

# BIOLOGY NOTES (Sept 6, 2007)

## Topic: Transport in Humans 1 – The Transport System

### Objectives:

At the end of this topic, the students should be able to:

1. Explain the importance of a transport system for humans.
2. Describe, with the aid of a diagram, the general plan of the human circulatory system.
3. Explain what is meant by the double circulatory system.
4. Describe the structure and function of the human heart.
5. Describe the effects of exercise on the heart beat rate.
6. Describe the causes and preventative measures for heart attack.
7. Describe the structure and function of the blood vessels which comprise the human transport system.

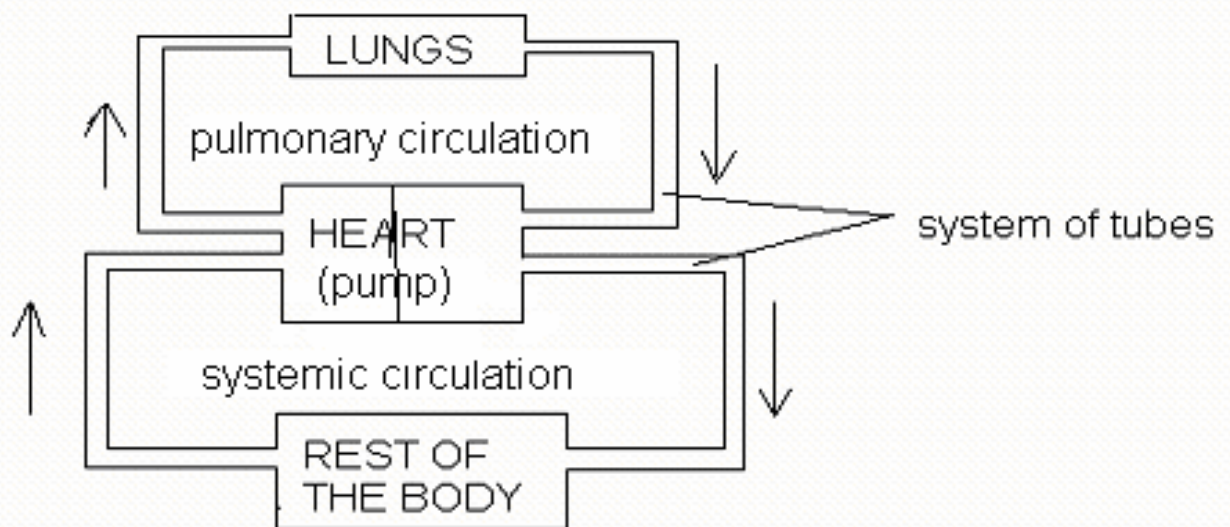
### Importance of a transport system

The complex structure of the human body requires that a transport system be in place to take materials to the cells where they are needed as well as to remove wastes from them.

### General plan of the human circulatory system

The human circulatory system consists of a **pump**, a **system of tubes** and **valves**. The pump is the heart and it provides the force to push blood all over the body. The system of tubes is the blood vessels and they include the arteries, arterioles, veins, venules and capillaries. **The valves are located in the heart and in the veins and they are important to prevent back- flow of blood ensuring that blood flows continuously in one direction.**

Generally, blood flows from the heart to the lungs, back to the heart and then to the rest of the body.

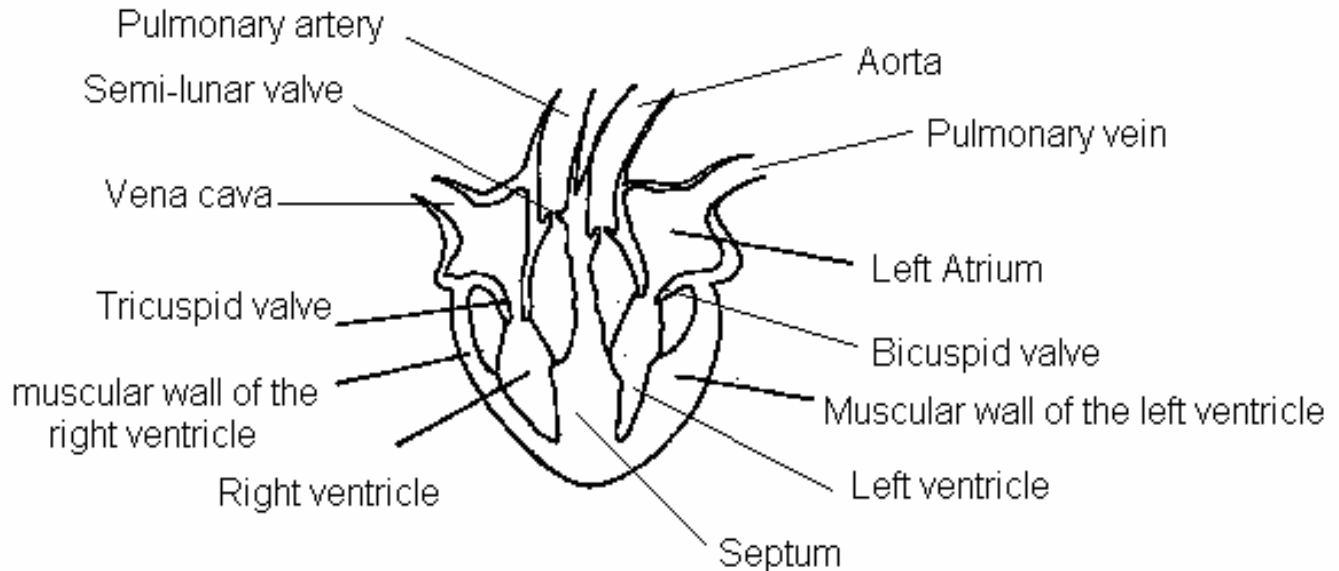


**Note: The arrows show the direction of flow of blood.**

### The double circulatory system

As can be seen from the diagram above, blood passes through the heart twice in every complete circulation. This is called double circulation. Humans therefore have what is called a double circulatory system. Blood flow between the heart and the lungs is called **pulmonary circulation** and blood flow between the heart and the rest of the body is called **systemic circulation**.

### Structure and function of the human heart



Note the following points about the heart:

- the heart is separated into a left side and a right side by the **septum**
- blood on the left side of the heart is **oxygenated blood** (coming from the lungs which supplied it with oxygen)
- blood on the right side of the heart is **deoxygenated blood** (coming from the rest of the body where the oxygen was used up)

**Note:** *oxygenated blood – blood with a high concentration of oxygen and low concentration of carbon dioxide*

*de-oxygenated blood – blood with a low concentration of oxygen and high concentration of carbon dioxide*

- there are four chambers – two atria (singular: atrium) and two ventricles
- each atrium is separated from its corresponding ventricle by a valve
- the valve between the left atrium and the left ventricle is the **bicuspid valve**
- the valve between the right atrium and the right ventricle is the **tricuspid valve**
- there are four blood vessels connected to the heart – two of them take blood into the heart and two take blood out of the heart
- the **vena cava** takes deoxygenated blood from the rest of the body to the right side of the heart
- the **pulmonary vein** takes oxygenated blood from the lungs to the left side of the heart
- the **aorta** takes oxygenated blood from the left side of the heart to the rest of the body

- the **pulmonary artery** takes deoxygenated blood from the right side of the heart to the lungs
- there are two valves that direct the flow of blood out of the heart
- the **left semi-lunar valve** is located between the left ventricle and the aorta
- the **right semi-lunar valve** is located between the right ventricle and the pulmonary artery
- the muscles of the left ventricle are thicker than the muscles of the right ventricle

**Reason:** *The blood from the left ventricle must be pumped all over the body so it needs a greater pumping force to do so. The thicker muscles of the left ventricle provide this greater pumping force for the blood to be sent all over the body. The right ventricle on the other hand pumps blood to the lungs. This does not require as great a force as that required for blood to be sent all over the body.*

### **Effects of exercise on the heart beat**

The sounds felt or heard by the heart results from the closure of the valves in the heart. The first heart sound (lub) results from the closure of the tricuspid and the bicuspid valves after blood passes from the atria into the ventricles. The second heart sound (dub) results from the closure of both semi-lunar valves after blood passes from the ventricles to the vessels which take blood out of the heart (pulmonary artery on the right side and the aorta on the left side).

Exercises and other physical activities cause blood to flow faster through the heart and around the body. This is because more oxygen and food nutrients need to be supplied to the muscles to sustain the body's activities. As a result, there is an increase in the heart beat rate. The pulse rate also increases because the pulse rate is a measure of the heart beat rate. The normal heart beat rate at rest is 72 beats per minute. This however may double with exercise depending on how strenuous the exercise is.

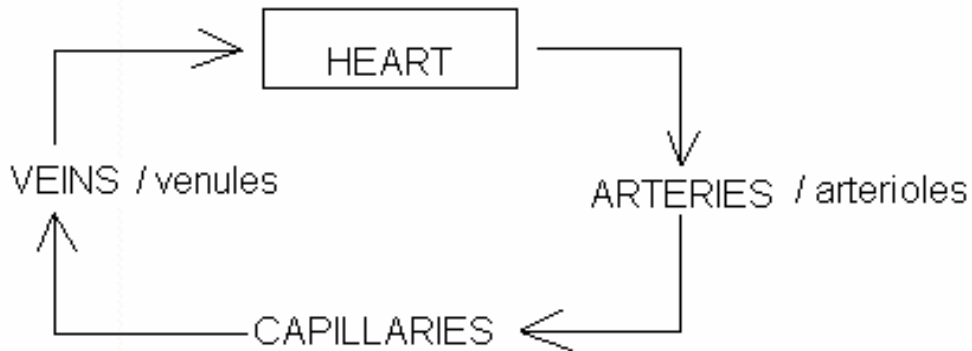
### **Heart attack**

The blood vessels that supply the heart muscles with blood are called the **coronary arteries**. If there is a blockage in any of these arteries, caused either by the build up of fatty substances (cholesterol) or by a blood clot, then the part of the heart served by these vessels will be deprived of oxygen and will stop contracting. The result is a severe pain in the chest called a heart attack. If only a small area of the heart is affected, the person may recover, but if a large part is involved, the attack may be fatal.

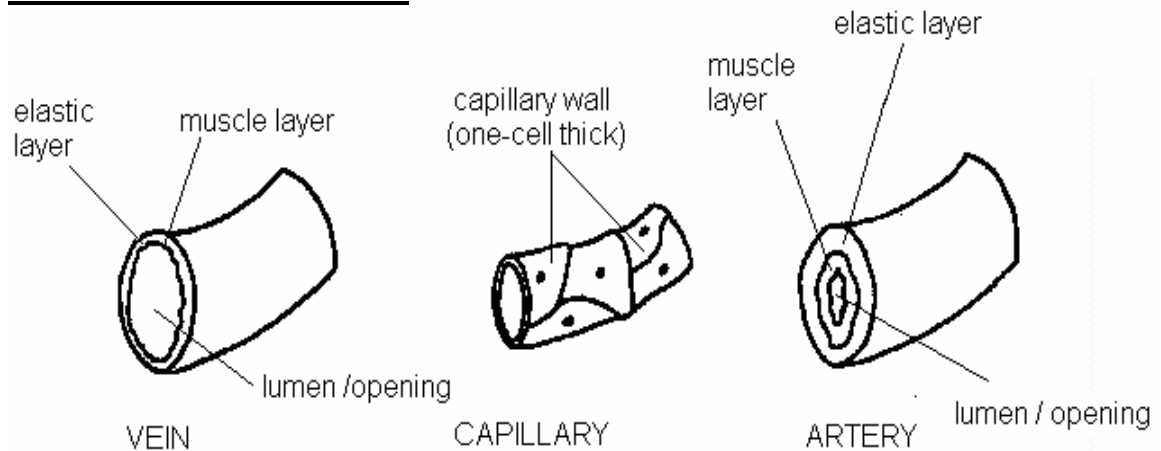
The main causes of heart attack are **poor diet** (too much fatty food or cholesterol in the diet), **smoking** (nicotine in cigarette smoke raises the blood pressure and increases the amount of fatty substance in the blood) and **stress** (tensions of modern life). Stress increases the blood pressure (hypertension). *Hypertension is called the silent killer because a person does not normally show any sign of the condition.* Hypertension puts extra strain on the heart leading to heart failure and heart attack. The walls of the arteries may also burst, spilling blood and forming a blood clot. Heart attack can be prevented by eating a well balanced diet, avoid smoking, exercise regularly and avoiding stressful situations.

### Blood vessels

There are three main kinds of blood vessels in the human body. They are **arteries**, **veins** and **capillaries**. The main artery in the body is called the **aorta**. All other arteries are branches from the aorta. Arteries branch into smaller arteries called arterioles. The main vein in the body is called the **vena cava**. All other veins are branches from the vena cava. Veins branch into smaller veins called venules. Capillaries are the smallest type of blood vessels in the body and they form a connecting link between the arterial system and the venous system. The following diagram shows how the three main kinds of blood vessels are connected in the human body.



### Structure of the blood vessels



### Function of the blood vessels

Arteries – all arteries (except the pulmonary artery) carries oxygenated blood from the heart to the rest of the body.

Veins – all veins (except the pulmonary vein) transports deoxygenated blood from the rest of the body to the heart.

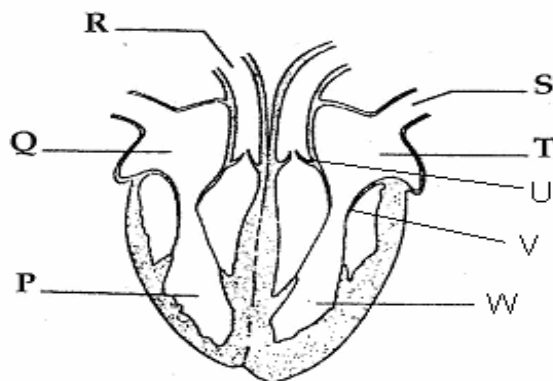
Capillaries – the function of the capillaries are to allow for the exchange of materials between the blood and the cells in the tissues.

**Comparison of arteries, veins and capillaries**

ARTERIES	VEINS	CAPILLARIES
carry blood away from the heart	carry blood to the heart	allow for the exchange of materials between the blood and the tissues
have thick elastic walls	have thin elastic walls	have walls one-cell thick (non-elastic)
have thick muscular walls	have thin muscular walls	have no muscles in its walls
carry blood under high pressure	carry blood under low pressure	blood flows at sufficient pressure to allow materials to be forced out into the surrounding tissues
have no valves	have valves to prevent the backflow of blood	have no valves
blood flows through in pulses	blood flows through smoothly	blood flows relatively slowly to allow for exchanges (food, oxygen and wastes).

**Assignment**

1. The diagram shows a longitudinal section of the human heart.



- Name the parts of the heart labeled with the letters Q, R and T. (3)
- Explain why the heart may be described as a “double pump”.(2)
- What happens to U and V when P and W contract? (2)
- Use the appropriate letters on the diagram to show the flow of blood from the right ventricle to the right lung and to the left ventricle.(3)
- (i) State the last chamber of the heart through which oxygenated blood passes.(1)  
(ii) Through which blood vessel is blood rich in oxygen distributed to other parts of the body? (1)
- Describe and explain the difference in oxygen concentration in the pulmonary artery and pulmonary vein. (2)
- Explain how a high blood cholesterol level could affect the function of the heart.(2)
- Describe how smoking can affect a person’s heart. (2)
- The blood vessels R and S transport blood rich in carbon dioxide and oxygen respectively. In what way are these two blood vessels exceptions to the general rule of circulation in blood vessels? (2)

