Circulation and Blood
IMPOSTER!
Primary Function

1. Carry **nutrients** to cells
2. Carry **waste** away from cells
3. Transport **dissolved gasses**
4. Transport **chemical messages** (hormones)
5. Regulate **temperature**
6. Highway for cells of the **immune system**

~96 000 km of blood vessels in your body!
Relationship to other Organ systems

- **Digestive System** – absorption of nutrients & transport to cells

- **Respiratory System** – gas exchange at the lungs and transport to/from cells
Blood

- A 70 kg person has ~ 5L of blood.

- Blood is a "fluid" tissue (individual cells working together for a common purpose).
Centrifuge

- A machine that uses centrifugal force to separate components in a liquid with different densities
The Components of Blood

1. Plasma
2. Red Blood Cells (Erythrocytes)
3. White Blood Cells (Leukocytes)
4. Platelets
Plasma

- Plasma = fluid medium which transports the following around the body:
  - Solid components
  - Dissolved gasses
  - Nutrients
  - Wastes
  - Hormones
Red Blood Cells (Erythrocytes)

- Transport oxygen
- No nucleus (more room for hemoglobin)
- Contain **hemoglobin**:  
  - Iron-containing protein with a high-affinity for oxygen

2 million – 3 million Erythrocytes are produced each second! (developed in the bone marrow)
White Blood Cells (Leukocytes)

- <1% of total blood cells
- Several types of WBC’s, all of which serve a specific role in the immune system
- Some WBC’s engulf invaders → release enzymes that digest invader and WBC
- **Pus**: remains of dead WBCs and invaders
Platelets

- Initiates blood clotting reaction (coagulation)
- Rupture when they hit a sharp edge (i.e. torn blood vessel)
Blood Vessels
Take your pulse

- How would you expect your pulse to change after a few minutes of exercise?

- How might the resting pulse of an athlete differ from that of a non-athlete?
Take your pulse

Radial artery

Carotid artery

Calculate # heartbeats/min
Fauja Singh – First 100 year old to run a full marathon!
Arteries

- Carry blood **away** from the heart
- Have **thick walls** - needed to withstand the **high blood pressure**

- **Pulse** = change in diameter of arteries following heart contraction
Capillaries

- One cell thick (ideal for diffusion)
- Site of **gas/fluid exchange**
  - Deliver O$_2$/nutrients to body cells
  - Picks up CO$_2$/wastes
- Easily ruptured → bruising
Capillaries Have Close Contact with Tissue Cells
ALL Tissues are Surrounded by Capillaries
Figure 9.13. The exchange of material between the circulatory system and the fluid surrounding the individual cells of the body takes place across the wall of the capillaries. The direction of diffusion of each material is a product of its concentration gradient. Nutrients diffuse out of the blood, while carbon dioxide and other waste materials diffuse in.
Veins

- Thinner walls than arteries, less muscle and connective tissue
  - Lower pressure
Why did these guards faint?
Venules/Veins – Returning Blood to Heart

Solution
1. One-Way Valves
   - ONLY veins have them!
   - Prevent low pressure blood from flowing backwards

2. Contracting muscles
   - Example: the muscles of the leg help force blood through the valves in a step-wise fashion
<table>
<thead>
<tr>
<th>Arteries</th>
<th>Veins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport blood <strong>AWAY</strong> from the heart</td>
<td>Transport blood <strong>TOWARDS</strong> the heart</td>
</tr>
<tr>
<td>Thick</td>
<td>Thin</td>
</tr>
<tr>
<td>Muscular</td>
<td>Less muscle</td>
</tr>
<tr>
<td>Do not have one-way valves</td>
<td>Have one-way valves</td>
</tr>
</tbody>
</table>
The Pulmonary and Systemic Circuits
Heart Circuits

- The pathway of vessels carrying blood to and from the **lungs** compromises the **pulmonary circulatory system**
- The pathway of vessels carrying blood to and from the **body** compromises the **systemic circulatory system**
Systemic Pulmonary Systemic
The Mammalian Heart
The beat goes on!

- A beating heart is essential for supplying oxygen to all parts of the body.
- Within a few minutes of the heart stopping, the lack of oxygen in the brain will lead to brain damage and death.
- **100,000** heart beats per day!!
Structure of the Heart

- Heart consist of **two pumps**
- Pumps are separated by the **septum**
- **Septum** = a wall of muscle that separates the right heart pump from the left
Structure of the Heart

Right ‘Pump’

Left ‘Pump’

Septum
Heart Chambers

- **Atrium** = a thin-walled chamber of the heart that receives blood from the veins

- **Ventricle** = a muscular, thick walled chamber of the heart that delivers blood to the arteries
Heart Pumps - Chambers

- Each pump contains **two** chambers:
  - an **atrium**
  - and a **ventricle**
- Heart has **four** chambers total
- *Blood flows from atrium → ventricle*
Heart Pumps

Left Pump

- Receives *oxygenated* blood from the lungs and pumps it to the body tissues
  - Systemic

Right Pump

- Receives *deoxygenated* blood from the body tissues and pumps it to the lungs
  - Pulmonary
Heart Pumps

Arteries

Superior vena cava
From Body
(upper extremities)

To Body

Pulmonary Artery
To Lungs
(for Re-oxygenation)

Pulmonary veins
From Lungs
(Freshly Oxygenated)

Inferior vena cava
From Body
(lower extremities)

Recall:
• Arteries carry blood away from heart
• Veins carry blood to heart

Oxygen-poor

Oxygen-rich
Heart Valves: One Way Flow

- Semilunar Valves
- Atrioventricular Valves
Summary of Heart Structure

- Superior Vena Cava
- Right Atrium
- Semilunar Valve
- Atrioventricular Valve
- Right Ventricle
- Inferior Vena Cava

Arteries
- Aorta
- Pulmonary artery
- Pulmonary vein

Left Atrium
- Atrioventricular Valve
- Left Ventricle
- Septum
Heart Beat – *lubb-dubb*

- Lub sound = Atrioventricular valves shutting
- Dub sound = Semilunar valves shutting
Artificial Pacemaker

- a medical device that uses electrical impulses, delivered by electrodes contacting the heart muscles, to regulate the beating of the heart.
Artificial Heart