Vertebrate cardiovascular systems reflect evolution

- Figure 1: Single circulation, two-chambered heart
- Figure 2: Double circulation, three-chambered heart
- Figure 3: Double circulation, four-chambered heart
The human cardiovascular system

Diagram 1: Blood flow through the double circulation of the human cardiovascular system

The human cardiovascular system (cont.)

Figure 6: Blood flow through the human heart

The heart contracts and relaxes rhythmically

Diagram 2: A cardiac cycle in a human with a heart rate of about 72 beats per minute
The pacemaker sets the tempo of the heartbeat

Figure 7: An artificial pacemaker implanted in the chest

What is a heart attack?

Figure 8: Blockage of a coronary artery, resulting in a heart attack

What is a heart attack? (cont.)

Figure 9: Atherosclerosis: a normal artery (left) and an artery partially closed by plaque (right)
The structure of blood vessels fits their functions

Figure 10: Diffusion between blood and tissue cells

The structure of blood vessels fits their functions (cont.)

Figure 11: Structural relationships of blood vessels

Figure 12: Blood pressure and velocity in the blood vessels
Measuring blood pressure can reveal cardiovascular problems

Smooth muscle controls the distribution of blood

Capillaries allow the transfer of substances through their walls
Blood consists of red and white blood cells suspended in plasma

**Figure 14: The composition of blood**

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Major Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Derived by osmosis</td>
</tr>
<tr>
<td>Proteins</td>
<td>Derived from cells</td>
</tr>
<tr>
<td>Plasma proteins</td>
<td>Derived from cells</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enzymes</td>
<td>E. coli</td>
</tr>
<tr>
<td>Lactobacilli</td>
<td>Lactic acid</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Defense</td>
</tr>
</tbody>
</table>

Too few or too many red blood cells can be unhealthy

**Figure 15: Human red blood cells**

Blood clots plug leaks when blood vessels are injured

**Diagram 5: The blood-clotting process**

1. Platelets adhere to exposed connective tissue
2. Platelet plug forms
3. Fibrin clot traps blood cells
Stem cells offer a potential cure for blood cell diseases

Figure 16: Differentiation of blood cells from stem cells