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Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

• Content: A clear outline of the content covered by the delivery guide;
• Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
• Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resourcesfeedback@ocr.org.uk

KEY

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Click to view external resources

AS Level only

AS Level content only
### 2.2.2 Transport systems in mammals

| (a) | the importance of the closed double circulatory system | To include reference to blood pressure in systemic and pulmonary systems. |
| (b) | (i) the structure and functions of arteries, arterioles, capillaries, venules and veins | HSW4, HSW5, HSW6 |
| (b) | (ii) transverse sections of arteries, veins and capillaries as observed using a light Microscope | Prepared slides or photomicrographs may be examined to show the structural differences between these vessels. |
| (c) | the formation and importance of tissue fluid | To include references to HP (hydrostatic pressure) and OP (oncotic pressure or colloidal osmotic pressure). |
| (d) | (i) the use of a sphygmomanometer to measure systolic and diastolic blood pressure | To include reference to both manual and electronic measuring. |
| (d) | (ii) comparisons of blood pressure readings | HSW3, HSW4, HSW5, HSW6 |
| (e) | the interpretation of systolic and diastolic blood pressure measurements | To include hypertension and hypotension and their possible consequences. |
As with the study of 2.2.1 The heart and monitoring heart function, no study of the mammalian heart or circulatory system would be complete without considering the work of William Harvey and his description of how blood circulated around the body which revolutionised how scientists viewed the role of the heart.

Both websites 1 and 2 provide good background information on the works of Harvey with regard to the circulatory system:

1. BBC website – Historical figures
   [http://www.bbc.co.uk/history/historic_figures/harvey_william.shtml](http://www.bbc.co.uk/history/historic_figures/harvey_william.shtml)

2. Physiology on line – William Harvey and blood circulation
   [http://physiologyonline.physiology.org/content/17/5/175](http://physiologyonline.physiology.org/content/17/5/175)

   "It has been shown by reason and experiment that blood by the beat of the ventricles flows through the lungs and heart and is pumped to the whole body. There it passes through pores in the flesh into the veins through which it returns from the periphery everywhere to the centre, from the smaller veins into the larger ones, finally coming to the vena cava and right atrium."

   William Harvey - extract from ‘De motu cordis’

3. ncbi Biomed central - Quotes from William Harvey
   [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2776239/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2776239/)

   Quotes from translated text from “Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus”, commonly referred to as “de Motu Cordis” was published in Latin at Frankfurt in 1628.

Having considered the need for a transport system in the last topic, students will now consider the importance of the closed, double circulatory system found in mammals. Encouraging students to compare the mammalian system with that of other animals creates the opportunity for discussion and debate as to how circulatory systems may have developed.

Examination of prepared slides and photomicrographs will enable students to gain knowledge of the key features of blood vessels and then relate this to their function within the circulatory system. Their role in the formation of tissue fluid is also considered at this stage and linked to the pressures within the system that aid its formation.

- To include references to HP (hydrostatic pressure) and OP (oncotic or colloidal osmotic pressure)
Once the concept of pressure within the circulatory system has been introduced, students can undertake practical activities to take measurements of systolic and diastolic blood pressures using both manual and electronic methods. The topic then lends itself to the use of case study materials to give students the opportunity to develop their skills of interpretation when comparing blood pressure readings.

- To include hypertension and hypotension and their possible consequences

As with the study of electrocardiograms in the previous unit (2.2.1), studying the concept of blood pressure in context promotes interest and encourages discussion as to the use of such procedures in medical diagnoses.

**Blood pressure UK – case studies and context**
http://www.bloodpressureuk.org/BloodPressureandyou/Thebasics

There is also the opportunity for enhancing evaluation when considering the methods for measuring blood pressure.
Thinking Conceptually

There are many early drawings of dissected mammals to show the circulatory system and background research into the ideas presented by Aristotle and William Harvey (see websites already listed), together with a look at the anatomical drawings of Leonardo da Vinci, are good ways to instigate discussion and interest in this topic.\(^1,2,3\) There is also a considerable overlap with 2.2.1 which can be revisited to assist understanding.

A thorough approach to microscope work, including the use of ready prepared slides and photomicrographs, will aid student understanding of how the structure of blood vessels relates to their function within the circulatory system. Arterioles and venules are often overlooked and a brief comparison of these vessels is also recommended to ensure that students can pick out similarities and differences of these smaller vessels. The role of smooth muscle and elastic tissue within blood vessel walls is commonly misunderstood and this can be addressed to some extent by encouraging students to annotate their own drawings from observed microscope slides. Links with heart action in 2.2.1 will also enable students to fully grasp the concepts surrounding the pressure changes throughout the circulatory system.

Confidence in comparing and interpreting blood pressure readings can be gained by providing students with case study examples and the only misunderstanding commonly seen is when students confuse pulse rate measurement (2.2.1 g) with blood pressure measurement (2.2.2 d). An evaluation of methods including the advantages/disadvantages of manual or electronic measuring may support students in the need to distinguish between these procedures.

Many of the contextual approaches (see below) can also be very effectively introduced in a more concept-driven first lesson if desired. For example students could take a theory-first route to Learner Activity 1 by commenting on the pros and cons of open and closed, single and double circulatory systems when they know the definitions but before they have seen the diagrams. Subsequent access to the diagrams should allow students to refine their understanding and improve the content, coherence and technical terminology of their responses.

The three websites are good for promoting interest into the anatomical works of the artist Leonardo da Vinci with regards to the heart and circulatory system.

\(^1\) BBC website - Leonardo da Vinci drawings
http://www.bbc.co.uk/science/leonardo/gallery/heart.shtml

\(^2\) Netplaces website - anatomical drawings of Leonardo da Vinci

\(^3\) Science in schools website – portrays the anatomical drawings and links with Science. Also suggests how to demonstrate the pumping action of a real heart.
http://www.scienceinschool.org/2013/issue27/hearts
ACTIVITIES

There are a number of interactive activities available for promoting interest and enhancing understanding of the concepts in this unit.

To aid understanding of the importance of a double circulatory system it is beneficial for students to compare the circulation in mammals with that found in other animals (Learner Activity 1).

Observing prepared slides under a microscope, comparing with photomicrographs of blood vessels available (Learner Activity 2) and then using modelling to represent blood vessels allow students to acquire and apply knowledge to aid explanation of how the structure of blood vessels is related to function. Both activities are also aimed at addressing some of the misconceptions that occur when students are studying blood vessel.

Electronic blood pressure monitors are now commonly available in schools and these can be compared with the use of sphygmomanometers for measuring systolic and diastolic pressures. Scenarios and case studies are a good way of ensuring that students have a firm grasp of this concept and are able to interpret data (Learner Activity 3).
## Thinking Contextually

<table>
<thead>
<tr>
<th>Activities</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learner Activity 1</strong>&lt;br&gt;<strong>Open or closed? Single or double?</strong>&lt;br&gt;In this activity, students are encouraged to consider a variety of circulatory systems that exist within the animal kingdom. Prior to the activity, teachers can gather as many images of different circulatory systems and label accordingly (see Learner Resource 1 for examples). 1) Images of different types of circulation are given to students i.e. open, closed, single and double. Students compare them and discuss similarities and differences and then advantages and disadvantages of each. Discussion of the importance of the closed, double circulation in humans should also be encouraged at this stage. 2) Consolidation activity can then be to ensure that students can recognise types of systems using resource cards – names of animals can be removed.</td>
<td>Learner Resource 1</td>
</tr>
<tr>
<td><strong>Learner Activity 2</strong>&lt;br&gt;<strong>Observing blood vessels</strong>&lt;br&gt;In this activity, students can observe prepared slides of arteries, veins and capillaries under the light microscope and then compare with photomicrographs and diagrammatical representations. It is also a good activity for students to assess size of blood vessels and to consolidate the terms 'transverse' and 'longitudinal' when applied to viewing sections of tissue. Learner Resource 2 extends the work to look at functional aspects and encourages students to evaluate a model for measuring blood flow through vessels. 1) Whilst viewing slides, students should have access to labelled photomicrographs and diagrams to enable consolidation of knowledge and for students to have a clear understanding of what they are observing. 2) Students can use resources available to draw their own images, label and annotate to show structure and function of each vessel. 3) In particular note structures such as: lumen, (smooth) endothelium, area containing smooth muscle and elastic fibres and how these structures relate to function. 4) Complete tasks on Learner Resource 2. Capillary/rubber tubing can be offered to students when they are attempting to evaluate the model.</td>
<td>Learner Resource 2</td>
</tr>
</tbody>
</table>
### Activities

Good websites for providing students with information for their annotation of blood vessels:

1. **Bodypartchart.com website — arteries, veins and capillaries**

2. **Southern Illinois University website — image of stained micrograph of blood vessels**
   - [http://www.siumed.edu/~dking2/crr/CR020b.htm](http://www.siumed.edu/~dking2/crr/CR020b.htm)

3. **University of the Cumberlands website — Blood vessel structure**
   - [www.ucumberlands.edu/academics/biology/faculty/kuss/courses/CirculatorySystem/ArteriesVeins.htm](http://www.ucumberlands.edu/academics/biology/faculty/kuss/courses/CirculatorySystem/ArteriesVeins.htm)

### Learner Activity 3

**Blood Pressure Case Studies**

This activity can be used to support understanding and interpretation of blood pressure readings. It is best offered to students after they have had the opportunity to take measurements of blood pressure and understand the terms systolic and diastolic.

1. Students work in pairs or small groups.
2. Each group is given one of the case studies (Learner Resource 3) and asked to study the information and then to give a presentation to the class about what they can interpret from the information.
3. There are three case studies to consider and it does not matter if two groups have the same case study as different groups of students may approach this differently.
4. It is important to stress to students that the case studies do not involve real people but offer representations.
Learner Resource 1: Open or closed? Double or single?

Open System

Closed System

Fish

Gills

Dorsal Aortae

Reptile

Carotid arteries

Pulmonary arteries

Mammal

Aortic arches

1 2 3 4 5 6
Learner Resource 1  Open or closed? Double or single?

Snake

- snake
- right aorta
- pulmonary artery
- right atrium
- left aorta
- left atrium
- right ventricle
- left ventricle

Frog
Learner Resource 1

Open or closed? Double or single?

Earthworm

Fresh water fish

Dog

Bird
Relation between blood flow velocity and total cross-section area in human vessels

<table>
<thead>
<tr>
<th>Type of blood vessels</th>
<th>Total cross-section area (cm$^2$)</th>
<th>Mean velocity of blood flow (cms$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta</td>
<td>3–5 cm$^2$</td>
<td>40</td>
</tr>
<tr>
<td>Capillaries</td>
<td>4500–6000 cm$^2$</td>
<td>0.03</td>
</tr>
<tr>
<td>Vena cavae inferior and superior</td>
<td>14 cm$^2$</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Circulatory System Capillary Blood Flow

- Oxygenated blood from heart
- Arteriole
- Arterial capillary
- Venous capillary
- Venule
- De-oxygenated blood to heart

See page 10
1. Explain why a) total cross sectional area and b) mean velocity of blood flow are used when comparing blood flow in the different vessels.

2. Describe the trend shown by the results.

3. Describe how tissue fluid is formed as blood flows through capillaries.

4. Explain the importance of having low mean velocity through capillaries.

5. Students set up a model to try to measure blood flow through vessels of differing diameters and they used capillary tubing of different diameters, A, B and C as shown in the diagram below.

Evaluate the model by comparing it to real blood vessels.
Learner Resource 3: Blood Pressure Case Studies

See page 11
Case Study 1

Tony is 49 years old and works in construction. He has visited the GP because he has a recurrent chest infection. The GP makes historical notes and then takes readings of his pulse rate, temperature and blood pressure.

Profile:
• No known previous medical conditions
• Smoker
• Drinks alcohol at weekends
• Pulse Rate: 75bpm
• Temperature 37.5°C
• Blood pressure 145/95 mmHg (Repeat reading: 144/94 mmHg)

Case Study 2

Jaswinder is 29 years old and works as a journalist. She suffered kidney damage when she was a teenager since when her blood pressure has varied between 140 and 146 for systolic and 89 and 95 for diastolic.

Jaswinder was placed on a specialist treatment programme which included recommendation for changes to her diet.

After three months on the specialist programme, Jaswinder’s blood pressure was averaging 129/85.

Case Study 3

Fred is 78 years old. He was taken to hospital by his neighbour who found him sitting at the bottom of the steps to his house. Fred said that he ‘felt light-headed and dizzy’ but he had not hit his head and he had not lost consciousness. Fred also told the doctor that he always felt this way when getting out of bed in the morning and had to ‘sit down for a bit’.

Fred mentioned that he was taking aspirin daily and had type II diabetes. The doctor measured Fred’s blood pressure and found it to be 120/70 mmHg whilst lying down. He then repeated the measurement whilst Fred was sitting up in bed and found it to be 81/65 mmHg.