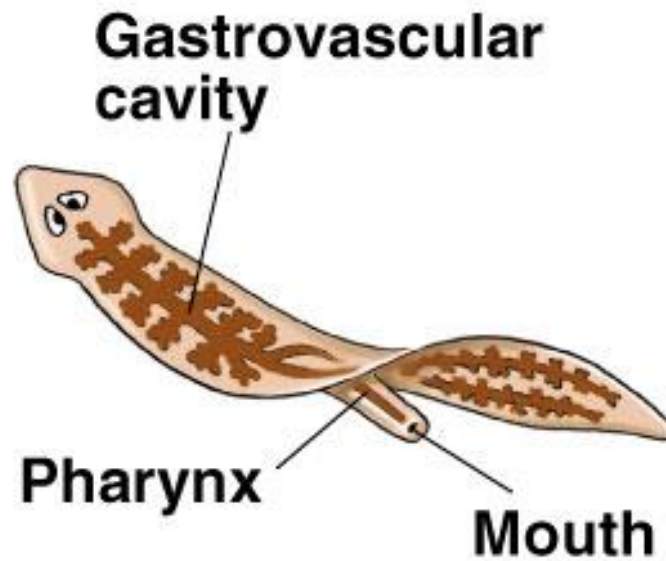


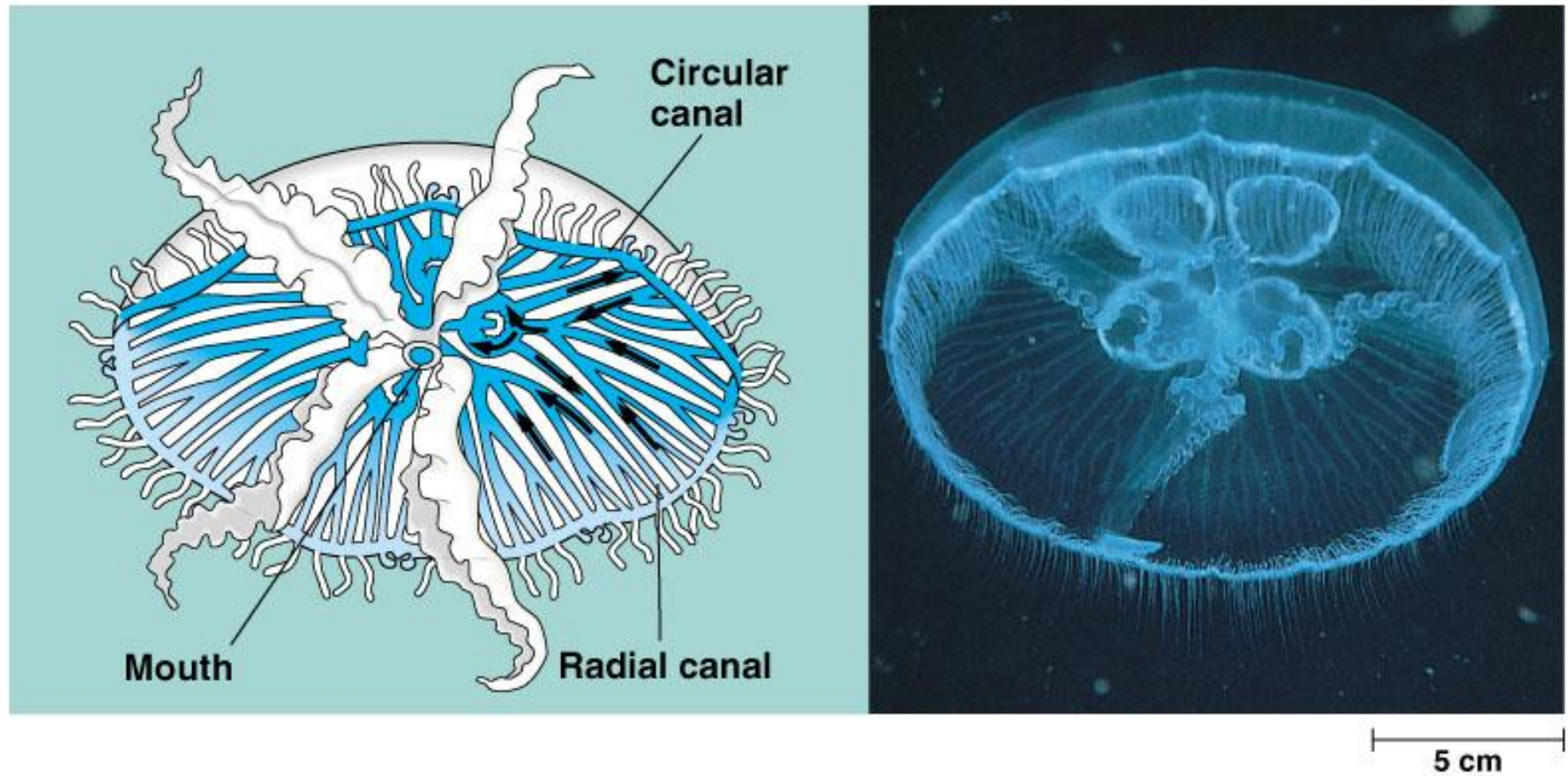
Transport in Animals

- **Gastrovascular cavities**
 - flatworms and cnidarians
- Nutrients and gases can move by processes such as diffusion and active transport.



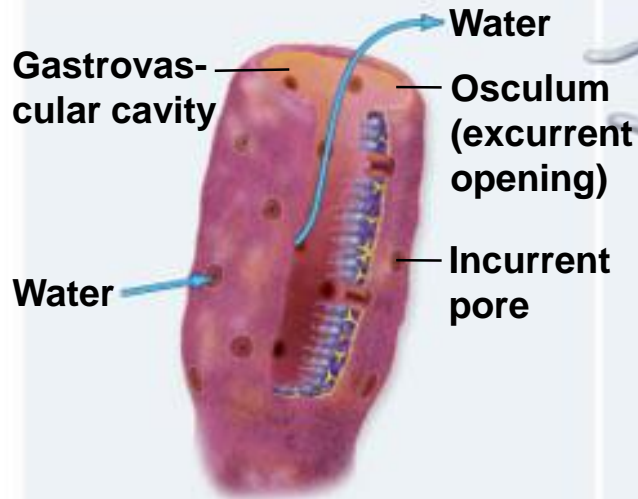
**(a) Planarian:
gastrovascular
cavity**

Figure 42.1 Internal transport in the cnidarian *Aurelia*

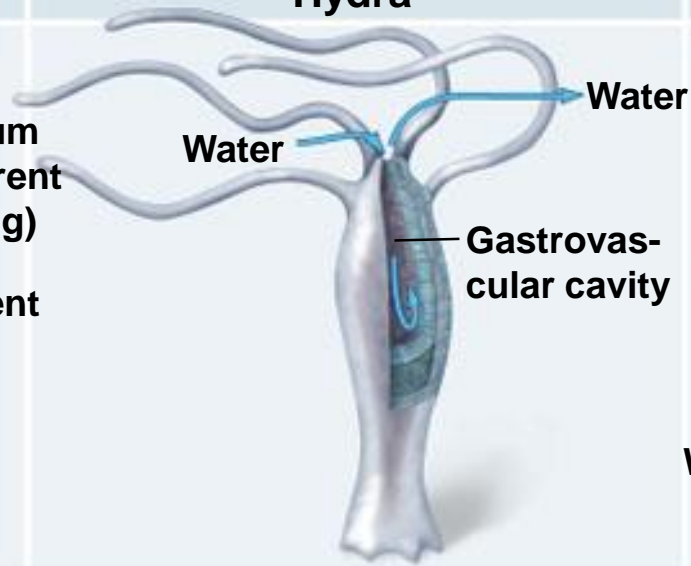


No Circulatory System

Sponge



Hydra



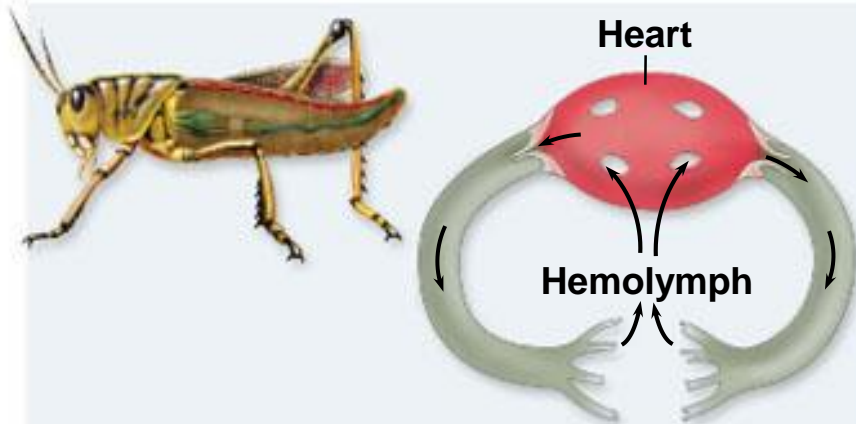
Nematode



a.

Open Circulation

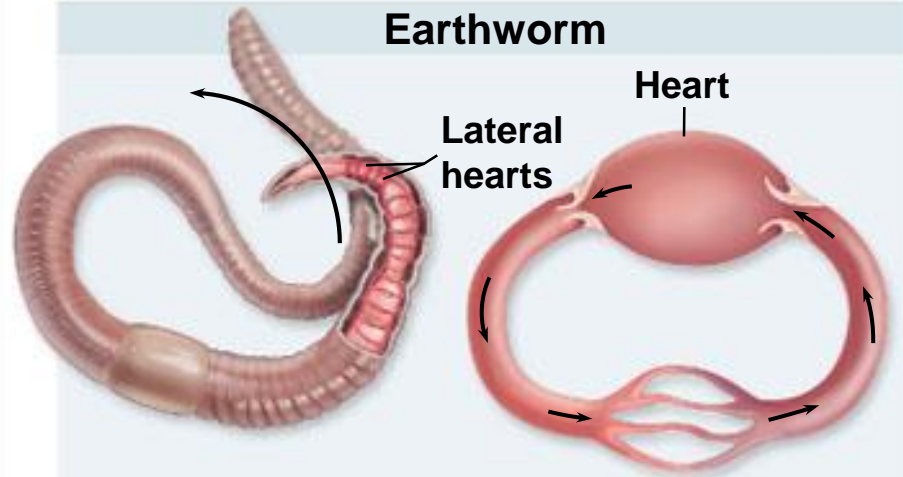
Grasshopper



b.

Closed Circulation

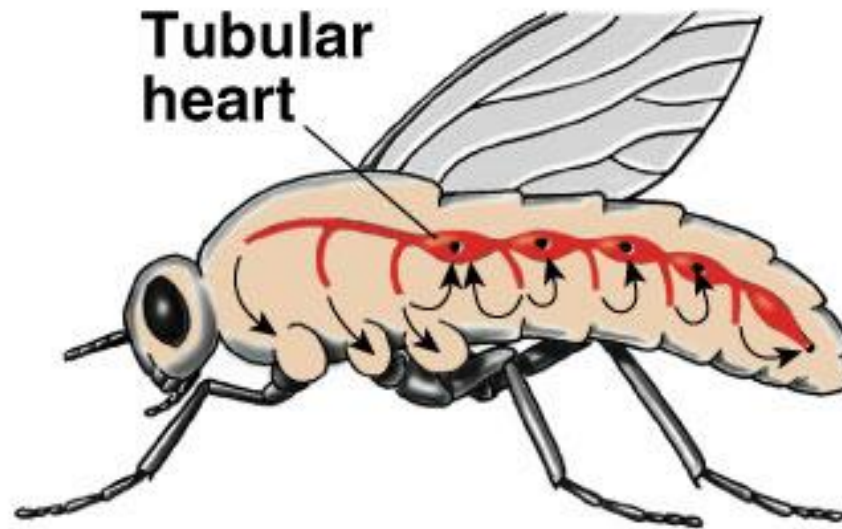
Earthworm



c.

Open Circulatory systems

- *Insects, other arthropods and most mollusks*
- No distinction between blood and the interstitial fluid



**(b) Insect:
open
circulation**

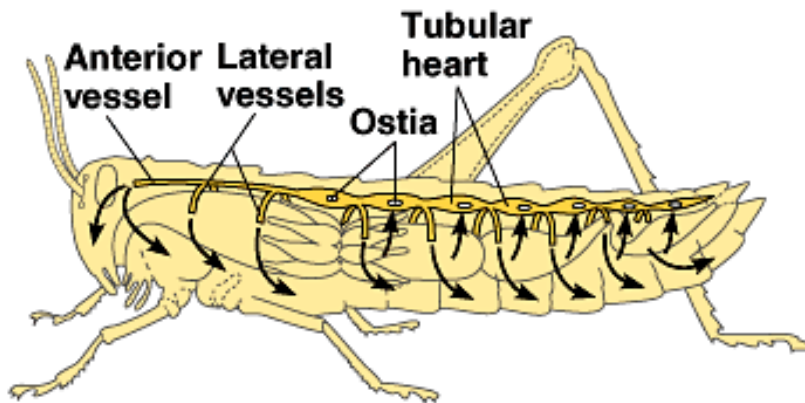
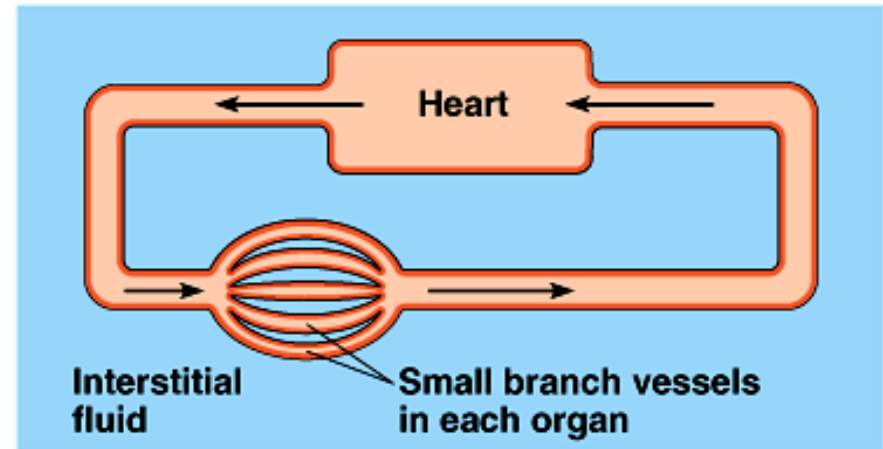
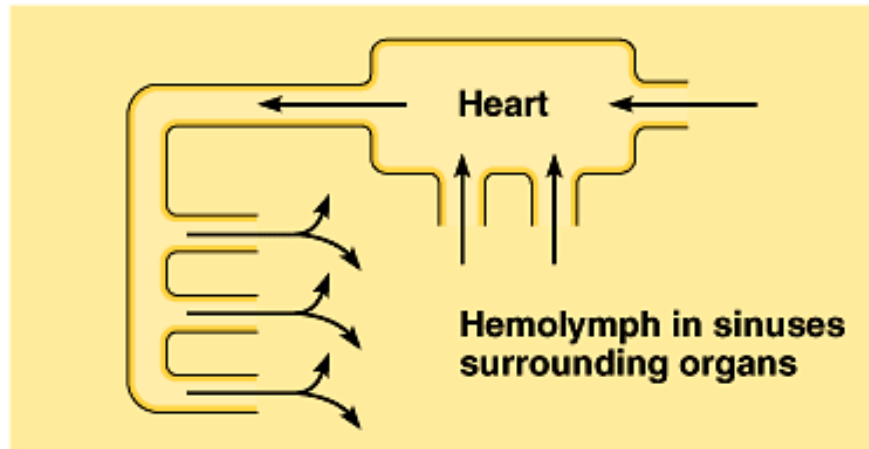
Open Circulatory systems

- Hemolymph
 - name of general body fluid
 - directly bathes the internal organs
- System of sinuses
- Heart and body movements cause circulation

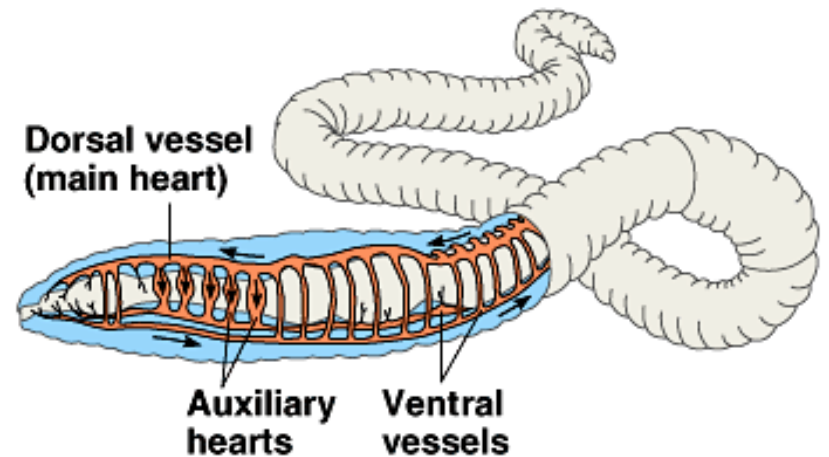
Open Circulatory systems

- Slower circulation
- sluggish animals BUT...
 - Insects are very active

Figure 42.2 Open and closed circulatory systems



(a) Open circulatory system



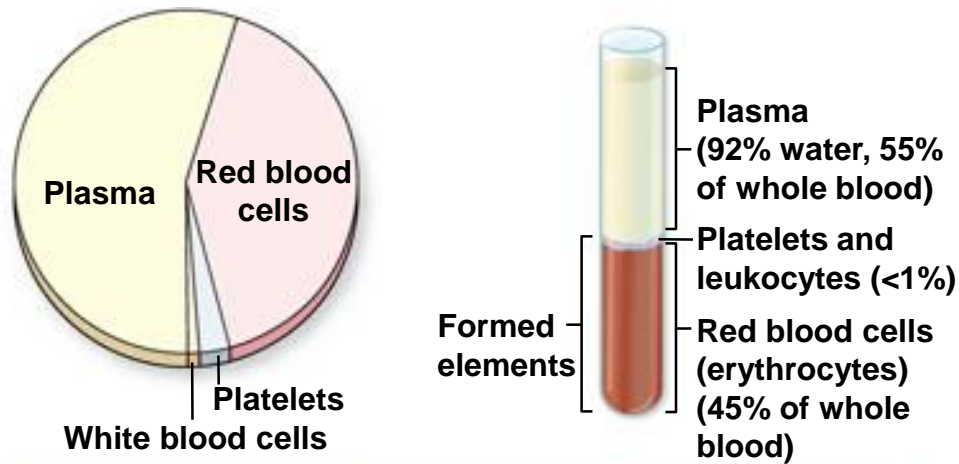
(b) Closed circulatory system

Closed Circulatory Systems

- *Earthworms, squids, octopuses, and vertebrates*
- Blood is confined to vessels and is distinct from interstitial fluid
- Consists of the heart, blood vessels and blood

Blood

- **Plasma** – about 55% of blood volume
 - 90% water
 - inorganic salts (electrolytes), metabolites (vitamins, aa, glucose), wastes & hormones
 - proteins
 - osmotic balance, viscosity
 - buffers, transport lipids, antibodies, clotting factors (fibrinogen)










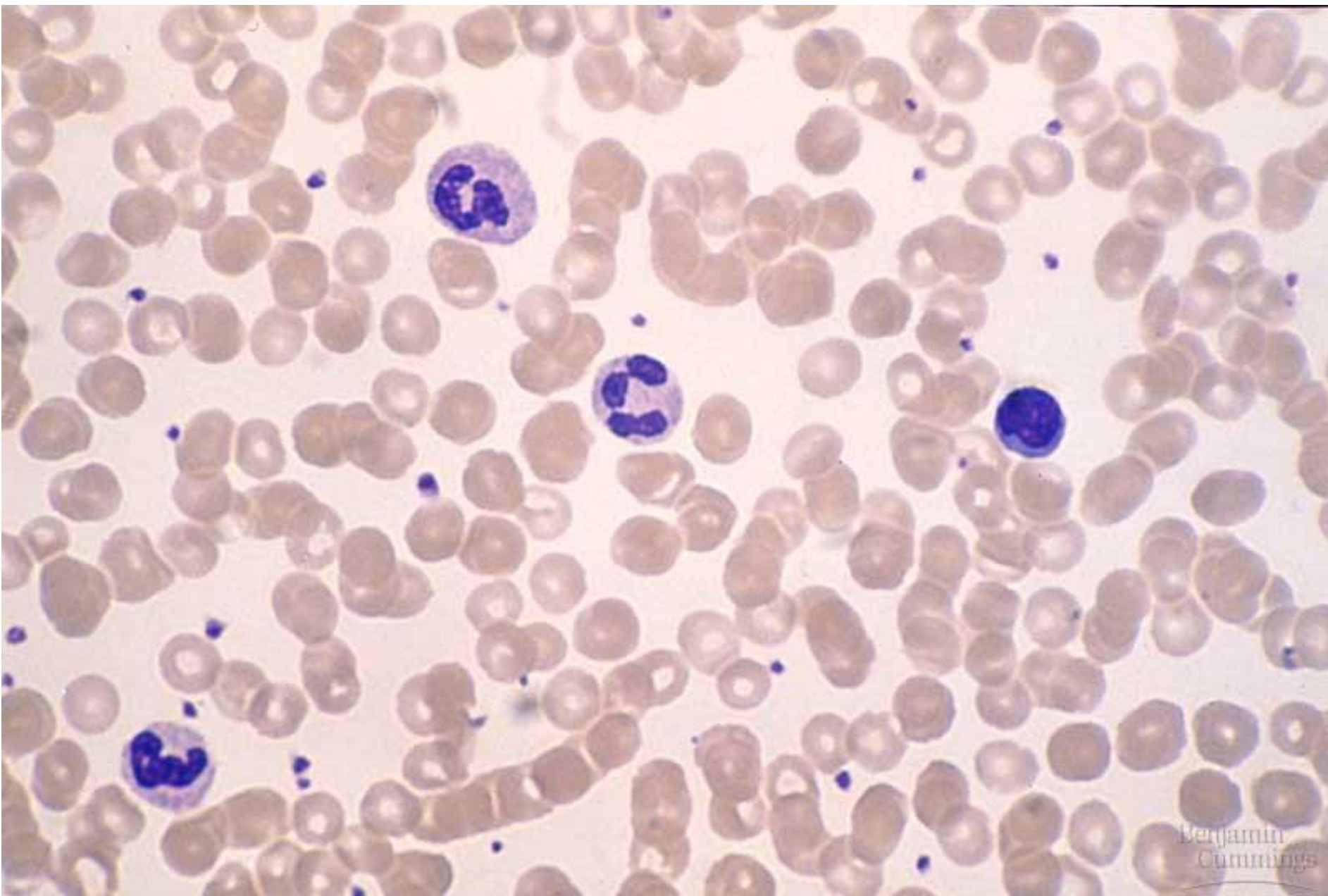
Blood Plasma	Red Blood Cells	Platelets
Plasma proteins (7%) Albumin (54%) Globulins (38%) Fibrinogen (7%) All others (1%)		
Water (91.5%) Other solutes (1.5%) Electrolytes Nutrients Gases Regulatory substances Waste products	4 million–6 million/ mm ³ blood	150,000–300,000 mm ³ blood
	Neutrophils	Eosinophils
		
	60–70%	2–4%
Monocytes	Basophils	Lymphocytes
		
3–8%	0.5–1%	20–25%

Figure 42.14x Blood smear



Blood

Cellular Elements:

- **Red Blood Cells (Erythrocytes)**
 - Most numerous (5-6 million in one cubic ml)
 - Transport oxygen & carbon dioxide

Blood

Cellular Elements:

- **White Blood Cells (Leukocytes)**
 - Function in body's defense
 - A cubic ml of blood has about 5,000 – 10,000
 - in interstitial fluid or in the lymphatic system – where your body fights pathogens

Blood

Cellular Elements:

Platelets are cell fragments that pinch off from larger cells in the bone marrow

-Function in the formation of blood clots

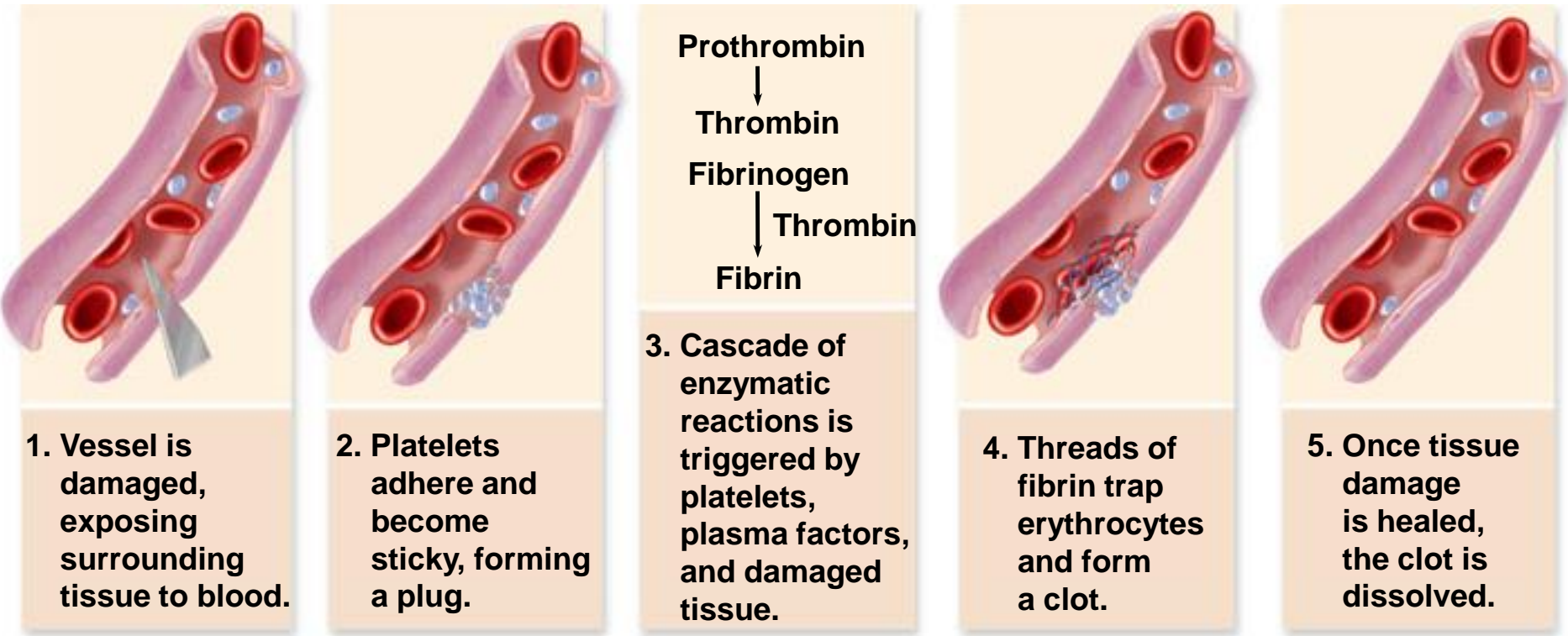


Figure 42.16x Blood clot



Heart

- one atrium or two **atria**
- one or two **ventricles**

Heart

- one atrium or two **atria**
 - chambers that receive blood returning to the heart
- one or two **ventricles**
 - chambers that pump blood out of the heart.

Blood vessels

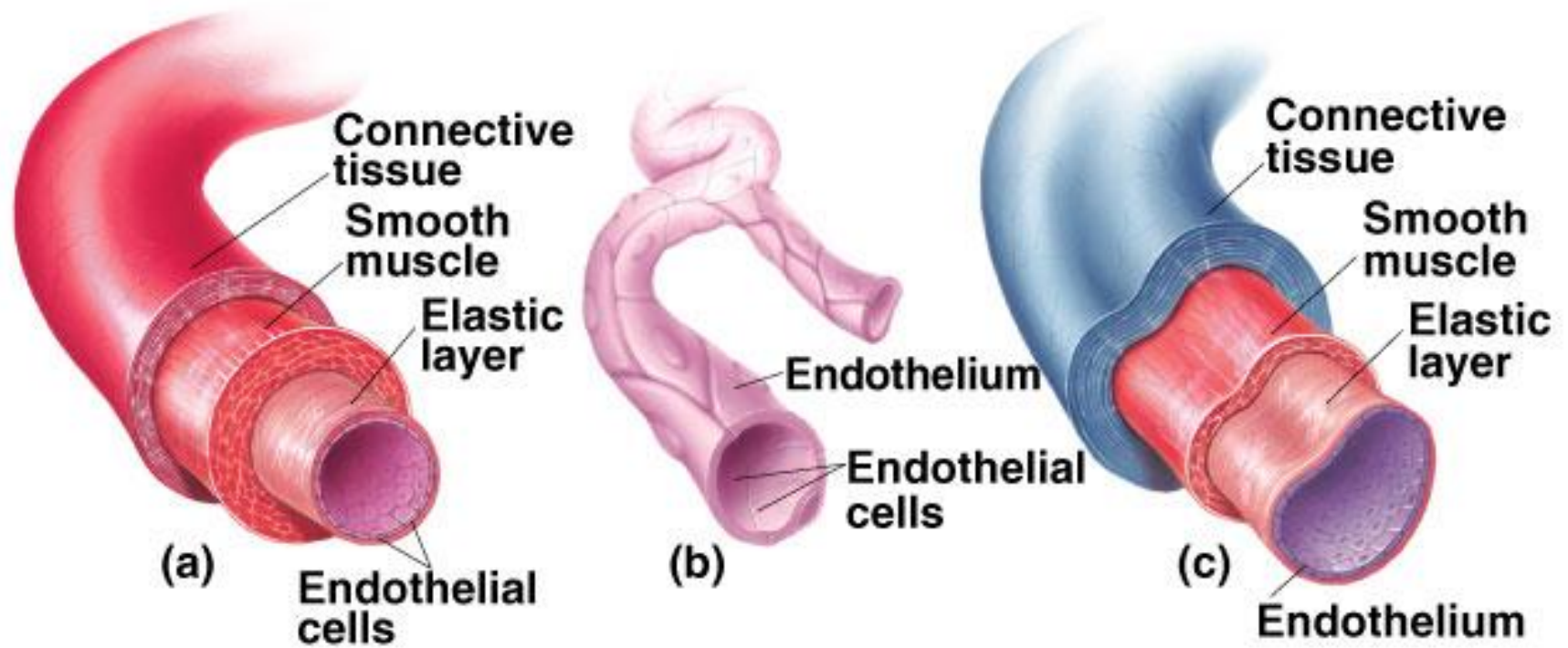
- Arteries
 - branch into arterioles
- Capillaries
- Veins
 - venules merge into veins

Blood vessels

- Arteries
 - branch into arterioles
 - carry blood away from heart
- Capillaries
 - materials are exchanged
- Veins
 - venules merge into veins
 - carry blood back toward heart

Blood Vessel Structure

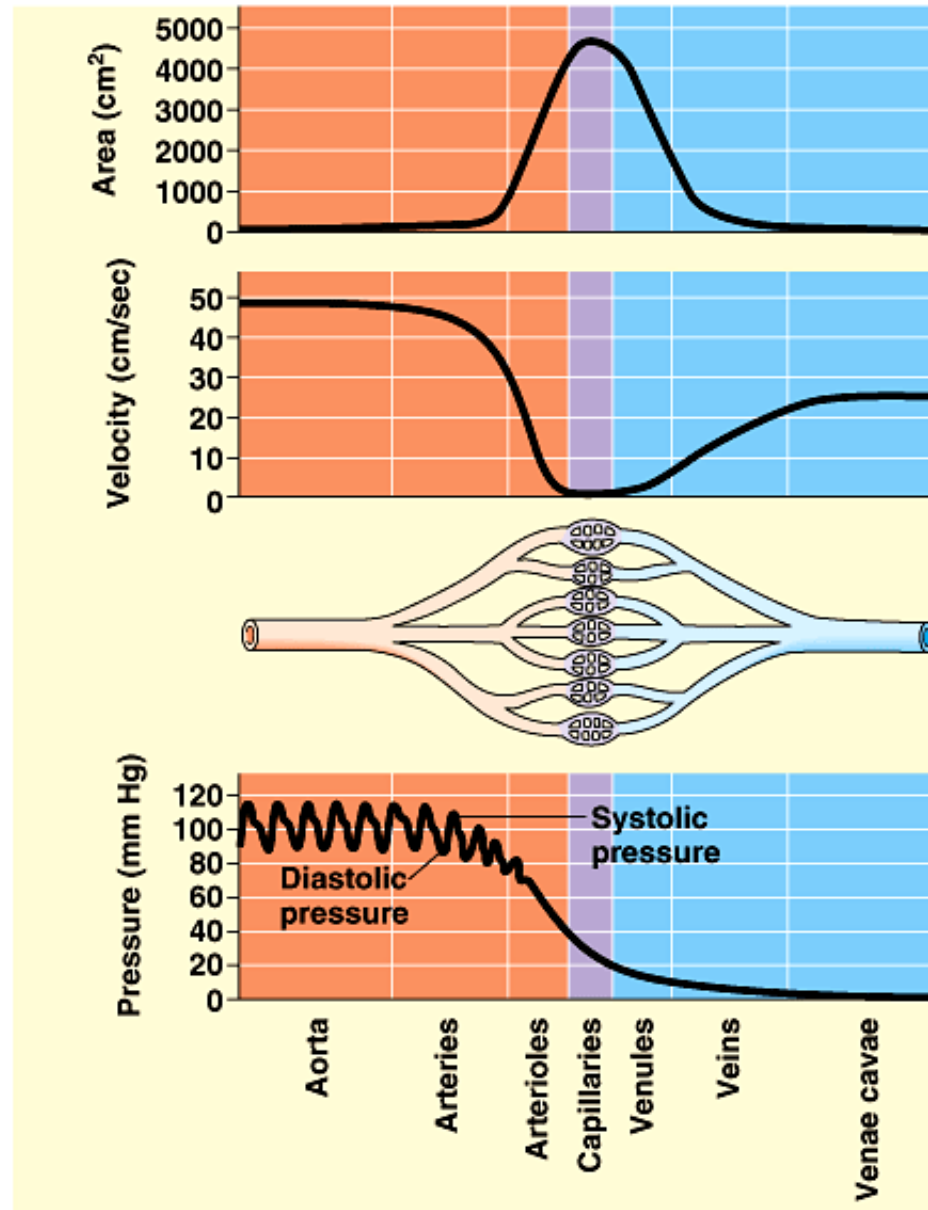
- Walls of arteries or veins have three layers:
 - **epithelium**
 - **smooth muscle** with elastic fibers
 - **connective tissue**
 - *Arteries have thicker walls than veins*
- *Capillaries only have the inner epithelium layer*

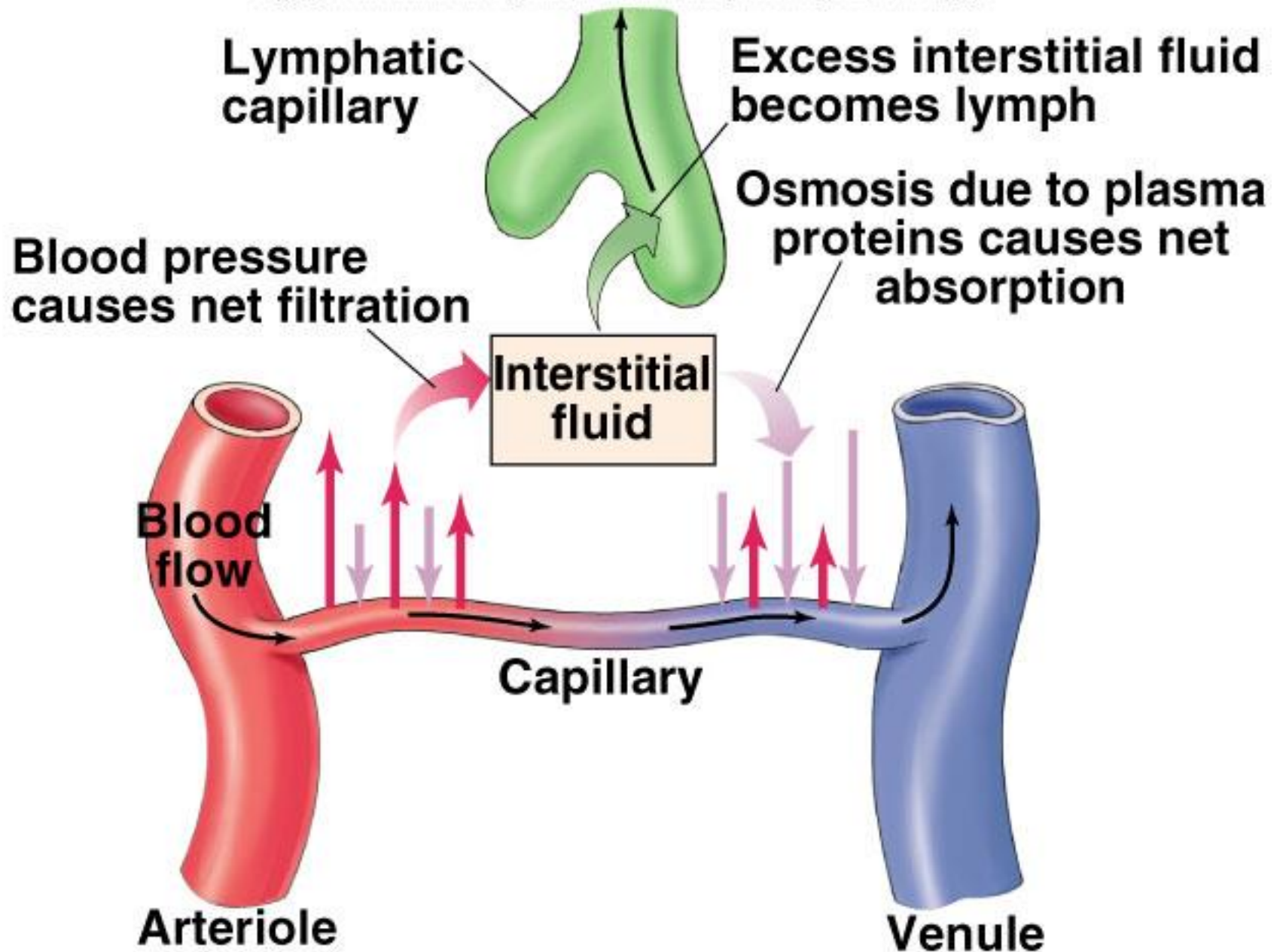


Capillary Exchange

- Law of Continuity
 - blood flows slowly in capillaries because larger total cross-section
 - allows materials to be exchanged

Figure 42.10 The interrelationship of blood flow velocity, cross-sectional area of blood vessels, and blood pressure



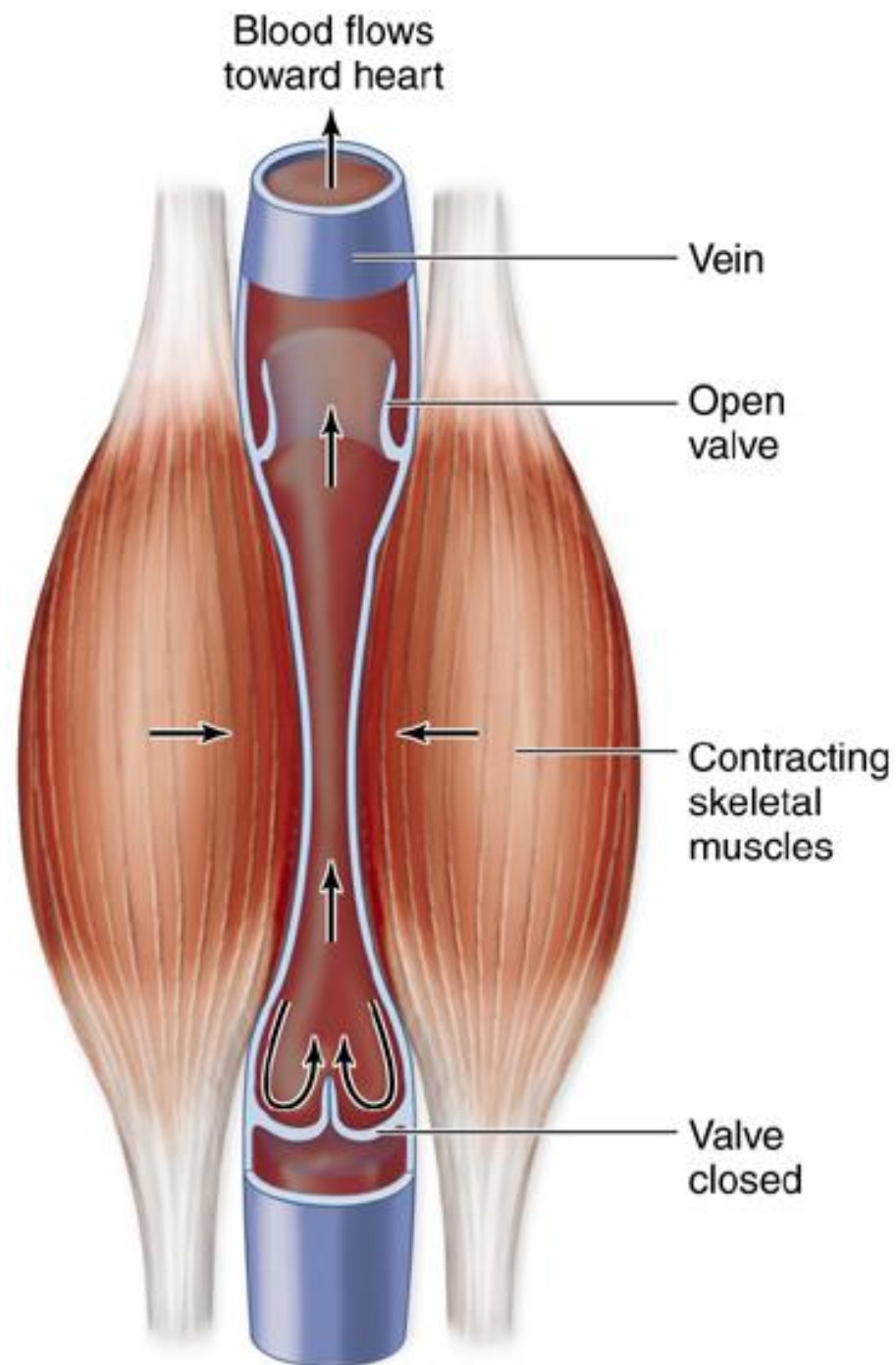


Capillary Exchange

- About 85% of the fluid that exits capillaries re-enters at the venule end.

Return of Blood to Heart

- Pressure too low in veins
- contraction of skeletal muscles move blood
- one-way valves in veins prevent backflow



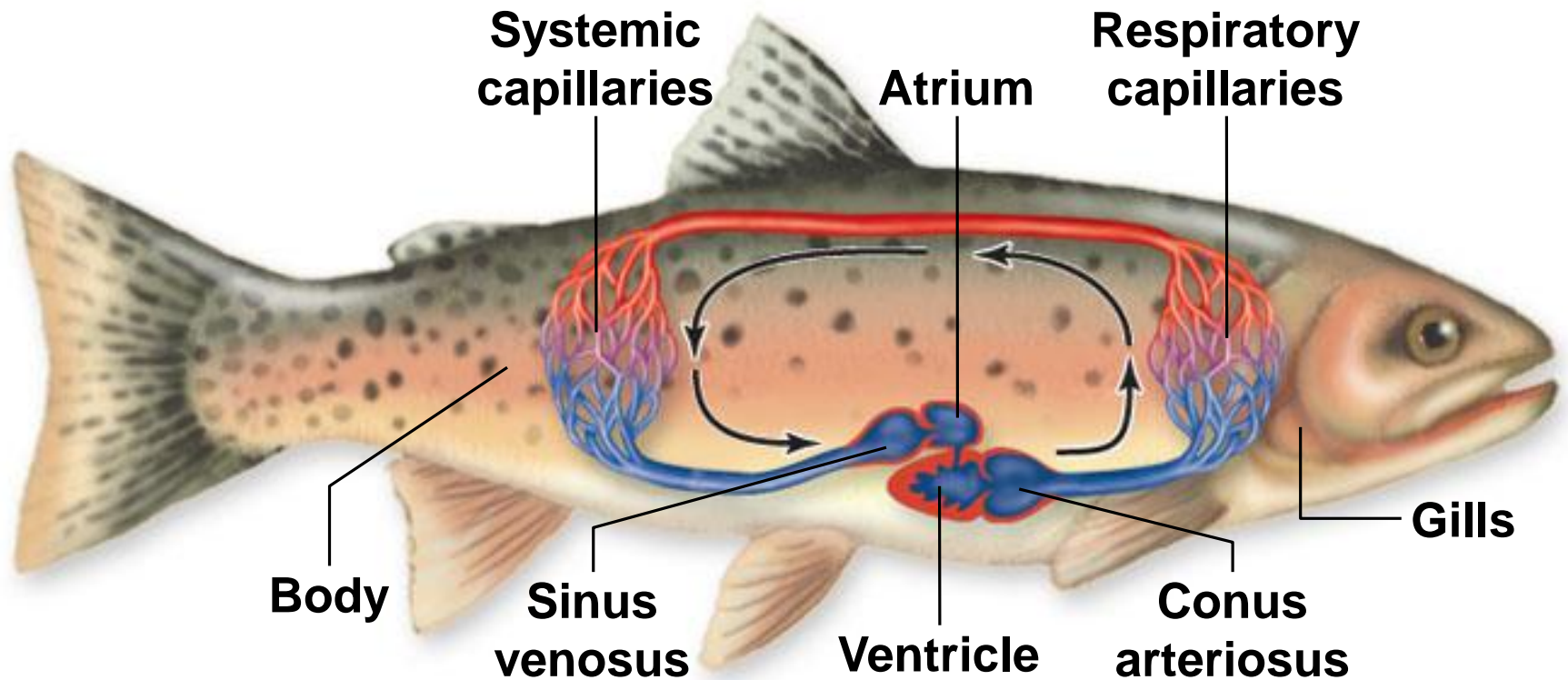
Variation in Vertebrate Circulation

FISH

- *Two chambered heart and a single circuit of blood flow*

Vertebrate Circulatory Systems

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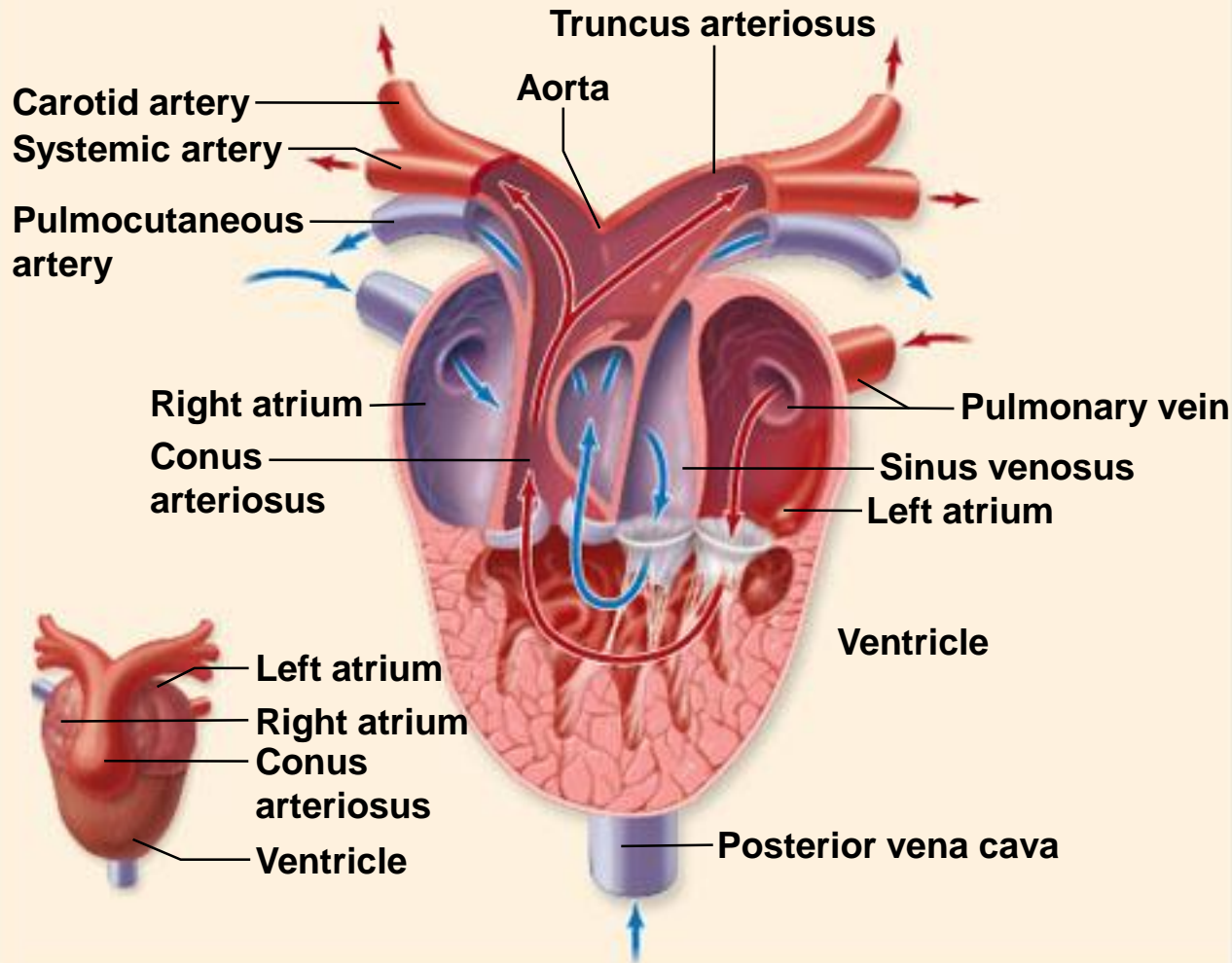
Variation in Vertebrate Circulation

AMPHIBIAN

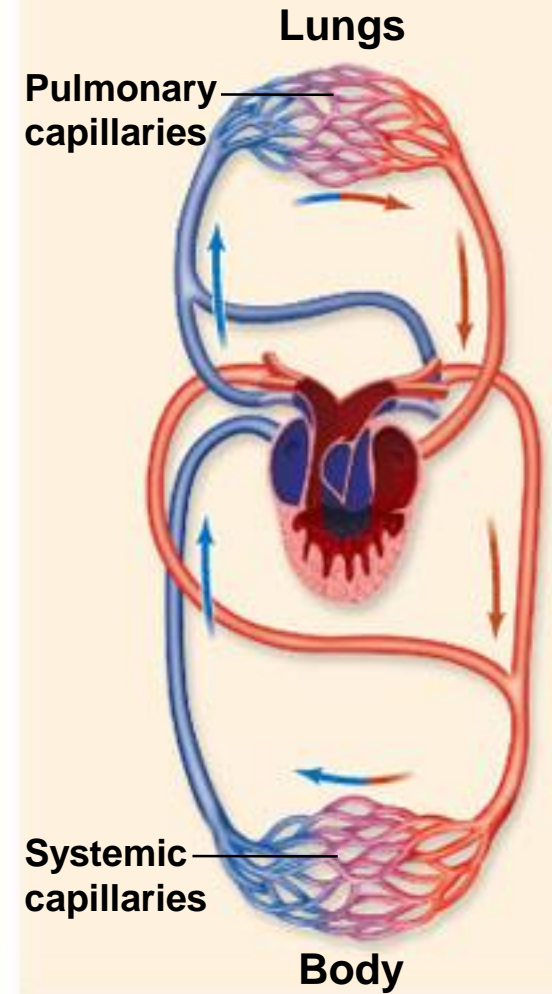
- *Three chambered heart (two atria and one ventricle) and double circulation (two circuits of flow)*

Amphibian Circulation

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a.



b.

Variation in Vertebrate Circulation

AMPHIBIAN

- **Pulmonary circuit**
 - blood is pumped to the lungs, where it is oxygenated and carried back to the left atrium
- **Systemic circuit**
 - blood is pumped to the rest of the body, where it gives up oxygen and is carried back to the right atrium

Variation in Vertebrate Circulation

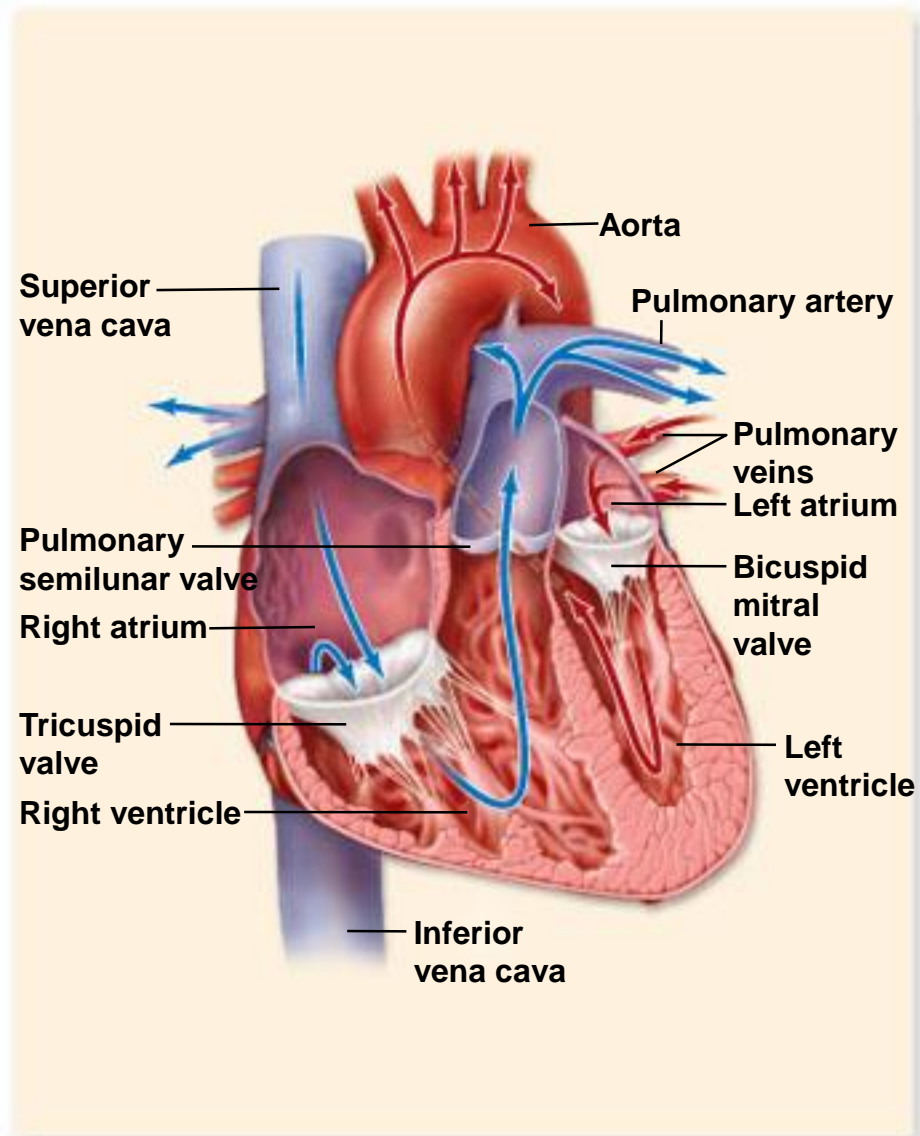
AMPHIBIAN

- Double circulation assures a vigorous flow of blood to the vital organs
- single ventricle --some mixing of oxygen-rich and oxygen-poor blood.

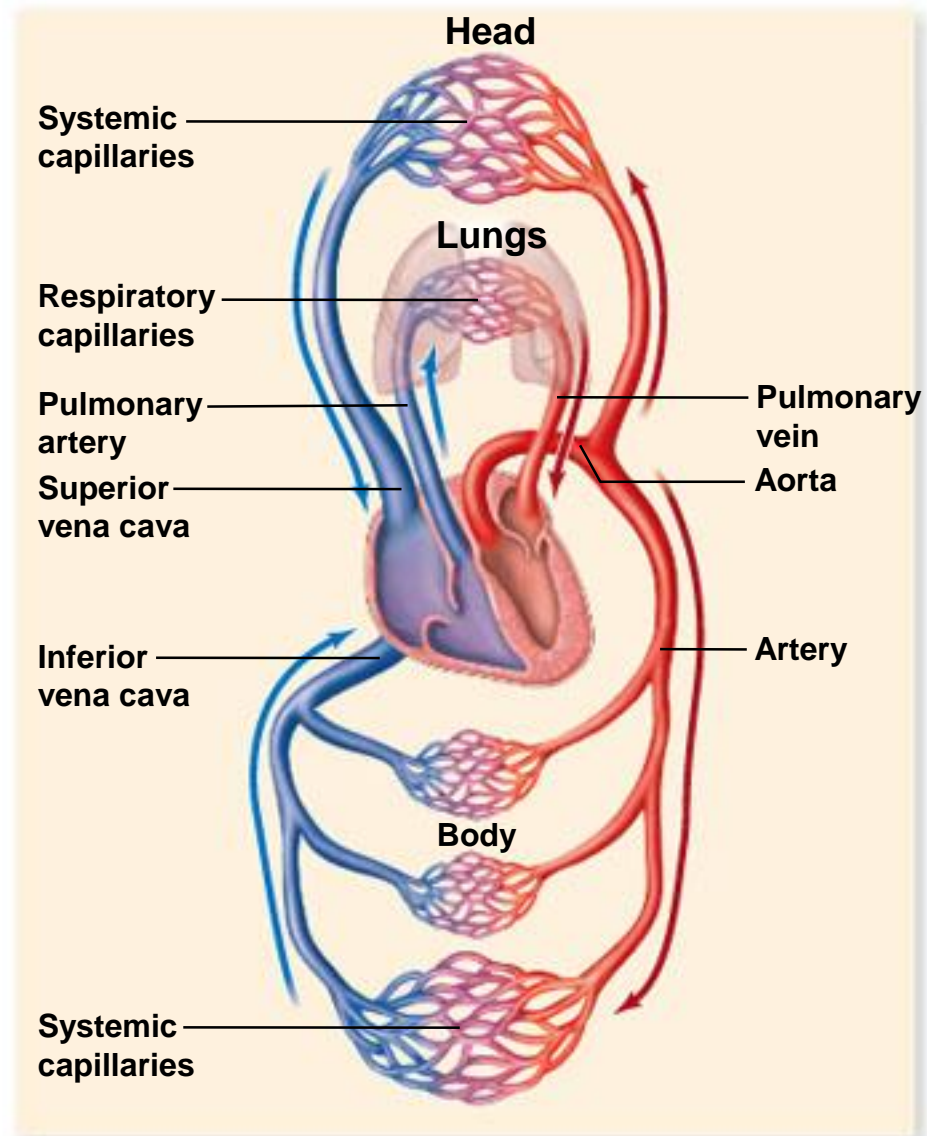
Variation in Vertebrate Circulation

MAMMALS & BIRDS

- *Have a four chambered heart and double circulation*
- The left side of the heart handles oxygen-rich blood and the right side handles only oxygen-poor blood.



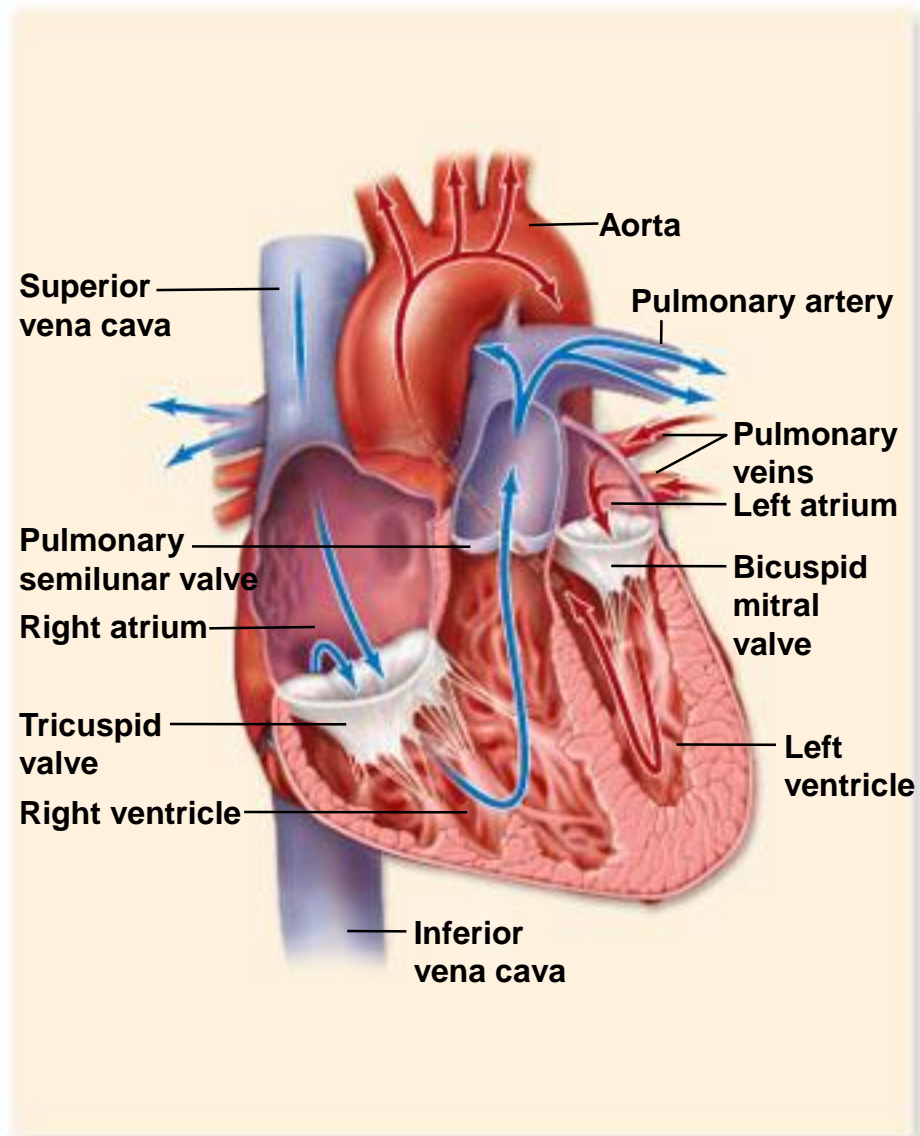
a.



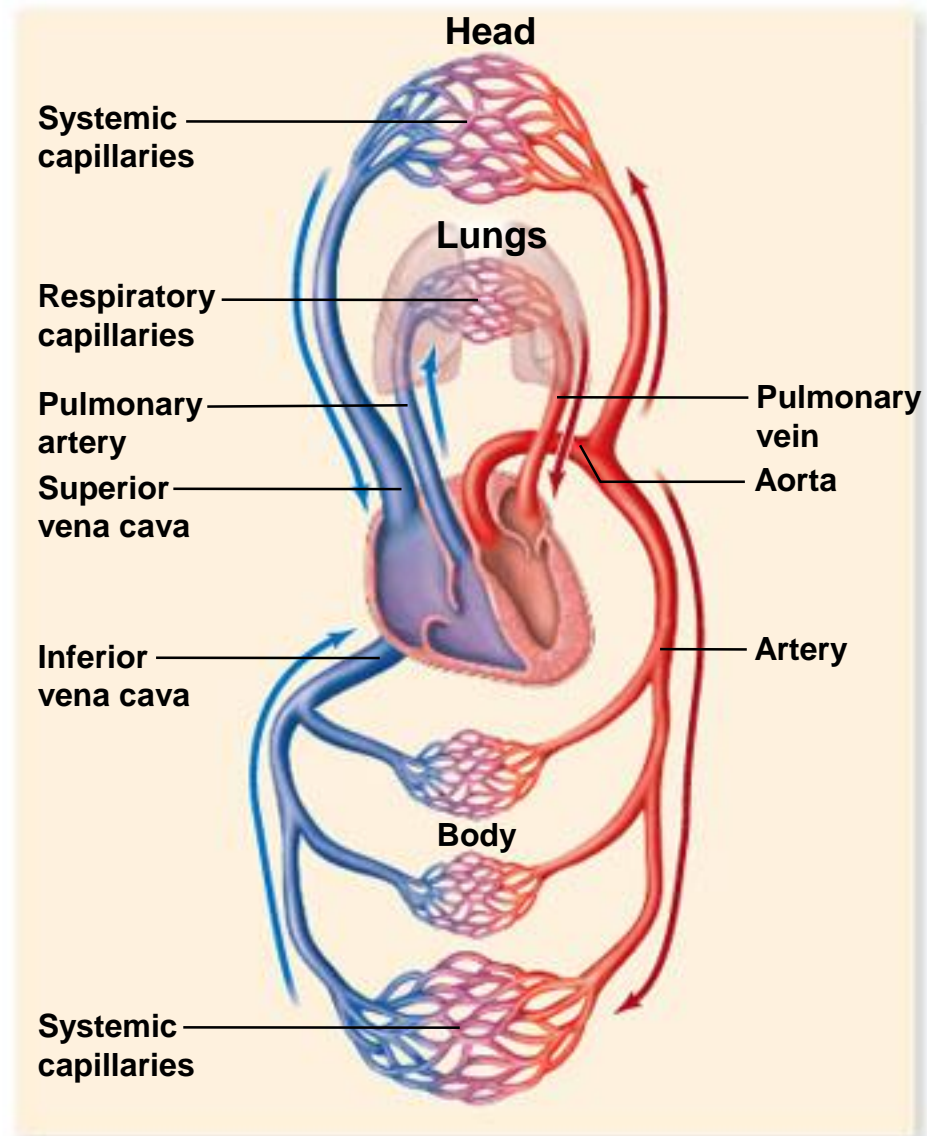
b.

Mammalian or Bird Heart

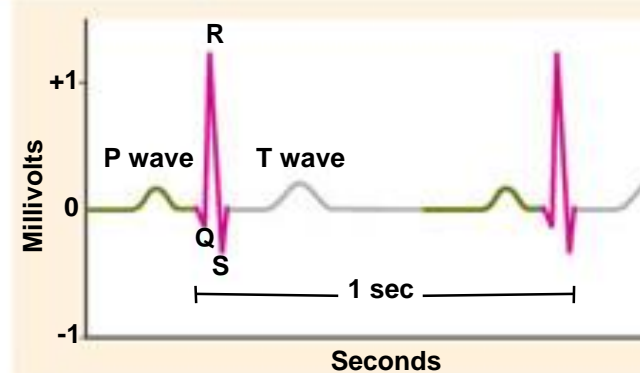
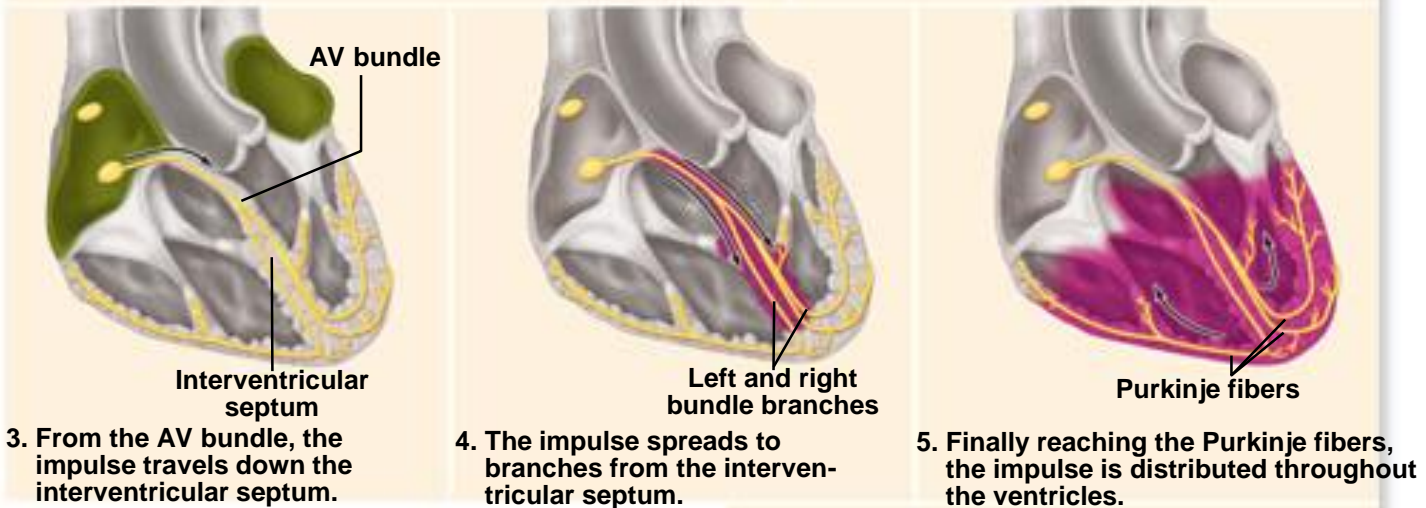
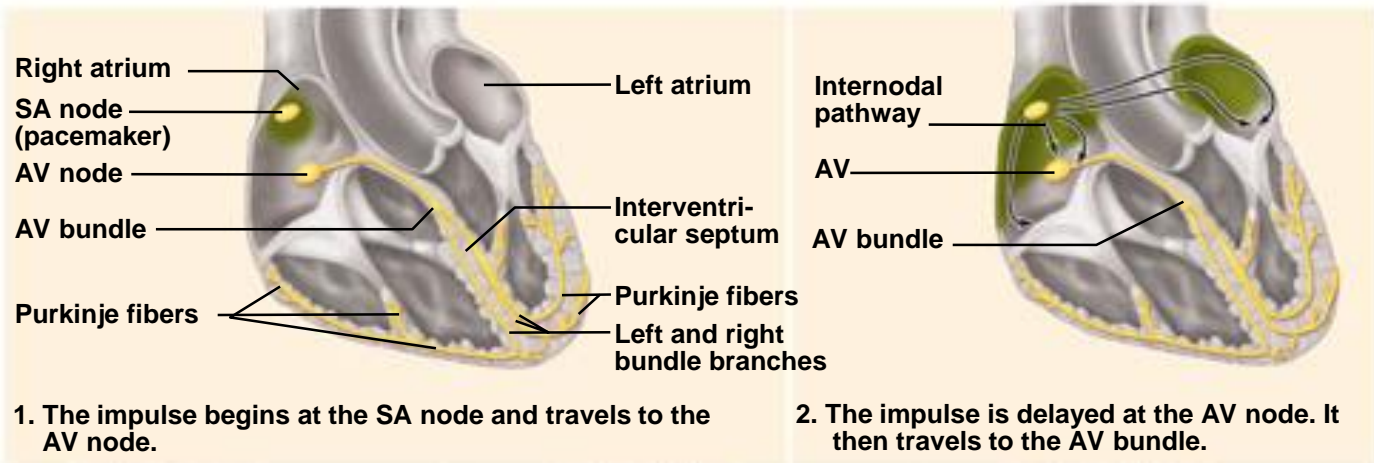
- Valves prevent backflow of blood when the ventricles contract
 - Between each ventricle and atrium is an atrioventricular (AV) valve
 - tricuspid and bicuspid (mitral)
 - At the exits of the heart are the semilunar valves



a.



b.

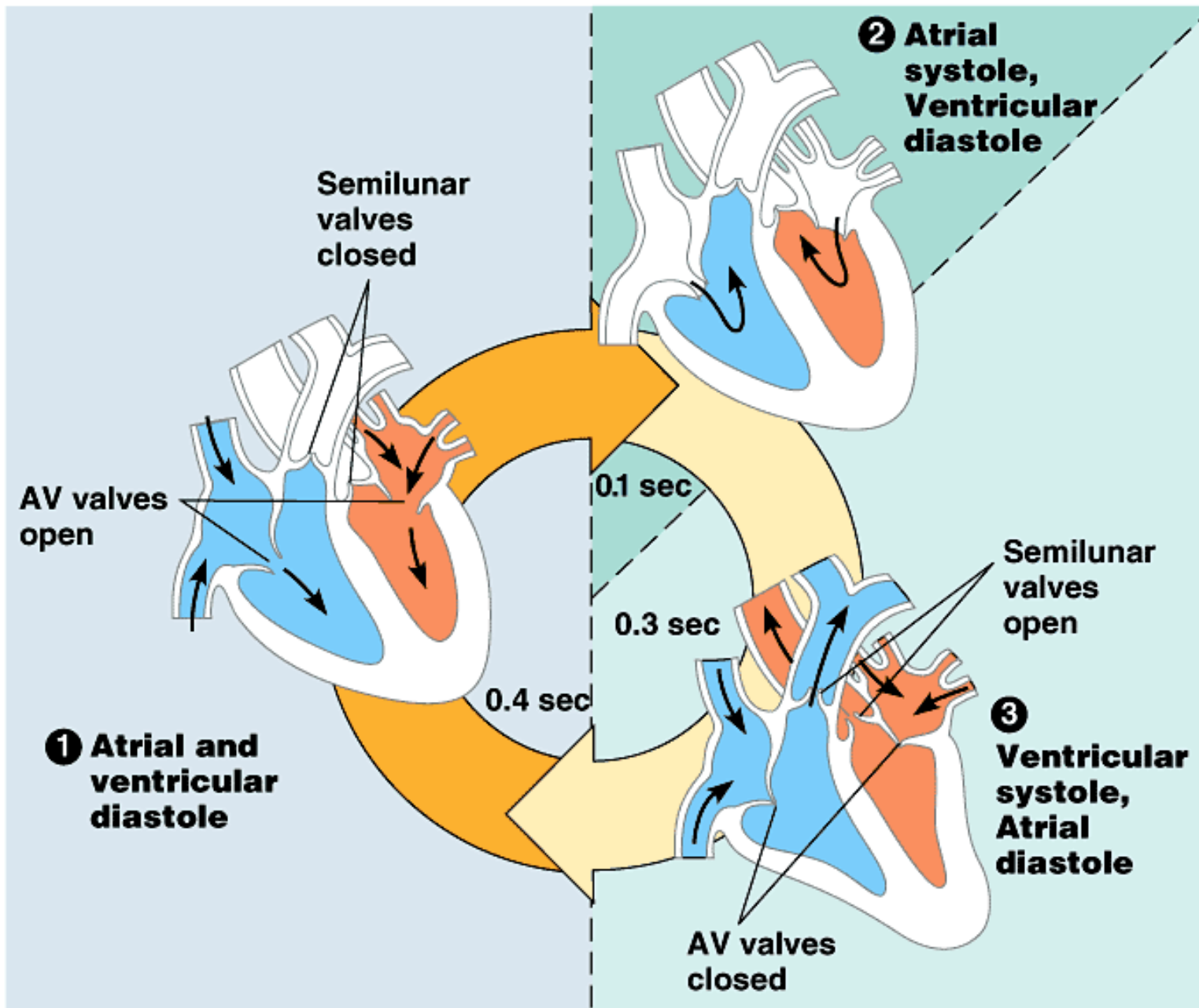


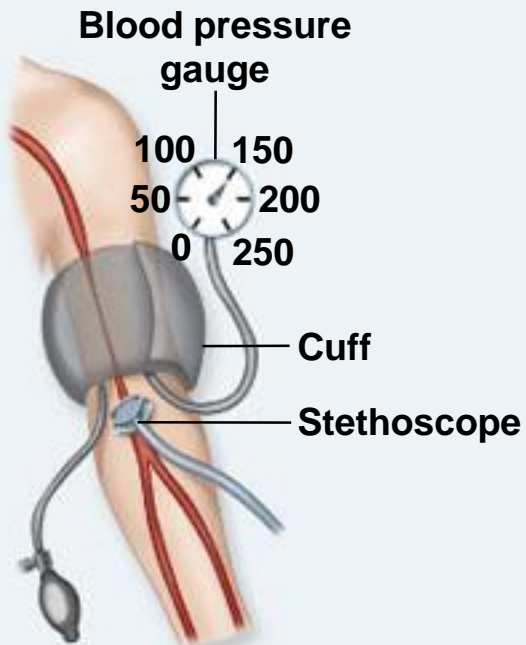
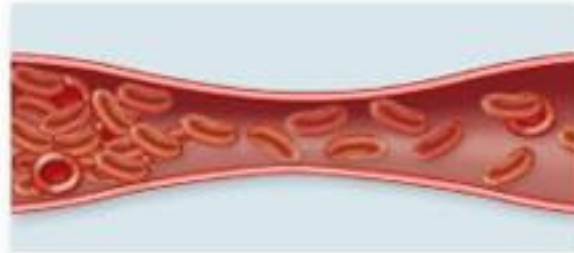
The control of heart rhythm

Cardiac Cycle

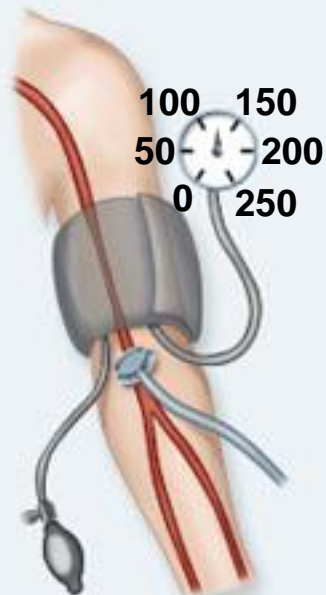
- a complete sequence of the heart contracting to pump blood, relaxing to fill with blood.
- total length is about 0.8 s
 - The contraction phase is called **systole**
 - The relaxation phase is called **diastole**

Figure 42.6 The cardiac cycle

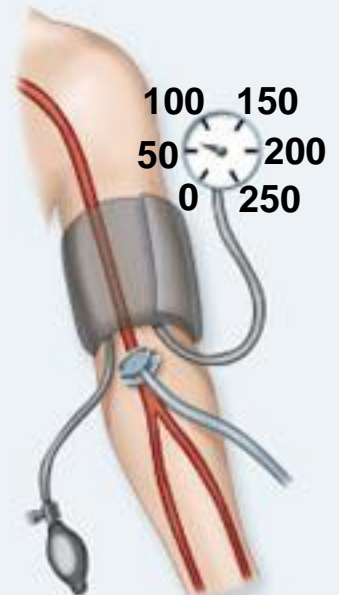




1. Cuff pressure: 150 mm Hg
No sound:
Artery closed



2. Cuff pressure: 120 mm Hg
Pulse sound:
Systolic pressure



3. Cuff pressure: 75 mm Hg
Sound stops:
Diastolic pressure