

Lecture 19 Circulatory System

§1 Circulatory System

1. Circulation

Every organism must exchange materials with its environment, relying on

- 1^o diffusion, the spontaneous movement of molecules from an area of higher concentration to an area of lower concentration
- 2^o a circulatory system (循环系统), facilitates the exchange of materials for all but the simplest animals.

2. Cardiovascular system (心血管系统)

The cardiovascular system of vertebrates consists of the

- 1^o heart
- 2^o blood vessels

3. Heart

In the heart

- 1^o the atrium (心房) receives blood
- 2^o the ventricle (心室) pumps blood away from the heart.

4. Blood vessels

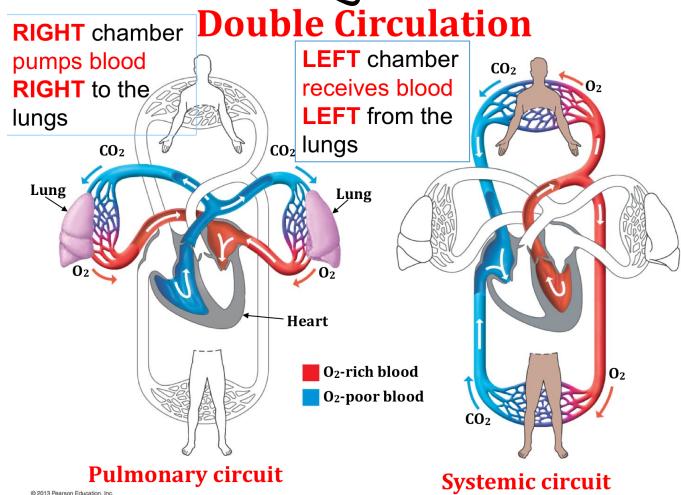
- 1^o Arteries (动脉) carry blood away from the heart into smaller arterioles (小动脉) as they approach the organs.
- 2^o Capillaries (毛细血管) are the site of exchange between blood and interstitial fluid (组织液)
- 3^o Venules (小静脉) collect blood from the capillaries and converge to form veins (静脉), which return blood back to the heart.

§2 The Path of Blood

1. Double circulation system

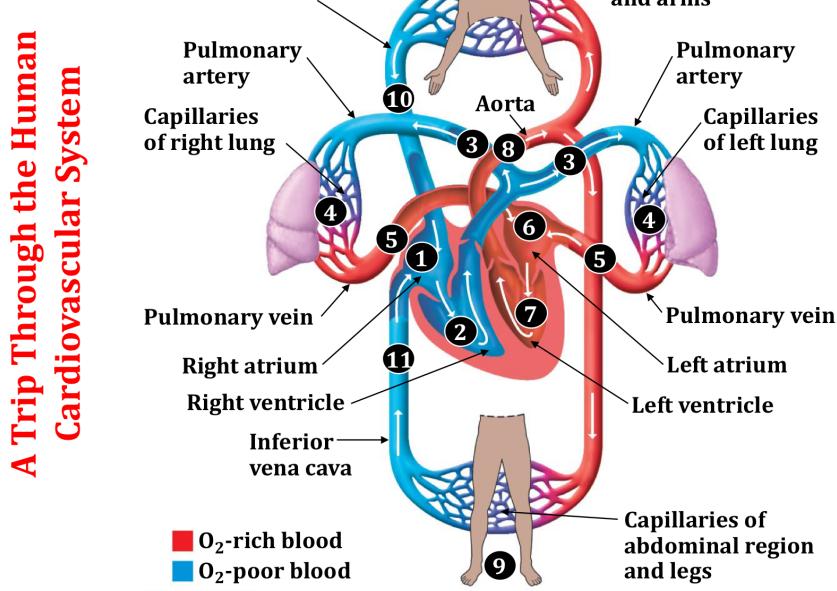
Humans and other terrestrial vertebrates have a **double circulation system** consisting of

- 1° a **pulmonary circuit** (肺循环) between the heart and lungs.
- 2° a **systemic circuit** (体循环) between the heart and the rest of the body.

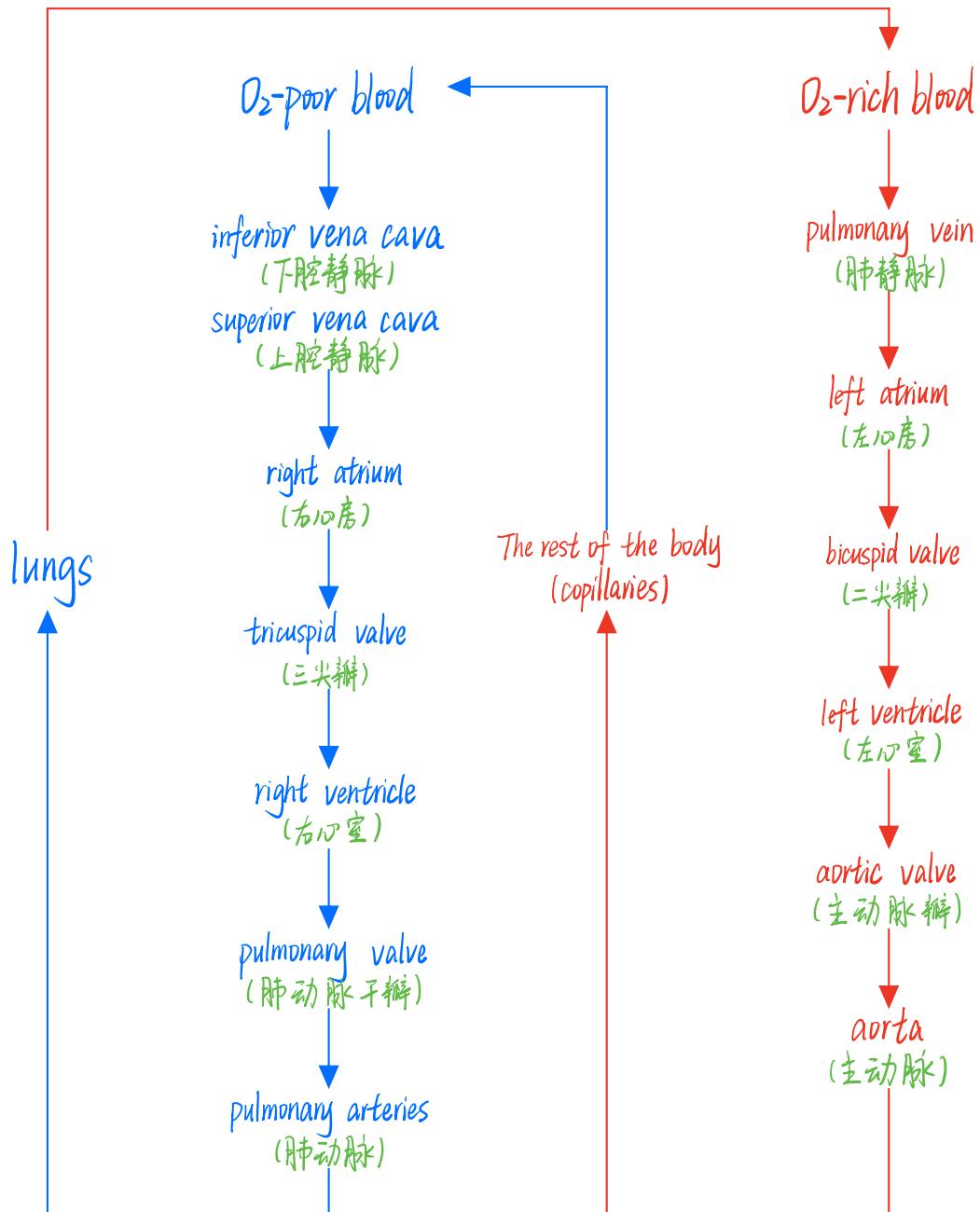


2. A trip through the human cardiovascular system

- 1° takes about one minutes
- 2° requires two passes through the heart.



3° The path of blood



§3 Heart

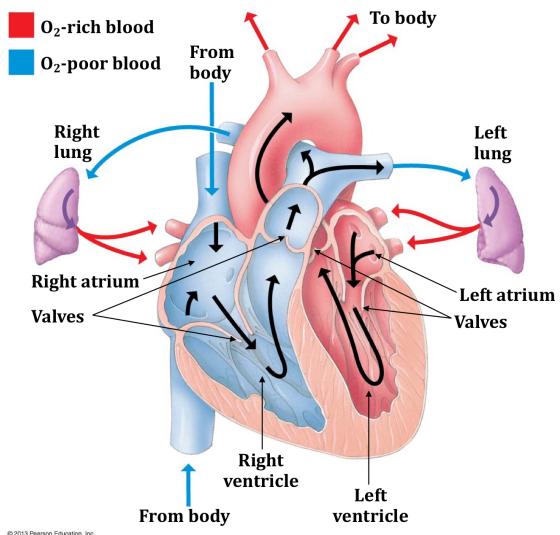
1. The human heart

1° about the size of fist

2° is located under the breastbone

3° has 4 chambers

Path of Blood flow Through the Human Heart

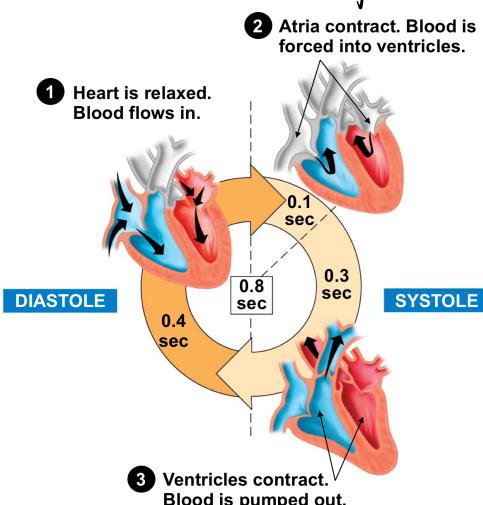


2. The cardiac cycle (心动周期)

The heart relaxes and contracts throughout our lives

- 1° Diastole (心脏舒张) is the relaxation phase of the heart cycle
- 2° Systole (心脏收缩) is the contraction phase
- * A heart murmur (心杂音) is a sound that may indicate a defect in one or more of the heart valve.

The Cardiac Cycle



3. Sinoatrial node (窦房结)

The pacemaker (起搏器), or SA node (sinoatrial node)

- 1° sets the tempo (节律) of the heartbeat
- 2° is composed of specialized muscle tissue (pacemaker cells (起搏细胞)) in the wall of the right atrium.
- 3° pacemaker cells are specialized heart muscle cells. They

spontaneously generate electrical impulses.

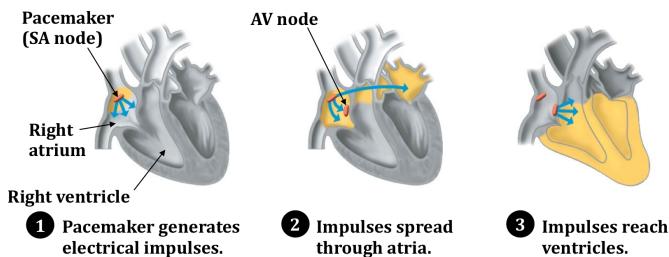
Impulses from the pacemaker spread quickly through the walls of both atria, prompting the atria to contract at the same time.

4. Atrioventricular node (房室结)

1° is a relay point that *delay* the signal.

2° sends impulses to the ventricles

The heart's natural pacemaker



§4 Blood Vessels

1. "Plumbing" system

1° *Arteries* carry blood away from the heart

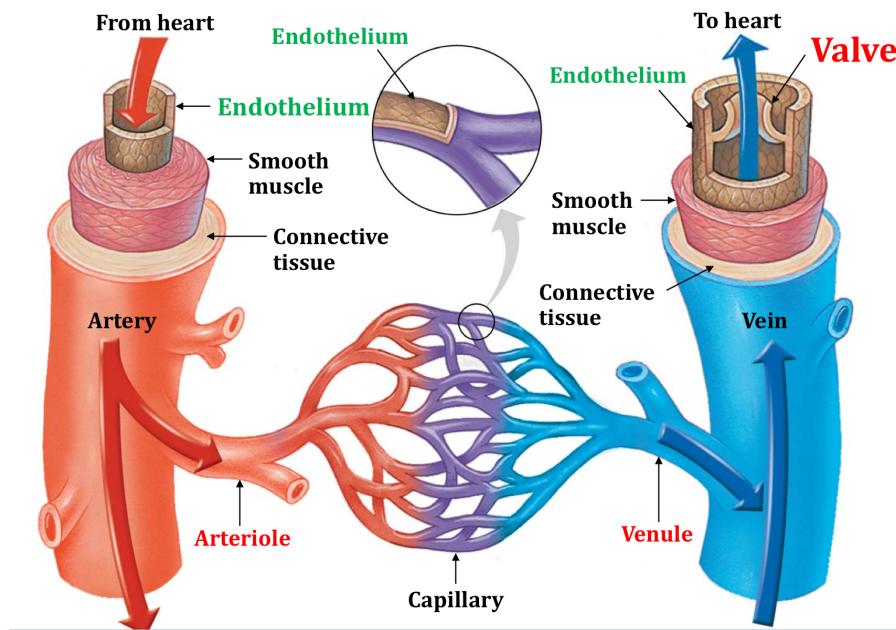
2° *Veins* carry blood toward the heart

3° *Capillaries* allow the exchange between the bloodstream and tissue cells.

All blood vessels are lined by a thin layer of *tightly packed epithelial cells*.

- Structural differences in the walls of the different kinds of blood vessels correlate with their different functions.

The Structure of Blood Vessels

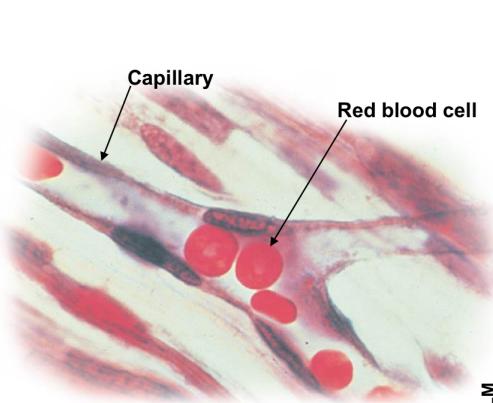


2. Blood flow through arteries

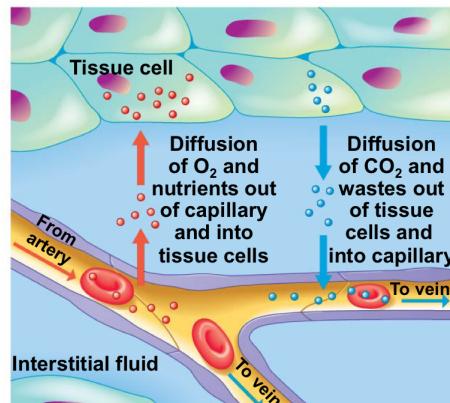
- 1^o The force that blood exerts against the walls of blood vessels is **blood pressure**.
- 2^o A **pulse** (脉搏) is the rhythmic stretching of arteries caused by the pressure of blood forced into the arteries during systole.
 - Optimal blood pressure for adults is
 - < 120 mmHg for systolic (results from blood being forced into the arteries during ventricular systole), and
 - < 80 mmHg for diastolic (is the pressure in the arteries during ventricular diastole).
 - High blood pressure, or **hypertension**, is persistent
 - systolic blood pressure > 140 mmHg, and/or
 - diastolic blood pressure > 90 mmHg.

3. Blood flow through capillary beds

- At the arterial end of the capillary, blood pressure pushes fluid rich in oxygen, nutrients, and other substances into the interstitial fluid.
- At the venous end of the capillary, CO₂ and other wastes diffuse from tissue cells into the interstitial fluid, and then into the capillary bloodstream.



(a) Capillaries



(b) Chemical exchange

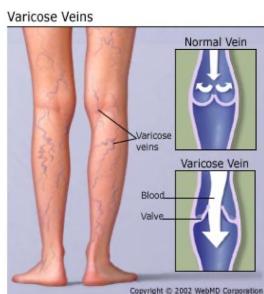
- At any given time, only about 5–10% of the capillaries have a steady flow of blood.

- Blood flow through capillaries may be diverted from one part of the body to another, depending on need.

4. Blood return through veins

- Blood moves back toward the heart because of
 - surrounding skeletal muscles that compress the veins and
 - one-way valves that permit blood flow only toward the heart.

Blood flow in a vein



If the valves malfunction, then the blood falls back down to some extent after every muscle contraction and begins to pool in the veins. This causes the veins to swell with blood, which can be painful and unsightly, and is known as varicose veins.

