The Heart

Introduction to Physiology (course no. 72336)

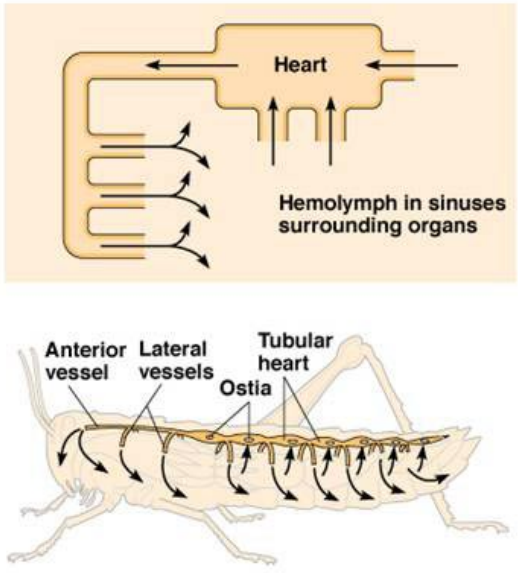
Circulatory system functions

- Transferring oxygen and nutrients to the body
- Removal of CO2 and metabolic waste from the tissues to the lungs and kidneys
- Transferring hormones from the glands to the target organs
- Thermoregulation
- Transportation of immune system cells in the body

Circulatory system evolution

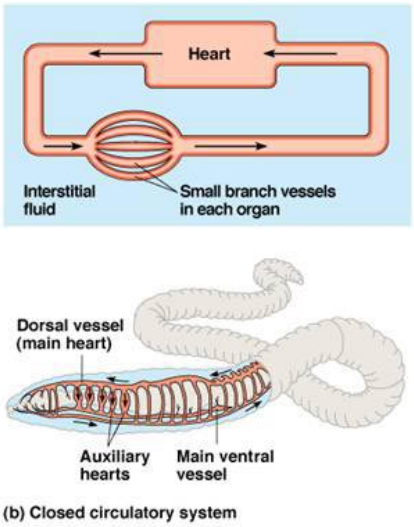
- **Diffusion** – organisms sized 1 mm or less
- **Open circulation system** - A system in which the circulating fluid is not enclosed in vessels at all times. found in insects, crayfish, some mollusks, and other invertebrates.

  Blood is pumped by a heart into the body cavities (hemocoel), where tissues are surrounded by the blood, and diffuses back into the circulatory system

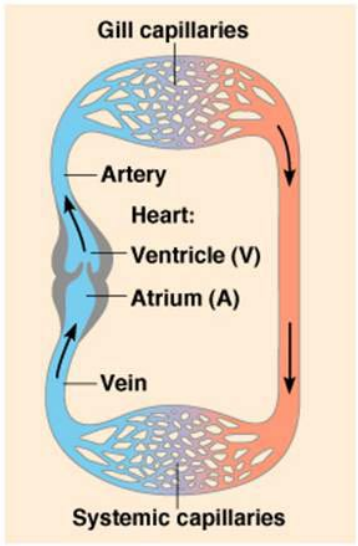


(a) Open circulatory system

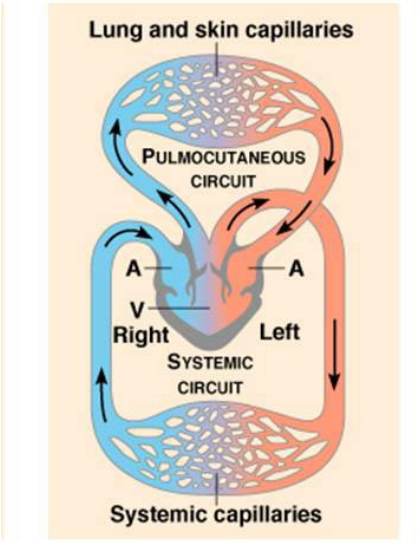
- **Close circulation system** (vertebrates, echinoderms) - A system that uses a continuous series of vessels of different sizes to deliver blood to body cells and return it to the heart



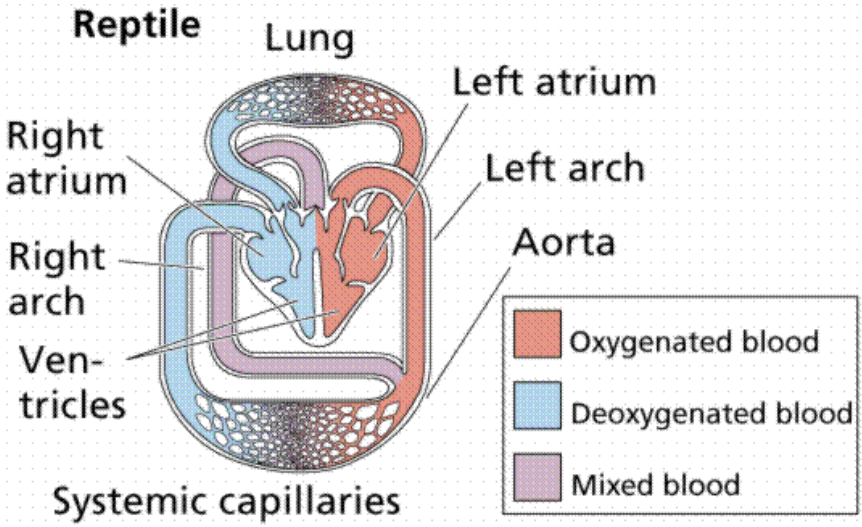
Fish

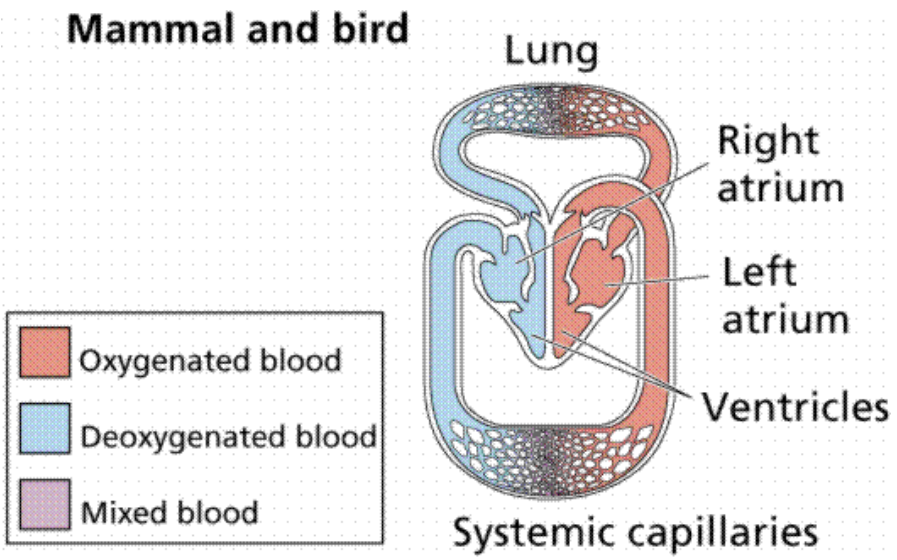


Amphibian



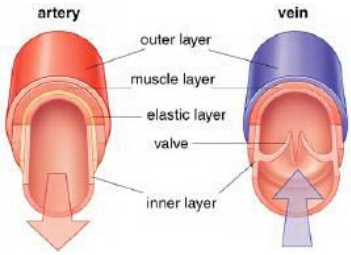
(b) Amphibian





Circulatory system

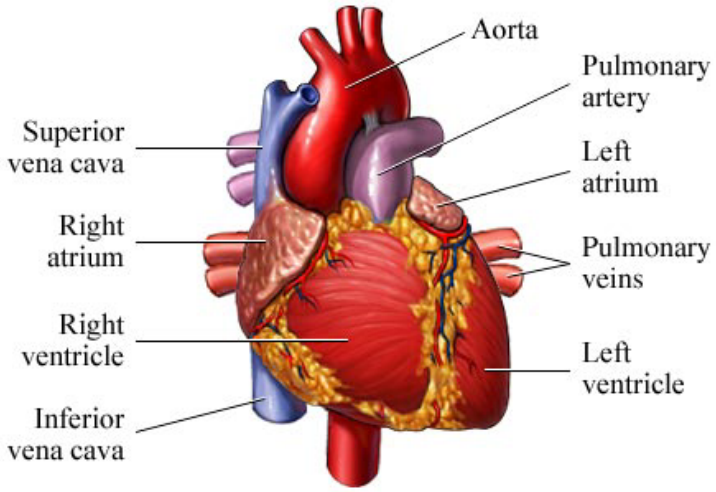
- **Systemic circulatory system**
- **Pulmonary circulation system**
  - Less pressure
  - Less resistance
  - Weaker ventricle is required
- **Arteries**
- **Veins**



Heart anatomy

- The heart is surrounded by the **Pericardium** - The membranous sac filled with serous fluid that encloses the heart, the roots of the aorta and other large blood vessels, and the **Epicardium** – a fibrous membrane closely affixed to the heart itself.
- The space between them is filled with watery fluid that serves as a lubricant
- The heart structure: **Myocardium** (cardiac muscle cells), **Endothelium**
- The heart is divided into left & right, divided in the ventricle area by the **interventricular septum**

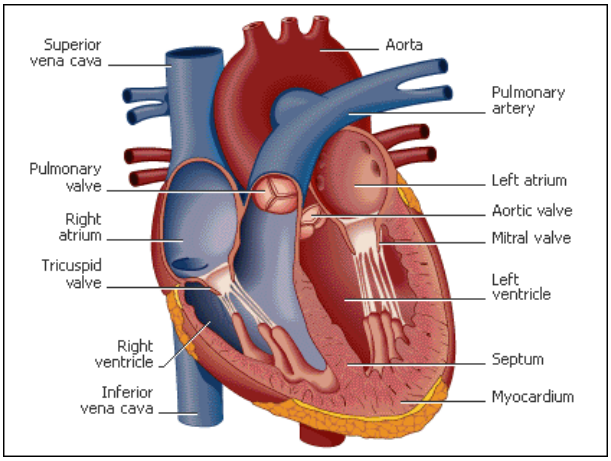
Heart anatomy



Heart anatomy

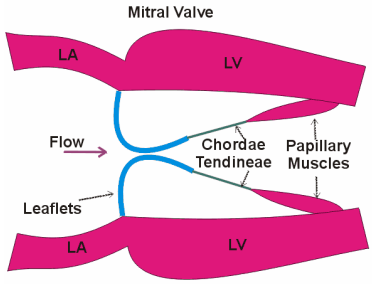
- 2 **atria**
- 2 **ventricles**
- Valves between the atria and venticles – **atrioventricular (AV) valves** –
- Valves between the ventricles and the aorta / pulmonary artery – **semilunar valves**
- one way valves

Heart anatomy



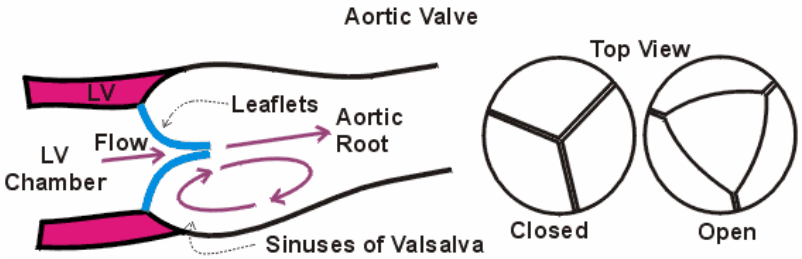
AV valves structure

- The right AV valve – **tricuspid valve** – 3 fibrous flaps (=cusps)
- The left AV valve – **bicuspid (**also **mitral) valve**
- Stringlike **chordae tendineae** connect the valve flaps to **conical papillary muscles** found on the ventricular floor.
- These function to prevent the valves from bulging into the atria

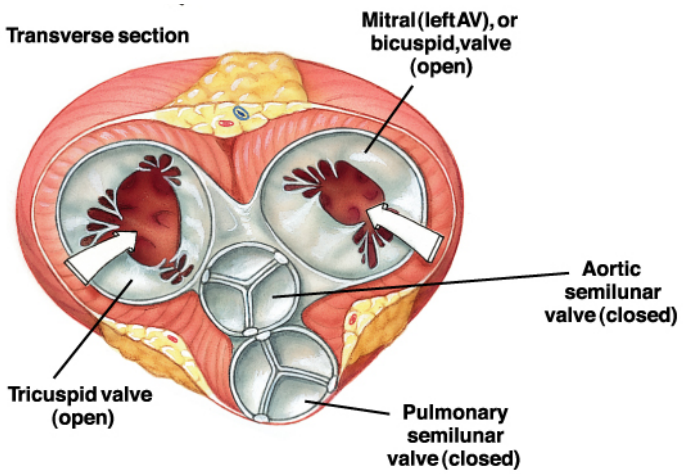


Pulmonary & aortic valves

- **Semilunar valves** – 3 cusps with a stronger structure, require no external support.
- Left semilunar valve – **Aortic valve**
- Right semilunar valve – **pulmonary valve**



Heart anatomy



Valve operation principles

- Open and close passively – according to pressure differences
- Do not offer resistance to flow (normally)
- Enable flow in one direction only (normally)

When the principles are violated

- **Aortic stenosis** – when the aortic valve is narrowed due to calcification (or other factors). The narrowing causes larger resistance to flow, and required larger pressures to be produced by the LV, and thus larger effort
- This results in growth of LV heart tissue (hypertrophy), and eventually in it's stiffening, and malfunction
- **Mitral regurgitation** – when the mitral valve leaks, the efficiency of the heart is reduced (blood flows back to the lungs), causing hypertrophy

Basic Pathway of Blood Flow