Two Pathways

• **Pulmonary Circulation**
  – Carries blood to lungs and back

• **Systemic Circulation**
  – Carries blood to body and back
The 3 main parts of the circulatory system

1. The Heart

2. The blood vessels

3. Blood
HEART

- The heart is actually **two separate pumps**.
- The left side pumps blood to the body (systemic circulation)
- The right side pumps blood to the lungs (pulmonary circulation)
The Structures of the Heart

- **Superior Vena Cava**: Large vein that brings oxygen-poor blood from the upper part of the body to the right atrium.
- **Pulmonary Veins**: Bring oxygen-rich blood from each of the lungs to the left atrium.
- **Pulmonary Valve**: Prevents blood from flowing back into the right ventricle after it has entered the pulmonary artery.
- **Tricuspid Valve**: Prevents blood from flowing back into the right atrium after it has entered the right ventricle.
- **Inferior Vena Cava**: Vein that brings oxygen-poor blood from the lower part of the body to the right atrium.
- **Right Atrium**: Receives blood from the right atrium and pumps it to the right ventricle.
- **Right Ventricle**: Pumps blood to the lungs via the pulmonary arteries.
- **Aorta**: Brings oxygen-rich blood from the left ventricle to the rest of the body.
- **Pulmonary Arteries**: Bring oxygen-poor blood to the lungs.
- **Left Atrium**: Receives oxygen-rich blood from the pulmonary veins and pumps it to the left ventricle.
- **Aortic Valve**: Prevents blood from flowing back into the left ventricle after it has entered the aorta.
- **Mitral Valve**: Prevents blood from flowing back into the left atrium after it has entered the left ventricle.
- **Left Ventricle**: Pumps oxygen-rich blood to the body via the aorta.
- **Septum**: Divides the heart into right and left sides.
The 3 main parts of the circulatory system

1. The Heart

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Types of blood vessels

1. Arteries
   - Carry blood away from the heart
   - The Aorta is the largest artery

2. Veins
   - Carry blood away from the heart
   - Veins contain valves
   - The vena cava is the largest veins

3. Capillaries
   - Known as the ‘Distribution Pipes’
Arteries: carries blood away from heart

- Large
- Thick-walled, Muscular
- Elastic
- Oxygenated blood
  - Exception Pulmonary Artery
- Carried under great pressure
- Steady pulsating

Arterioles: smaller vessels, enter tissue
Artery vs. Vein

Fox, Stuart I.
Human Physiology 4th
Brown Publishers
Veins

The diameter of veins is greater than that of arteries. The blood pressure in the veins is low so valves in veins help prevent backflow.

The contraction of skeletal muscle squeezes the veins and assists with moving blood back to the heart.

The vena cava returns blood to the right atrium of the heart from the body. In the right atrium, the blood pressure is close to 0.

*Varicose veins* develop when the valves weaken. Veins act as blood reservoirs because they contain 50% to 60% of the blood volume.

Smooth muscle in the walls of veins can expand or contract to adjust the flow volume returning to the heart and make more blood available when needed.
Veins:
Carries blood to heart

- Carries blood that contains waste and CO$_2$
  - Exception pulmonary vein
- Blood not under much pressure
- **Valves** to prevent much gravity pull

Venules: larger than capillaries
Capillaries

- Smallest vessel
- Microscopic
- Walls one cell thick
- Nutrients and gases diffuse here
Blood vessels expand during exercise to meet the increased demand for blood and to cool the body. Blood vessels contract after an injury to reduce bleeding and also to conserve body heat.
The 3 main parts of the circulatory system

1. The Heart
2. The blood vessels
3. Blood
The composition of blood

1. The plasma (Fluid) – makes up 55% of the blood volume

2. The solids (cells) – makes up 45% of the blood volume

**Blood Plasma (fluid)**
- 97% water
- other 3% (antibodies and protein & nutrients and wastes)

**Blood Solid (cells)**
- Red Blood Cells – Carry O2 and contain hemoglobin
- White Blood Cells – Attack bacteria & other invaders
- Platelets – Control the blood clothing process
Blood is made up of a number of types of cells:

**Plasma**: Plasma is a straw-coloured fluid in which blood cells are suspended. It is made up of approximately 90% water as well as electrolytes such as sodium and potassium and proteins.

**Red Blood Cells** *(Erythrocytes)*: The main function of red blood cells is to carry oxygen. RBC's contain a protein called Haemoglobin. This combines with oxygen to form Oxyhaemoglobin. Each RBC has a lifespan of approximately 120 days before it gets broken down by the spleen. New RBC's are manufactured in the bone marrow of most bones. There are approximately 4.5-5 million RBC's per micro-litre of blood.

**White Blood Cells** *(Leucocytes)*: There a number of types of white blood cells, although the function of all of them is to help fight disease and infection. They typically have a lifespan of a few days and there are only 5-10 thousand WBC's per micro-litre of blood.

**Platelets** *(Thrombocytes)*: Platelets are disc shaped cell fragments which are involved in clotting the blood to prevent the excess loss of body fluids.
Erythrocytes (RBC)

- Transporters of
  - Oxygen
  - Carbon Dioxide
- RBC
  - Lack a nucleus
  - Contain hemoglobin
  - Disk-shaped
- RBC are produced in red bone marrow of
  - ribs,
  - humerus,
  - femur,
  - sternum, and other long bones
- Lives for 120 days
- Old RBC are destroyed in liver and spleen
Leukocytes (WBC)

- WBC fight infection
  - Attack foreign substances
- Less abundant
- Large cells
- Some live for months
  - Most just a few days
- Several types
- ALL contain nuclei
Platelets

- PLATELETS are for CLOTTING blood
- Cell fragments
- Produced in bone marrow
- Short life span (1 week)
- Fibrin (sticky network of protein fibers)
  - Form a web trapping blood cells
The Blood

- Body contains 4-6 L
- Consists of
  - Water
  - Red Blood Cells
  - Plasma
  - White blood cells and platelets
Blood Clotting

**Break in Capillary Wall**
Blood vessels injured.

**Clumping of Platelets**
Platelets clump at the site and release thromboplastin. Thromboplastin converts prothrombin into thrombin.

**Clot Forms**
Thrombin converts fibrinogen into fibrin, which causes a clot. The clot prevents further loss of blood.
1. Transportation:
The blood carries other substances around the body inside arteries, veins and capillaries. These include gasses (Oxygen and Carbon Dioxide), waste products (water, urea), hormones, enzymes and nutrients (glucose, amino acids, vitamins and minerals). The blood flows through the circulatory system.

2. Maintaining Homeostasis:
Altering the blood flow to the skin can help to reduce body temperature. Transportation of enzymes which are used to maintain our internal environments.

3. Immunity and defense:
White blood cells fight infection and platelets help repair damage and clot the blood.
What is the circulatory system?

- transports food, hormones, metabolic wastes, and gases (oxygen, carbon dioxide) to and from cells.

Components of the circulatory system include:

**BLOOD**: consisting of liquid plasma and cells

**BLOOD VESSELS** (vascular system): the "channels" (arteries, veins, capillaries) which carry blood to/from all tissues.

  - **Arteries** carry blood away from the heart.
  - **Veins** return blood to the heart.
  - **Capillaries** are thin-walled blood vessels in which gas/nutrient/waste exchange occurs.

**HEART**: a muscular pump to move the blood
Respiratory system via Circulatory system

The arteries, veins, and capillaries are divided into two systems of circulation: **systemic** and **pulmonary**.

The systemic circulation **carries oxygenated blood from the heart** to all the tissues in the body except the lungs and **returns deoxygenated blood carrying waste products**, such as carbon dioxide, back to the heart.

The pulmonary circulation carries this **spent blood from the heart to the lungs**.

In the lungs, the blood releases its carbon dioxide and absorbs oxygen. The oxygenated blood then returns to the heart before transferring to the systemic circulation.
Blood Pressure

• Blood against the blood vessel’s walls
  – The systolic pressure refers to
    • the pressure recorded while the ventricles pump the blood.
  – The diastolic pressure refers to
    • the pressure recorded as the ventricles fill with blood.

• A normal blood pressure is 120/80
The circulatory system also transports nutrients derived from digested food to the body.

Nutrients enter the bloodstream by passing through the walls of the intestine - absorbed through a network of capillaries and veins that drain the intestines, called the hepatic portal circulation.

The hepatic portal circulation carries the nutrients to the liver for further metabolic processing.

The liver also cleans the blood by removing waste products and toxins.
What happens when you mix blood types?

- Plasma contains proteins that correspond to the shape of the different antigens
- If you mix one type with the wrong one, you get CLUMPING
- Type O is the universal donor
- Type AB is the universal acceptor