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AS and A LEVEL

Delivery Guide

BIOLOGY A

H020/H420
For first teaching in 2015

Transport in animals 3.1.2

Version 2

Introduction

AS and A LEVEL
BIOLOGY A

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.

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3.1.2 Transport in animals		
(a)	the need for transport systems in multicellular animals	To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V). *M0.1, M0.3, M0.4, M1.1, M2.1, M4.1* HSW1, HSW3, HSW5, HSW8
(b)	the different types of circulatory systems	To include single, double, open and closed circulatory systems in insects, fish and mammals.
(c)	the structure and functions of arteries, arterioles, capillaries, venules and veins	To include the distribution of different tissues within the vessel walls. **PAG2**
(d)	the formation of tissue fluid from plasma	To include reference to hydrostatic pressure, oncotic pressure and an explanation of the differences in the composition of blood, tissue fluid and lymph. HSW8
(e)	**(i)** the external and internal structure of the mammalian heart **(ii)** the dissection, examination and drawing of the external and internal structure of the mammalian heart	**PAG2** HSW4
(f)	the cardiac cycle	To include the role of the valves and the pressure changes occurring in the heart and associated vessels. HSW2, HSW5, HSW8
(g)	how heart action is initiated and coordinated	To include the roles of the sino-atrial node (SAN), atrio-ventricular node (AVN), purkyne tissue and the myogenic nature of cardiac muscle (no detail of hormonal and nervous control is required at AS level). HSW2, HSW5, HSW8
(h)	the use and interpretation of electrocardiogram (ECG) traces	To include normal and abnormal heart activity e.g. tachycardia, bradycardia, fibrillation and ectopic heartbeat. *M0.1, M1.1, M1.3, M2.4* HSW2, HSW5
(i)	the role of haemoglobin in transporting oxygen and carbon dioxide	To include the reversible binding of oxygen molecules, carbonic anhydrase, haemoglobinic acid, HCO_3^- and the chloride shift. HSW8
(j)	the oxygen dissociation curve for fetal and adult human haemoglobin.	To include the significance of the different affinities for oxygen **AND** the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect). *M3.1* HSW2, HSW8

Activity 1
Circulatory system song
3.1.2 Transport in animals follows on from GCSE content. A good, fun introduction to this topic can be seen with this song;

http://www.youtube.com/watch?v=LqhvmUEdOYY&index=10&list=PL806169ECA3C97794

Activity 2
Effect of size on uptake by diffusion 3.1.2(a)
This links with the structure of the lungs in 3.1.1(a) and diffusion from 2.1.5(d) and it is a good visual teaching resource.

Students will design a creature based on cubes, so any mathematical calculations are straightforward. The creature is then cut out of phenolphthalein stained agar and placed in acid to see how long it takes for that acid to diffuse into the creature. Students can then suggest how active their creature could be based on diffusion alone and how it could be improved. This allows for module 1 skills and **PAG8** to be explored and can link to mathematical skills *M0.3* and *M4.1* if surface area to volume ratio is attempted, however this can be purely visual or used as a differentiation tool.

The basic technique can be found at;

https://pbiol.rsb.org.uk/exchange-of-materials/diffusion/effect-of-size-on-uptake-by-diffusion

Activity 3
The pressure's rising 3.1.2(d)

A large vessel is drawn on the board, or tubes of card (such as empty toilet rolls or kitchen rolls) are given to each student. Students work in pairs, one student has a few cards with numbers representing pressure inside the vessel and the other student has cards representing pressures outside the vessel. The students take it in turns to place their cards in the correct place and work out whether fluid will go into the vessel or out. The tube can be squeezed and pushed out accordingly. Students can also work out the difference in pressure. Ultimately students relate their tubes and values to different blood vessels, blood proteins and blood pressure. An extension could be to add in layers of muscle and students suggest what difference that would have on various pressures which then links with 3.1.2(c).

Learner resource 1 - The pressure's rising cards

Thinking conceptually

Approaches to teaching the content

This topic can be taught from a clinical perspective. This links well with 5.1.5(j) and (k) and is particularly good for 3.1.2(e-h).

The structure of blood vessels (3.1.2c) can be discussed with pictures of atherosclerotic plaques and varicose veins and also the increase in capillary beds with exercise (see the 'How big is the capillary bed?' activity). The clinical aspect can include increased health as well as pathological conditions.

The cardiac cycle (3.1.2f) can be discussed in terms of heart murmurs for valves, angina for the importance of coronary arteries, hole in the heart for the role of the septum and defibrillation for the hearts electrical activity. The cycle could be taught first and then students given various conditions and asked to suggest how these will affect the heart function, or the teaching can be tailored around the conditions. This links well with 3.1.2(h) and the ECG traces can be discussed around various conditions (see the 'Roleplaying ECG traces' activity).

Common misconceptions or difficulties students may have

The emphasis on comparative circulatory systems for 3.1.2(b) links well with 4.2.2 Classification and evolution, but can become jumbled for students if not clearly and visually explained. Aside from dissections (which would support **PAG2**) this can be shown using tools similar to those discussed in the 'Go compare them activity'.

Students often find pressure differences difficult to comprehend for 3.1.2(d) so although they do not need to know values it is a good tool for students to visualise the differences as suggested in the 'How big is the capillary bed?' activity. This can flow well from 3.1.2(c) where the structure/function relationship of the blood vessels should be emphasised and helps students to link the anatomy with the physiology.

The cardiac cycle sequence (3.1.2f) requires a firm understanding of the timing of the events especially when tied in with 3.1.2(g). This can be emphasised by a simple role play in time to the beat of the music being played (see the 'Heartbeat' activity).

Oxygen dissociation curves can be poorly explained as students often focus on haemoglobin binding to oxygen easily at high partial pressure and not binding (much) at low partial pressure. They do not appreciate the importance of oxygen being released easily at low oxygen partial pressures. This vital physiological function is highlighted in the 'Pass the O_2' activity.

Conceptual links to other areas of the specification – useful ways to approach this topic to set students up for topics later in the course

Section 3.1.2 Transport in animals links back to 3.1.1 Exchange surfaces and to the next section 3.1.3 Transport in plants. There are also opportunities to cover practical skills from module 1 such as 1.1.3 Analysis. To enhance synoptic understanding, links between 3.1.2 and other topics can also be highlighted, for example:

- 2.1.2(n) globular proteins
- 2.1.5(d) diffusion
- 4.2.2 Classification and evolution
- 5.1.5(j) and (k) nervous and endocrine systems.

Activities

Learner Activity 1

How big is the capillary bed? 3.1.2(c)

Students have cards representing different parts of the body and match these with cards showing different blood flow rates, as shown in the table below:

Part of the body	Blood Flow ml min^{-1}	
	At Rest	During Strenuous Exercise
Heart	250	750
Kidneys	1,200	600
Skeletal Muscles	1,000	12,500
Skin	400	1,900
Viscera	1,400	600
Brain	750	750
Other	600	400
Total	5,600	17,500

Students can use this activity to suggest which organ has the largest capillary bed(s) and then use their understanding of 3.1.2(c) to explain why.

Learner Activity 2

Roleplaying ECG traces 3.1.2(h) and 1.1.3

Students could take on the roles of patients and student doctors. The student doctors have to interpret the patients ECG trace. The traces can be given out randomly. This not only underlines the relevant aspects of the trace but also emphasises the possible health issues arising from that trace as the student patient should role play some relevant symptoms. A fun trace could be given with a flatline to see which student can role play that symptom!

https://www.dcbiomed.com/proimages/materials/EKG_Introduction/portableEKG_weitere_Informationen.pdf

This website gives a few abnormal ECG's to work with, although students could be encouraged to come up with their own ECG's once they are familiar with a normal ECG.

Thinking contextually

Contexts

3.1.2 Transport in animals can be taught using dissection for 3.1.2(b) and (e) and microscope images for 3.1.2(c). If slides are not available a good website for histology is; http://faculty.une.edu/com/abell/histo/histolab3a.htm.

There are many videos to show the chronology of events for 3.1.2(f) and (g) and this can be followed through with role play, either simple blood movement role play (see the 'Heartbeat' activity) or doctor/patient (see the 'Roleplaying ECG traces' activity).

The differential pressure gradients for formation of tissue fluid can be taught using a mixture of numerical data and visual aids (see 'The pressure's rising' activity) and this method can also be used for oxygen dissociation curves with students constructing their own graph from given data alongside the role play outlined in the 'Pass the O_2' activity. This gives an opportunity to cover mathematical skills *M3.1* and *M3.3*.

Some data can be extrapolated from this website:

http://www.diatronic.co.uk/nds/webpub/myoglobin.htm.

The general theme when teaching 3.1.2 can revolve around clinical data, visuals and traces as illustrated in the 'Doctor, doctor' activity.

Learner Activity 1
Go compare them 3.1.2(b)

Students are given a balloon, some fluid (red coloured water is good), two tubes and sticky tape. Students partially inflate the balloon and put the fluid into the balloon with a tube placed in it. A thick straw could be used as the tube although it may need to be tied to the balloon. Make holes along the side of the tube and then squeeze the balloon to show an open circulatory system. Make sure this is done near a sink otherwise it may get very messy!

Next students make a closed system (and single circulatory system) by bending the tube around and back to the balloon. The second tube can be added for moving into the double circulatory system.

A good website to show the comparative systems is shown below:

https://www.siyavula.com/read/science/grade-10-lifesciences/transport-systems-in-animals/07-transport-systems-in-animals-02

Learner Activity 2
Heartbeat 3.1.2(f) and (g)

Students have red or blue dots on them, representing oxygenated and deoxygenated blood. The lab needs to be set up to represent the chambers of the heart, curtains or A3 sheets of paper could represent the valves and arrows can be used to show which vessel the 'blood' should go through. Students move through the correct parts of the heart in the correct order in time to music ('Heartbeat' by Nick Berry is a good rhythm to follow). If this works well then some students could also have flowing strands of paper and represent the electrical activity. These students start off the cycle and the blood movement must follow the trailing pieces of paper from the 'electrical activity students'.

A good website to show prior to this activity can be seen at:

http://www.youtube.com/watch?v=rguztY8aqpk

This video shows each side in turn and has a good discussion of valves and chambers.

The following link shows good slow motion of the electrical activity of the heart:

http://www.youtube.com/watch?v=IlQXzgesdDg

Learner Activity 3
Pass the O_2 3.1.2(j)

This activity is designed to emphasise the release and uptake of oxygen at various parts of the body and the relevance of this to physiological function.

Students have 8 balls attached to them (oxygen) with double-sided tape. The students represent haemoglobin, either saturated or not. Other students can position themselves around the room and represent various parts of the body. As the haemoglobin reaches the different areas of the body, they must release balls or take on balls. This ties in well with 2.1.2(n) and the role of haemoglobin and can be used to help explain the sigmoidal shape of the oxygen dissociation curve with different speeds of uptake at high partial pressures of oxygen.

Possible parts of the body are;

Placenta
Respiratory muscle
Lungs
Myoglobin in muscle

For some information on the Bohr effect see:

http://www.pathwaymedicine.org/bohr-effecthttp://www.pathwaymedicine.org/bohr-effect

The pressure's rising cards

10mmHg

25mmHg

50mmHg

30mmHg

32mmHg

How big is the capillary bed?

Body parts cards

Heart	Kidneys
Skeletal muscles	Skin
Viscera	Brain

Learner Resource 2

How big is the capillary bed?

Blood flow rates cards

At rest: 250 ml min^{-1} During exercise: 750 ml min^{-1}	At rest: 1200 ml min^{-1} During exercise: 600 ml min^{-1}
At rest: 1000 ml min^{-1} During exercise: 12500 ml min^{-1}	At rest: 400 ml min^{-1} During exercise: 1900 ml min^{-1}
At rest: 1400 ml min^{-1} During exercise: 600 ml min^{-1}	At rest: 750 ml min^{-1} During exercise: 750 ml min^{-1}

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