

## Chapter 42

### The Circulatory System

Consists of several parts:

- Blood- the tissue that is at the core of the system
- Heart- the muscle that moves the blood
- Blood Vessels- the place which the blood moves through

### Parts of the Blood

There are four components to the blood:

- *Plasma*- composed of approximately 92% water, 7% proteins, the remaining 1% in salts, nutrients, wastes, and anything else carried through the bloodstream. This is about 55% of the volume of blood. It carries everything around and helps to maintain homeostasis.
- *Erythrocytes (red blood cells)*- specialized cells designed to carry oxygen. Has a concave disc shape to maximize oxygen transport. Produced in the bone marrow, a red blood cell lasts about 120 days. An average of 2.4 million red blood cells are destroyed every second and an equal amount created.  
Anemia- a lack of hemoglobin in the cells (hemoglobin carries the oxygen)
- *Lymphocytes (white blood cells)*- protect your body from infections.
- *Platelets*- Function in blood clotting.

In mammals, thrombocytes are tiny spherical or disc-shaped bits of cytoplasm that lack nuclei. (Platelets)

- 300,000 platelets per  $\mu\text{L}$  in human blood.
- Pinched off from very large cells in the bone marrow.
  1. When blood cell is cut, it constricts, reducing loss of blood.
  2. Platelets stick to the rough, cut edges of the vessel, physically patching the break in the wall.
  3. Platelets gather and begin to release substances that attract other platelets.
  4. They platelets become sticky and adhere to collagen fibers in the blood vessel wall. So within 5 mins, there is a platelet plug or temporary clot.
  5. At the same time as temporary platelet forms, a stronger more permanent clot begins to develop.

Prothrombin- plasma protein manufactured in the liver, requires vitamin K for its production.

Damaged cells and platelets release substances that activate clotting factors such as Prothrombin which converts to thrombin and catalyzes the conversion of the soluble plasma protein fibrinogen to an insoluble protein, fibrin. Once formed, fibrin polymerizes and produces long threads that stick to the damages surface of the blood vessels.

3 main types of blood vessels: Arteries, Capillaries, and Veins.

Artery: carries blood away from the heart chamber toward other tissues.

- Divides into smaller arterioles when entering other organs, and these arterioles deliver blood to the microscopic capillaries.

Veins: transport the blood back toward the heart.

Both the walls of artery and vein have 3 layers.

- Innermost layer: endothelium
- Middle layer: connective tissue and smooth muscle cells
- Outer layer: connective tissue rich in elastic and collagen fibers.

Vasoconstriction: smooth muscles in the artery wall can constrict

Vasodilation: smooth muscles in the artery wall can relax.

These changes help maintain appropriate blood pressure and can help control the volume of blood pressure.

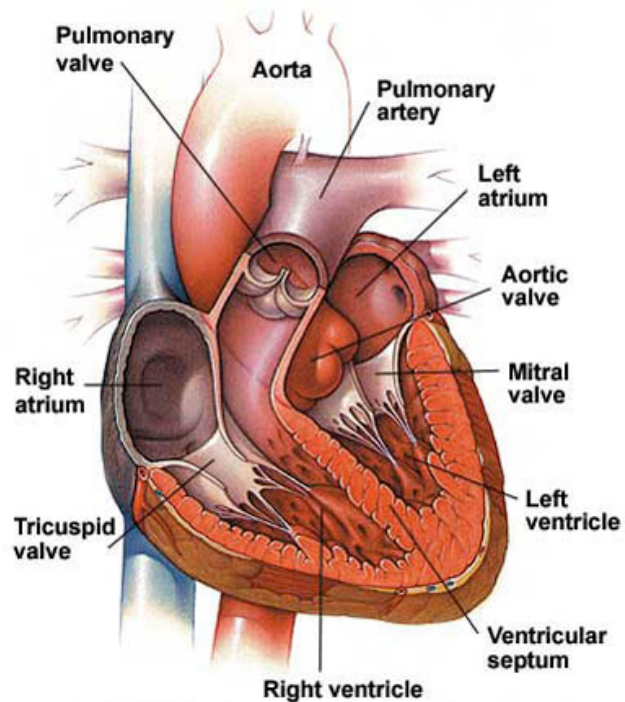
They are controlled by the nervous system and are in response to the metabolic needs of the tissue as well as the demands of the body as a whole.

Metarterioles- small vessels that directly link arterioles with venules (small veins)

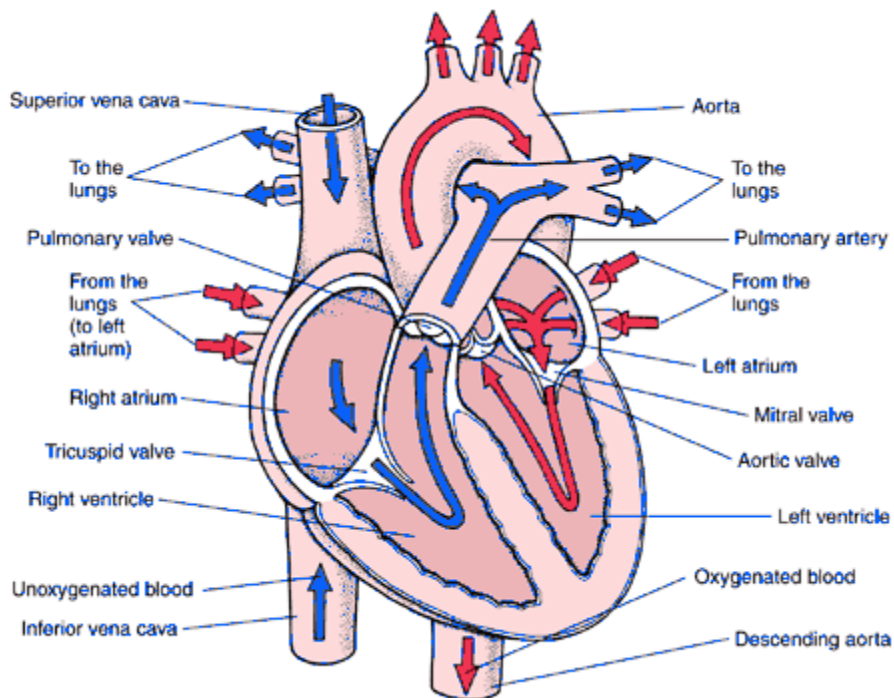
Blood Circulation Pattern:

Veins (conducted blood from organs) → Right Atrium → Right Ventricle → Pulmonary arteries → Capillaries in the lungs → pulmonary veins → left atrium → left ventricle → aorta → arteries (conducted blood to organs) → arterioles → capillaries.

## The Heart



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\*Each heart beat is initiated by the pacemaker, aka the sinoatrial node, located in the right atrium along the lower part of the septum

\*The action potential in the SA node is triggered mainly by the opening of  $Ca^{2+}$  channels

\*One group of atrial muscle fibers conducts the action potential directly to the right atrioventricular node, located in the right atrium along the lower part of the septum. Transmission is then delayed so that the atria can finish their contraction before the ventricles can contract

\*action potential then spreads to the AV bundle. When it reaches the end it spreads through the ordinary cardiac muscle fibers of the ventricles.

Each minute the heart beats about 70 times

Cardiac cycle: heartbeat

Systole: contraction period of heartbeat

Diastole: relaxation

Heartbeat is myogenic, which means it beats of its own accord and speeds up or slows down through involuntary control

Lub-dup sound: sound of closure of the heart valves

Lub: closing of AV valves

Dup: closing of the semilunar valves

Damaged valves can cause heart murmurs

Heart rate is regulated by the nervous system:

- Although the heart is capable of beating independently, its rate is carefully regulated by the nervous system and endocrine system
- Sensory receptors in the walls of certain blood vessels and heart chambers are sensitive to changes in blood pressure and when stimulated, they send messages to cardiac centers in the medulla of the brain

Blood Pressure Depends on Blood Flow and Resistance to blood flow:

- Blood pressure is the force exerted by the blood against the inner walls of the blood vessels (greatest on arteries) It's determined by Cardiac Output (CO), blood volume, and the resistance to blood flow
- Cardiac output increases = blood pressure increases = blood flow decreases
- An increase of salt causes water retention which causes blood volume and blood pressure to increase
- High Blood pressure can be due to:
  - Obesity
  - Heredity
  - Diet
  - Smoking
- High BP = hypertension
- Peripheral resistance: resistance to Blood flow caused by viscosity of blood and by friction between the blood and wall of the blood vessel

Blood Pressure Highest in Arteries:

- Flow rate can be maintained in veins at low pressure because they are low-resistance vessels
- Veins have larger diameter and it's a smoother muscle so that's why the blood pressure is lower there

### Blood Pumped Through Pulmonary and Systemic Circuits:

- Pulmonary circulation: connects heart and lungs; oxygenates blood
- Systemic circulation: connects heart with all of the tissues of body; delivers blood to the tissues

### Pulmonary Circulation:

1. Blood from tissues returns to Right atrium of heart
  2. it goes through the tricuspid valve into the right ventricle
  3. right ventricle pushes it out through pulmonary valve
  4. from the valve, it goes to the pulmonary arteries which take blood to the lungs
  5. in the lungs, pulmonary arteries branch off into smaller vessels called capillaries
  6. oxygen diffused in blood
  7. oxygenated blood comes in through pulmonary veins into the left atrium
- Right Atrium → Right ventricle → Pulmonary arteries → pulmonary capillaries in lungs → pulmonary veins → left atrium

### Systemic Circulation:

- Coronary arteries: branch off from aorta to the heart itself
  - Heart wall covered with carotid arteries
  - Jugular vein: blood returning from capillaries within brain
  - Subclavian: blood from shoulders and arms carried by this vein
1. Blood that is oxygenated goes from left atrium to mitral valve to left ventricle
  2. aortic valve pushes blood out to aorta which branches off up to the brain, to carotid artery (heart), and down to systemic (legs, etc)
  3. blood returns from inferior vena cava and superior vena cava to right atrium
- Left atrium → mitral valve → left ventricle → aortic valve → aorta → systemic → carotid artery → superior and inferior vena cava → right atrium

### Lymphatic System:

#### Functions:

1. Collect and return interstitial fluid to blood
  2. defend body against through immunity
  3. absorb lipids from digestive tracks
- lymph: watery fluid formed from interstitial fluid

#### Lymphatic system consists of:

1. network of lymphatic veins that conduct lymph
2. lymph tissue
  - connective tissue
  - made of lymph nodes