Chapter 23: Circulation

Guided Reading Activities

Big idea: Circulatory systems

Answer the following questions as you read modules 23.1–23.2:

1. In most animals, the circulatory system fulfills what three functions? 
   The three functions are acquisition of nutrients, exchange of gases, and disposal of waste products.

2. Complete the Venn diagram that compares an open circulatory system to a closed circulatory system.

3. Complete the following table, which compares and describes the different blood vessels.

<table>
<thead>
<tr>
<th>Description</th>
<th>Arteries</th>
<th>Arterioles</th>
<th>Veins</th>
<th>Venules</th>
<th>Capillaries</th>
<th>Capillary beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carries blood away from the heart</td>
<td>Smaller arteries that turn into capillaries</td>
<td>Carry blood to the heart</td>
<td>Small veins that are the links between capillaries and larger veins</td>
<td>Pass blood between the arteries and veins</td>
<td>Extensive networks of capillaries that facilitate gas and nutrient exchange</td>
<td></td>
</tr>
</tbody>
</table>
4. The development of a(n) four-chambered heart was a critical adaptation for organisms with high metabolic needs.

5. A new terrestrial tetrapod is discovered. Upon a detailed examination of its anatomy, it is discovered that the animal has a three-chambered heart. List the types of organisms it could not be. 
   It could not be a mammal.

6. Humans have what type of circulation?
   Humans have double circulation.

**Big idea: The human cardiovascular system and heart**

Answer the following questions as you read modules 23.3–23.6:

1. Which of the following vessels and structures carry oxygen-rich blood?
   a. Aorta
   b. Pulmonary vein
   c. Left atrium
   d. All of the above carry oxygen-rich blood.

2. True or false: The pulmonary artery is part of the systemic circuit. If false, make it a correct statement.
   True

3. A common misconception regarding arteries is that they always carry oxygen-rich blood. Briefly explain why this is not accurate. Your answer should include specific vessels.
   This is not accurate because the pulmonary arteries carry oxygen-poor blood to the lungs.

4. The rhythmic contraction and relaxation of the heart is known as the cardiac cycle.

5. List the stages of the cardiac cycle in order.
   - The heart is relaxed.
   - The atria contract.
   - The ventricles contract.

6. During strenuous exercise, your cardiac output increases. Which component of the cardiac output changes?
   Your heart rate changes, increasing due to exercise.

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7. True or false: The human heart beats on its own without input from the brain. If false, make it a correct statement.
   True

8. List the stages of the electrical impulse as it begins during a heartbeat.
   SA node—AV node—specialized muscle fibers—up through the walls of the ventricles

9. A person has a medical condition that results in the Purkinje fibers (the muscle fibers in step 3 of Figure 23.5A on page 472 of your textbook) being unable to relay the electrical impulse efficiently to the apex of the heart. What effect does this have on contraction?
   The atria would be able to contract, but the ventricles would not. This would effectively disrupt the beating of your heart.

10. A blockage in a coronary artery leads to a(n) myocardial infarction, also known as a(n) heart attack.

11. When a blockage occurs in a coronary artery, it cuts off oxygenated blood flow to the cells of the heart serviced by that artery. Briefly explain why those specific cells die. In other words, what is it about the loss of oxygenated blood flow that is causing them to die? (Hint: Think back to Chapter 6.)
   Those cells will die because they will be unable to make ATP through aerobic cellular respiration.

**Big idea: Structure and function of blood vessels**

Answer the following questions as you read modules 23.7–23.11:

1. What features do veins have that allow them to perform their specialized function?
   Veins have thinner walls than arteries do because the veins carry blood under low pressure and velocity.

2. Place the following in order of blood passing from the aorta back to the heart through the inferior vena cava: arteriole, vein, artery, venule, and capillary.
   Artery, arteriole, capillary, venule, and vein

3. Which of the following diffuse into and out of capillaries?
   a. CO₂/wastes
   b. Glucose/nutrients
   c. O₂
   d. All of the above
4. The force of the blood against your blood vessels is known as blood pressure.

5. The velocity of blood flow is very low in capillaries. Propose an explanation for why the velocity is so low at this point.
   The drop in blood pressure is due primarily to friction of the blood with the blood vessels.

6. List two mechanisms your body has for returning blood to your heart.
   One-way valves and skeletal muscle contractions

7. A person has her blood pressure taken at a doctor’s office and her reading is 137/75 mm Hg. Briefly explain that reading and where the numbers come from.
   That is a healthy blood pressure. The top number is the systolic pressure and is equal to the pressure at which blood first spurts through the artery after the cuff is inflated. The bottom number is the diastolic number and is equal to the pressure in the artery at which you can no longer hear the blood pulsing.

8. Briefly explain how hypertension aggravates atherosclerosis.
   Hypertension causes little ruptures in the arterial wall, which can lead to plaque buildup.

9. A person has a disorder in which his precapillary sphincters leading to the capillary beds under his skin are nonfunctional. What is the likely result of this disorder?
   This would likely lead to excessive flushing of the skin.

10. True or false: Only capillaries and venules can exchange materials with the surrounding interstitial fluid that bathes cells. If false, make it a correct statement.
    False, only capillaries can exchange materials with the surrounding tissues.

11. How does the structure of the capillary allow it to perform its function?
    It is very smooth, which allows for the easy passage of red blood cells. A capillary is also only a single epithelial cell layer thick, which allows for the diffusion of substances across it.

12. Complete the following table, which describes the two forces that work upon the fluid entering and leaving a capillary.

<table>
<thead>
<tr>
<th></th>
<th>Blood pressure</th>
<th>Osmotic pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cause of pressure</strong></td>
<td>Created by the beating of the heart</td>
<td>Created by concentration gradients of certain soluble substances</td>
</tr>
<tr>
<td><strong>Direction of pressure</strong></td>
<td>Outward from the blood vessel</td>
<td>Inward to the blood vessel</td>
</tr>
<tr>
<td><strong>Strength of pressure</strong></td>
<td>Relatively strong</td>
<td>Weaker than the blood pressure</td>
</tr>
</tbody>
</table>
Big idea: Fermentation: Structure and function of blood

Answer the following questions as you read modules 23.12–23.15:

1. A common misconception about blood is that it is entirely red blood cells (erythrocytes). Briefly explain how this could not be further from the case. Blood is a mixture of formed elements (red blood cells, platelets, and white blood cells) and plasma (water, ions, gases, proteins, and hormones).

2. Complete the following table, which compares and describes the different components of blood.

<table>
<thead>
<tr>
<th>Percentage contribution to blood</th>
<th>Plasma</th>
<th>Cellular elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, ions, gases, hormones, nutrients, wastes, and various proteins</td>
<td>Erythrocytes, leukocytes, and platelets</td>
<td></td>
</tr>
<tr>
<td>Osmotic balance, pH buffering, maintaining ion concentration, and clotting</td>
<td>Transport of O$_2$ and some CO$_2$, clotting, and defense</td>
<td></td>
</tr>
</tbody>
</table>

3. A vampire gets blood from a local blood bank, but he does not like leukocytes in the blood. He asks that the blood bank remove all of them from the blood he gets. Which of the following cells would the blood bank keep in his blood?

   a. Neutrophils
   b. Erythrocytes
   c. Monocytes
   d. Eosinophils

4. A condition characterized by low numbers of erythrocytes is known as __anemia__.

5. An athlete injects himself with EPO in order to increase his oxygen-carrying capacity. Would this increase or decrease his blood pressure? Briefly explain your answer. It would increase his blood pressure because there are now more cells in the blood, which makes blood more viscous.
6. A person has a condition that causes overproduction of fibrin and platelets that are beyond the normal level of “sticky.” What would be the likely result in this person? Your answer should include what this person might do medically as a treatment.
The person would be prone to getting blood clots. Such a person might be prescribed anticoagulants.

7. List the three basic steps in blood clot formation.
Platelets adhere to the damaged area, platelets form a plug at the wound site, and fibrin adds to the strength of the clot.

8. True or false: Stem cells divide through mitosis; one daughter cell undergoes specialization to become various blood cells, and the other cell remains a stem cell. If false, make it a correct statement.
True

9. A common misconception regarding leukemia comes from not knowing what cells are actually cancerous. People usually realize that it is a blood cancer. Specifically, what is leukemia cancer of?
Leukemia is cancer of the white blood cells.

CONNECTING THE BIG IDEAS

Use your knowledge of the information contained within this chapter’s “Big Ideas” to answer this question.

What is the significance of atherosclerosis in the carotid arteries (the major arteries that serve the head region)?