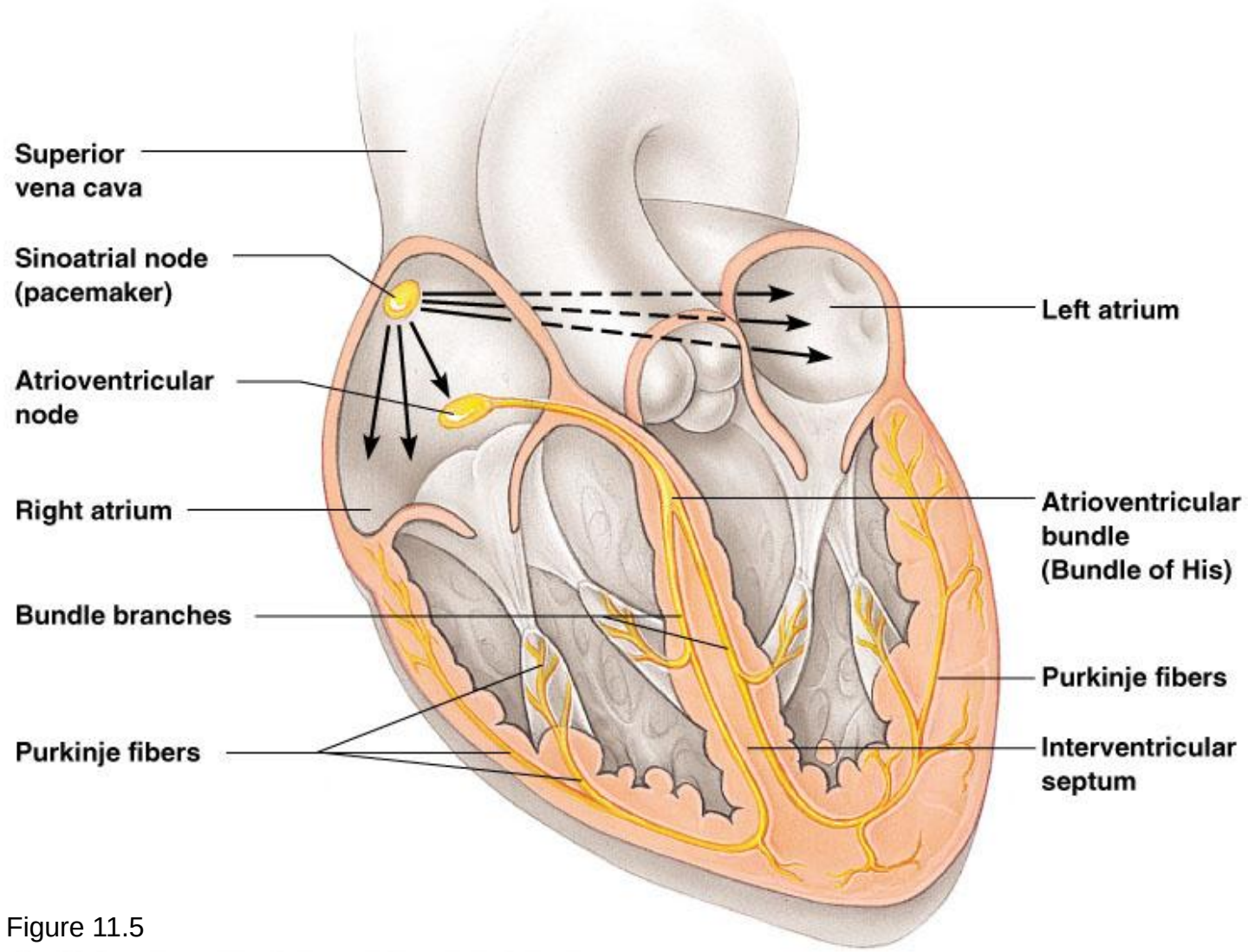


Figure 11.5

Filling of Heart Chambers – the Cardiac Cycle

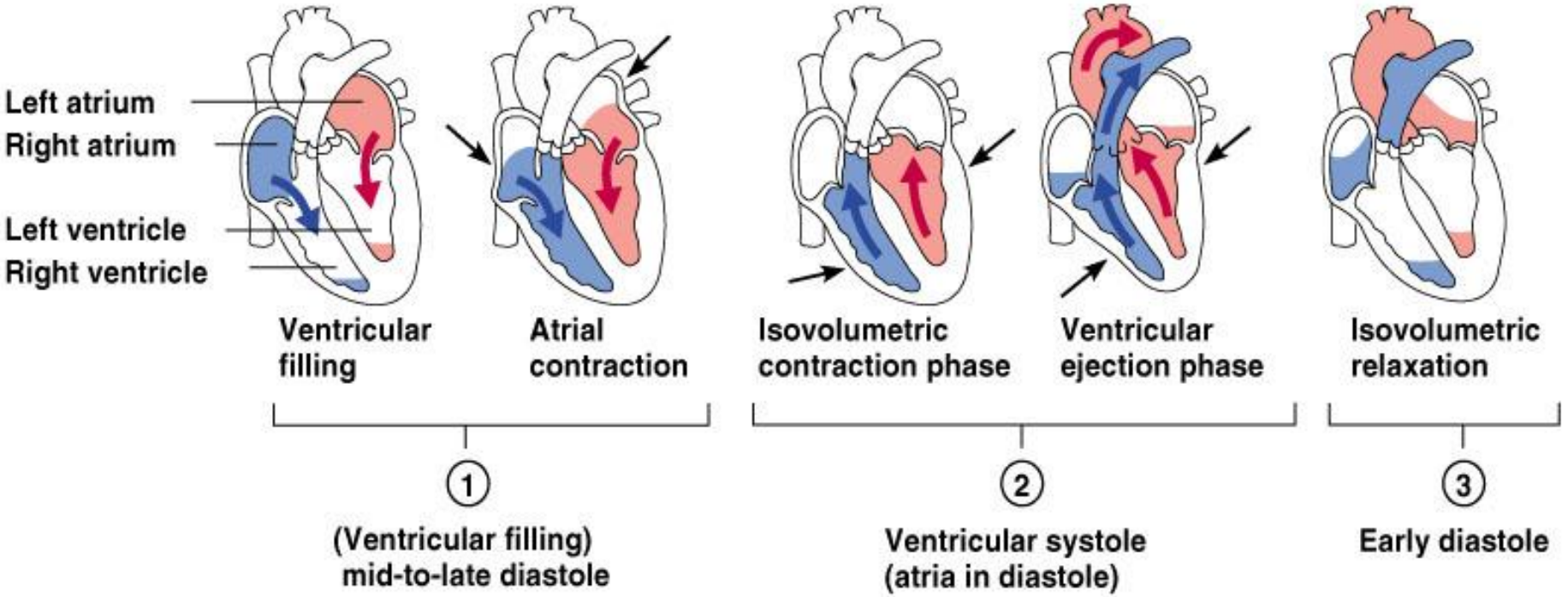


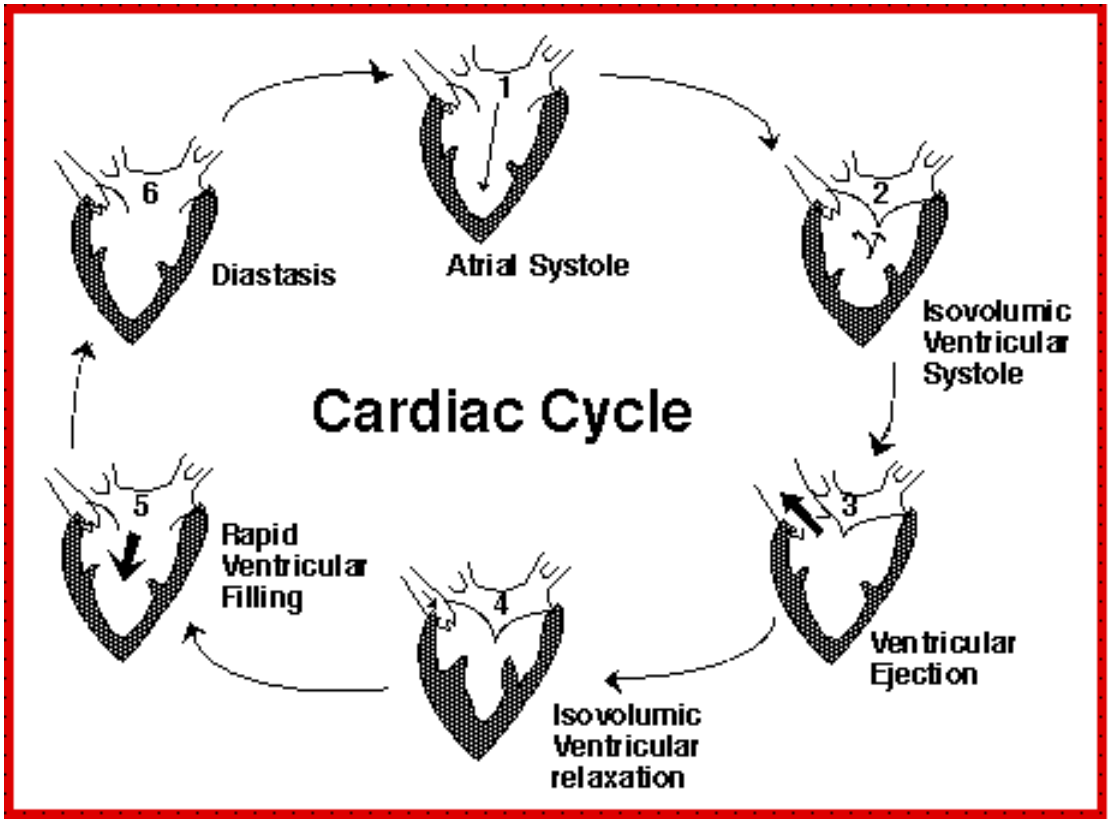
Figure 11.6

The Heart: Cardiac Cycle

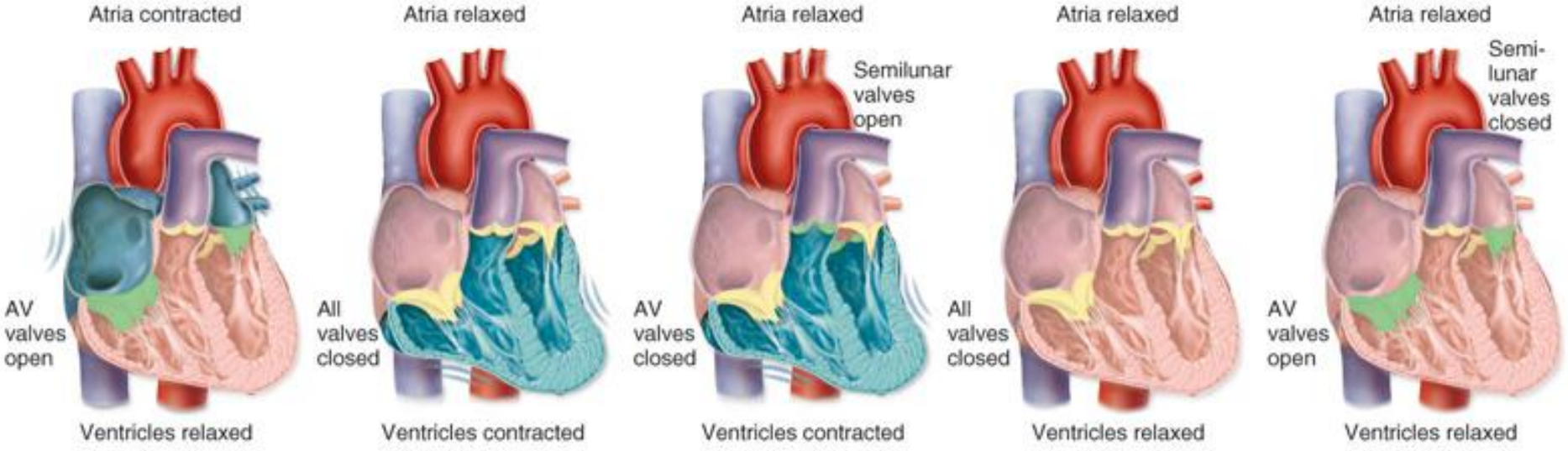
- **Cardiac cycle** – events of one complete heart beat
- **Overview**
  - Atria contract simultaneously
  - Atria relax, then ventricles contract
- **Systole** = contraction
- **Diastole** = relaxation

The Heart: Cardiac Cycle

- **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

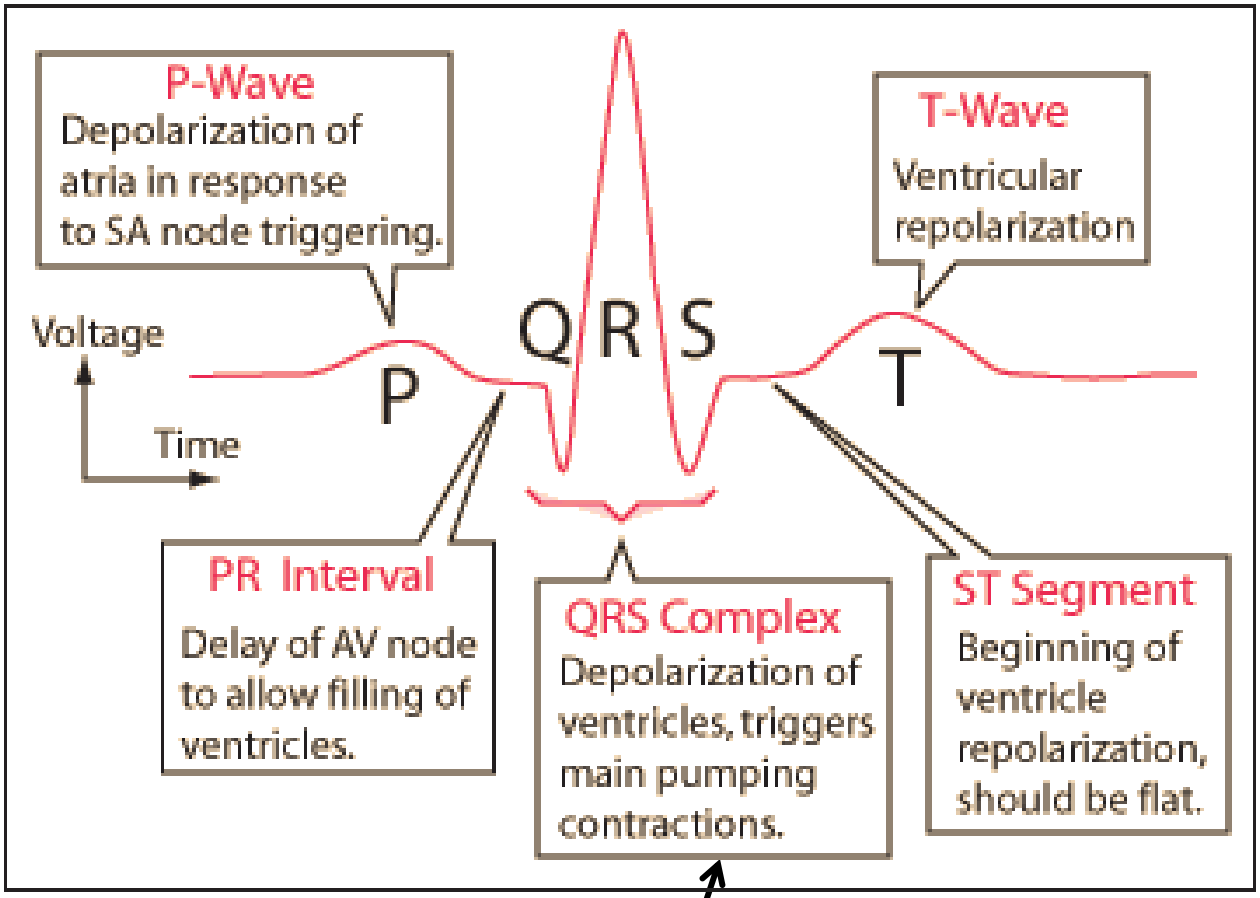

Cardiac Cycle
1
Atrial Systole
2
Isovolumic
Ventricular
Systole
3
Ventricular
Ejection
4
Isovolumic
Ventricular
relaxation
5
Rapid
Ventricular
Filling
6
Diastasis

Structure \ Phase	Atrial systole	Early ventricular systole ⟷ Late ventricular systole	Early ventricular diastole ⟷ Late ventricular diastole
Atria	Contract	Relax	Relax
Ventricles	Relax	Contract	Relax
AV valves	Open	Closed	Open
Semilunar valves	Closed	Open	Closed



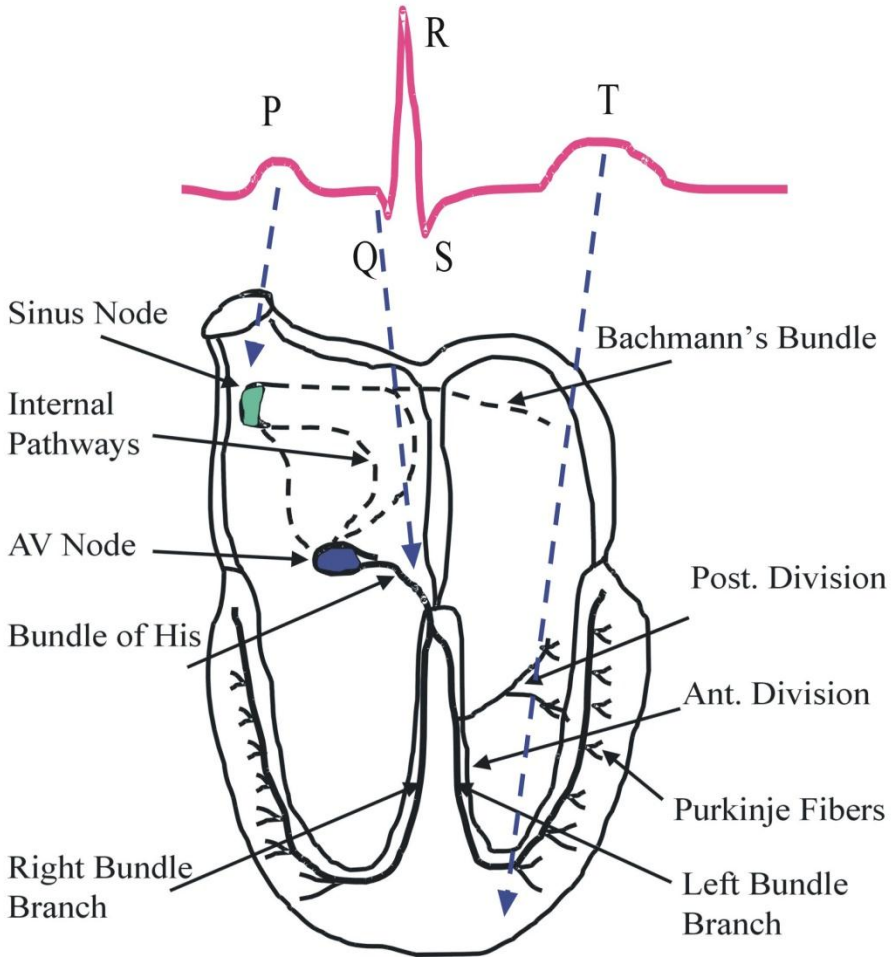
1. **Atrial systole**
   Atria contract, AV valves open, semilunar valves closed
2. **Early ventricular systole**
   Atria relax, ventricles contract, AV valves forced closed, semilunar valves still closed
3. **Late ventricular systole**
   Atria relax, ventricles contract, AV valves remain closed, semilunar valves forced open
4. **Early ventricular diastole**
   Atria and ventricles relax, AV valves and semilunar valves closed, atria begin passively filling with blood
5. **Late ventricular diastole**
   Atria and ventricles relax, atria passively fill with blood as AV valves open, semilunar valves closed

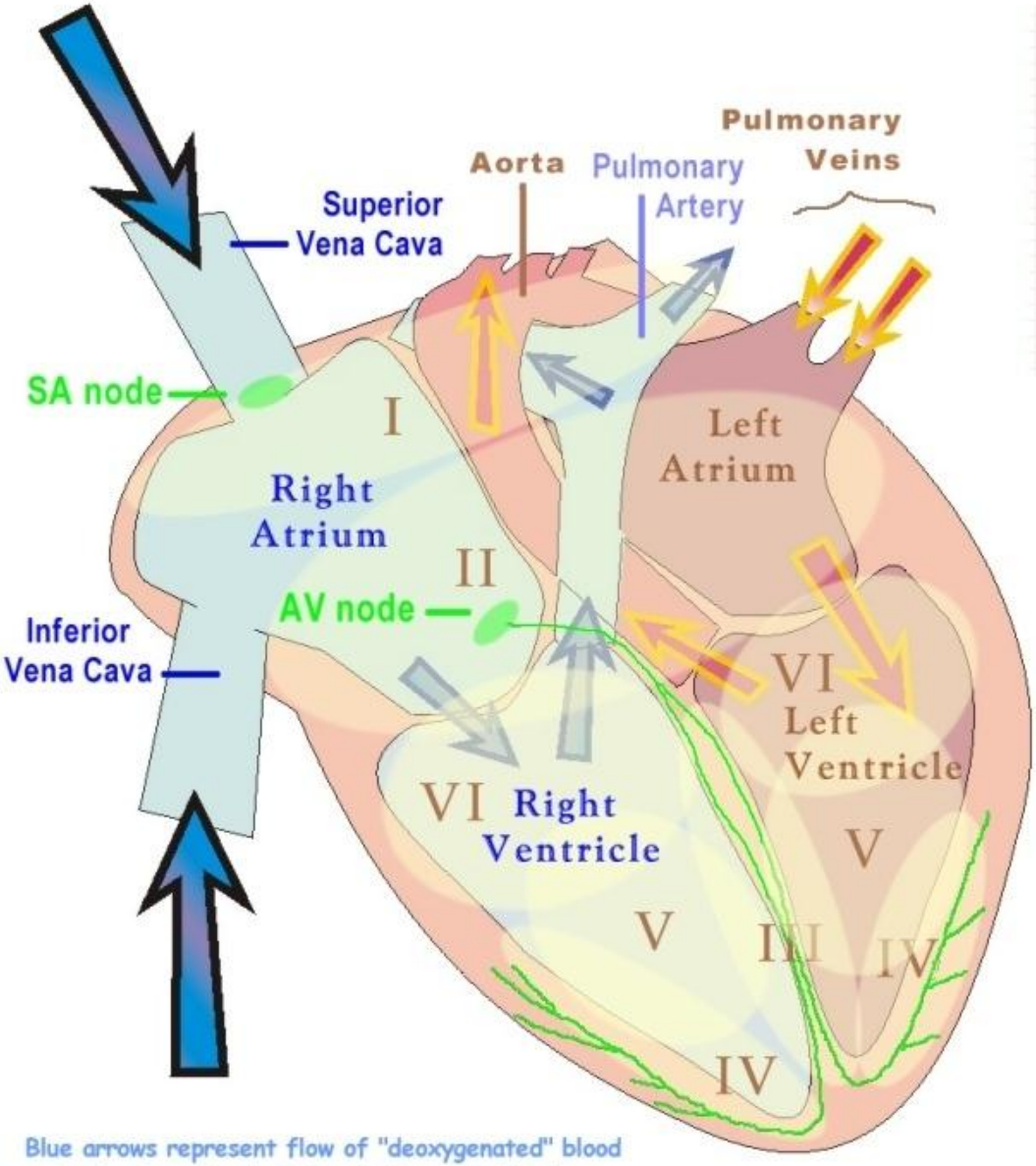
ECG WAVE



http://uploadImage:ECG principle slow.gif - Wikipedia, the free encyclopedia.

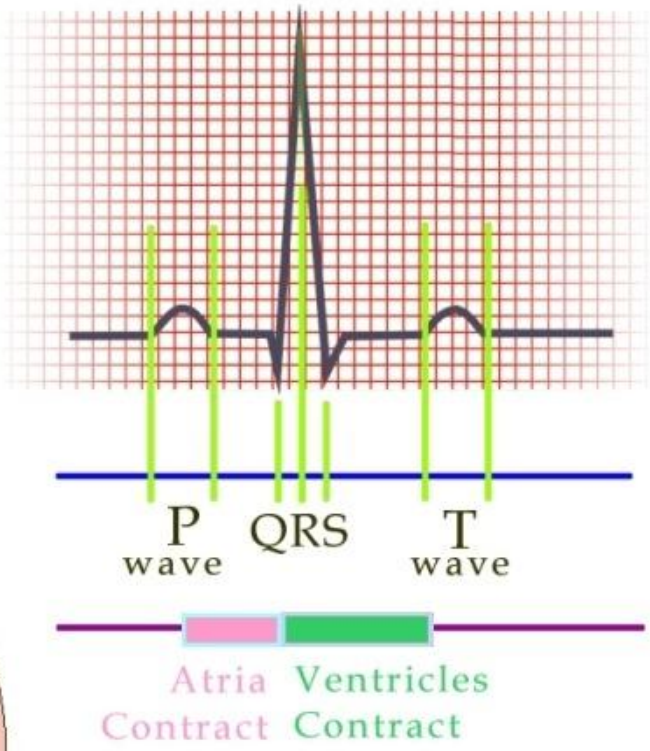
Atrial Reploarization


R
P
T
Q
S
Sinus Node
Bachmann's Bundle
Internal
Pathways
AV Node
Post. Division
Bundle of His
Ant. Division
Purkinje Fibers
Right Bundle
Branch
Left Bundle
Branch

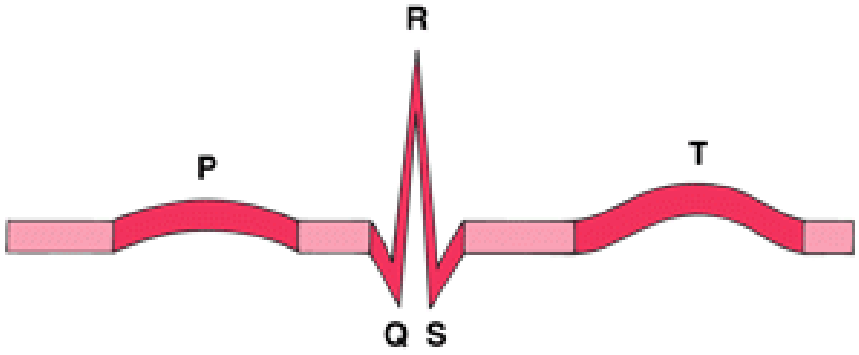


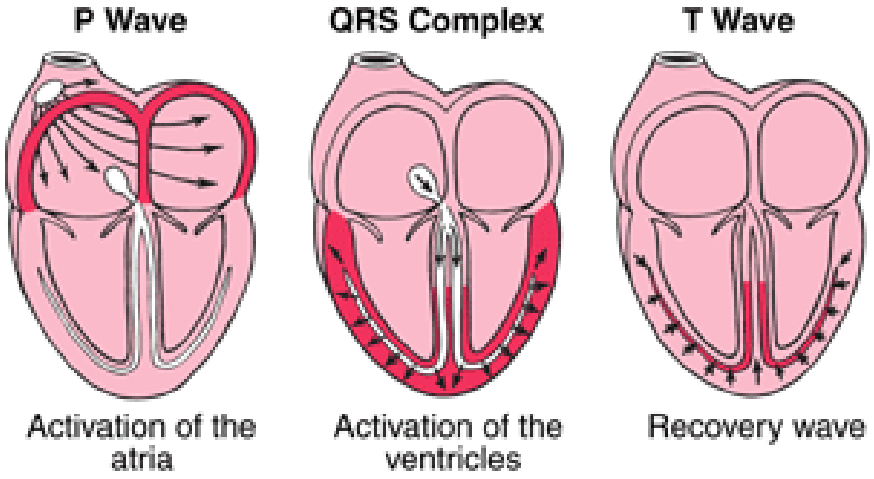
Blue arrows represent flow of "deoxygenated" blood returning from the body headed towards the lungs

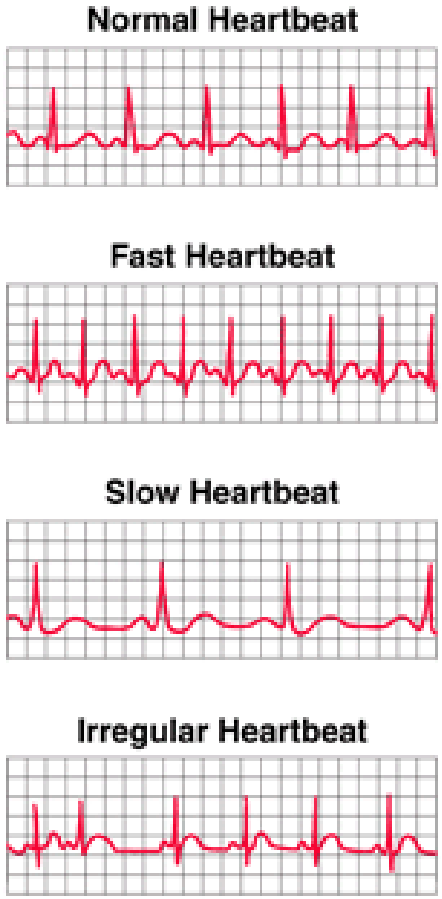
Red arrows represent flow of reoxygenated blood returning from the lungs headed towards the body



P wave	Depolarization of sinoatrial (AV) node Atrial contraction (systole) Depolarization through region I
PQ	Continued atrial depolarization Conduction of AP through the atrio-ventricular (AV) node Depolarization through region I then II
Q wave	Depolarization through region III
QRS	Ventricular depolarization Atrial repolarization Depolarization through refions III & IV
RS	Depolarization through regions IV, V & VI
T wave	Ventricular repolarization


R
P
T
Q S


P Wave
QRS Complex
T Wave
Activation of the atria
Activation of the ventricles
Recovery wave


Normal Heartbeat
Fast Heartbeat
Slow Heartbeat
Irregular Heartbeat


STOP

Title

- Physiology of Circulation

Essential Question

- Describe the regulation of cardiac output and blood pressure.

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])

The Heart: Cardiac Output

- Stroke volume
  - Volume of blood pumped by each ventricle in one contraction

Cardiac Output Regulation

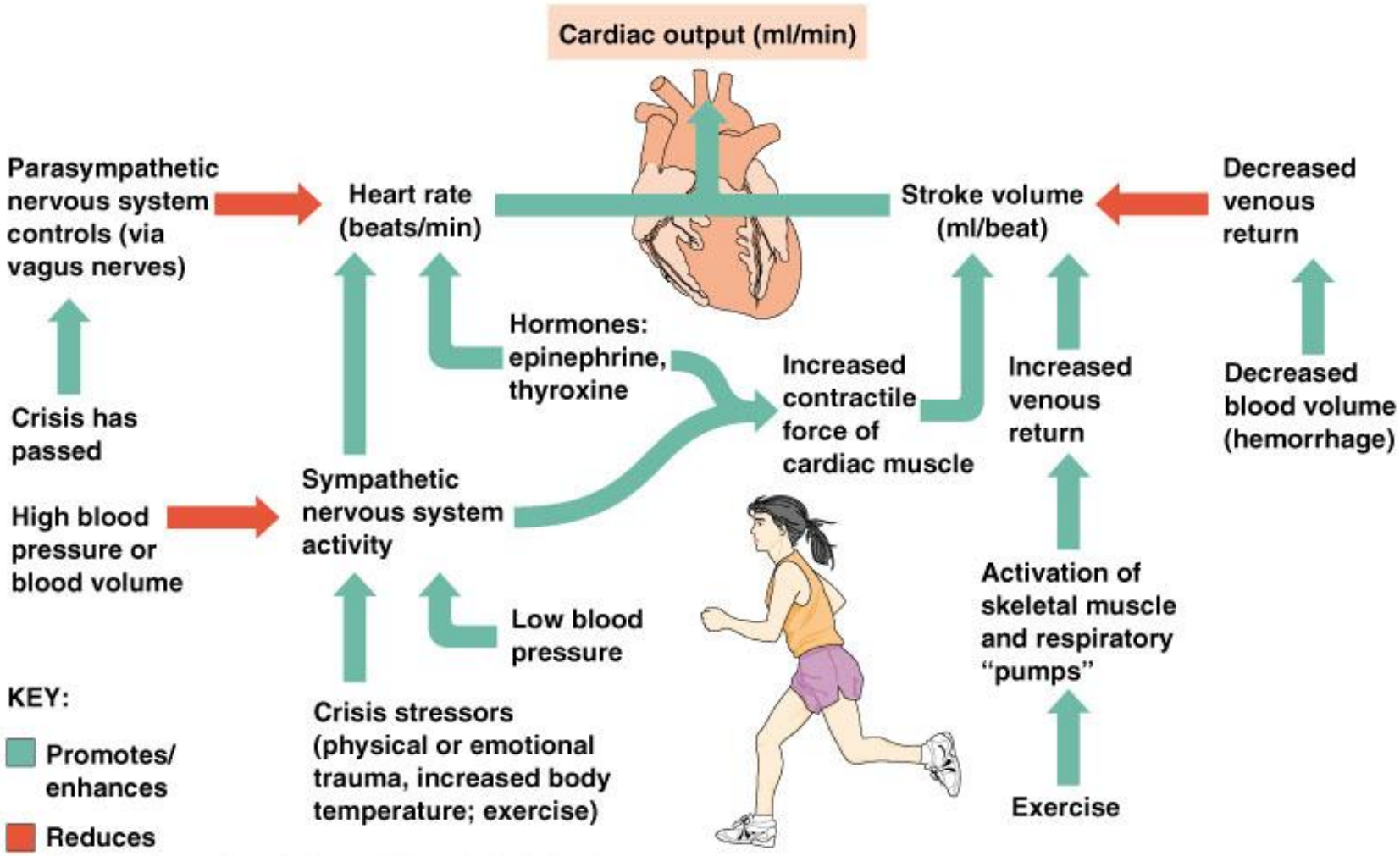
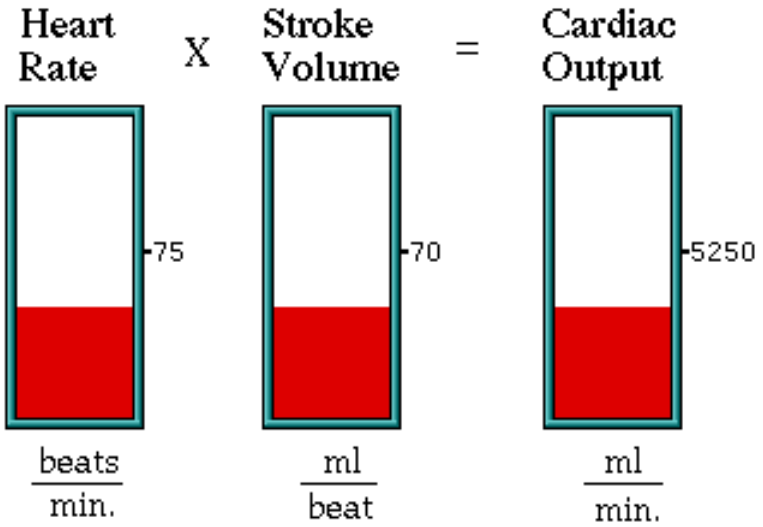


Figure 11.7

Factors Affecting Cardiac Output



Rising blood pressure reduces sympathetic activity, decreasing heart rate. High blood pressure also increases the arterial pressure which ventricles must overcome before semilunar valves open, increasing ESV and decreasing stroke volume. Reduced cardiac output helps bring blood pressure down to normal levels.

The Heart: Regulation of Heart Rate

- **Starling's law of the heart** – the more that the cardiac muscle is stretched, the stronger the contraction

The Heart: 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
  - Decreased venous return

Pulse

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

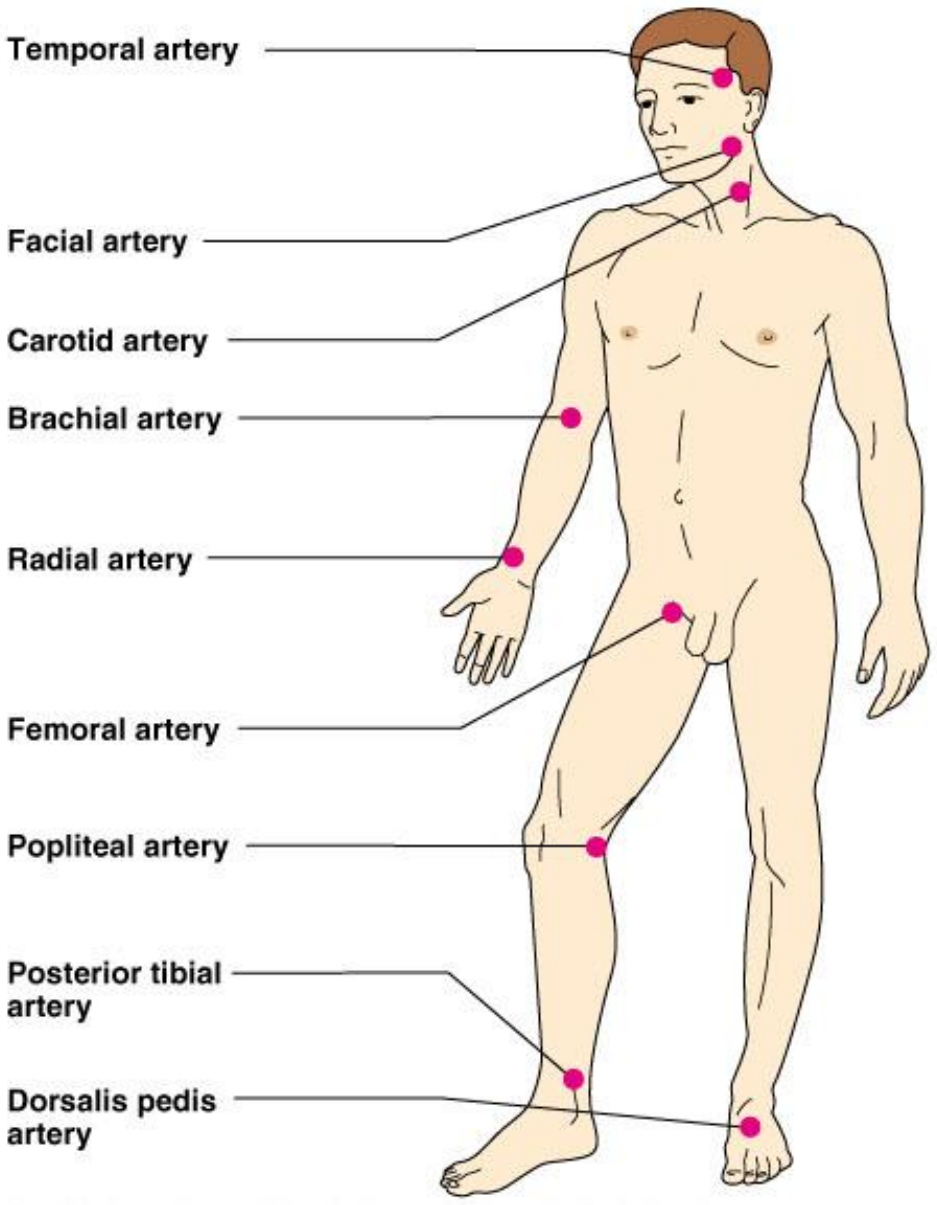
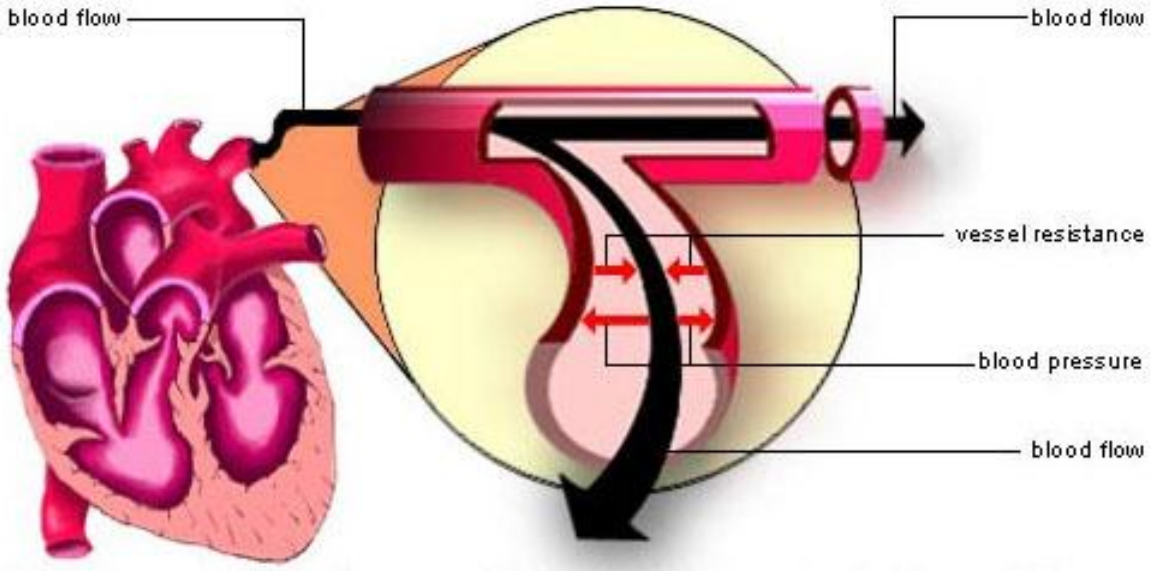


Figure 11.16

Blood Pressure

- Measurements made on large arteries
  - Systolic – pressure at the peak of ventricular contraction
  - Diastolic – pressure when ventricles relax



Blood pressure, the outward pressure of blood against blood vessel walls, is the product of **blood flow** from the heart and inward **resistance** of blood vessel walls.

Measuring Arterial Blood Pressure

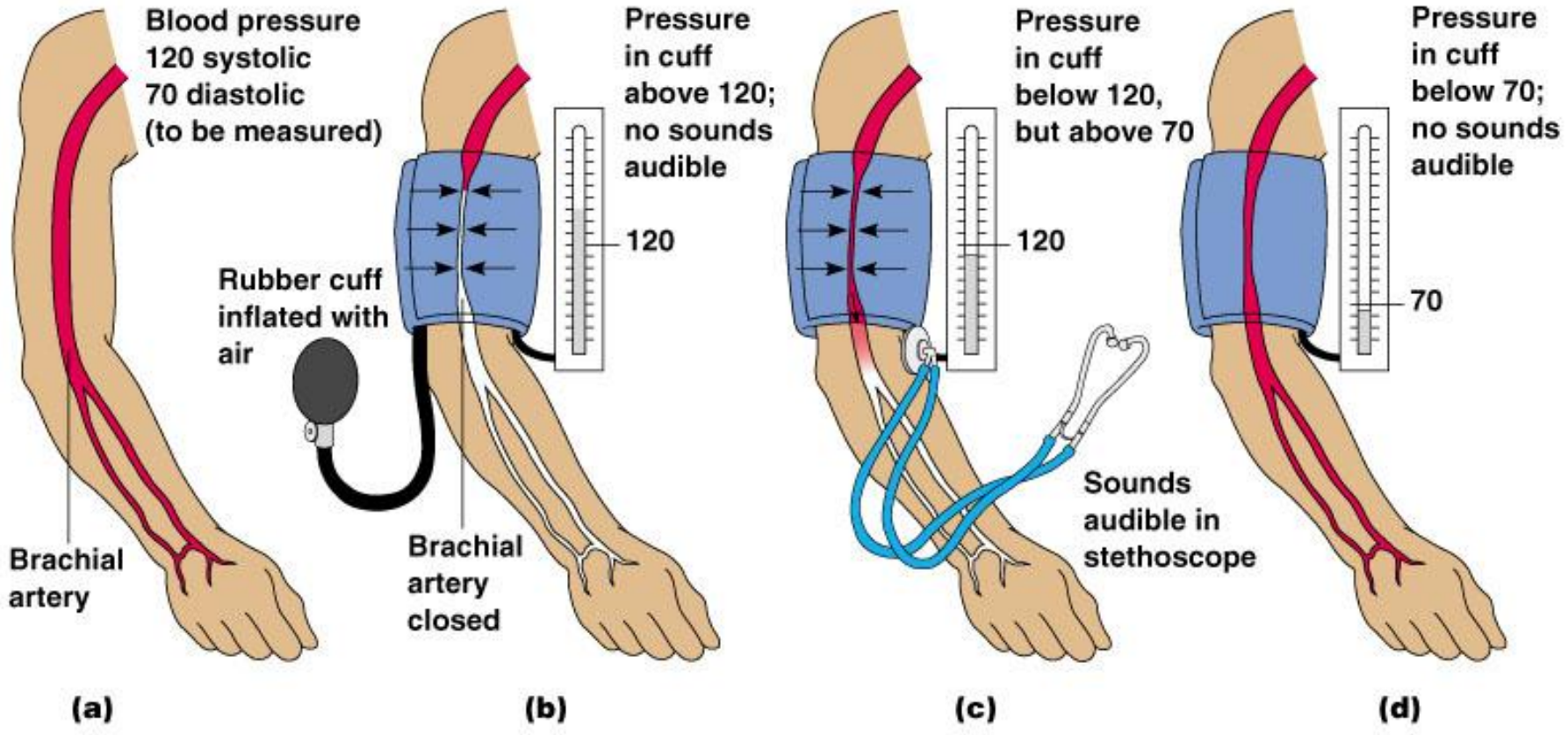


Figure 11.18

Comparison of Blood Pressures in Different Vessels

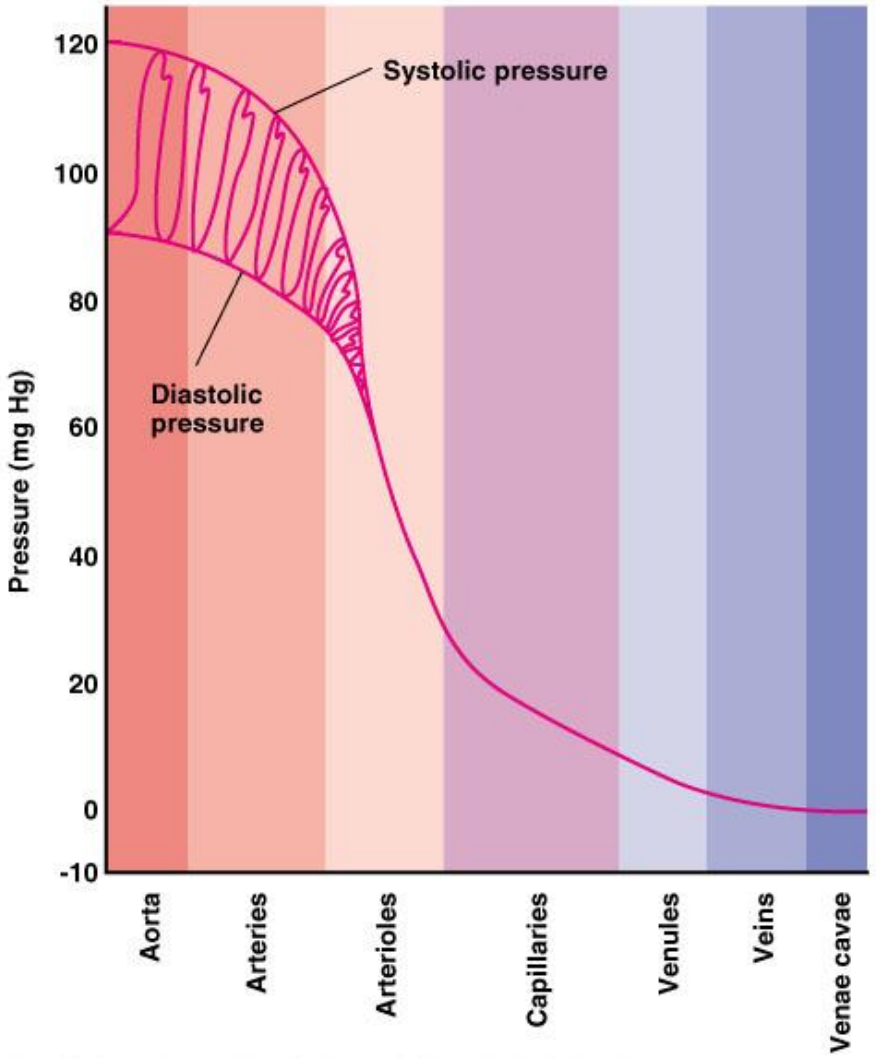


Figure 11.17

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

Factors Determining Blood Pressure

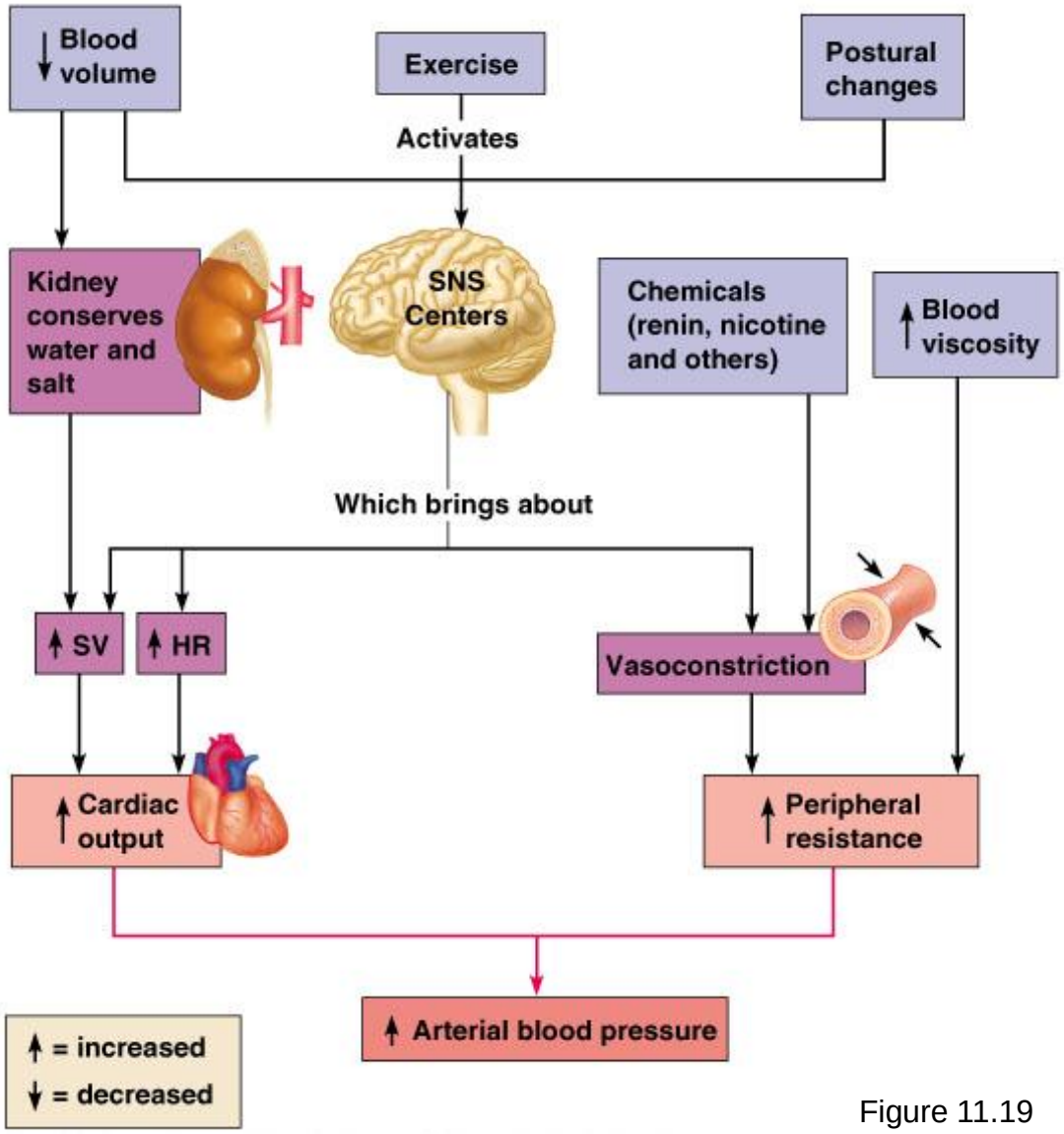


Figure 11.19

Variations in Blood Pressure

- Normal
  - 140–110 mm Hg systolic
  - 80–75 mm Hg diastolic

Variations in Blood Pressure

- 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