Circulatory and Respiratory Systems

Chapter 37: Biology II
The Circulatory System

• Larger organisms cannot rely on diffusion to move oxygen, nutrients and wastes through cells
The Circulatory System

- **Closed circulatory system:** found in humans and other vertebrates

- Circulating fluid (blood) is pumped through a system of vessels

- **Human circulatory system:** heart, blood vessels, and the blood that flows through them
The Circulatory System... The Heart
Pericardium

- Protective sac of tissue that encloses the heart
Myocardium

• Thick middle muscle layer of the heart

• Pumps blood through the circulatory system
Septum

• A wall that separates the right and left side of the heart; prevents the mixing of oxygen rich and oxygen poor blood

• Humans have a 4 chambered heart: 2 atria, 2 ventricles
Atrium

- Large muscular upper chamber of the heart that **receives** and holds blood that is about to enter the ventricle

- Plural: atria
Ventricle

- Thick-walled lower chamber of the heart that **pumps blood out** of the heart
Pulmonary Circulation

• Pathway in which the right side of the heart pumps deoxygenated blood to the lungs
Systemic Circulation

- Pathway in which the left side of the heart pumps oxygenated blood to all of the body except the lungs
Valve

- Flap of connective tissue between an atrium and a ventricle, or in a vein, that prevents the backflow of blood
The Heart: Blood Flow

- Right atrium \(\rightarrow\) right ventricle \(\rightarrow\) pulmonary artery \(\rightarrow\) lungs \(\rightarrow\) pulmonary vein \(\rightarrow\) left atrium \(\rightarrow\) left ventricle \(\rightarrow\) aorta \(\rightarrow\) body \(\rightarrow\) superior/inferior vena cava
Pacemaker

• Small group of cardiac muscle cells in the right atrium that “set the pace” for the heart as a whole

• Also known as the sinoatrial node
Blood Vessels
Artery

• Large blood vessel that carries blood from the heart to the tissues of the body

• Artery = away
Capillary

- Smallest blood vessel
- Brings nutrients and oxygen to the tissues and absorbs carbon dioxide and waste products
Vein

- A blood vessel that returns blood to the heart
Disorders of the Circulatory System
High Blood Pressure/Hypertension

- Forces the heart to work harder
- May weaken or damage the heart muscle and blood vessels
- Increases the risk of heart attack and stroke
Heart Attack

- Atherosclerosis/blocking of the coronary arteries by deposits of fatty substances, cholesterol, cellular waste, etc.

- **Symptoms:** nausea, shortness of breath, severe, crushing chest pain
Stroke

- Blood clots form as a result of atherosclerosis may break free and get stuck in one of the blood vessels leading to a part of the brain.

- Brain cells served by that blood vessel may die from lack of oxygen.
Stroke

• Brain function may be lost

• Can also occur when a weakened artery in the brain bursts, flooding the area with blood

• May result in: paralysis, loss of the ability to speak, even death
Prevention

- Exercise
- Weight control
- Sensible diet
- No smoking
Blood Plasma

- Straw-colored fluid that makes up about 55% of blood
Blood Plasma

- 90% water
- 10% dissolved gases, salts, nutrients, enzymes, hormones, waste products, and plasma proteins
Red Blood Cells

- **RBC/Erythrocytes**: the most numerous cells in the blood
- Made in the bone marrow
- Never divide
- Live about 3 months
- Removed by the liver and spleen
Red Blood Cells

- Transport oxygen
- Red color is from hemoglobin
- **Hemoglobin**: iron-containing protein in red blood cells that transports oxygen from the lungs to the tissues of the body
RBC Disorder: Sickle Cell Anemia

- Abnormal hemoglobin causes the cells to develop a sickle, or crescent, shape
- Cells are stiff and sticky
- Tend to block blood flow in the blood vessels of the limbs and organs
- Oxygen cannot get through and episodes can cause pain, serious infections, and organ damage
RBC Disorder: Sickle Cell Anemia

- Recessive genetic disorder
  - 1 in 600 African-American infants
  - 1 in 12 African-Americans are carriers of the condition

- RBC count is low because sickle cells die after only about 10 to 20 days.

- Bone marrow can't make new red blood cells fast enough to replace the dying ones.
Malaria

- A disease caused by a parasitic protozoan that invades RBCs
- Sickled cells kill the parasite
- The individual’s normal RBCs can deliver oxygen
- Heterozygous individuals (sickle cell trait) have a better survival rate in areas plagued by malaria
- Malaria is most often seen in Africa and in the Mediterranean area of Europe.
White Blood Cells

- **WBC/Leukocytes**: much less abundant than RBC
White Blood Cells

• Attack foreign substances or organisms

• Do not contain hemoglobin

• **Phagocyte**: white blood cell that engulfs and digests foreign cells
# Types of WBCs

<table>
<thead>
<tr>
<th>Type</th>
<th>Microscopic Appearance</th>
<th>Diagram</th>
<th>Approx. % in adults</th>
<th>Diameter (μm)</th>
<th>Main targets</th>
<th>Nucleus</th>
<th>Granules</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrophil</td>
<td><img src="Image" alt="Neutrophil Image" /></td>
<td><img src="Image" alt="Neutrophil Diagram" /></td>
<td>62%</td>
<td>10–12</td>
<td>- bacteria&lt;br&gt;- fungi</td>
<td>multilobed</td>
<td>fine, faintly pink (H&amp;E Stain)</td>
<td>6 hours–few days (days in spleen and other tissue)</td>
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<tr>
<td>Eosinophil</td>
<td><img src="Image" alt="Eosinophil Image" /></td>
<td><img src="Image" alt="Eosinophil Diagram" /></td>
<td>2.3%</td>
<td>10–12</td>
<td>- larger parasites&lt;br&gt;- modulate allergic inflammatory responses</td>
<td>bi-lobed</td>
<td>full of pink-orange (H&amp;E Stain)</td>
<td>8–12 days (circulate for 4–5 hours)</td>
</tr>
<tr>
<td>Basophil</td>
<td><img src="Image" alt="Basophil Image" /></td>
<td><img src="Image" alt="Basophil Diagram" /></td>
<td>0.4%</td>
<td>12–15</td>
<td>- release histamine for inflammatory responses</td>
<td>bi-lobed or multi-lobed</td>
<td>large blue</td>
<td>a few hours to a few days</td>
</tr>
<tr>
<td>Lymphocyte</td>
<td><img src="Image" alt="Lymphocyte Image" /></td>
<td><img src="Image" alt="Lymphocyte Diagram" /></td>
<td>30%</td>
<td>Small lymphocytes 7–8 Large lymphocytes 12–15</td>
<td>- B cells: releases antibodies and assists activation of T cells&lt;br&gt;- T cells:&lt;br&gt;  - CD4+ Th (T helper) cells: activate and regulate T and B cells&lt;br&gt;  - CD8+ cytotoxic T cells: virus-infected and tumor cells.&lt;br&gt;- γδ T cells: bridge between innate and adaptive immune responses; phagocytosis&lt;br&gt;- Regulatory (suppressor) T cells: Return the functioning of the immune system to normal operation after infection; prevents autoimmunity&lt;br&gt;- Natural killer cells: virus-infected and tumor cells.</td>
<td>deeply staining, eccentric</td>
<td>NK-cells and Cytotoxic (CD8+) T-cells</td>
<td>years for memory cells, weeks for all else</td>
</tr>
<tr>
<td>Monocyte</td>
<td><img src="Image" alt="Monocyte Image" /></td>
<td><img src="Image" alt="Monocyte Diagram" /></td>
<td>5.3%</td>
<td>7.72–9.99</td>
<td>Monocytes migrate from the bloodstream to other tissues and differentiate into tissue resident macrophages, Kupffer cells in the liver.</td>
<td>kidney shaped</td>
<td></td>
<td>hours to days</td>
</tr>
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Platelets and Blood Clotting

- Blood clotting is made possible by plasma proteins and cell fragments called platelets.

- **Platelet**: cell fragment released by bone marrow.
The Lymphatic System

- **Lymph**: the fluid lost by the blood into surrounding tissue

- **The lymphatic system**: a network of vessels that collects the fluid that is lost by blood and returns it to the circulatory system

- Plays a role in nutrient absorption
Respiration

• (A) Release of energy from the breakdown of molecules in food in the presence of oxygen

• (B) The process by which oxygen and carbon dioxide are exchanged between cells, the blood, and air in the lungs
The Respiratory System

• Exchange of oxygen and carbon dioxide

• Air → nose and mouth →

• **Pharynx**: muscular tube at the end of the throat that serves as a passageway for air and food →
The Respiratory System

- **Trachea**: windpipe; tube through which air moves; epiglottis covers the entrance when you swallow food →

- **Larynx**: at the top of the trachea; contains the vocal cords →
The Respiratory System

- **Bronchi**: passageways leading from the trachea to the lungs → Bronchioles →

- **Alveoli**: tiny air sacs at the end of the bronchioles in the lungs that provide SA for gas exchange to occur → LUNGS
Breathing

- The movement of air into and out of the lungs

- **Diaphragm**: large, flat muscle at the bottom of the chest cavity

- Contracts during breathing, pulling the bottom of the chest cavity down and increasing its volume
Tobacco and the Respiratory System

• The upper part of the respiratory system is generally able to filter out dust and foreign particles that could damage the lungs

• Tobacco use damages and eventually destroys this protective system
Tobacco and the Respiratory System

- Tobacco contains 3 dangerous substances:
  - Nicotine
  - Carbon monoxide
  - Tar
Tobacco and the Respiratory System

• **Nicotine**: stimulant drug in tobacco that increases heart rate and blood pressure

• **Tar**: contains a number of compounds that have been shown to cause cancer

• Smoking can cause such respiratory diseases as chronic bronchitis, emphysema, and lung cancer