The Cardiovascular System –
Blood Vessels, Blood Pressure and Pulse

Session Objectives.

What you will cover
• Structure and function of blood vessels
• Haemodynamics
• Blood pressure

Your objectives are
• Identify blood vessels by their structures
• Name the different types of capillaries and give their functions
• Describe the structure and function of a capillary bed
• Explain the function of anastomoses
• Identify factors affecting blood flow
• Define blood pressure as a product of cardiac output and total peripheral resistance
• Explain why blood pressure fluctuates in arteries
• Explain the blood pressure changes across the circulatory system
• Describe factors that influence blood pressure
• Explain how to take blood pressure
• Explain how to take a pulse
• State normal ranges for blood pressure and pulse rates
• State abnormal ranges for blood pressure and pulse rates

Suggested reading:
Tortora & Grabowski, 10TH Edition, Principles of Anatomy and Physiology, Ch 21
Marieb 6th Edition. Human Anatomy and Physiology, Ch 20;
Gould 2ND Edition, Pathophysiology for Healthcare Professionals Ch18
The central cavity of a blood vessel is called the _______________.
Reduction of the diameter of this cavity is called _________________.
If the internal diameter of blood vessels increases, this is called _______________.
Blood is carried to the heart by _________ and away from the heart by _________.
Capillary beds are supplied by smaller versions of the blood vessels called ____________ and are drained by _____________.

<table>
<thead>
<tr>
<th>Venules</th>
<th>lumen</th>
<th>arterioles</th>
<th>vasodilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arteries</td>
<td>veins</td>
<td>vasoconstriction</td>
<td></td>
</tr>
</tbody>
</table>
Capillary Beds
These are formed from single arterioles. The arterioles subdivide into capillaries.

Task
What is the function of pre-capillary sphincters?

What is a metarteriole?

What is an anastomosis?

What is the function of anastomoses?

Veins, valves and venous return.
Infolds of the tunica interna of veins form valves that stick out into the lumen of the vein. These curl in the direction of the blood flow. Many veins pass through muscles, or between muscles and bones. This is shown in the diagram on the right.

Task
What is the effect of muscular contraction on the return of blood to the heart [venous return]?

Other than muscular pumps, what other organ system can assist with venous return?
Haemodynamics
This is the correct term for the study of blood flow and pressures in the circulatory system.

Pressure and fluid flow
All fluids, when put into a confined space, like a tube or a balloon, exert pressure against the wall of the container. When blood is confined in blood vessels and the chambers of the heart, it exerts blood pressure on the cardiovascular system.

To get flow, you need to have pressure differences or gradients. In the circulatory system, the heart generates high pressures. There is a decreasing pressure gradient towards the capillaries. Blood can therefore flow to the capillaries.

Resistance to fluid flow
This is a measure of how easy it is for a fluid to flow through a tube. In the circulatory system it is called vascular resistance or total peripheral resistance.

Task
The following factors affect total peripheral resistance. Describe what their effects are.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube/blood vessel radius</td>
<td></td>
</tr>
<tr>
<td>Tube/blood vessel length</td>
<td></td>
</tr>
<tr>
<td>Fluid/blood viscosity</td>
<td></td>
</tr>
</tbody>
</table>
Blood pressure.
The figure below illustrates what happens to systemic blood pressure across the circulatory system. Peak blood pressure in the aorta is approximately 120 mm Hg [millimetres of mercury].

<table>
<thead>
<tr>
<th>Blood Pressure [mm Hg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

| Aorta | arteries | capillaries | veins | Vena Cava |

Task
Why does the blood pressure fluctuate in the arterial part of the circulatory system?

Which blood vessels [and it isn’t arteries] see the biggest drop in blood pressure [think !].

Blood pressure can be defined as follows...

\[
BP = \text{Cardiac Output} \times \text{Total Peripheral Resistance}
\]

\[
BP = CO \times TPR
\]

You will find out later that cardiac output can vary with heart rate and stroke volume. This means that these factors can influence blood pressure. Blood pressure maintenance is therefore an excellent example of a homeostatic control mechanism.
**Task**
List as many factors as you can that influence blood pressure

**Measurement of blood pressure.**
This can be done using a manual sphygmomanometer. You will measure your own blood pressures using a digital sphygmomanometer. They operate on similar principles. Traditionally they detect the systolic and diastolic blood pressures of the brachial artery.

To write your blood pressure out, you record the systolic pressure over the diastolic pressure, so that it looks like a fraction e.g. 120/80 mm Hg. This means that the systolic blood pressure was 120 mm Hg and the diastolic was 80 mm Hg.

**Task**
Find the *ranges* of blood pressures for the normotensive state, and mild, moderate and severe hypertension.

<table>
<thead>
<tr>
<th>Normotensive</th>
<th>Mild Hypertension</th>
<th>Moderate Hypertension</th>
<th>Severe Hypertension</th>
</tr>
</thead>
</table>

**Task**
What effects do the following biochemicals have on blood pressure?

<table>
<thead>
<tr>
<th>Biochemical</th>
<th>Source</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline (epinephrine)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrial Natriuretic Peptide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angiotensin II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-diuretic hormone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endothelin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitric Oxide</td>
<td></td>
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</tbody>
</table>
Pulse
This is a consequence of blood pressure pressing against the elastic walls of arteries.

Task
Identify 7 pulse points.
1. 2. 3.
4. 5. 6. 7.

Suggested further reading/note preparation.
Blood vessel structure and function
Capillary bed structure and function
Blood pressure influences and control